LAMPIRAN 1

(Tabel Pengujian Kenormalan Data)

- Tabel Pengujian Kenormalan Data Stasiun *Forming* 2A
- Tabel Pengujian Kenormalan Data Stasiun *Forming* 2B
- Tabel Pengujian Kenormalan Data Stasiun *Machining*

Pengujian Kenormalan Data Stasiun *Forming* 2A

Ho : Data mengikuti distribusi normal

Hi : Data tidak mengikuti distribusi normal

Statistik uji : Distribusi normal

α = 1 – tingkat kepercayaan = 0.05

K = 3.3 Log n + 1 = 3.3 Log 40 + 1 = 6.28

$$C = \frac{DataMax - DataMin}{K} = \frac{29.53 - 19.28}{6.28} = 1.63$$

$$\bar{X} = \frac{957.2}{40} = 23.93$$

$$S = \sqrt{\frac{\Sigma\left(xi - \bar{x}\right)^2}{N - 1}} = \sqrt{\frac{367.0602}{39}} = 3.06$$

Keterangan :

K : Jumlah kelas : 9

C : Interval kelas : 1.63

N : Jumlah data : 40

Tabel Pengujian Kenormalan Data Stasiun *Forming* 2A

Kelas	Batas Kelas	Z1	Z2	P(Z1)	P(Z2)	P(Z2)-P(Z1)	oi	ei	oigab	eigab	χ^2
…<19.28	…-19.275	0	-1.521	0	0.0641	0.0641	0	2.5652	7	6.4631	0.0446
19.28-20.90	19.275-20.905	-1.521	-0.988	0.0641	0.1616	0.0974	7	3.8979			
20.91-22.53	20.905-22.535	-0.988	-0.455	0.1616	0.3246	0.1630	7	6.5191	7	6.5191	0.0355
22.54-24.16	22.535-24.165	-0.455	0.076	0.3246	0.5303	0.2057	10	8.2294	10	8.2294	0.38094
24.17-25.79	24.165-25.795	0.076	0.609	0.5303	0.7287	0.1984	4	7.9379	4	7.9379	1.95354
25.80-27.42	25.795-27.425	0.609	1.142	0.7287	0.8733	0.1445	4	5.7814	4	5.7814	0.5489
27.43-29.05	27.425-29.055	1.142	1.674	0.8733	0.9529	0.0797	7	3.1865	8	5.0691	1.69464
29.06-30.68	29.055-30.685	1.674	2.207	0.9529	0.9863	0.0334	1	1.3363			
30.69-…	30.685-…	2.207	0	0.9863	1	0.0137	0	0.54628			
						1	40	40	40	40	4.6581

Contoh perhitungan :

$$Z1 = \frac{BatasBawah - \bar{x}}{s} = \frac{19.275 - 23.93}{3.06} = -1.521$$

$$Z2 = \frac{BatasAtas - \bar{x}}{s} = \frac{20.905 - 23.93}{3.06} = -0.988$$

Ei = [P(Z2) – P(Z1)] x Σ oi = 0.0641 x 40 = 2.5652

Ei gab : Standar penggabungan 5.

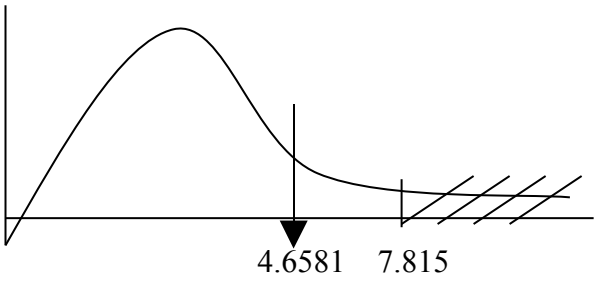
Oi gab : Standar penggabungan ei gab.

$$\chi^2 = \frac{(oi - ei)^2}{ei} = \frac{(7 - 6.4631)^2}{6.4631} = 0.0446$$

$$\chi^2_{hitung} = 4.6581$$

Wilayah kritis : α = 0.05 dan v = k-r-1 = 6-2-1 = 3 maka $\chi^2_{tabel} = 7.815$

Maka $\chi^2_{hitung} < \chi^2_{tabel}$ (4.6581 < 7.815)



Keputusan : Terima Ho

Kesimpulan : Data mengikuti distribusi normal.

Pengujian Kenormalan Data Stasiun *Forming* 2B

Ho : Data mengikuti distribusi normal

Hi : Data tidak mengikuti distribusi normal

Statistik uji : Distribusi normal

α = 1 – tingkat kepercayaan = 0.05

K = 3.3 Log n + 1 = 3.3 Log 40 + 1 = 6.28

$$C = \frac{DataMax - DataMin}{K} = \frac{34.58 - 24.4}{6.28} = 1.62$$

$$\bar{X} = \frac{1183.73}{40} = 29.59$$

$$S = \sqrt{\frac{\Sigma\left(xi - \bar{x}\right)^2}{N - 1}} = \sqrt{\frac{224.0415}{39}} = 2.39$$

Keterangan :

K : Jumlah kelas : 9

C : Interval kelas : 1.62

N : Jumlah data : 40

Tabel Pengujian Kenormalan Data Stasiun *Forming* 2B

Kelas	Batas Kelas	Z1	Z2	P(Z1)	P(Z2)	P(Z2)-P(Z1)	oi	ei	oigab	eigab	χ^2
…<24.4	…-24.395	0	-2.173	0	0.0149	0.0149	0	0.5956	8	8.2786	0.0094
24.4-26.01	24.395-26.015	-2.173	-1.495	0.0149	0.0675	0.0526	4	2.1027			
26.02-27.63	26.015-27.635	-1.495	-0.817	0.0675	0.2070	0.1395	4	5.5803			
27.64-29.25	27.635-29.255	-0.817	-0.140	0.2070	0.4443	0.2374	8	9.4946	8	9.4946	0.23528
29.26-30.87	29.255-30.875	-0.140	0.537	0.4443	0.7044	0.2600	12	10.4015	12	10.4015	0.24567
30.88-32.49	30.875-32.495	0.537	1.215	0.7044	0.8878	0.1835	8	7.3380	12	11.8254	0.00258
32.50-34.11	32.495-34.115	1.215	1.893	0.8878	0.9708	0.0830	3	3.3202			
34.12-35.73	34.115-35.735	1.893	2.571	0.9708	0.9949	0.0241	1	0.9643			
35.74-…	35.735-…	2.571	0	0.9949	1	0.0051	0	0.20281			
						1	40	40	40	40	0.4929

Contoh perhitungan :

$$Z1 = \frac{BatasBawah - \bar{x}}{s} = \frac{24.395 - 29.59}{2.39} = -2.173$$

$$Z2 = \frac{BatasAtas - \bar{x}}{s} = \frac{26.015 - 29.59}{2.39} = -1.495$$

Ei = [P(Z2) – P(Z1)] x Σ oi = 0.0149 x 40 = 0.5956

Ei gab : Standar penggabungan 5.

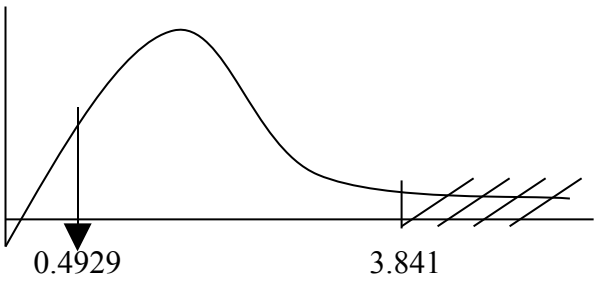
Oi gab : Standar penggabungan ei gab.

$$\chi^2 = \frac{(oi - ei)^2}{ei} = \frac{(8 - 8.2786)^2}{8.2786} = 0.0094$$

$$\chi^2_{hitung} = 0.4929$$

Wilayah kritis : $\alpha = 0.05$ dan v = k-r-1 = 4-2-1 = 1 maka $\chi^2_{tabel} = 3.841$

Maka $\chi^2_{hitung} < \chi^2_{tabel}$ (0.4929 < 3.841)



Keputusan : Terima Ho

Kesimpulan : Data mengikuti distribusi normal.

Pengujian Kenormalan Data Stasiun *Machining*

- **Uji Normal :**

  Ho : Data mengikuti distribusi normal

  Hi : Data tidak mengikuti distribusi normal

  Statistik uji : Distribusi normal

  α = 1 – tingkat kepercayaan = 0.05

  K = 3.3 Log n + 1 = 3.3 Log 40 + 1 = 6.28

  $$C = \frac{DataMax - DataMin}{K} = \frac{32.91 - 26.95}{6.28} = 0.95$$

  $$\bar{X} = \frac{1187.44}{40} = 29.69$$

  $$S = \sqrt{\frac{\Sigma\left(xi - \bar{x}\right)^2}{N - 1}} = \sqrt{\frac{110.89}{39}} = 1.69$$

  Keterangan :

  K : Jumlah kelas : 9

  C : Interval kelas : 0.95

  N : Jumlah data : 40

Tabel Pengujian Kenormalan Data Stasiun *Machining*

Kelas	Batas Kelas	Z1	Z2	P(Z1)	P(Z2)	P(Z2)-P(Z1)	oi	ei	oigab	eigab	χ^2
…<26.95	…-26.945	0	-1.624	0	0.0522	0.0522	0	2.0875	6	5.7647	0.0096
26.95-27.89	26.945-27.895	-1.624	-1.062	0.0522	0.1441	0.0919	6	3.6772			
27.90-28.84	27.895-28.845	-1.062	-0.500	0.1441	0.3085	0.1644	4	6.5768	4	6.5768	1.0096
28.85-29.79	28.845-29.795	-0.500	0.062	0.3085	0.5247	0.2162	9	8.6472	9	8.6472	0.0144
29.80-30.74	29.795-30.745	0.062	0.624	0.5247	0.7337	0.2090	9	8.3587	9	8.3587	0.0492
30.75-31.69	30.745-31.695	0.624	1.186	0.7337	0.8822	0.1485	6	5.9401	12	10.6525	0.17044
31.70-32.64	31.695-32.645	1.186	1.749	0.8822	0.9599	0.0777	1	3.1066			
32.65-33.59	32.645-33.595	1.749	2.311	0.9599	0.9896	0.0297	5	1.1892			
33.60-…	33.595-…	2.311	0	0.9896	1	0.0104	0	0.4167			
						1	40	40	40	40	1.2532

Contoh perhitungan :

$$Z1 = \frac{BatasBawah - \bar{x}}{s} = \frac{26.945 - 29.69}{1.69} = -1.624$$

$$Z2 = \frac{BatasAtas - \bar{x}}{s} = \frac{27.895 - 29.69}{1.69} = -1.062$$

Ei = [P(Z2) – P(Z1)] x Σ oi = 0.0512 x 40 = 2.0494

Ei gab : Standar penggabungan 5.

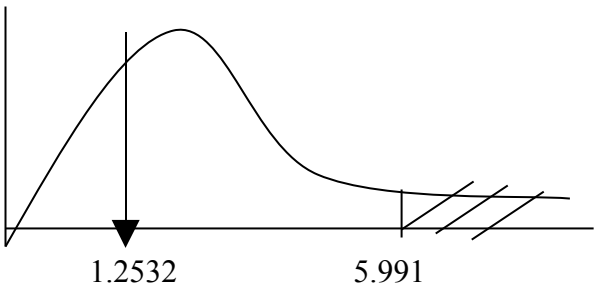
Oi gab : Standar penggabungan ei gab.

$$\chi^2 = \frac{(oi - ei)^2}{ei} = \frac{(6 - 5.7647)^2}{5.7647} = 0.0096$$

$$\chi^2_{hitung} = 1.2532$$

Wilayah kritis : $\alpha = 0.05$ dan v = k-r-1 = 5-2-1 = 2 maka $\chi^2_{tabel} = 5.991$

Maka $\chi^2_{hitung} < \chi^2_{tabel}$ (1.2532 < 5.991)



Keputusan : Terima Ho

Kesimpulan : Data mengikuti distribusi normal.

LAMPIRAN 2

(Tabel Perhitungan Uji Keseragaman Data)

- Tabel Pengujian Keseragaman Data Stasiun *Forming* 2A
- Tabel Pengujian Keseragaman Data Stasiun *Forming* 2B
- Tabel Pengujian Keseragaman Data Stasiun *Machining*

Pengujian Keseragaman Data Stasiun *Forming* 2A

Tabel Pengujian Keseragaman Data Stasiun *Forming* 2A

Sub Grup ke-	Waktu Penyelesaian ke-					$\bar{x}$
	1	2	3	4	5	
1	24.59	27.97	20.43	22.75	22.83	23.71
2	26.03	28.80	19.53	25.37	19.28	23.80
3	25.10	22.41	28.51	25.84	23.48	25.07
4	29.53	23.47	25.39	22.19	21.35	24.39
5	28.67	21.10	22.85	19.57	28.20	24.08
6	27.43	23.28	19.71	21.13	22.32	22.77
7	19.28	20.53	26.44	22.94	22.65	22.37
8	28.19	20.97	27.34	24.60	25.15	25.25
					Total	191.44
					rata-rata	23.93

$$\bar{\bar{x}} = \frac{\Sigma \bar{x}}{k} = \frac{191.44}{8} = 23.93$$

Jumlah Sub grup (k) = 8, maka n (jumlah data tiap sub grup)

$$= \frac{N}{k} = \frac{40}{8} = 5$$

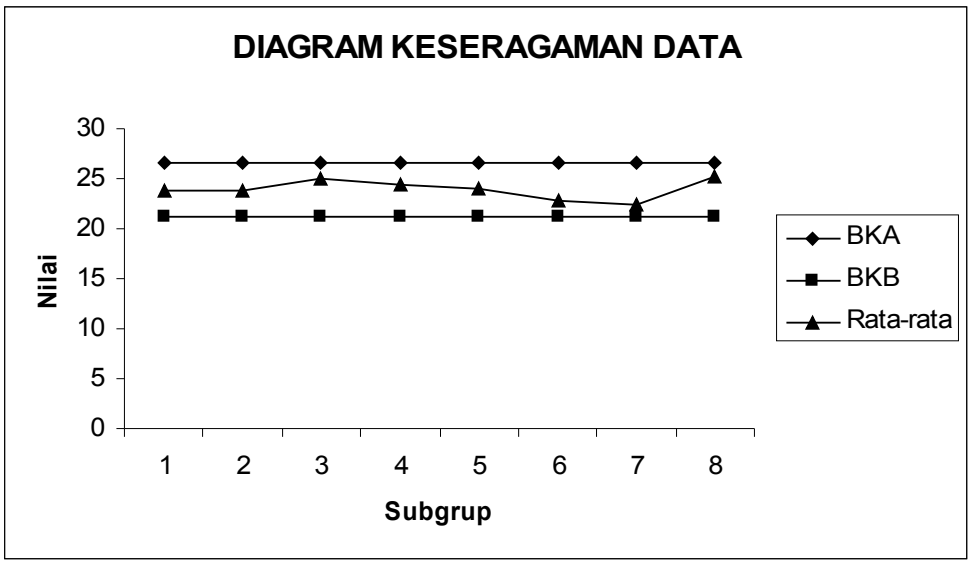
$$\sigma = \sqrt{\frac{\Sigma (xi - \bar{\bar{x}})^2}{N - 1}} = 3.06$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{3.06}{\sqrt{5}} = 1.368$$

BKA = $\bar{\bar{x}} + 2\,\sigma_{\bar{x}} = 23.93 + (2)(1.368) = 26.666$

BKB = $\bar{\bar{x}} - 2\,\sigma_{\bar{x}} = 23.93 - (2)(1.368) = 21.194$

Grafik BKA dan BKB :



Gambar Diagram Keseragaman Data Stasiun *Forming* 2A

Karena semua harga rata – rata waktu penyelesaian berada diantara batas kontrol atas dan batas kontrol bawah, maka semua data telah seragam.

Pengujian Keseragaman Data Stasiun *Forming* 2B

Tabel Pengujian Keseragaman Data Stasiun *Forming* 2B

Sub Grup ke-	Waktu Penyelesaian ke-					$\bar{x}$
	1	2	3	4	5	
1	24.40	27.99	29.46	30.42	32.15	28.88
2	24.67	28.02	29.63	30.54	32.24	29.02
3	25.02	28.18	30.02	31.08	32.67	29.39
4	26.08	29.11	30.18	31.18	33.05	29.92
5	27.34	29.15	30.24	31.46	34.58	30.55
6	27.51	29.18	30.32	31.49	30.59	29.82
7	26.09	29.18	30.25	31.44	32.51	29.89
8	25.66	28.67	29.89	30.21	31.88	29.26
					Total	236.75
					rata-rata	29.59

$$\bar{\bar{x}} = \frac{\Sigma \bar{x}}{k} = \frac{236.75}{8} = 29.59$$

Jumlah Sub grup (k) = 8, maka n (jumlah data tiap sub grup)

$$= \frac{N}{k} = \frac{40}{8} = 5$$

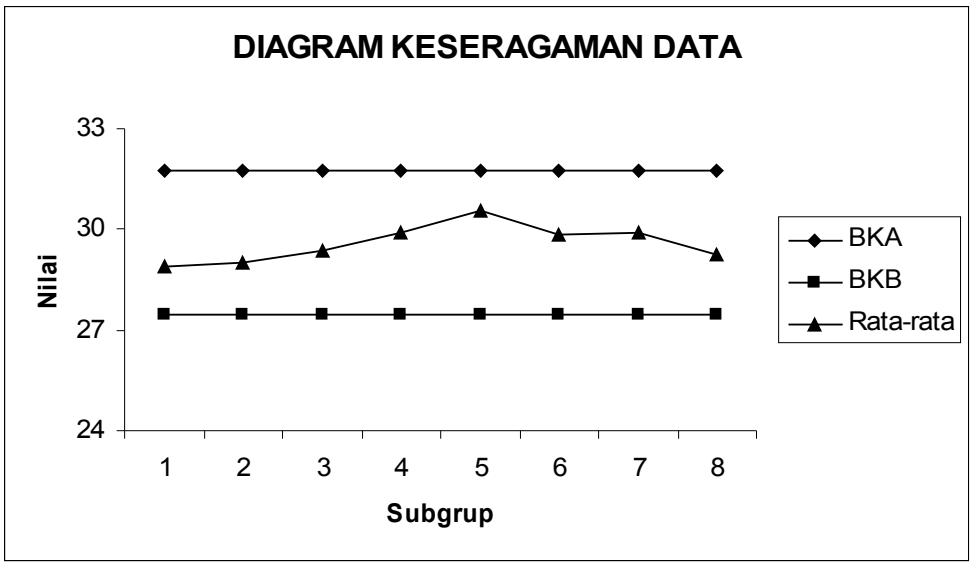
$$\sigma = \sqrt{\frac{\Sigma (xi - \bar{\bar{x}})^2}{N - 1}} = 2.39$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{2.39}{\sqrt{5}} = 1.068$$

BKA = $\bar{\bar{x}} + 2\,\sigma_{\bar{x}}$ = 29.59 + (2)(1.068) = 31.726

BKB = $\bar{\bar{x}} - 2\,\sigma_{\bar{x}}$ = 29.59 – (2)(1.068) = 27.454

Grafik BKA dan BKB :



Gambar Diagram Keseragaman Data Stasiun *Forming* 2B

Karena semua harga rata – rata waktu penyelesaian berada diantara batas kontrol atas dan batas kontrol bawah, maka semua data telah seragam.

Pengujian Keseragaman Data Stasiun *Machining*

Tabel Pengujian Keseragaman Data Stasiun *Machining*

Sub Grup ke-	Waktu Penyelesaian ke-					$\bar{x}$
	1	2	3	4	5	
1	27.93	32.66	29.94	28.89	29.92	29.87
2	29.65	27.79	32.78	28.77	27.93	29.38
3	28.85	27.81	29.85	30.85	26.95	28.86
4	30.88	28.63	28.90	31.72	28.93	29.81
5	32.79	29.88	26.95	30.82	29.89	30.07
6	29.87	28.98	29.88	32.88	28.97	30.12
7	28.88	30.78	26.99	32.91	30.89	30.09
8	29.85	29.87	26.98	30.87	28.88	29.29
					Total	237.49
					rata-rata	29.69

$$\bar{\bar{x}} = \frac{\Sigma \bar{x}}{k} = \frac{237.49}{8} = 29.69$$

Jumlah Sub grup (k) = 8, maka n (jumlah data tiap sub grup)

$$= \frac{N}{k} = \frac{40}{8} = 5$$

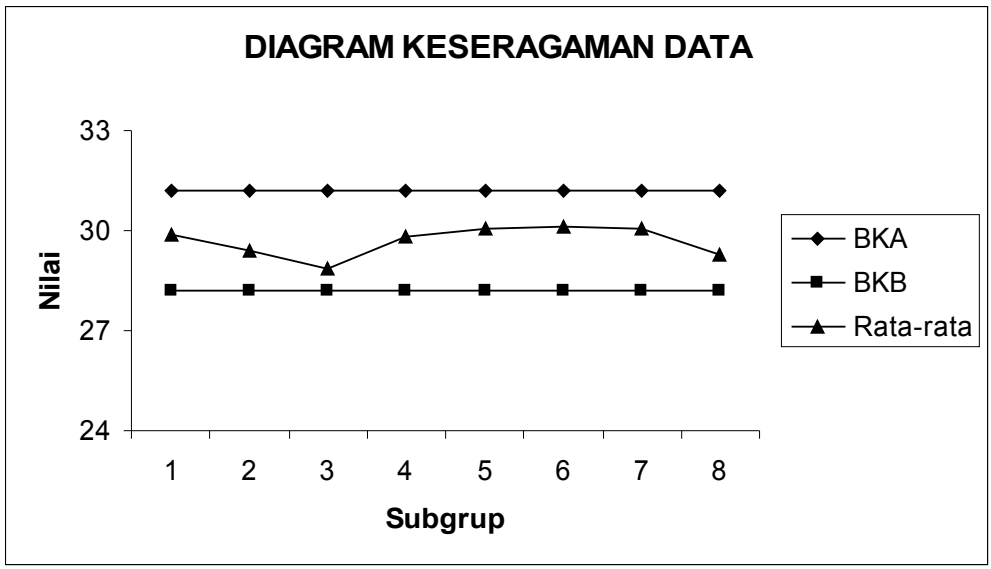
$$\sigma = \sqrt{\frac{\Sigma (xi - \bar{\bar{x}})^2}{N - 1}} = 1.69$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{1.69}{\sqrt{5}} = 0.756$$

BKA = $\bar{\bar{x}} + 2\,\sigma_{\bar{x}} = 29.69 + (2)(0.756) = 31.202$

BKB = $\bar{\bar{x}} - 2\,\sigma_{\bar{x}} = 29.69 - (2)(0.756) = 28.178$

Grafik BKA dan BKB :



Gambar Diagram Keseragaman Data Stasiun *Machining*

Karena semua harga rata – rata waktu penyelesaian berada diantara batas kontrol atas dan batas kontrol bawah, maka semua data telah seragam.

LAMPIRAN 3

(Perhitungan Uji Kecukupan Data)

- Tabel Pengujian Kecukupan Data Stasiun *Forming* 2A
- Tabel Pengujian Kecukupan Data Stasiun *Forming* 2B
- Tabel Pengujian Kecukupan Data Stasiun *Machining*

Pengujian Kecukupan Data Stasiun *Forming* 2A

Tingkat kepercayaan = 95% dan Tingkat Ketelitian = 5%

$\Sigma x_i = x_1 + x_2 + x_3 + \ldots + x_{40} = 24.59 + 26.03 + 25.1 + \ldots + 25.15 = 957.2$

$(\Sigma xi)^2 = 957.2^2 = 916231.84$

$\Sigma (x_i)^2 = x_1^2 + x_{x2}^2 + x_3^2 + \ldots + x_{36}^2 = 24.59^2 + 26.03^2 + 25.1^2 + \ldots + 25.15^2$

$= 23272.8562$

$$N' = \left[\frac{\frac{C}{\alpha}\sqrt{N\Sigma xi^2 - (\Sigma xi)^2}}{\Sigma xi} \right]^2 = \left[\frac{\frac{2}{0.05}\sqrt{(40x23272.8562) - 916231.84}}{957.2} \right]^2 = 25.639$$

Karena jumlah data yang diambil lebih besar dari jumlah data yang diharuskan maka data yang diambil cukup ($N' < N$) yaitu $25.639 < 40$

Keterangan : $C = 2 \rightarrow$ tingkat kepercayaan = 95 %

: $\alpha = 0.05$

Pengujian Kecukupan Data Stasiun *Forming* 2B

Tingkat kepercayaan = 95% dan Tingkat Ketelitian = 5%

$\Sigma x_i = x_1 + x_2 + x_3 + \ldots + x_{40} = 24.4 + 24.67 + 25.02 + \ldots + 31.88 = 1183.73$

$(\Sigma xi)^2 = 1183.73^2 = 1401216.713$

$\Sigma (x_i)^2 = x_1^2 + x_{x2}^2 + x_3^2 + \ldots + x_{36}^2 = 24..4^2 + 24.67^2 + 25.02^2 + \ldots + 31.88^2$

$= 35254.4589$

$$N' = \left[\frac{\frac{C}{\alpha} \sqrt{N \Sigma xi^2} - (\Sigma xi)^2}{\Sigma xi} \right]^2 = \left[\frac{\frac{2}{0.05} \sqrt{(40 x 35254.4589) - 1401216.713}}{1183.73} \right]^2 = 10.23$$

Karena jumlah data yang diambil lebih besar dari jumlah data yang diharuskan maka data yang diambil cukup ($N' < N$) yaitu $10.23 < 40$

Keterangan : $C = 2 \rightarrow$ tingkat kepercayaan = 95 %

: $\alpha = 0.05$

Pengujian Kecukupan Data Stasiun *Machining*

Tingkat kepercayaan = 95% dan Tingkat Ketelitian = 5%

$\Sigma x_i = x_1 + x_2 + x_3 + \ldots + x_{40} = 27.93 + 29.65 + 28.85 + \ldots + 28.88 = 1187.44$

$(\Sigma xi)^2 = 1187.44^2 = 1410013.754$

$\Sigma (x_i)^2 = x_1^2 + x_{x2}^2 + x_3^2 + \ldots + x_{36}^2 = 2793^2 + 29.65^2 + 28.85^2 + \ldots + 28.88^2$

$= 35361.2328$

$$N' = \left[\frac{\frac{C}{\alpha}\sqrt{N\Sigma xi^2 - (\Sigma xi)^2}}{\Sigma xi} \right]^2 = \left[\frac{\frac{2}{0.05}\sqrt{(40 * 35361.2328) - 1410013.754}}{1187.44} \right]^2 = 5.033$$

Karena jumlah data yang diambil lebih besar dari jumlah data yang diharuskan maka data yang diambil cukup ($N' < N$) yaitu $5.033 < 40$

Keterangan : $C = 2 \rightarrow$ tingkat kepercayaan = 95 %

: $\alpha = 0.05$

LAMPIRAN 4

(Bagan Analisa MTM – 1 "Aktual")

- Bagan Analisa MTM – 1 "Aktual" Stasiun *Expand*
- Bagan Analisa MTM – 1 "Aktual" Stasiun *Forming* 2A
- Bagan Analisa MTM – 1 "Aktual" Stasiun *Forming* 2B
- Bagan Analisa MTM – 1 "Aktual" Stasiun *Machining*

BAGAN ANALISA (MTM -1)

Bagian :
Operasi : *Expand*

Tanggal : 17 Oktober 2006
Analis : Fitri

No :
Lembar
ke 1_ dari 1_

Keterangan Tangan Kiri	No.	LH	TMU	RH	No.	Keterangan Tangan Kanan
1. Memasang benda kerja						
Menjangkau benda kerja		R10B	11.5			-
Memegang benda kerja		G1C1	7.3			-
Membawa benda kerja		M10C	13.5			-
Mengarahkan benda kerja		P2SD	21.8			-
-		-	7.3	EF		Eye focus
Melepas benda kerja		Rl1	2			-
Tangan kembali		R10B	11.5			-
2. Menarik handle						
-		-	9.6	R12A		Menjangkau handle
-		-	2	G1A		Memegang handle
-		-	12.9	M12A		Membawa handle
3. Menginjak pedal untuk menggerakkan mesin						
-		-	7.1	LM		Menginjak pedal
4. Melepas benda kerja						
-		-	12.9	M12A		Membawa handle
-		-	2	Rl1		Melepas handle
-		-	8.7	R10A		Menjangkau benda kerja
-		-	7.3	G1C1		Memegang benda kerja
-		-	25.5	M24C		Membawa benda kerja
-		-	5.6	P1SE		Mengarahkan benda kerja
-		-	2	Rl1		Melepas benda kerja
-		-	14.4	R14B		Tangan kembali

No	Keterangan elemen gerakan	TMU	faktor Konversi 0.036 detik	Kelonggaran 0.28	waktu (detik)	Jumlah ulang waktu	Total Waktu (detik)
1	Memasang benda kerja	74.9	2.696	0.755	3.451	1	3.451
2	Menarik handle	24.5	0.882	0.247	1.129	1	1.129
3	Menginjak pedal untuk proses	7.1	0.256	0.072	0.327	1	0.327
4	Melepas benda kerja	78.4	2.822	0.790	3.613	1	3.613
							8.52

BAGAN ANALISA (MTM -1)

Bagian :
Operasi : *Forming* 2A

Tanggal : 17 Oktober 2006
Analis : Fitri

No :
Lembar ke 1_ dari 1_

Keterangan Tangan Kiri	No.	LH	TMU	RH	No.	Keterangan Tangan Kanan
1. Memasang benda kerja						
Menjangkau benda kerja		R12B	12.9			-
Memegang benda kerja		G1C1	7.3			-
Membawa benda kerja		M10C	13.5			-
Mengarahkan benda kerja		P2SD	21.8			-
-			7.3	EF		Eye focus
Melepas benda kerja		Rl1	2			-
Tangan kembali		R10B	11.5	R7B		Menjangkau dies
-			7.3	G1C1		Memegang dies
-			6.7	M3C		Membawa dies
-			21.8	P2SD		Mengarahkan dies
-			7.3	EF		Eye focus
-			2	Rl1		Melepas dies
2. Menekan tombol						
Menjangkau tombol		R12A	9.6	R12A		Menjangkau tombol
Memegang tombol		G5	0	G5		Memegang tombol
Menekan tombol		APA	10.6	APA		Menekan tombol
Melepas tombol		Rl1	2	Rl1		Melepas tombol
Tangan kembali		R12B	12.9	R12B		Tangan kembali
3. Waktu proses mesin forming pada benda kerja						
4. Melepas benda kerja						
			8.7	R10A		Menjangkau dies
-			7.3	G1C1		Memegang dies
-			6.7	M3C		Membawa dies
-			5.6	P1SE		Mengarahkan dies
-			2	Rl1		Melepas dies
-			8.7	R10A		Menjangkau benda kerja
-			7.3	G1C1		Memegang benda kerja
-			25.5	M24C		Membawa benda kerja
-			5.6	P1SE		Mengarahkan benda kerja
-			2	Rl1		Melepas benda kerja
			14.4	R14B		Tangan kembali

No	Keterangan elemen gerakan	TMU	faktor Konversi 0.036 detik	Kelonggaran 0.2825	waktu (detik)	Jumlah ulang waktu	Total Waktu (detik)
1	Memasang benda kerja	121.4	4.370	1.235	5.605	1	5.605038
2	Menekan tombol	35.1	1.264	0.357	1.621	1	1.620567
3	Waktu proses	-	-	-	5.620	1	5.62
4	Melepas benda kerja	93.8	3.377	0.954	4.331	1	4.330746
							17.18

BAGAN ANALISA (MTM -1)						
Bagian :		Tanggal : 17 Oktober 2006				No :
Operasi : *Forming* 2B		Analis : Fitri				Lembar
						ke 1_ dari 1_
Keterangan	**No.**	**LH**	**TMU**	**RH**	**No.**	**Keterangan**
Tangan Kiri						**Tangan Kanan**
1. Stamping benda kerja						
Menjangkau benda kerja		R9B	10.8	-		-
Memegang benda kerja		G1C1	7.3	-		-
Membawa benda kerja		M10C	13.5	-		-
Mengarahkan benda kerja		P2SD	21.8	-		-
		-	7.3	EF		Eye focus
Melepas benda kerja		R11	2	-		-
2. Menekan tombol mesin						
Menjangkau tombol		R9A	8.3	R9A		Menjangkau tombol
Memegang tombol		G5	3.5	G5		Memegang tombol
Menekan tombol		APA	10.6	APA		Menekan tombol
Melepas tombol		R11	2	R11		Melepas tombol
Tangan kembali		R9B	10.8	R9B		Tangan kembali
3. Waktu proses stamping						
4. Memasang benda kerja pada mesin						
-		-	8.7	R10A		Menjangkau benda kerja
-		-	7.3	G1C1		Memegang benda kerja
-		-	6.7	M3C		Membawa benda kerja
-		-	21.8	P2SD		Mengarahkan benda kerja
-		-	7.3	EF		Eye focus
-		-	2	R11		Melepas benda kerja
-		-	5.3	R3A		Menjangkau handle
-		-	2	G1A		Memegang handle
-		-	12.9	M12A		Membawa handle
-		-	2	R11		Melepas handle
Menjangkau tombol		R9A	8.3	R9A		Menjangkau tombol
Memegang tombol		G5	0	G5		Memegang tombol
Menekan tombol		APA	10.6	APA		Menekan tombol
Melepas tombol		R11	2	R11		Melepas tombol
Tangan kembali		R9B	10.8	R9B		Tangan kembali
5. Waktu proses mesin expand pada benda kerja						
6. Melepas benda kerja						
-		-	9.6	R12A		Menjangkau handle
-		-	2	G1A		Memegang handle
-		-	12.9	M12A		Membawa handle
-		-	2	R11		Melepas handle
-		-	9.6	R12A		Menjangkau benda kerja
-		-	7.3	G1C1		Memegang benda kerja
-		-	25.5	M24C		Membawa benda kerja
-		-	5.6	P1SE		Mengarahkan benda kerja
-		-	2	R11		Melepas benda kerja
-		-	14.4	R14B		Tangan kembali

No	Keterangan elemen gerakan	TMU	faktor Konversi 0.036 detik	Kelonggaran 0.27	waktu (detik)	Jumlah ulang waktu	Total Waktu (detik)
1	Stamping benda kerja	62.7	2.257	0.609	2.867	1	2.867
2	Menekan tombol	35.2	1.267	0.342	1.609	1	1.609
3	Waktu proses stamping	-	-	-	6.850	1	6.850
4	Memasang benda pada mesin	107.7	3.8772	1.046844	4.924044	1	4.924044
5	Waktu proses mesin expand	-	-	-	6.850	1	6.85
6	Melepas benda	90.9	3.272	0.884	4.156	1	4.156
							27.26

BAGAN ANALISA (MTM -1)

Bagian :
Operasi : *Machining*

Tanggal : 17 Oktober 2006
Analis : Fitri

No :
Lembar ke 1_ dari 1_

Keterangan Tangan Kiri	No.	LH	TMU	RH	No.	Keterangan Tangan Kanan
1. Memasang benda kerja						
Menjangkau benda kerja		R14B	14.4	R14B		Menjangkau benda kerja
Memegang benda kerja		G1C1	7.3	G1C1		Memegang benda kerja
Membawa benda kerja		M18C	20.4	M18C		Membawa benda kerja
Mengarahkan benda kerja		P2SD	21.8	P2SD		Mengarahkan benda kerja
-		-	7.3	EF		Eye focus
Melepas benda kerja		Rl1	2	Rl1		Melepas benda kerja
2. Menekan Tombol						
Menjangkau pintu mesin		R10A	8.7	R10A		Menjangkau pintu mesin
Memegang pintu mesin		G1A	2	G1A		Memegang pintu mesin
Membawa pintu mesin		M5A	7.3	M5A		Membawa pintu mesin
Melepas pintu mesin		Rl1	2	Rl1		Melepas pintu mesin
Menjangkau tombol		R9A	8.3	R9A		Menjangkau tombol
Memegang tombol		G5	0	G5		Memegang tombol
Menekan tombol		APA	10.6	APA		Menekan tombol
Melepas tombol		Rl1	2	Rl1		Melepas tombol
Tangan kembali		R9B	10.8	R9B		Tangan kembali
3. Waktu proses mesin machining pada benda kerja						
4. Melepas benda kerja						
Menjangkau pintu mesin		R10A	8.7	R10A		Menjangkau pintu mesin
Memegang pintu mesin		G1A	2	G1A		Memegang pintu mesin
Membawa pintu mesin		M5A	7.3	M5A		Membawa pintu mesin
Melepas pintu mesin		Rl1	2	Rl1		Melepas pintu mesin
Menjangkau benda kerja		R10A	8.7	R10A		Menjangkau benda kerja
Memegang benda kerja		G1C1	7.3	G1C1		Memegang benda kerja
Membawa benda kerja		M18C	20.4	M18C		Membawa benda kerja
Mengarahkan benda kerja		P1SE	5.6	P1SE		Mengarahkan benda kerja
Melepas benda kerja		Rl1	2	Rl1		Melepas benda kerja
Tangan kembali		R16B	15.8	R16B		Tangan kembali

No	Keterangan elemen gerakan	TMU	faktor Konversi 0.036 detik	Kelonggaran 0.27	waktu (detik)	Jumlah ulang waktu	Total Waktu (detik)
1	Memasang benda kerja	73.2	2.635	0.712	3.347	1	3.347
2	Menekan tombol	51.7	1.861	0.503	2.364	1	2.364
3	Waktu proses	-	-	-	21.170	1	21.170
4	Melepas benda kerja	79.8	2.873	0.776	3.648	1	3.648
							30.53

LAMPIRAN 5

(Bagan Analisa MTM – 1 "Usulan")

- Bagan Analisa MTM – 1 "Usulan" Stasiun *Expand*
- Bagan Analisa MTM – 1 "Usulan" Stasiun *Forming* 2A
- Bagan Analisa MTM – 1 "Usulan" Stasiun *Forming* 2B
- Bagan Analisa MTM – 1 "Usulan" Stasiun *Machining*

BAGAN ANALISA (MTM -1)

Bagian :		Tanggal : 17 Oktober 2006				No :
Operasi : *Expand*		Analis : Fitri				Lembar
						ke 1_ dari 1_
Keterangan	**No.**	**LH**	**TMU**	**RH**	**No.**	**Keterangan**
Tangan Kiri						**Tangan Kanan**
1. Memasang benda kerja						
Menjangkau benda kerja		R10B	11.5			-
Memegang benda kerja		G1C1	7.3			-
Membawa benda kerja		M10C	13.5			-
Mengarahkan benda kerja		P2SD	21.8			-
-		-	7.3	EF		Eye focus
Melepas benda kerja		RI1	2			-
Tangan kembali		R10B	11.5			-
2. Menarik handle						
-		-	9.6	R12A		Menjangkau handle
-		-	2	G1A		Memegang handle
-		-	12.9	M12A		Membawa handle
3. Menginjak pedal untuk menggerakkan mesin						
-		-	7.1	LM		Menginjak pedal
4. Melepas benda kerja						
-		-	12.9	M12A		Membawa handle
-		-	2	RI1		Melepas handle
-		-	8.7	R10A		Menjangkau benda kerja
-		-	7.3	G1C1		Memegang benda kerja
-		-	25.5	M24C		Membawa benda kerja
-		-	5.6	P1SE		Mengarahkan benda kerja
-		-	2	RI1		Melepas benda kerja
-		-	14.4	R14B		Tangan kembali

No	Keterangan elemen gerakan	TMU	faktor Konversi 0.036 detik	Kelonggaran 0.23	waktu (detik)	Jumlah ulang waktu	Total Waktu (detik)
1	Memasang benda kerja	74.9	2.696	0.620	3.317	1	3.317
2	Menarik handle	24.5	0.882	0.203	1.085	1	1.085
3	Menginjak pedal untuk proses	7.1	0.256	0.059	0.314	1	0.314
4	Melepas benda kerja	78.4	2.822	0.649	3.472	1	3.472
							8.19

BAGAN ANALISA (MTM -1)						
Bagian :		Tanggal : 17 Oktober 2006				No :
Operasi : *Forming* 2A		Analis : Fitri				Lembar
						ke 1_ dari 1_
Keterangan	**No.**	**LH**	**TMU**	**RH**	**No.**	**Keterangan**
Tangan Kiri						**Tangan Kanan**
1. Memasang benda kerja						
Menjangkau benda kerja		R12B	12.9			-
Memegang benda kerja		G1C1	7.3			-
Membawa benda kerja		M10C	13.5			-
Mengarahkan benda kerja		P2SD	21.8			-
-			7.3	EF		Eye focus
Melepas benda kerja		R1I	2			-
Tangan kembali		R10B	11.5	R7B		Menjangkau dies
-			7.3	G1C1		Memegang dies
-			6.7	M3C		Membawa dies
-			21.8	P2SD		Mengarahkan dies
-			7.3	EF		Eye focus
-			2	R1I		Melepas dies
2. Menekan tombol						
Menjangkau tombol		R12A	9.6	R12A		Menjangkau tombol
Memegang tombol		G5	0	G5		Memegang tombol
Menekan tombol		APA	10.6	APA		Menekan tombol
Melepas tombol		R1I	2	R1I		Melepas tombol
Tangan kembali		R12B	12.9	R12B		Tangan kembali
3. Waktu proses mesin forming pada benda kerja						
4. Melepas benda kerja						
			8.7	R10A		Menjangkau dies
-			7.3	G1C1		Memegang dies
-			6.7	M3C		Membawa dies
-			5.6	P1SE		Mengarahkan dies
-			2	R1I		Melepas dies
-			8.7	R10A		Menjangkau benda kerja
-			7.3	G1C1		Memegang benda kerja
-			25.5	M24C		Membawa benda kerja
-			5.6	P1SE		Mengarahkan benda kerja
-			2	R1I		Melepas benda kerja
			14.4	R14B		Tangan kembali

No	Keterangan elemen gerakan	TMU	faktor Konversi 0.036 detik	Kelonggaran 0.195	waktu (detik)	Jumlah ulang waktu	Total Waktu (detik)
1	Memasang benda kerja	121.4	4.370	0.852	5.223	1	5.222628
2	Menekan tombol	35.1	1.264	0.246	1.510	1	1.510002
3	Waktu proses	-	-	-	5.620	1	5.62
4	Melepas benda kerja	93.8	3.377	0.658	4.035	1	4.035276
							16.39

BAGAN ANALISA (MTM -1)						
Bagian :		Tanggal : 17 Oktober 2006				No :
Operasi : *Forming* 2B		Analis : Fitri				Lembar
						ke 1_ dari 1_
Keterangan	**No.**	**LH**	**TMU**	**RH**	**No.**	**Keterangan**
Tangan Kiri						**Tangan Kanan**
1. Stamping benda kerja						
Menjangkau benda kerja		R9B	10.8	-		-
Memegang benda kerja		G1C1	7.3	-		-
Membawa benda kerja		M10C	13.5	-		-
Mengarahkan benda kerja		P2SD	21.8	-		-
		-	7.3	EF		Eye focus
Melepas benda kerja		R11	2	-		-
2. Menekan tombol mesin						
Menjangkau tombol		R9A	8.3	R9A		Menjangkau tombol
Memegang tombol		G5	3.5	G5		Memegang tombol
Menekan tombol		APA	10.6	APA		Menekan tombol
Melepas tombol		R11	2	R11		Melepas tombol
Tangan kembali		R9B	10.8	R9B		Tangan kembali
3. Waktu proses stamping						
4. Memasang benda kerja pada mesin						
-		-	8.7	R10A		Menjangkau benda kerja
-		-	7.3	G1C1		Memegang benda kerja
-		-	6.7	M3C		Membawa benda kerja
-		-	21.8	P2SD		Mengarahkan benda kerja
-		-	7.3	EF		Eye focus
-		-	2	R11		Melepas benda kerja
-		-	5.3	R3A		Menjangkau handle
-		-	2	G1A		Memegang handle
-		-	12.9	M12A		Membawa handle
-		-	2	R11		Melepas handle
Menjangkau tombol		R9A	8.3	R9A		Menjangkau tombol
Memegang tombol		G5	0	G5		Memegang tombol
Menekan tombol		APA	10.6	APA		Menekan tombol
Melepas tombol		R11	2	R11		Melepas tombol
Tangan kembali		R9B	10.8	R9B		Tangan kembali
5. Waktu proses mesin expand pada benda kerja						
6. Melepas benda kerja						
-		-	9.6	R12A		Menjangkau handle
-		-	2	G1A		Memegang handle
-		-	12.9	M12A		Membawa handle
-		-	2	R11		Melepas handle
-		-	9.6	R12A		Menjangkau benda kerja
-		-	7.3	G1C1		Memegang benda kerja
-		-	25.5	M24C		Membawa benda kerja
-		-	5.6	P1SE		Mengarahkan benda kerja
-		-	2	R11		Melepas benda kerja
-		-	14.4	R14B		Tangan kembali

No	Keterangan elemen gerakan	TMU	faktor Konversi 0.036 detik	Kelonggaran 0.195	waktu (detik)	Jumlah ulang waktu	Total Waktu (detik)
1	Stamping benda kerja	62.7	2.257	0.440	2.697	1	2.697
2	Menekan tombol	35.2	1.267	0.247	1.514	1	1.514
3	Waktu proses stamping	-	-	-	6.850	1	6.850
4	Memasang benda pada mesin	107.7	3.8772	0.756054	4.633254	1	4.633254
5	Waktu proses mesin expand	-	-	-	6.850	1	6.85
6	Melepas benda	90.9	3.272	0.638	3.911	1	3.911
							26.46

BAGAN ANALISA (MTM -1)						
Bagian :		Tanggal : 17 Oktober 2006				No :
Operasi : *Machining*		Analis : Fitri				Lembar
						ke 1_ dari 1_
Keterangan	**No.**	**LH**	**TMU**	**RH**	**No.**	**Keterangan**
Tangan Kiri						**Tangan Kanan**
1. Memasang benda kerja						
Menjangkau benda kerja		R14B	14.4	R14B		Menjangkau benda kerja
Memegang benda kerja		G1C1	7.3	G1C1		Memegang benda kerja
Membawa benda kerja		M18C	20.4	M18C		Membawa benda kerja
Mengarahkan benda kerja		P2SD	21.8	P2SD		Mengarahkan benda kerja
-		-	7.3	EF		Eye focus
Melepas benda kerja		R1I	2	R1I		Melepas benda kerja
2. Menekan Tombol						
Menjangkau pintu mesin		R10A	8.7	R10A		Menjangkau pintu mesin
Memegang pintu mesin		G1A	2	G1A		Memegang pintu mesin
Membawa pintu mesin		M5A	7.3	M5A		Membawa pintu mesin
Melepas pintu mesin		R1I	2	R1I		Melepas pintu mesin
Menjangkau tombol		R9A	8.3	R9A		Menjangkau tombol
Memegang tombol		G5	0	G5		Memegang tombol
Menekan tombol		APA	10.6	APA		Menekan tombol
Melepas tombol		R1I	2	R1I		Melepas tombol
Tangan kembali		R9B	10.8	R9B		Tangan kembali
3. Waktu proses mesin machining pada benda kerja						
4. Melepas benda kerja						
Menjangkau pintu mesin		R10A	8.7	R10A		Menjangkau pintu mesin
Memegang pintu mesin		G1A	2	G1A		Memegang pintu mesin
Membawa pintu mesin		M5A	7.3	M5A		Membawa pintu mesin
Melepas pintu mesin		R1I	2	R1I		Melepas pintu mesin
Menjangkau benda kerja		R10A	8.7	R10A		Menjangkau benda kerja
Memegang benda kerja		G1C1	7.3	G1C1		Memegang benda kerja
Membawa benda kerja		M18C	20.4	M18C		Membawa benda kerja
Mengarahkan benda kerja		P1SE	5.6	P1SE		Mengarahkan benda kerja
Melepas benda kerja		R1I	2	R1I		Melepas benda kerja
Tangan kembali		R16B	15.8	R16B		Tangan kembali

No	Keterangan elemen gerakan	TMU	faktor Konversi 0.036 detik	Kelonggaran 0.195	waktu (detik)	Jumlah ulang waktu	Total Waktu (detik)
1	Memasang benda kerja	73.2	2.635	0.514	3.149	1	3.149
2	Menekan tombol	51.7	1.861	0.363	2.224	1	2.224
3	Waktu proses	-	-	-	21.170	1	21.170
4	Melepas benda kerja	79.8	2.873	0.560	3.433	1	3.433
							29.98

LAMPIRAN 6

(Peta Kerja)

- Peta Aliran Proses Pembuatan *Pipe Frame Head*
- Diagram Aliran Proses Pembuatan *Pipe Frame Head*
- Peta Pekerja dan Mesin stasiun *Expand*
- Peta Pekerja dan Mesin stasiun *Forming* 2A
- Peta Pekerja dan Mesin stasiun *Forming* 2B
- Peta Pekerja dan Mesin stasiun *Machining*

PETA ALIRAN PROSES

ringkasan

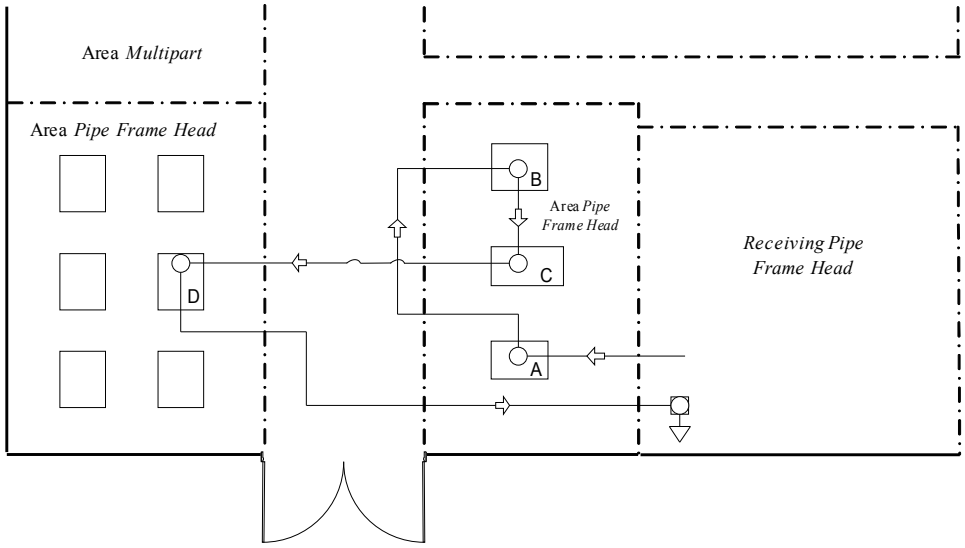
KEGIATAN	SEKARANG		USULAN		BEDA	
	JML	WKT	JML	WKT	JML	WKT
○ OPERASI	5					
□ PEMERIKSAAN	1					
⇨ TRANSPORTASI	6					
D MENUNGGU	-					
▽ PENYIMPANAN	1					
D GABUNGAN	-					
JARAK TOTAL						

PEKERJAAN : PEMBUATAN PIPE FRAME HEAD
NOMOR PETA : 01
SEKARANG ☑ USULAN ☐
BAHAN ☑ ORANG ☐
DIPETAKAN OLEH : FITRI. I. P. IRAWAN
TANGGAL DIPETAKAN : 14 JUNI 2006

URAIAN KEGIATAN	LAMBANG						JARAK	JUMLAH	WAKTU	ANALISA					CATATAN	TINDAKAN					
	○	□	⇨	D	▽	D	m		dtk	APA	DIMANA	KAPAN	SIAPA	BAGAIMANA		RUANG	GABUNG	UBAH URUTAN	UBAH TEMPAT	UBAH ORANG	PERBAIKI
Bahan baku dibawa dari *receiving pipe frame head* ke stasiun *expand*			●																		
Bahan diproses dengan menggunakan mesin *press*	●																				
Bahan dibawa ke stasiun kerja *forming* 2A			●																		
Bahan diproses dengan menggunakan mesin hidrolik	●																				
Bahan dibawa ke stasiun kerja *forming* 2B			●																		
Bahan diproses dengan menggunakan mesin hidrolik	●																				
Bahan dibawa ke stasiun kerja *machining*			●																		
Bahan diproses dengan menggunakan mesin *double borring*	●																				
Produk dibawa ke *receiving pipe frame head*			●																		
Produk diperiksa		●																			
Produk dipacking	●																				
Produk disimpan					●																

DIAGRAM ALIRAN

Pekerjaan	: Aliran Pembuatan *Pipe Frame Head*
Nomor Peta	: 1
Sekarang ☐	Usulan ☐
Dipetakan Oleh	: Fitri Irawan
Tanggal Dipetakan	: 14 November 2006



PETA PEKERJA DAN MESIN

PEKERJAAN : PROSES *EXPAND*
NAMA MESIN : MESIN *PRESS*
NAMA PEKERJA :
SEKARANG ▭ USULAN ▭

DIPETAKAN OLEH : FITRI
TANGGAL: 10 JANUARI 2007

	ORANG			MESIN		
	OPERATOR	WAKTU DETIK		MESIN	WAKTU DETIK	
7.28 8.75	Mengambil bahan untuk diproses ke mesin	7.28	■	Delay	7.28	
	Menggerakkan mesin	1.47		Mesin Bekerja	1.47	
	Mengambil bahan dari mesin untuk disimpan dan tangan kembali	5.68	■	Delay	5.68	

■ Waktu kerja tak bergantungan

▭ Waktu menganggur

▭ Waktu kerja kombinasi

	Operator	Mesin
Waktu Menganggur (detik)	0	12.96
Waktu Kerja (detik)	14.43	1.47
Total Waktu (detik)	14.43	14.43
Presentase Penggunaan	100%	10.18%

PETA PEKERJA DAN MESIN

PEKERJAAN : PROSES *FORMING* 2A
NAMA MESIN : MESIN HIDROLIK
NAMA PEKERJA :
SEKARANG ▭ USULAN ▭

DIPETAKAN OLEH : FITRI
TANGGAL: 10 JANUARI 2007

	ORANG		MESIN		
	OPERATOR	WAKTU DETIK	MESIN	WAKTU DETIK	
9.21	Mengambil bahan ke mesin, memasang *dies* dan menekan tombol mesin	9.21	Delay	9.21	
	Delay	5.62	Proses oleh mesin	5.62	
14.83	Mengambil bahan dari mesin untuk disimpan dan tangan kembali	9.10	Delay	9.10	

■ Waktu kerja tak bergantungan

▭ Waktu menganggur

▭ Waktu kerja kombinasi

	Operator	Mesin
Waktu Menganggur (detik)	5.62	18.31
Waktu Kerja (detik)	18.31	5.62
Total Waktu (detik)	23.93	23.93
Presentase Penggunaan	76.51%	23.49%

PETA PEKERJA DAN MESIN

PEKERJAAN : PROSES *FORMING* 2B
NAMA MESIN : MESIN HIDROLIK
NAMA PEKERJA :
SEKARANG USULAN

DIPETAKAN OLEH : FITRI
TANGGAL: 10 JANUARI 2007

	ORANG			MESIN		
	OPERATOR	WAKTU DETIK		MESIN	WAKTU DETIK	
5.35	Mengambil bahan ke mesin dan menekan tombol mesin	5.35	■	Delay	5.35	
12.20	Delay	6.85		Proses oleh mesin	6.85	■
17.17	Mengambil bahan untuk diproses selanjutnya dan menekan tombol mesin	4.97	■	Delay	4.97	
24.02	Delay	6.85		Proses oleh mesin	6.85	■
	Mengambil bahan untuk disimpan dan tangan kembali	5.57	■	Delay	5.57	

■ Waktu kerja tak bergantungan

Waktu menganggur

Waktu kerja kombinasi

	Operator	Mesin
Waktu Menganggur (detik)	13.70	15.89
Waktu Kerja (detik)	15.89	13.70
Total Waktu (detik)	29.59	29.59
Presentase Penggunaan	53.70%	46.30%

PETA PEKERJA DAN MESIN

PEKERJAAN : PROSES *MACHINING*
NAMA MESIN : MESIN *DOUBLE BORRING*
NAMA PEKERJA :
SEKARANG USULAN

DIPETAKAN OLEH : FITRI
TANGGAL: 10 JANUARI 2007

	ORANG			MESIN		
	OPERATOR	WAKTU DETIK		MESIN	WAKTU DETIK	
4.30	Mengambil bahan untuk diproses ke mesin dan menekan tombol mesin	4.30		Delay	4.30	
	Delay	21.17		Proses oleh mesin	21.17	
25.47	Mengambil bahan dari mesin untuk disimpan dan tangan kembali	4.22		Delay	4.22	

Waktu kerja tak bergantungan

Waktu menganggur

Waktu kerja kombinasi

	Operator	Mesin
Waktu Menganggur (detik)	21.17	8.52
Waktu Kerja (detik)	8.52	21.17
Total Waktu (detik)	29.69	29.69
Presentase Penggunaan	28.70%	71.30%

LAMPIRAN 7

(Tabel Waktu Kunjungan *Sampling* untuk Mengetahui Faktor Kelonggaran Tak Terhindarkan)

- Tabel Waktu Kunjungan *Sampling* untuk Mengetahui Faktor Kelonggaran Tak Terhindarkan Pada Stasiun *Expand*
- Tabel Waktu Kunjungan *Sampling* untuk Mengetahui Faktor Kelonggaran Tak Terhindarkan Pada Stasiun *Forming* 2B
- Tabel Waktu Kunjungan *Sampling* untuk Mengetahui Faktor Kelonggaran Tak Terhindarkan Pada Stasiun *Forming* 2A
- Tabel Waktu Kunjungan *Sampling* untuk Mengetahui Faktor Kelonggaran Tak Terhindarkan Pada Stasiun *Machining*

JADWAL KUNJUNGAN RANDOM

1) **<u>Hari kerja senin s/d kamis :</u>**

Jam kerja : 08.00 – 17.00

Jam istirahat : 12.00 – 13.00

Waktu kunjungan : Senin tgl.29 Mei 2006, Selasa tgl.30 Mei 2006, Kamis tgl.1 Juni 2006, Senin tgl.5 Juni 2006, Selasa tgl.6 Juni 2006 dan Kamis tgl.8 Juni 2006

- **Bilangan Random terbesar :**

Bilangan random terbesar :

$$\text{pkl.08.00-17.00} = \frac{\text{jumlah jam kerja perhari x 60mnt}}{\text{interval pengamatan}}$$

$$= \frac{9x60}{6} = 90$$

- **Jam Istirahat :**

Jam Istirahat :

$$\text{pkl.12.00} = \frac{\Sigma\text{jam kerja dari awal sd jam istirahat awal x 60mnt}}{\text{interval pengamatan}}$$

$$= \frac{4x60}{60} = 40$$

$$\text{pk.13.00} = \frac{\Sigma\text{jam kerja dari awal sd jam istirahat akhir x 60mnt}}{\text{interval pengamatan}}$$

$$= \frac{5x60}{60} = 50$$

Jadi bilangan random yang tidak boleh dipakai adalah 40 s/d 50 dan 90 keatas.

- **Senin tgl.29 Mei 2006 :**

Tabel Waktu Kunjungan Bilangan Random Untuk Kelonggaran Tak Terhindarkan, Senin tgl.29 Mei 2006

No. Urut	Bil. Random	Jam Kunjungan	Hari Kunjungan Senin 29 Mei 2006			
			Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
1	6	08.36-08.42	3	3	3	3
2	12	09.12-09.18	3	3	3	3
3	17	09.42–09.48	3	3	3	3
4	19	09.54–10.00	3	3	3	3
5	20	10.00–10.06	3	5	4	3
6	21	10.06–10.12	5	3	3	5
7	23	10.18–10.24	3	4	3	3
8	25	10.30–10.36	3	3	3	3
9	33	11.18-11.24	4	3	5	3
10	37	11.42–11.48	3	3	3	3
11	39	11.54–12.00	2	2	2	2
12	51	13.06-13.12	3	3	3	3
13	52	13.12-13.18	3	3	3	5
14	60	14.00-14.06	3	5	3	3
15	63	14.18-14.24	3	3	3	3
16	64	14.24-14.30	3	3	3	3
17	65	14.30-14.36	3	3	5	3
18	67	14.42-14.48	5	3	3	5
19	69	14.54-15.00	3	3	3	3
20	70	15.00-15.06	3	4	3	3
21	71	15.06-15.12	4	3	3	3
22	72	15.12-15.18	3	3	4	3
23	73	15.18-15.24	3	5	3	3
24	74	15.24-15.30	3	3	3	5
25	75	15.30-15.36	3	3	3	3
26	76	15.36-15.42	5	3	5	5
27	78	15.48-15.54	3	3	3	3
28	79	15.54-16.00	3	5	3	3
29	84	16.24-16.30	3	3	3	3
30	88	16.48-16.54	3	3	3	3
Jumlah kelonggaran tak terhindarkan			0	0	0	0

Keterangan :

1. Briefing.
2. Membereskan alat kerja
3. Melakukan proses produksi
4. Mengambil benda kerja
5. Membersihkan dies
6. Meminta petunjuk pada kepala seksi
7. Mengencangkan dies

- **Selasa tgl.30 Mei 2006 :**

Tabel Waktu Kunjungan Bilangan Random Untuk Kelonggaran Tak Tehindarkan, Selasa tgl.30 Mei 2006

No. Urut	Bil. Random	Jam Kunjungan	Hari Kunjungan Selasa 30 Mei 2006			
			Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
1	0	08.00-08.06	1	1	1	1
2	5	08.30-08.36	3	3	3	3
3	7	08.42-08.48	3	3	3	3
4	10	09.00-09.06	3	3	3	3
5	22	10.12–10.18	3	3	5	3
6	24	10.24–10.30	3	4	3	5
7	25	10.30–10.36	5	3	3	3
8	28	10.48–10.54	3	3	4	3
9	30	11.00–11.06	3	3	3	3
10	31	11.06–11.12	4	5	3	3
11	35	11.30–11.36	3	3	5	3
12	38	11.48-11.54	3	3	3	3
13	39	11.54–12.00	2	2	2	2
14	53	13.18–13.24	3	3	3	3
15	54	13.24–13.30	3	3	3	5
16	57	13.42-13.48	3	3	3	3
17	58	13.48–13.54	3	5	3	3
18	60	14.00-14.06	3	3	5	3
19	61	14.06-14.12	3	3	3	3
20	63	14.18-14.24	5	3	3	3
21	64	14.24-14.30	3	3	3	3
22	65	14.30-14.36	3	4	3	3
23	70	15.00-15.06	4	3	4	5
24	74	15.24-15.30	3	3	3	3
25	76	15.36-15.42	3	3	3	3
26	77	15.42-15.48	3	3	3	3
27	78	15.48-15.54	3	3	3	3
28	81	16.06-16.12	5	3	3	3
29	82	16.12-16.18	3	5	3	5
30	88	16.48-16.54	3	3	3	3
Jumlah kelonggaran tak terhindarkan			0	0	0	0

Keterangan :

1. Briefing.
2. Membereskan alat kerja
3. Melakukan proses produksi
4. Mengambil benda kerja
5. Membersihkan dies
6. Meminta petunjuk pada kepala seksi
7. Mengencangkan dies

- **Kamis tgl.1 Juni 2006 :**

Tabel Waktu Kunjungan Bilangan Random Untuk Kelonggaran Tak Terhindarkan, Kamis tgl.1 Juni 2006

No. Urut	Bil. Random	Jam Kunjungan	Hari Kunjungan Kamis 1 Juni 2006			
			Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
1	8	08.48-08.54	3	3	3	3
2	9	08.54-09.00	3	3	3	3
3	10	09.00-09.06	3	3	3	3
4	11	09.06-09.12	3	4	5	3
5	12	09.12-09.18	3	3	3	3
6	17	09.42–09.48	3	3	6	5
7	18	09.48–09.54	3	5	3	3
8	19	09.54–10.00	3	3	3	3
9	21	10.06–10.12	3	3	5	3
10	27	10.42–10.48	5	3	3	3
11	31	11.06–11.12	3	3	3	5
12	32	11.12-11.18	3	5	4	3
13	34	11.24–11.30	3	3	3	3
14	35	11.30–11.36	3	3	3	3
15	36	11.36–11.42	3	4	5	5
16	55	13.30-13.36	5	3	3	3
17	57	13.42-13.48	3	3	3	3
18	60	14.00-14.06	3	5	4	3
19	62	14.12-14.18	3	3	3	3
20	63	14.18-14.24	4	3	3	3
21	64	14.24-14.30	3	3	3	3
22	66	14.36-14.42	3	3	3	3
23	69	14.54-15.00	3	5	5	6
24	72	15.12-15.18	3	3	3	3
25	77	15.42-15.48	3	3	3	3
26	79	15.54-16.00	5	3	3	3
27	80	16.00-16.06	3	3	3	5
28	82	16.12-16.18	3	3	3	3
29	85	16.30-16.36	3	3	3	3
30	88	16.48-16.54	3	3	3	3
Jumlah kelonggaran tak terhindarkan			0	0	0	0

Keterangan :

1. Briefing.
2. Membereskan alat kerja
3. Melakukan proses produksi
4. Mengambil benda kerja
5. Membersihkan dies
6. Meminta petunjuk pada kepala seksi
7. Mengencangkan dies

- **Senin tgl.5 Juni 2006 :**

Tabel Waktu Kunjungan Bilangan Random Untuk Kelonggaran Tak Terhindarkan, Senin tgl.5 Juni 2006

No. Urut	Bil. Random	Jam Kunjungan	Hari Kunjungan Senin 5 Juni 2006			
			Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
1	0	08.00-08.06	1	1	1	1
2	6	08.36-08.42	3	3	3	3
3	11	09.06-09.12	3	3	3	3
4	12	09.12-09.18	3	3	3	3
5	14	09.24–09.30	3	3	4	5
6	19	09.54–10.00	3	5	3	3
7	20	10.00–10.06	5	3	5	3
8	23	10.18–10.24	3	3	3	3
9	24	10.24–10.30	3	4	3	3
10	26	10.36–10.42	3	3	3	3
11	30	11.00–11.06	3	3	3	3
12	31	11.06–11.12	3	3	5	5
13	33	11.18-11.24	3	5	3	3
14	34	11.24–11.30	3	3	3	3
15	36	11.36–11.42	3	3	3	3
16	38	11.48-11.54	3	3	3	3
17	39	11.54–12.00	2	2	2	2
18	51	13.06-13.12	3	3	3	3
19	56	13.36–13.42	3	3	3	3
20	58	13.48–13.54	3	3	3	3
21	60	14.00-14.06	3	5	5	3
22	61	14.06-14.12	3	3	3	3
23	62	14.12-14.18	3	3	4	5
24	64	14.24-14.30	4	4	3	3
25	65	14.30-14.36	3	3	3	5
26	69	14.54-15.00	5	3	3	3
27	70	15.00-15.06	3	3	5	3
28	75	15.30-15.36	3	3	3	3
29	76	15.36-15.42	3	3	3	3
30	83	16.18-16.24	3	3	3	3
Jumlah kelonggaran tak terhindarkan			0	0	0	0

Keterangan :

1. Briefing.
2. Membereskan alat kerja
3. Melakukan proses produksi
4. Mengambil benda kerja
5. Membersihkan dies
6. Meminta petunjuk pada kepala seksi
7. Mengencangkan dies

- **Selasa tgl.6 Juni 2006 :**

Tabel Waktu Kunjungan Bilangan Random Untuk kelonggaran Tak Terhindarkan, Selasa tgl.6 Juni 2006

No. Urut	Bil. Random	Jam Kunjungan	Hari Kunjungan Selasa 6 Juni 2006			
			Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
1	0	08.00-08.06	1	1	1	1
2	5	08.30-08.36	3	3	3	3
3	7	08.42-08.48	3	3	3	3
4	10	09.00-09.06	5	3	3	5
5	12	09.12-09.18	3	5	3	3
6	17	09.42–09.48	3	3	3	3
7	21	10.06–10.12	3	3	4	3
8	24	10.24–10.30	4	4	3	3
9	25	10.30–10.36	3	3	5	3
10	27	10.42–10.48	3	3	3	3
11	28	10.48–10.54	3	5	3	3
12	30	11.00–11.06	3	3	3	3
13	31	11.06–11.12	3	3	3	5
14	32	11.12-11.18	3	3	3	3
15	35	11.30–11.36	3	3	5	3
16	36	11.36–11.42	3	3	3	3
17	39	11.54–12.00	2	2	2	2
18	57	13.42-13.48	3	3	3	3
19	59	13.54–14.00	3	3	6	3
20	60	14.00-14.06	3	5	3	3
21	61	14.06-14.12	3	3	3	5
22	63	14.18-14.24	5	3	3	3
23	65	14.30-14.36	3	4	3	3
24	72	15.12-15.18	3	3	3	3
25	73	15.18-15.24	3	3	3	3
26	77	15.42-15.48	3	3	3	3
27	80	16.00-16.06	3	5	5	3
28	81	16.06-16.12	3	3	3	3
29	82	16.12-16.18	3	3	3	5
30	88	16.48-16.54	3	3	3	3
Jumlah kelonggaran tak terhindarkan			0	0	0	0

Keterangan :

1. Briefing.
2. Membereskan alat kerja
3. Melakukan proses produksi
4. Mengambil benda kerja
5. Membersihkan dies
6. Meminta petunjuk pada kepala seksi
7. Mengencangkan dies

- **Kamis tgl.8 Juni 2006 :**

Tabel Waktu Kunjungan Bilangan Random Untuk Kelonggaran Tak Terhindarkan, Kamis tgl. 8 Juni 2006

No. Urut	Bil. Random	Jam Kunjungan	Hari Kunjungan Kamis 8 Juni 2006			
			Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
1	0	08.00-08.06	1	1	1	1
2	5	08.30-08.36	3	3	3	3
3	7	08.42-08.48	3	3	3	3
4	8	08.48-08.54	3	3	5	3
5	10	09.00-09.06	3	4	3	3
6	11	09.06-09.12	3	3	3	3
7	12	09.12-09.18	5	3	6	5
8	17	09.42–09.48	3	5	3	3
9	21	10.06–10.12	3	3	3	3
10	24	10.24–10.30	3	3	4	5
11	27	10.42–10.48	3	3	3	3
12	28	10.48–10.54	5	3	3	3
13	30	11.00–11.06	3	3	5	3
14	32	11.12-11.18	3	3	3	3
15	35	11.30–11.36	3	3	3	3
16	36	11.36–11.42	3	3	3	3
17	39	11.54–12.00	2	2	2	2
18	55	13.30-13.36	3	3	3	3
19	57	13.42-13.48	3	3	3	3
20	60	14.00-14.06	3	3	3	5
21	61	14.06-14.12	3	6	3	3
22	62	14.12-14.18	5	3	3	3
23	63	14.18-14.24	3	3	5	3
24	64	14.24-14.30	3	5	3	3
25	65	14.30-14.36	4	3	3	3
26	73	15.18-15.24	3	3	4	3
27	77	15.42-15.48	3	4	3	5
28	80	16.00-16.06	3	3	3	3
29	82	16.12-16.18	3	3	3	3
30	88	16.48-16.54	3	3	3	3
Jumlah kelonggaran tak terhindarkan			0	0	0	0

Keterangan :

1. Briefing.
2. Membereskan alat kerja
3. Melakukan proses produksi
4. Mengambil benda kerja
5. Membersihkan dies
6. Meminta petunjuk pada kepala seksi
7. Mengencangkan dies

2) **Hari kerja jumat :**

Jam kerja : 08.00 – 17.00

Jam istirahat : 11.30 – 13.00

Waktu kunjungan : Jumat tgl.2 Juni 2006 dan Jumat tgl.9 Juni 2006

- **Bilangan Random terbesar :**

  Bilangan random terbesar :

  $$\text{pkl.08.00-17.00} = \frac{\text{jumlah jam kerja perhari x 60mnt}}{\text{interval pengamatan}}$$

  $$= \frac{9x60}{6} = 90$$

- **Jam Istirahat :**

  Jam Istirahat :

  $$\text{pkl.11.30} = \frac{\Sigma\text{jam kerja dari awal sd jam istirahat awal x 60mnt}}{\text{interval pengamatan}}$$

  $$= \frac{3.5x60}{60} = 35$$

  $$\text{pk.13.00} = \frac{\Sigma\text{jam kerja dari awal sd jam istirahat akhir x 60mnt}}{\text{interval pengamatan}}$$

  $$= \frac{5x60}{60} = 50$$

  Jadi bilangan random yang tidak boleh dipakai adalah 35 s/d 50 dan 90 keatas.

- **Jadwal kunjungan random sampling pekerjaan :**

  Jam kunjungan = Jam masuk kerja+(bil.random*interval pengamatan)

  Interval pengamatan = 6 menit

- **Jumat tgl.2 Juni 2006 :**

Tabel Waktu Kunjungan Bilangan Random Untuk Kelonggaran Tak Terhindarkan, Jumat tgl.2 Juni 2006

No. Urut	Bil. Random	Jam Kunjungan	Hari Kunjungan Jumat 2 Juni 2006			
			Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
1	0	08.00-08.06	1	1	1	1
2	1	08.06-08.12	3	3	3	3
3	5	08.30-08.36	3	3	3	3
4	6	08.36-08.42	3	3	3	3
5	7	08.42-08.48	3	3	3	3
6	9	08.54-09.00	3	3	5	3
7	11	09.06-09.12	3	5	3	3
8	14	09.24–09.30	5	3	3	5
9	20	10.00–10.06	3	3	3	3
10	22	10.12–10.18	3	3	3	3
11	24	10.24–10.30	3	4	3	3
12	28	10.48–10.54	4	3	3	3
13	29	10.54-11.00	3	3	3	5
14	30	11.00-11.06	3	3	4	3
15	33	11.18-11.24	3	5	3	3
16	51	13.06-13.12	3	3	5	5
17	52	13.12-13.18	6	3	3	3
18	53	13.18–13.24	3	3	3	3
19	59	13.54–14.00	3	3	3	3
20	61	14.06-14.12	5	3	3	3
21	69	14.54-15.00	3	3	3	5
22	70	15.00-15.06	3	3	3	3
23	71	15.06-15.12	3	3	5	3
24	75	15.30-15.36	3	6	3	3
25	78	15.48-15.54	3	3	3	3
26	79	15.54-16.00	3	3	3	3
27	80	16.00-16.06	3	5	3	6
28	81	16.06-16.12	3	3	3	3
29	83	16.18-16.24	3	3	5	3
30	84	16.24-16.30	3	3	3	3
Jumlah kelonggaran tak terhindarkan			0	0	0	0

Keterangan :

1. Briefing.
2. Membereskan alat kerja
3. Melakukan proses produksi
4. Mengambil benda kerja
5. Membersihkan dies
6. Meminta petunjuk pada kepala seksi
7. Mengencangkan dies

- **Jumat tgl.9 Juni 2006 :**

Tabel Waktu Kunjungan Bilangan Random Untuk Kelonggaran Tak Terhindarkan, Jumat tgl.9 Juni 2006

No. Urut	Bil. Random	Jam Kunjungan	Hari Kunjungan Jumat 9 Juni 2006			
			Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
1	0	08.00-08.06	1	1	1	1
2	6	08.36-08.42	3	3	3	3
3	11	09.06-09.12	3	3	3	3
4	12	09.12-09.18	3	3	5	3
5	14	09.24–09.30	3	3	3	5
6	19	09.54–10.00	5	4	3	3
7	20	10.00–10.06	3	3	3	3
8	23	10.18–10.24	3	3	3	3
9	24	10.24–10.30	3	3	3	5
10	26	10.36–10.42	3	5	4	3
11	30	11.00-11.06	3	3	3	3
12	31	11.06–11.12	3	7	5	3
13	33	11.18-11.24	3	7	3	3
14	34	11.24–11.30	3	7	3	3
15	51	13.06-13.12	5	5	3	3
16	52	13.12-13.18	3	3	3	3
17	56	13.36–13.42	3	3	3	3
18	58	13.48–13.54	3	3	3	3
19	60	14.00-14.06	3	3	3	5
20	61	14.06-14.12	3	5	3	3
21	62	14.12-14.18	3	3	3	3
22	64	14.24-14.30	3	3	5	3
23	65	14.30-14.36	4	5	3	3
24	69	14.54-15.00	3	3	3	3
25	70	15.00-15.06	3	3	3	3
26	71	15.06-15.12	5	3	3	5
27	73	15.18-15.24	3	4	4	3
28	75	15.30-15.36	3	3	3	5
29	76	15.36-15.42	3	3	3	3
30	83	16.18-16.24	3	3	3	3
Jumlah kelonggaran tak terhindarkan			0	3	0	0

Keterangan :

1. Briefing.
2. Membereskan alat kerja
3. Melakukan proses produksi
4. Mengambil benda kerja
5. Membersihkan dies
6. Meminta petunjuk pada kepala seksi
7. Mengencangkan dies

3) Ringkasan perhitungan kelonggaran tak terhindarkan :

Tabel Ringkasan Waktu Kunjungan Bilangan Random Untuk Kelonggaran Tak Terhindarkan

Hari	Stasiun Expand	Stasiun Forming 2A	Stasiun Forming 2B	Stasiun Machining
Senin, 29 Mei 2006	0	0	0	0
Selasa, 30 Mei 2006	0	0	0	0
Kamis, 1 Juni 2006	0	0	0	0
Jumat, 2 Juni 2006	0	0	0	0
Senin, 5 Juni 2006	0	0	0	0
Selasa, 6 Juni 2006	0	0	0	0
Kamis, 8 Juni 2006	0	0	0	0
Jumat, 9 Juni 2006	0	3	0	0
Total tak terhindarkan	0	3	0	0
Total data pengamatan	240	240	240	240
% kelonggaran tak terhindarkan	0.00	1.25	0.00	0.00

LAMPIRAN 8

(Tabel *The* χ^2 *Distribution*)

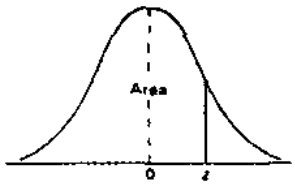


Table A.3 Areas Under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
−3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
−3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
−3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0017	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0352	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0722	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Table A.3 (continued) Areas Under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9278	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

LAMPIRAN 9

(Tabel Penyesuaian Menurut *Westinghouse*)

Tabel 9.2 Penyesuaian menurut Westinghouse

Faktor	Kelas	Lambang	Penyesuaian
Ketrampilan	Superskil	A1	+ 0,15
		A2	+ 0,13
	Excelent	B1	+ 0,11
		B2	+ 0,08
	Good	C1	+ 0,06
		C2	+ 0,03
	Average	D	0,00
	Fair	E1	– 0,05
		E2	– 0,10
	Poor	F1	– 0,16
		F2	–0,22
Usaha	Excessive	A1	+ 0,13
		A2	+ 0,12
	Excellent	B1	+ 0,10
		B2	+ 0,08
	Good	C1	+ 0,05
		C2	+ 0,02
	Average	D	0,00
	Fair	E1	– 0,04
		E2	– 0,08
	Poor	F1	– 0,12
		F2	– 0,17
Kondisi Kerja	Ideal	A	+ 0,06
	Excellenty	B	+ 0,04
	Good	C	+ 0,02
	Average	D	0,00
	Fair	E	–0,03
	Poor	F	– 0,07
Konsistensi	Perfect	A	+ 0,04
	Excellent	B	+ 0,03
	Good	C	+ 0,01
	Average	D	0,00
	Fair	E	– 0,02
	Poor	F	–0,04

LAMPIRAN 10

(Tabel Kelonggaran)

Tabel 9.4 Besarnya kelonggaran berdasarkan faktor-faktor yang berpengaruh

Faktor	Contoh pekerjaan	Ekivalen beban	Kelonggaran (%) Pria	Wanita
A. Tenaga yang dikeluarkan				
1. Dapat diabaikan	Bekerja dimeja, duduk	tanpa beban	0,0 – 6,0	0,0 – 6,0
2. Sangat ringan	Bekerja dimeja, berdiri	0,00 – 2,25 kg	6,0 – 7,5	6,0 – 7,5
3. Ringan	Menyekop, ringan	2,25 – 9,00	7,5 – 12,0	7,5 – 16,0
4. Sedang	Mencangkul	9,00 – 18,00	12,0 – 19,0	16,0 – 30,0
5. Berat	Mengayun palu yang berat	19,00 – 27,00	19,0 – 30,0	
6. Sangat berat	Memanggul beban	27,00 – 50,00	30,0 – 50,0	
7. Luar-biasa berat	Memanggul karung berat	diatas 50 kg		
B. Sikap kerja				
1. Duduk	Bekerja duduk, ringan		0,00 – 1,0	
2. Berdiri diatas dua kaki	Badan tegak, ditumpu dua kaki		1,0 – 2,5	
3. Berdiri diatas satu kaki	Satu kaki mengerjakan alat kontrol		2,5 – 4,0	
4. Berbaring	Pada bagian sisi, belakang atau depan badan		2,5 – 4,0	
5. Membungkuk	Badan dibungkukkan bertumpu pada kedua kaki		4,0 – 10	
C. Gerakan kerja				
1. Normal	Ayunan bebas dari palu		0	
2. Agak terbatas	Ayunan terbatas dari palu		0 – 5	
3. Sulit	Membawa beban berat dengan satu tangan		0 – 5	
4. Pada anggota-anggota badan terbatas	Bekerja dengan tangan diatas kepala		5 – 10	
5. Seluruh anggota badan terbatas	Bekerja dilorong pertambangan yang sempit		10 – 15	

Tabel 9.4 Besarnya kelonggaran berdasarkan faktor-faktor yang berpengaruh (*Lanjutan*)

Faktor		Kelonggaran (%)	
D. Kelelahan mata *)		Pencahayaan baik	Buruk
1. Pandangan yangterputus-putus	Membawa alat ukur	0,0 – 6,0	0,0 – 6,0
2. Pandangan yang hampir terus menerus	Pekerjaan-pekerjaan yang teliti	6,0 – 7,5	6,0 – 7,5
3. Pandangan terus menerus dengan fokus berubah-ubah	Memeriksa cacat-cacat pada kain	7,5 – 12,0	7,5 – 16,0
	Pemeriksaan yang sangat teliti	12,0 – 19,0	16,0 – 30,0
4. pandangan terus menerus dengan fokus tetap		19,0 – 30,0	
		30,0 – 50,0	

E. Keadaan temperatur tempat kerja **)	Temperatur (^{o}C)	Kelemahan normal	Berlebihan
1. Beku	Dibawah 0	diatas 10	diatas 12
2. Randah	0 – 13	10 – 0	12 – 5
3. Sedang	13 – 22	5 –0	8 – 0
4. Normal	22 – 28	0 – 5	0 – 8
5. Tinggi	28 – 38	5 – 40	8 – 100
6. Sangat tinggi	diatas –38	diatas 40	diatas 100

F. Keadaan atmosfer *)**		
1. Baik	Ruang yang berventilasi baik, udara segar	0
2. Cukup	Ventilasi kurang baik, ada bau-bauan (tidak berbahaya)	0 – 5

Tabel 9.4 Besarnya kelonggaran berdasarkan faktor-faktor yang berpengaruh (*Lanjutan*)

Faktor	Contoh pekerjaan	
3. Kurang baik	Adanya debu-debu bercaun, atau tidak beracun tetapi banyak	5 – 10
4. Buruk	Adanya bau-bauan berbahaya yang mengharuskan menggunakan alat-alat pernapasan	10 – 20
G. Keadaan lingkungan yang baik		
1. Bersih, sehat, cerah dengan kebisingan rendah		0
2. Siklus kerja berulang-ulang antara 5 – 10 detik		0 – 1
3. Siklus kerja berulang-ulang antara 0 – 5 detik		1 – 3
4. Sangat bising		0 – 5
5. Jika faktor-faktor yang berpengaruh dapat menurunkan kwalitas		0 – 5
6. Terasa adanya getaran lantai		5 – 10
7. Keadaan-keadaan yang luar biasa (bunyi, kebersihan, dll.)		5 – 15

*) Kontras antara warna hendaknya diperhatikan
**) Tergantung juga pada keadaan ventilasi
***) Dipengaruhi juga oleh ketinggian tempat kerja dari permukaan laut dan keadaan iklim

Catatan pelengkap : kelonggaran untuk kebutuhan pribadi bagi : Pria = 0 (2,5%

LAMPIRAN 11

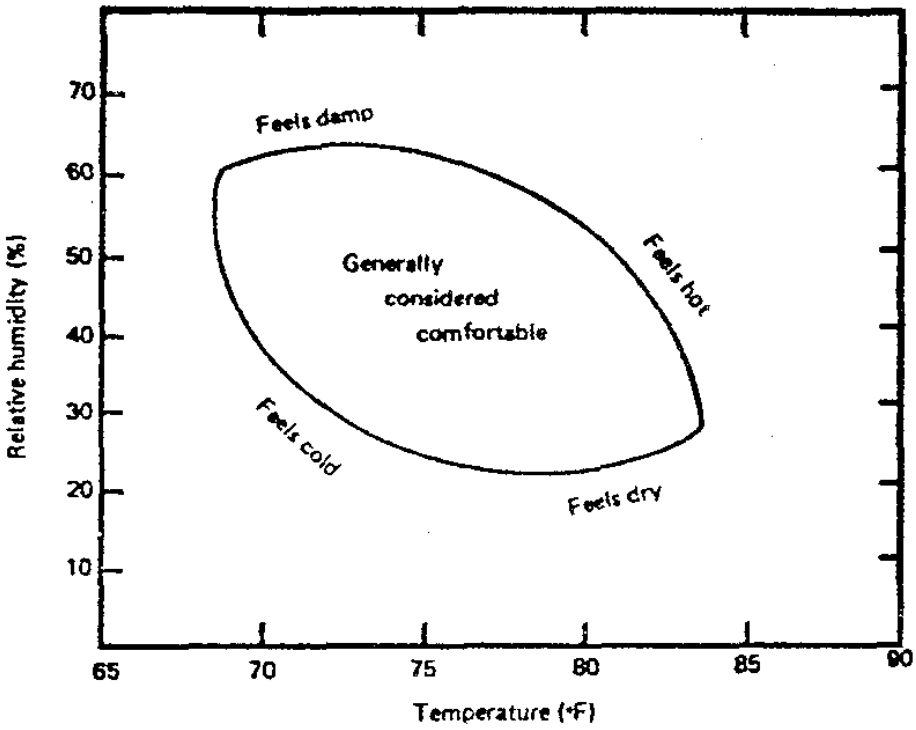
(Tabel-tabel yang Berhubungan dengan Kondisi Lingkungan)

- Tabel WRKSTN-E2: *Influences on Thermal Comfort Zone*
- Tabel *Relative Humidity* Vs *Temperature*
- Tabel Kebisingan
- Tabel *Lighting Industry Standard Practice*

Table WRKSTN-E2: Influences on Thermal Comfort Zone[1]

Factor	Level	Ambient Dry Bulb Temperature* Lower Limit °C	(°F)	Upper Limit °C	(°F)
Relative Humidity (%)	20	20	(68)	26	(79)
	50	19	(67)	25.5	(78)
	80	18.5	(66)	24	(76)
Air Velocity, m/sec (ft/min)	0.1 (20)	18	(65)	24	(76)
	0.25 (50)	19	(67)	25.5	(78)
	0.36 (70)	21	(70)	27	(80)
	0.51 (100)	22	(72)	28	(82)
	0.71 (140)	23	(74)	29	(84)
Work Load, 8-Hour Average, multiples of resting values	× 2	19	(67)	25.5	(78)
	× 3.5	17	(64)	23	(74)
	× 5	≈15.5	(≈60)†	20	(68)
Clothing Insulation (clo)	0.25	27	(80)	28	(83)
	1.25	19	(67)	22	(72)
	2.50	≈11	(≈52)	≈16	(≈62)
Radiant Heat, °C (°F), amount that globe temperature exceeds dry-bulb temperature	0	19	(67)	25.5	(78)
	1.1 (2)	17	(64)	24	(76)
	2.8 (5)	16	(62)	23	(74)
	5.6 (10)	13	(56)	20	(68)

* Unless otherwise noted, the following values have been used to calculate the thermal comfort zone limits: air velocity, 0.25 m/sec (50 ft/min); work load, sedentary, light assembly, up to two times resting metabolism; clothing insulation, 0.6 clo in heat, 1.25 clo in cold; no radiant heat load; humidity, 50 percent.


Relative humidity (%)
70
60
50
40
30
20
10
Feels damp
Generally
considered
comfortable
Feels hot
Feels cold
Feels dry
65
70
75
80
85
90
Temperature (°F)

LIGHTING INDUSTRY STANDARD PRACTICE

Facility	Light Level, fc
Art galleries:	
General	30
Paintings	30–60
Sculpture	30–100
Auditoriums:	
Lobbies	30
Seating area (nonperformance)	10–30
Seating area (during performance, in aisle)	1–3
Orchestra (music stands)	15–20
Banks:	
Lobby	30
Officer platform area	30–50
Teller line	50–75
Rear posting and keypunch area (work surface)	75–100
Depots and terminals:	
Waiting rooms	30
Ticket counter	50–75
Baggage room	50–75
Platform	30
Rest rooms	30
Hospitals:	
Lobbies and hallways	50–75
Patient rooms	3–50
Laboratory and examination rooms	75–100
Surgery and delivery	To 2500
Hotels:	
Lobbies	30–75
Front office	50–75
Halls and elevators	20–30
Rest rooms and guest rooms	20–50 plus reading lights to 75
Kitchen	100
Laundry	50–75
Office buildings:	
Lobbies, halls, and elevators	20–30
Offices	75–100
Residences:	
Entryway and porch	10
Hallways and stairs	10–25
Kitchen	50–75
Laundry	50
Library	50–70
Sewing room	50–100
Bathroom—general	30
sink and mirror	50
Workshop	70
Restaurants:	
Quick-service counter	50
Intimate dining area	15–30
Kitchen	70
Cashier area	50
Schools:	
Study areas and classrooms	50–100
Drafting room	100
Offices	50
Rest rooms	30
Retail stores:	
Circulation area	30
Showcase	100–150
Sports:	
Archery	10
Badminton	30
Baseball—seating	3–10
field	100–150
Basketball	50
Gymnasium, general exercise room, and	30
locker room	20
Hockey	20
Boxing	200
Football	100
Swimming pool, general overhead and	10
under water	100
Tennis	30–50
Volleyball	20

INDUSTRIAL/MANUFACTURING LIGHTING PRACTICES

Facility	Light Level, fc
Assembly:	
Rough seeing	30
Rough and difficult seeing	50
Medium-difficulty seeing	100
Fine seeing	500
Auto body:	
Frame assembly	50
Chassis assembly	100
Final inspection	200
Bakery:	
General	30–50
Hand decoration	100
Bookbinding:	
General	70
Embossing	200
Chemical laboratory	30–50
Cleaning and pressing:	
General inspection and spotting	50
	500
Hand pressing	150
Repair and alteration	200
Electrical equipment manufacturing:	
General	50
Coil winding	100
Foundries:	
General	30
Molding and pouring	50
Grinding and chipping	100
Fine inspection	500
Glassworks:	
General	30–50
Fine grinding and polishing	200
Engraving	200
Iron and steel manufacturing	20–30
Machine shops:	
General	50
Fine bench work	100
Paint manufacturing:	
General	30
Color matching	200
Printing industries:	
Presses	70
Composing	100
Proofing	150
Sheet metal works:	
General cutting and bending	50
Scribing and inspection	200
Shoe manufacturing	200–300
Textile mills:	
General	30
Carding, spooling, and spinning	50–150 (depending on color)
Inspection and weaving	100
Welding:	
General	50
Precision arc	1000
Woodworking:	
General	30
Finishing	100

*Note: Where color matching or working on darker colors is involved, higher illumination levels are required. In order to avoid spectral glare, when the work involves close visual inspection of materials with a high-gloss finish, light levels should not be too high. Although the above standards appear to be very specific, the reader is cautioned not to assume that the specified illumination levels are either adequate or necessary. Each visual task should be examined in detail to determine seeing difficulty. A lighting mockup is desirable to test the proposed lighting scheme as well as the proposed levels.

LAMPIRAN 12

(Tabel-tabel Perhitungan Pencahayaan)

- Tabel *Percent Effective Ceiling or Floor Cavity Reflectance*
- Tabel *Coefficient of Utilization*
- Gambar Faktor *Luminaire Dirt Depreciation* (LDD)
- Tabel Data Lampu *Flourecent*
- Tabel *Reflectance Factors for Surface Color*

TABLE 20.3 **Percent Effective Ceiling or Floor Cavity Reflectance (ρ_{ccc} ρ_{fc}) for Various Reflectance Combinations**

Percent Ceiling ρ_c or Floor Reflectance ρ_f:																						
Percent Wall Reflectance ρ_w:		*90*				*80*				*70*			*50*			*30*				*10*		
		90	*70*	*50*	*30*	*80*	*70*	*50*	*30*	*70*	*50*	*30*	*70*	*50*	*30*	*65*	*50*	*30*	*10*	*50*	*30*	*10*
Ceiling or Floor Cavity Rates CCR or FCR	0	90	90	90	90	80	80	80	80	70	70	70	50	50	50	30	30	30	30	10	10	10
	0.2	89	88	86	85	79	78	77	76	68	67	66	49	48	47	30	29	29	28	10	10	9
	0.4	88	86	83	81	78	76	74	72	67	65	63	48	46	45	30	29	27	26	11	10	9
	0.6	88	84	80	76	77	75	71	68	65	62	59	47	45	43	29	28	26	25	11	10	9
	0.8	87	82	77	73	75	73	69	65	64	60	56	47	43	41	29	27	25	23	11	10	8
	1.0	86	80	74	69	74	71	66	61	63	58	53	46	42	39	29	27	24	22	11	9	8
	1.2	86	78	72	65	73	70	64	58	61	56	50	45	41	37	29	26	23	20	12	9	7
	1.4	85	77	69	62	72	68	62	55	60	54	48	45	40	35	28	26	22	19	12	9	7
	1.6	85	75	66	59	71	67	60	53	59	52	45	44	39	33	28	25	21	18	12	9	7
	1.8	84	73	64	56	70	65	58	50	57	50	43	43	37	32	28	25	21	17	12	9	6
	2.0	83	72	62	53	69	64	56	48	56	48	41	43	37	30	28	24	20	16	12	9	6
	2.2	83	70	60	51	68	63	54	45	55	46	39	42	36	29	28	24	19	15	13	9	6
	2.4	82	68	58	48	67	61	52	43	54	45	37	42	35	27	28	24	19	14	13	9	6
	2.6	82	67	56	46	66	60	50	41	53	43	35	41	34	26	27	23	18	13	13	9	5
	2.8	81	66	54	44	66	59	48	39	52	42	33	41	33	25	27	23	18	13	13	9	5
	3.0	81	64	52	42	65	58	47	38	51	40	32	40	32	24	27	22	17	12	13	8	5
	3.5	79	61	48	37	63	55	43	33	48	38	29	39	30	22	26	22	16	11	13	8	5
	4.0	78	58	44	33	61	52	40	30	46	35	26	38	29	20	26	21	15	9	13	8	4
	4.5	77	55	41	30	59	50	37	27	45	33	24	37	27	19	25	20	14	8	14	8	4
	5.0	76	53	38	27	57	48	35	25	43	32	22	36	26	17	25	19	13	7	14	8	4

Extracted from *IES Handbook*; reprinted with permission; for more complete data see *IES Handbook* (1981).

TABLE 20.2 Coefficients of Utilization for Typical Luminaires with Suggested Maximum Spacing Ratios

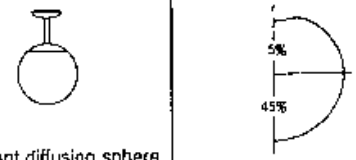
To obtain a coefficient of utilization:

1. Determine cavity ratios for the room, ceiling, and floor.
2. Determine the effective ceiling and floor cavity reflectances from Table 20.3. Use initial ceiling, floor, and wall reflectances.
3. Obtain coefficient of utilization (CU) for 20% effective floor cavity reflectance from appropriate table below for luminaire type to be used. Interpolate, when necessary, to obtain CU for exact room cavity ratio for nearest effective ceiling cavity reflectances above and below reflectance obtained in step 2; interpolate between these CUs to obtain CU for step 2 ceiling cavity reflectance.
4. If effective floor cavity reflectance differs significantly from 20%, obtain multiplier from Table 20.4 and apply this to the CU obtained in step 3.
5. To obtain CU for a ceiling cavity reflectance (ρ_{cc}) of 30 or 10%, multiply the figure for ρ_{cc} = 50% by 0.85 and 0.70, respectively. This is an approximation. For exact figures see *IES Handbook* (1981).
6. Use the figure in the last column (ρ_{cc} = 0; ρ_w = 0) for outdoor lighting, i.e., no walls or ceiling.
7. Legend:

ρ_{cc} = percent effective ceiling cavity reflectance
ρ_w = percent wall reflectance
RCR = room cavity ratio
Maximum *SIMH* guide = ratio of maximum luminaire spacing to mounting above work plane.

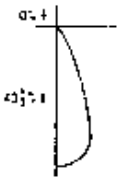
NOTE: In some cases, luminaire data in this table are based on an actual typical luminaire; in other cases, the data represent a composite of generic luminaire types. Therefore, whenever possible, specific luminaire data should be used in preference to this table of typical luminaires.

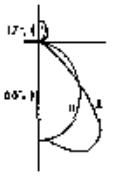
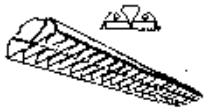
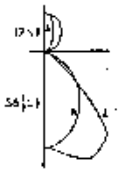
The polar intensity sketch (candlepower distribution curve) and the corresponding spacing-to-mounting height guide are representative of many luminaires of each type shown.

Typical Luminaire	Typical Distribution and Percent Lamp Lumens	Maintenance Category	Maximum S/MH Guide	RCR	ρ_{cc} → 80			70			50			0
					ρ_w → 50	30	10	50	30	10	50	30	10	0
					Coefficients of Utilization for 20% Effective Floor Cavity Reflectance (ρ_{FC} = 20)									
1		V	1.5	0	.87	.87	.87	.81	.81	.81	.69	.69	.69	.44
				1	.71	.67	.63	.66	.62	.59	.56	.53	.50	.31
				2	.61	.54	.49	.56	.50	.46	.47	.43	.39	.23
				3	.52	.45	.39	.48	.42	.37	.41	.36	.31	.18
				4	.45	.38	.33	.42	.36	.30	.36	.30	.26	.15
				5	.40	.33	.27	.37	.30	.25	.32	.26	.22	.12
				6	.36	.28	.23	.33	.26	.21	.28	.23	.19	.10
				7	.32	.25	.20	.29	.23	.18	.25	.20	.16	.09
Pendant diffusing sphere with incandescent lamp				8	.29	.22	.17	.27	.20	.16	.23	.17	.14	.07
				9	.26	.19	.15	.24	.18	.14	.20	.15	.12	.06
				10	.23	.17	.13	.22	.16	.12	.19	.14	.10	.05

(*continued*)

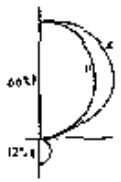
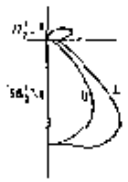
TABLE 20.2 Coefficients of Utilization for Typical Luminaires with Suggested Maximum Spacing Ratios *(continued)*

Typical Luminaire	Typical Distribution and Percent Lamp Lumens	Maintenance Category	Maximum SI/MH Guide	ρ_{CC}	80			70			50			0
				ρ_W	50	30	10	50	30	10	50	30	10	0
				RCR	Coefficients of Utilization for 20% Effective Floor Cavity Reflectance (ρ_{FC} = 20)									
3	 	IV	1.3	0	.99	.99	.99	.97	.97	.97	.92	.92	.92	.83
				1	.88	.85	.82	.86	.83	.81	.83	.80	.78	.72
				2	.78	.73	.68	.76	.72	.67	.73	.69	.66	.61
				3	.69	.62	.57	.67	.61	.57	.65	.60	.56	.52
				4	.61	.54	.49	.60	.53	.48	.58	.52	.48	.45
				5	.54	.47	.41	.53	.46	.41	.51	.45	.41	.38
				6	.48	.41	.35	.47	.40	.35	.46	.39	.35	.32
Porcelain-enameled ventilated standard dome with incandescent lamp				7	.43	.35	.30	.42	.35	.30	.41	.34	.30	.28
				8	.38	.31	.26	.38	.31	.26	.37	.30	.26	.24
				9	.35	.28	.23	.34	.27	.23	.33	.27	.23	.21
				10	.31	.25	.20	.31	.24	.20	.30	.24	.20	.18
7 		IV	0.7	0	.52	.52	.52	.51	.51	.51	.48	.48	.48	.44
				1	.49	.48	.48	.48	.48	.47	.47	.46	.46	.42
				2	.47	.46	.45	.46	.45	.44	.45	.44	.43	.41
				3	.45	.44	.43	.45	.43	.42	.44	.42	.42	.40
				4	.43	.42	.41	.43	.41	.40	.42	.41	.40	.38
				5	.42	.40	.39	.41	.40	.38	.41	.39	.38	.37
				6	.40	.39	.37	.40	.38	.37	.39	.38	.37	.36
EAR-38 lamp above 51 mm (2") diameter aperture (increase efficiency to 54½% for 76 mm (3") diameter aperture)				7	.39	.37	.36	.39	.37	.36	.38	.37	.35	.35
				8	.37	.36	.34	.37	.35	.34	.37	.35	.34	.33
				9	.36	.34	.33	.36	.34	.33	.35	.34	.33	.32
				10	.35	.33	.32	.35	.33	.32	.34	.33	.32	.31

18  "High-bay" wide distribution ventilated reflector with clear HID lamp	III	1.5 	0	.93	.93	.93	.91	.91	.91	.87	.87	.87	.78
			1	.85	.82	.80	.83	.81	.79	.79	.78	.76	.70
			2	.77	.73	.70	.76	.72	.69	.73	.70	.67	.63
			3	.70	.65	.61	.68	.64	.60	.66	.62	.59	.56
			4	.63	.58	.53	.62	.57	.53	.60	.56	.52	.49
			5	.57	.51	.47	.56	.51	.47	.55	.50	.46	.44
			6	.51	.45	.41	.51	.45	.41	.49	.44	.40	.38
			7	.46	.40	.35	.45	.39	.35	.44	.39	.35	.33
			8	.41	.35	.31	.41	.35	.31	.40	.34	.31	.29
			9	.37	.31	.27	.37	.31	.27	.36	.30	.27	.25
			10	.33	.28	.24	.33	.27	.23	.32	.27	.23	.22
26  Diffuse aluminum reflector with 35° crosswise shielding	II	1.5/1.3 	0	.95	.95	.95	.91	.91	.91	.83	.83	.83	.66
			1	.85	.82	.80	.82	.79	.77	.75	.73	.72	.59
			2	.76	.72	.68	.74	.70	.66	.68	.65	.62	.52
			3	.69	.63	.59	.66	.61	.57	.62	.58	.54	.46
			4	.62	.56	.51	.60	.54	.50	.56	.51	.47	.41
			5	.55	.49	.44	.53	.48	.43	.50	.45	.41	.36
			6	.50	.43	.39	.48	.42	.38	.45	.40	.36	.31
			7	.45	.38	.34	.43	.37	.33	.41	.36	.32	.27
			8	.40	.34	.29	.39	.33	.29	.37	.31	.28	.24
			9	.36	.30	.25	.35	.29	.25	.33	.28	.24	.20
			10	.33	.26	.22	.32	.26	.22	.30	.25	.21	.18
28  Diffuse aluminum reflector with 35° crosswise × 35° lengthwise shielding	II	1.5/1.1 	0	.83	.83	.83	.79	.79	.79	.72	.72	.72	.56
			1	.75	.72	.70	.72	.69	.67	.65	.64	.62	.50
			2	.67	.63	.60	.65	.61	.58	.59	.57	.54	.45
			3	.61	.56	.52	.58	.54	.51	.54	.50	.48	.40
			4	.55	.49	.45	.53	.48	.44	.49	.45	.42	.36
			5	.49	.44	.40	.47	.42	.39	.44	.40	.37	.31
			6	.45	.39	.35	.43	.38	.34	.40	.36	.33	.28
			7	.40	.35	.31	.39	.34	.30	.36	.32	.29	.25
			8	.36	.31	.27	.35	.30	.26	.33	.28	.25	.21
			9	.33	.27	.23	.32	.26	.23	.29	.25	.22	.19
			10	.30	.24	.21	.29	.24	.20	.27	.22	.19	.16

(continued)

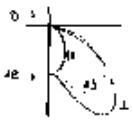
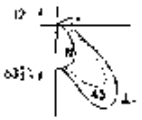
TABLE 20.2 **Coefficients of Utilization for Typical Luminaires with Suggested Maximum Spacing Ratios** (*continued*)

Typical Luminaire	Typical Distribution and Percent Lamp Lumens	Maintenance Category	Maximum SIMH Guide	RCR	ρ_{CC}: 80			70			50			0
				ρ_W:	50	30	10	50	30	10	50	30	10	0
					Coefficients of Utilization for 20% Effective Floor Cavity Reflectance (ρ_{FC} = 20)									
33	 	VI	N.A.	0	.77	.77	.77	.68	.68	.68	.50	.50	.50	.12
				1	.67	.64	.62	.59	.57	.54	.44	.42	.41	.10
				2	.59	.54	.50	.52	.48	.45	.38	.36	.34	.09
				3	.51	.46	.42	.45	.41	.37	.34	.31	.28	.07
				4	.45	.40	.35	.40	.35	.31	.30	.27	.24	.06
				5	.40	.34	.30	.35	.30	.27	.26	.23	.20	.05
				6	.36	.30	.26	.32	.27	.23	.24	.20	.18	.05
				7	.32	.26	.22	.28	.23	.20	.21	.18	.15	.04
Luminous bottom suspended unit with extra-high-output lamp				8	.29	.23	.19	.25	.21	.17	.19	.16	.13	.03
				9	.26	.20	.17	.23	.18	.15	.17	.14	.12	.03
				10	.24	.18	.15	.21	.16	.13	.16	.12	.10	.03
35	 	V	1.5/1.2	0	.83	.81	.81	.78	.78	.78	.72	.72	.72	.59
				1	.71	.69	.66	.69	.66	.64	.64	.62	.60	.50
				2	.64	.59	.56	.61	.58	.54	.57	.54	.51	.44
				3	.57	.52	.48	.55	.50	.47	.51	.48	.45	.38
				4	.51	.46	.41	.49	.44	.41	.46	.42	.39	.34
				5	.46	.40	.36	.44	.39	.35	.41	.37	.34	.29
				6	.41	.35	.31	.40	.35	.31	.38	.33	.30	.26
				7	.37	.31	.27	.36	.31	.27	.34	.29	.26	.23
Two-lamp prismatic wraparound; multiply by 0.95 for four lamps				8	.33	.28	.24	.32	.27	.23	.30	.26	.22	.19
				9	.30	.24	.20	.29	.24	.20	.27	.23	.19	.17
				10	.27	.22	.18	.26	.21	.18	.25	.20	.17	.15

38	IV	1.0	0	.60	.60	.60	.58	.58	.58	.56	.56	.56	.50
			1	.54	.52	.50	.52	.51	.49	.50	.49	.48	.44
			2	.48	.45	.43	.47	.44	.42	.45	.43	.41	.39
			3	.43	.40	.37	.42	.39	.37	.41	.38	.36	.34
			4	.39	.35	.32	.38	.35	.32	.37	.34	.32	.30
			5	.35	.31	.28	.35	.31	.28	.34	.30	.28	.26
			6	.32	.28	.25	.32	.28	.25	.31	.27	.25	.23
			7	.29	.25	.22	.29	.25	.22	.28	.25	.22	.21
Four-lamp, 610 mm (2') wide troffer with 45° plastic louvre			8	.26	.22	.20	.26	.22	.20	.25	.22	.20	.18
			9	.24	.20	.17	.24	.20	.17	.23	.20	.17	.16
			10	.22	.18	.16	.22	.19	.16	.21	.18	.16	.15
42	V	1.4/1.2	0	.75	.75	.75	.73	.73	.73	.70	.70	.70	.63
			1	.67	.65	.63	.66	.64	.62	.63	.62	.60	.55
			2	.60	.57	.54	.59	.56	.53	.57	.54	.52	.49
			3	.54	.50	.47	.53	.49	.46	.52	.48	.45	.43
			4	.49	.44	.40	.48	.44	.40	.47	.43	.40	.37
			5	.44	.39	.35	.43	.38	.35	.42	.38	.34	.33
			6	.40	.34	.31	.39	.34	.31	.38	.34	.30	.29
Fluorescent unit with flat prismatic lens, four-lamp 610 mm (2') wide			7	.36	.30	.27	.35	.30	.27	.34	.30	.27	.25
			8	.32	.27	.23	.32	.27	.23	.31	.26	.23	.22
			9	.29	.24	.20	.28	.23	.20	.28	.23	.20	.19
			10	.26	.21	.18	.26	.21	.18	.25	.21	.18	.16
44	IV	N.A.	0	.71	.71	.71	.70	.70	.70	.66	.66	.66	.60
			1	.65	.63	.61	.63	.62	.60	.61	.59	.58	.54
			2	.59	.55	.53	.58	.55	.52	.55	.53	.51	.48
			3	.53	.49	.46	.52	.48	.45	.50	.47	.45	.42
			4	.47	.43	.40	.47	.43	.40	.45	.42	.39	.37
			5	.42	.38	.34	.42	.37	.34	.41	.37	.34	.32
			6	.38	.33	.30	.38	.33	.30	.37	.33	.30	.28
			7	.34	.29	.26	.33	.29	.26	.33	.28	.25	.24
Radial batwing distribution—louvred fluorescent unit			8	.30	.25	.22	.30	.25	.22	.29	.25	.22	.20
			9	.27	.22	.18	.26	.22	.18	.26	.21	.18	.17
			10	.24	.19	.16	.24	.19	.16	.23	.19	.16	.15

(*continued*)

TABLE 20.2 **Coefficients of Utilization for Typical Luminaires with Suggested Maximum Spacing Ratios (*continued*)**

Typical Luminaire	Typical Distribution and Percent Lamp Lumens	Maintenance Category	Maximum SIMH Guide	RCR	ρ_{cc}: 80			70			50			0
				ρ_w:	50	30	10	50	30	10	50	30	10	0
					Coefficients of Utilization for 20% Effective Floor Cavity Reflectance (ρ_{FC} = 20)									
45  Radial batwing distribution—four lamp, 610 mm (2′) wide fluorescent unit with flat prismatic lens and overlay		V	N.A.	0	.57	.57	.57	.56	.56	.56	.53	.53	.53	.48
				1	.50	.48	.47	.49	.47	.46	.47	.46	.44	.41
				2	.44	.41	.38	.43	.40	.38	.41	.39	.37	.34
				3	.39	.35	.32	.38	.34	.31	.37	.33	.31	.29
				4	.34	.30	.27	.33	.29	.26	.32	.29	.26	.24
				5	.30	.25	.22	.29	.25	.22	.28	.24	.22	.20
				6	.26	.22	.19	.26	.22	.18	.25	.21	.18	.17
				7	.23	.19	.16	.23	.19	.16	.22	.18	.16	.14
				8	.21	.16	.13	.20	.16	.13	.19	.16	.13	.12
				9	.18	.14	.11	.18	.14	.11	.17	.14	.11	.10
				10	.16	.12	.09	.16	.12	.09	.16	.12	.09	.08
46  Bilateral batwing distribution—one lamp, surface-mounted fluorescent with prismatic wraparound lens		V	N.A.	0	.87	.87	.87	.84	.84	.84	.77	.77	.77	.64
				1	.76	.73	.70	.73	.70	.67	.67	.65	.63	.53
				2	.66	.61	.57	.64	.59	.56	.59	.56	.52	44
				3	.59	.53	.48	.56	.51	.47	.53	.48	.44	.38
				4	.52	.45	.40	.50	.44	.40	.47	.42	.38	.32
				5	.46	.39	.34	.44	.38	.33	.41	.36	.32	.27
				6	.41	.34	.29	.39	.33	.29	.37	.31	.27	.23
				7	.36	.30	.25	.35	.29	.24	.33	.27	.23	.20
				8	.32	.26	.21	.31	.25	.21	.29	.24	.20	.17
				9	.29	.22	.18	.28	.22	.18	.26	.21	.17	.14
				10	.26	.20	.16	.25	.19	.15	.23	.18	.15	.12

47  Radial batwing distribution—four lamp, 610 mm (2') wide fluorescent unit with flat prismatic lens	V	1.7	0	.71	.71	.71	.63	.69	.69	.66	.66	.66	.60
			1	.62	.60	.58	.61	.59	.57	.59	.57	.55	.51
			2	.55	.51	.47	.53	.50	.47	.51	.48	.46	.42
			3	.48	.43	.39	.47	.43	.39	.45	.41	.38	.36
			4	.42	.37	.33	.41	.37	.33	.40	.36	.32	.30
			5	.37	.32	.27	.36	.31	.27	.35	.30	.27	.25
			6	.33	.27	.23	.32	.27	.23	.31	.26	.23	.21
			7	.29	.24	.20	.29	.24	.20	.28	.23	.20	.18
			8	.26	.21	.17	.25	.20	.17	.25	.20	.17	.15
			9	.23	.18	.14	.23	.18	.14	.22	.17	.14	.13
			10	.21	.16	.12	.20	.16	.12	.20	.15	.12	.11
48  Two-lamp fluorescent strip unit	I	1.6/1.2	0	1.01	1.01	1.01	.96	.96	.96	.87	.87	.87	.68
			1	.85	.81	.77	.81	.77	.73	.73	.70	.67	.53
			2	.73	.66	.61	.69	.63	.58	.63	.58	.54	.42
			3	.63	.56	.50	.60	.53	.48	.55	.49	.44	.35
			4	.56	.47	.41	.53	.46	.40	.48	.42	.37	.29
			5	.49	.40	.34	.46	.39	.33	.42	.36	.31	.24
			6	.43	.35	.29	.41	.34	.28	.38	.31	.26	.20
			7	.39	.31	.25	.37	.29	.24	.34	.27	.23	.17
			8	.34	.27	.21	.33	.26	.21	.30	.24	.19	.15
			9	.31	.23	.18	.30	.23	.18	.27	.21	.17	.12
			10	.28	.21	.16	.27	.20	.16	.25	.19	.15	.11
49  Two-lamp fluorescent strip unit with 235° reflector fluorescent lamps	I	1.4/1.2	0	1.13	1.13	1.13	1.09	1.09	1.09	1.01	1.01	1.01	.85
			1	.96	.92	.88	.93	.89	.85	.87	.83	.80	.68
			2	.83	.76	.70	.80	.74	.68	.75	.69	.65	.55
			3	.73	.65	.58	.70	.63	.57	.66	.59	.54	.46
			4	.64	.55	.49	.62	.54	.48	.58	.51	.46	.39
			5	.56	.47	.41	.55	.46	.40	.51	.44	.38	.33
			6	.50	.41	.35	.49	.40	.34	.46	.38	.33	.28
			7	.45	.36	.30	.44	.35	.30	.41	.34	.28	.24
			8	.40	.32	.26	.39	.31	.25	.37	.30	.25	.21
			9	.36	.28	.22	.35	.27	.22	.33	.26	.21	.18
			10	.33	.25	.20	.32	.24	.19	.30	.23	.19	.15

(continued)

TABLE 20.2 Coefficients of Utilization for Typical Luminaires with Suggested Maximum Spacing Ratios (*continued*)

Typical Luminaire	Typical Distribution and Percent Lamp Lumens	Maintenance Category	Maximum SHR Guide	RCR	ρ_{cc}	80			70			50			0
					ρ_w	50	30	10	50	30	10	50	30	10	0
						Coefficients of Utilization for 20% Effective Floor Cavity Reflectance (ρ_{FC} = 20)									
50				1		.42	.40	.39	.36	.35	.33	.25	.24	.23	Coves are not recommended for lighting areas having low reflectances
				2		.37	.34	.32	.32	.29	.27	.22	.20	.19	
				3		.32	.29	.26	.28	.25	.23	.19	.17	.16	
				4		.29	.25	.22	.25	.22	.19	.17	.15	.13	
				5		.25	.21	.18	.22	.19	.16	.15	.13	.11	
				6		.23	.19	.16	.20	.16	.14	.14	.12	.10	
				7		.20	.17	.14	.17	.14	.12	.12	.10	.09	
Single-row fluorescent lamp cove without reflector, multiplied by 0.93 for two rows and by 0.85 for three rows.				8		.19	.15	.12	.16	.13	.10	.11	.09	.08	
				9		.1	.13	.10	.15	.11	.09	.10	.08	.07	
				10		.15	.12	.09	.13	.10	.08	.09	.07	.06	
															ρ_{cc} = 10%
					ρ_w =										50 30 10
53 ρ_{cc} from below ~45%				1								.51	.49	.48	.47 .46 .45
				2								.46	.44	.42	.43 .42 .40
				3								.42	.39	.37	.39 .38 .36
				4								.38	.35	.33	.36 .34 .32
				5								.35	.32	.29	.33 .31 .29
				6								.32	.29	.26	.30 .28 .26
Louvred ceiling. Ceiling efficiency ~50%; 45° shielding opaque louvres of 80% reflectance. Cavity with minimum obstructions and painted with 80% reflectance paint—use ρ_{cc} = 50.				7								.29	.26	.23	.28 .25 .23
				8								.27	.23	.21	.26 .23 .21
				9								.24	.21	.19	.24 .21 .19
				10								2	.19	.17	.22 .19 .17

NOTES:
1. Data extracted from *IES Handbook* (1981), Reference Volume, with permission.
2. Multiply by 1.05 for three lamps and 1.1 for two lamps.

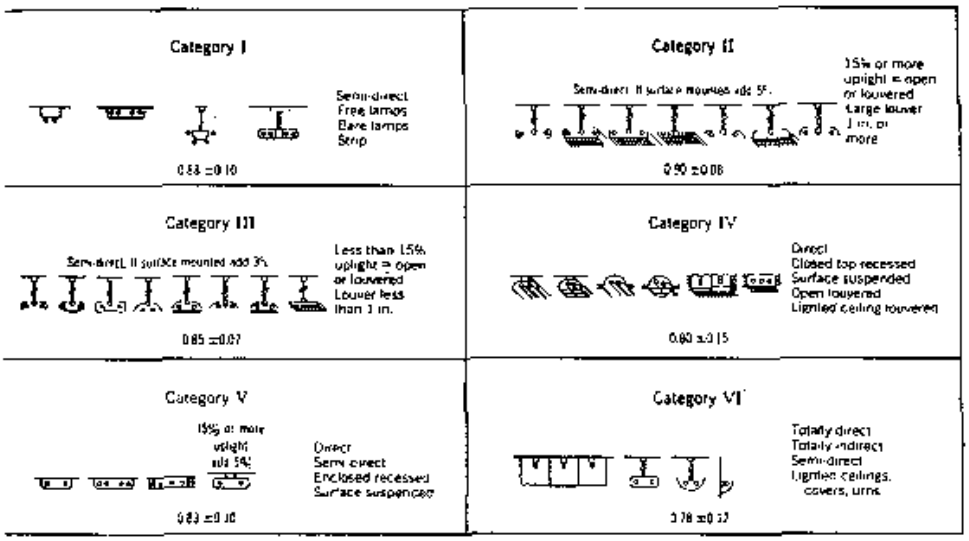


Fig. 20.36 The LDD factor is determined from the category of luminaire, which is an indication of its proneness to dirt accumulation, plus a knowledge of room ambient conditions.

ditions of dirt and maintenance. The categories correspond to those of the IES.

Total LLF is the product of all the depreciation factors above, that is,

$$\text{LLF} = a \times b \times c \times d \times e \times f \times g \times h$$

For example, a fluorescent air troffer in a regularly maintained group-lamp-replacement, air-conditioned office might typically have an LLF of

$$\text{LLF} = 1.1 \times 1 \times 0.92 \times 1 \times 0.95 \times 0.9 \times 1.0 \times 0.93 = 0.80$$

The same fixture in the same office, but with walls and fixture cleaned only when replacing burned-out lamps would typically have an LLF of

$$\text{LLF} = 1.1 \times 1 \times 0.92 \times 1 \times 0.87 \times 0.85 \times 0.95 \times 0.78 = 0.55$$

Thus, if in the first case the maintained illumination is E fc, in the second case it is $0.55/0.80$ or $0.69E$fc, that is, a reduction of 31% as a result of poor maintenance. When a detailed determination of light loss factor is not possible, use the factors given in Section 20.33. They are somewhat more conservative than those given in Section 20.5c.

20.31 Determination of Coefficient of Utilization (CU) by the Zonal Cavity Method

The coefficient of utilization connects a particular fixture to a particular space, by relating the luminaire's light distribution characteristic to the room size and its surface reflectances. To account for the luminaire's mounting height and its relationship to the working plane, the space is divided into three cavities: the ceiling cavity above the fixture, the floor cavity below the working plane, and the room cavity between the two (see Fig. 20.37). Given the surface reflectances, the effective reflectances of the floor and ceiling cavities can be obtained. With these, the CU can be selected from the tables (either Table 20.2 or manufacturer's data) and the lumen formula (equation 20.3 above) applied to arrive at average illuminance. A step-by-step explanation of the method plus illustrative examples will demonstrate the procedure. The reader should follow the steps with the flow chart in Fig. 20.38 and the calculation form in Fig. 20.39.

STEP 1. First, dimensional data are recorded. In offices, schools, and many other occupancies

Lamp Abbreviation	Lamp Data: Lamp (W)	Diameter (in)	Length (in)	Lamp Current (mA)	Ballast (W)[b,c]	Total Watts[c]	Lamp Life (h)[d]	Initial Output (lm)[e]	Lumens at 40% Life	Initial Actual Efficacy (lm/W)[f]	Remarks
Preheat lamps[a]											
F-15 T-8 CW	15	8/8	18	430	8	23	7,500	870	765	38	Cool white
F-20 T-12 WW	20	12/8	24	430	10	30	9,000	1,300	1,155	43	Warm white
Rapid-start—preheat lamps[g]											
F40 T-12 CW	40	12/8	48	430	7.5	46	20,000 +	3,150	2,770	68	
F40 T-12 WW	40	12/8	48	430	7.5	46	20,000 +	3,200	2,815	70	Warm white
F40 T-12 CWX	40	12/8	48	430	7.5	46	20,000 +	2,250	1,855	49	Cool white deluxe
F40 T-12 D	40	12/8	48	430	7.5	46	20,000 +	2,600	2,290	57	Daylight
F40 T-12/C50	40	12/8	48	430	7.5	46	20,000 +	2,200	1,890	48	5000 K color
F40 T-12/C75	40	12/8	48	430	7.5	46	20,000 +	2,000	1,720	44	7500 K color
F40 T-12/U	40	12/8	--	430	7.5	46	12,000	2,900	2,525	55	"U" shape[h]
Rapid start—high output											
F48 T-12 CW/HO	60	12/8	48	800	12.5	72.5	12,000	4,300	3,740	55	
F60 T-12 CW/HO	75	12/8	60	800	15	90	12,000	5,400	4,700	60	
F72 T-12 CW/HO	85	12/8	72	800	22.5	107.5	12,000	6,650	5,785	62	
F96 T-12 CW/HO	110	12/8	96	800	18.5	128.5	12,000	9,200	8,005	72	
Rapid-start—very high output											
F48 PG-17 CW	110	12/8	48	1500	5	125	12,000	6,900	5,100	55	G.E. Power Groove[i]
F72 PG-17 CW	165	12/8	72	1500	10	175	12,000	11,500	8,510	66	G.E. Power Groove[i]
F96 PG-17 CW	215	12/8	96	1500	10	225	12,000	16,000	12,160	71	G.E. Power Groove[i]
Instant-start (Slimline) lamps											
F42 T-6 CW	25	6/8	42	200	10.5	35.5	7,500	1,750	1,490	49	
F64 T-6 CW	40	6/8	64	200	9	49	7,500	2,800	2,350	57	
F24 T-12 CW	20	12/8	24	430	14	34	7,500	1,150	1,035	34	
F36 T-12 CW	30	12/8	36	430	13	43	7,500	2,000	1,800	47	Warm white
F48 T-12 CW	40	12/8	48	430	12	52	9,000	3,000	2,760	58	
F72 T-12 CW	55	12/8	72	430	11	66	12,000	4,550	4,275	69	
F96 T-12 CW	75	12/8	96	430	13	85	12,000	6,300	5,800	74	

[a]Data given for a preheat circuit.

[b]Figures are for a two-lamp circuit.

[c]ANSI figures.

[d]Life figures are for 3-h burning per start.

[e]After 100-h burning.

[f]Includes ballast loss.

[g]Data given for lamps in a rapid-start circuit.

[h]U-shaped lamps available with 3⅝- or 6-in. leg spacing; all other characteristics equal.

Table WRKSTN-D7: Reflectance Factors for Surface Color[3]

Color	Reflectance	Color	Reflectance
White	85		
Light:		Dark:	
Cream	75	Gray	30
Gray	75	Red	13
Yellow	75	Brown	10
Buff	70	Blue	8
Green	65	Green	7
Blue	55		
Medium:		Wood Finish:	
Yellow	65	Maple	42
Buff	63	Satinwood	34
Gray	55	English Oak	17
Green	52	Walnut	16
Blue	35	Mahogany	12

Table WRKSTN-D8: Techniques for Controlling Glare[4]

To Control Direct Glare	To Control Indirect Glare (Veiling Reflections and Reflected Glare)
Position luminaires, the lighting units, as far from the operator's line of sight as is practical	Avoid placing luminaires in the indirect-glare offending zone (see Figure VC–2)
Use several low-intensity luminaires instead of one bright one	Use luminaires with diffusing or polarizing lenses
Use luminaires that produce a batwing light distribution*, and position workers so that the highest light level comes from the sides, not front and back	Use surfaces that diffuse light, such as flat paint, non-gloss paper, and textured finishes
Use luminaires with louvers or prismatic lenses	Change the orientation of a workplace, task, viewing angle, or viewing direction until maximum visibility is achieved
Use indirect lighting	
Use light shields, hoods, and visors at the workplace if other methods are impractical	

* The effectiveness of the batwing distribution varies with the orientation of the workplace and worker. It can also be used to control indirect glare, because maximum output is in the arc between approximately 35° to 45° angles.

Examples of ways to control direct glare (column 1) and indirect glare (column 2) at the workplace are given. These methods include design approaches that can be used when installing the lighting, as well as interventions that can be made after glare has been identified in a workplace.

LAMPIRAN 13

(Tabel Data Anthropometri Orang Indonesia)

Tabel 5.3

Antropometri masyarakat Indonesia yang didapat dari interpolasi masyarakat British dan Hongkong (Pheasant, 1986) terhadap masyarakat Indonesia (Suma'mur, 1989) serta istilah dimensionalnya dari (Nurmianto, 1991a ;Nurmianto, 1991b).

Dimana : G_x = nilai rata-rata (mean), T = nilai standar deviasi (SD), 5% = nilai 5 persentil, 95% = nilai 95 persentil

DIMENSI TUBUH	PRIA				WANITA			
	5%	X	95%	S.D	5%	X	95%	S.D
1. Tinggi Tubuh Posisi berdiri Tegak	1.532	1.632	1.732	61	1.464	1.563	1.662	60
2. Tinggi Mata	1.425	1.520	1.615	58	1.350	1.446	1.542	58
3. Tinggi Bahu	1.247	1.338	1.429	55	1.184	1.272	1.361	54
4. Tinggi Siku	932	1.003	1.074	43	886	957	1.028	43
5. Tinggi Genggaman Tangan *(Knuckle)* pada Posisi Relaks kebawah	655	718	782	39	646	708	771	38
6. Tinggi Badan pada Posisi Duduk	809	864	919	33	775	834	893	36
7. Tinggi Mata pada Posisi Duduk	694	749	804	33	666	721	776	33
8. Tinggi Bahu pada Posisi Duduk	523	572	621	30	501	550	599	30
9. Tinggi siku pada Posisi Duduk	181	231	282	31	175	229	283	33
10. Tebal Paha	117	140	163	14	115	140	165	15
11. Jarak dari Pantat ke Lutut	500	545	590	27	488	537	586	30
12. Jarak dari Lipat Lutut *(popliteal)* ke Pantat	405	450	495	27	488	537	586	30
13. Tinggi Lutut	448	496	544	29	428	472	516	27
14. Tinggi Lipat Lutut *(popliteal)*	361	403	445	26	337	382	428	28
15. Lebar Bahu *(bideltoid)*	382	424	466	26	342	385	428	26
16. Lebar Punggul	291	331	371	24	298	345	392	29
17. Tebal Dada	174	212	250	23	178	228	278	30
18. Tebal Perut *(abdominal)*	174	228	282	33	175	231	287	34
19. Jarak dari Siku ke Ujung Jari	405	439	473	21	374	409	287	34
20. Lebar Kepala	140	150	160	6	135	146	157	7
21. Panjang Tangan	161	176	191	9	158	168	185	9
22. Lebar Tangan	71	79	87	5	64	71	78	4
23. Jarak Bentang dari Ujung Jari Tangan Kiri ke Kanan	1.520	1.663	1.806	87	1.400	1.523	1.646	75
24. Tinggi Pegangan Tangan *(grip)* pada Posisi Tangan Vertikal ke Atas & Berdiri Tegak	1.795	1.923	2.051	78	1.713	1.841	1.969	79
25. Tinggi Pegangan Tangan *(grip)* pada Posisi Tangan Vertikal ke Atas & Duduk	1.065	1.169	1.273	63	945	1.030	1.115	52
26. Jarak Genggaman Tangan *(grip)* ke Punggung pada Posisi Tangan ke Depan (horisontal)	649	708	767	37	610	661	712	31

LAMPIRAN 14

(Tabel Bilangan Random)

Tabel Bilangan Acak

39	65	76	45	45	19	90	69	64	61	20	26	36	34	62	58	24	97	14	97	95	06	70	99	00
73	71	23	70	90	65	97	60	12	11	31	56	34	19	19	47	83	75	52	33	30	61	38	20	46
72	20	47	33	84	51	67	47	97	19	98	40	07	17	66	23	05	09	51	80	59	78	11	52	49
75	17	25	69	17	17	95	21	78	58	24	33	45	77	48	69	81	84	09	29	92	22	70	45	80
37	48	79	88	74	63	52	06	34	30	01	31	60	10	27	35	07	79	71	53	28	99	52	01	41
02	89	08	16	94	85	53	83	29	95	56	27	09	24	43	21	78	59	09	82	72	61	88	73	61
87	18	15	70	07	37	79	49	12	38	48	13	93	55	96	41	92	45	71	51	09	18	25	58	94
98	83	71	70	15	89	09	39	59	24	00	06	41	41	20	14	36	59	25	47	54	45	17	24	89
10	06	58	07	04	76	62	16	48	68	58	76	17	14	86	59	53	11	52	21	66	04	18	72	87
47	90	56	37	31	71	82	13	50	41	27	55	10	24	92	28	04	67	53	44	95	23	00	84	47
93	05	31	93	07	34	18	04	52	35	74	13	39	35	22	68	95	23	92	35	86	63	70	35	33
21	89	11	47	99	11	20	99	45	18	76	51	94	84	86	13	79	93	37	55	98	16	04	41	67
95	18	94	06	97	27	37	83	28	71	79	57	95	13	91	09	64	87	25	21	56	20	11	32	44
97	08	31	55	73	10	65	81	92	59	77	31	61	95	46	20	44	90	32	64	26	99	76	75	63
69	26	88	86	13	59	71	74	17	32	48	38	75	93	29	73	37	32	04	05	60	82	29	20	25
41	47	10	25	03	87	63	93	95	17	81	83	83	04	49	77	45	85	50	51	79	88	01	98	30
93	94	14	63	62	08	61	74	51	69	92	79	43	89	79	29	18	94	51	23	14	86	11	47	23
80	06	54	18	47	08	52	85	08	40	48	40	35	94	22	72	65	71	08	86	50	03	42	99	36
67	72	77	63	99	89	85	84	46	06	64	71	06	21	66	89	37	20	70	01	61	65	70	22	12
59	40	24	13	75	42	29	72	23	19	06	94	76	10	08	81	30	15	39	14	81	83	17	16	33
63	62	06	34	41	79	53	36	02	95	94	61	09	43	62	20	21	14	68	86	94	95	48	46	45
78	47	23	53	90	79	93	96	38	63	34	85	52	05	09	85	43	01	72	73	14	94	87	81	40
87	68	62	15	43	97	48	72	66	48	53	16	71	13	81	59	97	50	99	52	24	62	20	42	31
47	60	92	10	77	26	97	05	73	51	88	46	38	03	58	72	68	49	29	31	75	70	16	08	24
56	88	87	59	41	06	87	37	78	48	65	88	69	58	39	88	02	84	27	83	85	81	56	39	38
22	17	68	65	84	87	01	22	57	51	68	69	80	95	44	11	29	01	95	80	49	34	35	86	47
19	36	27	59	46	39	77	32	77	09	79	57	92	36	59	89	74	39	82	15	08	58	94	34	74
16	77	23	02	77	28	06	24	25	93	22	45	44	84	11	87	80	61	65	11	09	71	91	74	25
78	43	76	71	61	97	67	63	99	61	80	45	67	93	82	59	73	19	85	23	54	33	65	97	21
03	28	28	26	08	69	30	16	09	05	53	58	47	70	93	66	56	45	65	79	45	56	20	19	47
04	31	17	21	56	33	73	99	19	87	26	72	39	27	67	53	77	57	68	93	60	61	97	22	61
61	06	98	03	91	87	14	77	43	96	43	00	65	98	50	45	60	33	01	07	98	99	46	50	47
23	68	35	26	00	99	53	93	61	28	52	70	05	48	34	56	65	05	61	86	90	92	10	70	80
15	39	25	70	99	93	86	52	77	65	15	33	59	05	28	22	87	26	07	47	86	96	98	29	06
58	71	96	30	24	18	46	23	34	27	85	13	99	24	44	49	18	09	79	49	74	16	32	23	02
93	22	53	64	39	07	10	63	76	35	87	03	04	79	88	08	18	13	85	31	35	34	57	72	69
78	76	58	54	74	92	38	70	96	92	52	06	79	79	45	82	63	18	27	44	69	66	92	19	09
61	81	31	96	82	00	57	25	60	59	46	72	60	18	77	55	66	12	62	11	08	99	55	64	57
42	88	07	10	05	24	98	65	63	21	47	21	61	88	32	27	80	30	21	60	10	92	35	36	12
77	94	30	05	39	28	10	99	00	27	12	73	73	99	12	49	99	57	94	82	96	88	57	17	91

LAMPIRAN 15

(Tabel MTM - 1)

REACH

Distance Moved Inches	Time TMU				Hand in Motion		Case and Description
	A	B	C or D	E	A	B	
3/4 or less	2	2	2	2	1.6	1.6	A Reach to object in fixed location
1	2.5	2.5	3.6	2.4	2.3	2.3	or to object in other hand or on
2	4	4	5.9	3.8	3.5	2.7	which other hand rests
3	5.3	5.3	7.3	5.3	4.5	3.6	
4	6.1	6.4	8.4	6.8	4.9	4.3	B Reach to single object in location
5	6.5	7.8	9.4	7.4	5.3	5	which may vary slightly from
6	7	8.6	10.1	8	5.7	5.7	cycle to cycle
7	7.4	9.3	10.8	8.7	6.1	6.5	
8	7.9	10.1	11.5	9.3	6.5	7.2	C Reach to object jumbled with
9	8.3	10.8	12.2	9.9	6.9	7.9	other objects in a group so that
10	8.7	11.5	12.9	10.5	7.3	8.6	search and select occur
12	9.6	12.9	14.2	11.8	8.1	10.1	
14	10.5	14.4	15.6	13	8.9	11.5	D Reach to a very small object
16	11.4	15.8	17	14.2	9.7	12.9	or where accurate grasp is
18	12.3	17.2	18.4	15.5	10.5	14.4	required
20	13.1	18.6	19.8	16.7	11.3	15.8	
22	14	20.1	21.2	18	12.1	17.3	E Reach to indefinite location to
24	14.9	21.5	22.5	19.2	12.9	18.8	get hand in position for body
26	15.8	22.9	23.9	20.4	13.7	20.2	balance or next motion or
28	16.7	24.4	25.3	21.7	14.5	21.7	out of way
30	17.5	25.8	25.7	22.9	15.3	23.2	
Additional	0.4	0.7	0.7	0.6			TMU per inch over 30 inches

MOVE

Distance Moved Inches	Time TMU				Wt Allowance			Case and Description
	A	B	C	Hand In Motion B	Wt. (lb.) Up to	Dynamic Factor	Static Constant TMU	
3/4 or less	2	2	2	1.7				
1	2.5	2.9	3.4	2.3	2.5	1	0	A Move object to other hand or against stop
2	3.6	4.6	5.2	2.9				
3	4.9	5.7	6.7	3.6	7.5	1.06	2.2	
4	6.1	6.9	8	4.3				
5	7.3	8	9.2	5	12.5	1.11	3.9	
6	8.1	8.9	10.3	5.7				
7	8.9	9.7	11.1	6.5	17.5	1.17	5.6	
8	9.7	10.6	11.8	7.2				
9	10.5	11.5	12.7	7.9	22.5	1.22	7.4	B Move object to approximate or indefinite location.
10	11.3	12.2	13.5	8.6				
12	12.9	13.4	15.2	10	27.5	1.28	9.1	
14	14.4	14.6	16.9	11.4				
16	16	15.8	18.7	12.8	32.5	1.33	10.8	
18	17.6	17	20.4	14.2				
20	19.2	18.2	22.1	15.6	37.5	1.39	12.5	
22	20.8	19.4	23.8	17				
24	22.4	20.6	25.5	18.4	42.5	1.44	14.3	
26	24	21.8	27.3	19.8				C Move object to exact location
28	25.5	23.1	29	21.2	47.5	1.5	16	
30	27.1	24.3	30.7	22.7				
Additional	0.8	0.6	0.85		TMU per inch over 30 inches			

GRASP

Type of Grasp	Case	Time TMU	Description	
Pick-up	1a	2	Any size object by itself, easily grasped	
	1b	3.5	Object very small or lying close againt a flat surface	
	1c1	7.3	Diameter larger than 1/2 "	Interference with Grasp
	1c2	8.7	Diameter 1/4 " to 1/2 "	on Bottom & one side of
	1c3	10.8	Diameter less than 1/4 "	nearly cylindrical object
Regrasp	2	5.6	Change grasp without relinguishing control	
Transfer	3	5.6	Control transferred from one hand to the other	
Select	4a	7.3	Larger than 1 " X 1 " X 1 "	Object jumbled with
	4b	9.1	1/4"X1/4"X1/8" to 1"X1"X1"	other object so that
	4c	12.9	Smaller than ¼"X1/4"X1/8"	Search and select occur
Contact	5	0	Contact, Sliding or Hook Grasp	

RELEASE

Case	Time TMU	Description
1	2	Normal release performanced by opening fingers as independent motion
2	0	Contact Release

POSITION

	Class of Fit	Symmetry	Easy to handle	Difficult to handle
1-loose	No pressure required	S	5.6	11.2
		SS	9.1	14.7
		NS	10.4	16
2-Close	Light pressure required	S	16.2	21.8
		SS	19.7	25.3
		NS	21	26.6
3-Exact	Heavy pressure required	S	43	48.6
		SS	46.5	52.1
		NS	47.8	53.4
Supplementary rule for surface aligment				
P1SE per aligment : > 1/16 <= 1/4 "		P2SE per aligment : <= 1/16 "		

Distance moved to engage - 1 " or less

DISENGAGE

Class of Fit	Height of Record	Easy to Handle	Difficult to Handle
1 - Loose - Very slight effort, blends with subsequent move	Up to 1 "	4	5.7
2 - Close - Normal effort, slight recoil	Over 1 " to 5 "	7.5	11.8
3 - Tight - Considerable effort, hand recoils markedly	Over 5 " to 12 "	22.9	34.7

TURN

Weight	Time TMU for degree turned										
	30	45	60	75	90	105	120	135	150	165	180
Small - 0 to 2 pounds	2.8	3.5	4.1	4.8	5.4	6.1	6.8	7.4	8.1	8.7	9.4
Medium - 2.1 to 10 pounds	4.4	5.5	6.5	7.5	8.5	9.6	10.6	11.6	12.7	13.7	14.8
Large - 10.1 to 35 pounds	8.4	10.5	12.3	14.4	16.2	18.3	20.4	22.2	24.3	26.1	28.2

CRANK

Diameter of Cranking (inches)	TMU (T) per Revolution	D	T
1	8.5	9	14
2	9.7	10	14.4
3	10.6	11	14.7
4	**11.4**	12	15
5	12.1	14	15.5
6	12.7	16	16
7	13.2	18	16.4
8	13.6	20	16.7

EYE TRAVEL & EYE FOCUS

Eye Travel Time = 15.2 X (T/D) TMU, with a maximum value of 20 TMU

Where T = the distance between points from and to which the eye travels.

D = the perpendivular distance from the eye to the line of travel T.

Eye Focus Time = 7.3 TMU

Supplementary Information

Area of Normal Vision = Circle 4 " in Diameter 16 " from eye.

Reading Formula = 5.05 N Where N = The Number of Words.

APPLY PRESSURE

Full Cycle			Components		
Symbol	TMU	Description	Symbol	TMU	Description
APA	10.6	AF + DM + RLF	AF	3.4	Apply Force
APB	16.2		DM	4.2	Dwell Minimum
			RLF	3.0	Release Force

WALK

	Nominal	Small	Medium	Large
	s/d 5 lbs	> 5 & « 35 lbs	> 35 & « 50 lbs	> 50 lbs
	34 "/langkah	30" /langkah	24 " / langkah	17 " / langkah
W_P	15	15	15	17
W_Po	17	17	17	17
W_FT	5.3	6	7.5	8.5
W_FTo	6	6.8	8.5	8.5

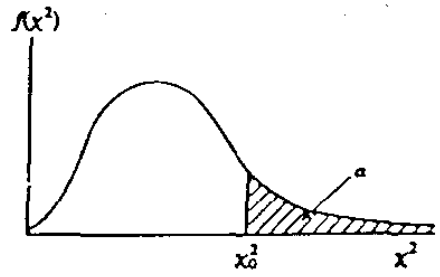
BODY, LEG & FOOT MOTION

Type		Symbol	TMU	Distance
Leg - Foot Motion		FM	8.5	To 4 "
		FMP	19.1	To 4 "
		LM	7.1	To 6 "
			1.2	add/inch
Motion	Side Step	SSC1		< 12 "
			17	12 "
			0.6	add/inch
		SSC2	34.1	12 "
			1.1	add/inch
	Turn Body	TBC1	18.6	
		TBC2	37.2	
Horizontal	Walk	W FT	5.3	per foot
		W P	15	per pace
		W PO	17	per pace
Vertikal Motion		SIT	34.7	
		STD	43.4	
		B,S,KOK	29	
		AB,AS,AKOK	31.9	
		KBK	69.4	
		AKBK	76.7	

LAMPIRAN 16

(Tabel Distribusi Normal)

Table B-4 The χ^2 Distribution



Given ν, the table gives the χ^2_0 value with α of the area above it; that is,

$P(\chi^2 \geq \chi^2_0) = \alpha$

ν \ α	0.995	0.990	0.975	0.950	0.900	0.500	0.100	0.050	0.025	0.010	0.005
1	0.00	0.00	0.00	0.00	0.02	0.45	2.71	3.84	5.02	6.63	7.88
2	0.01	0.02	0.05	0.10	0.21	1.39	4.61	5.99	7.38	9.21	10.60
3	0.07	0.11	0.22	0.35	0.58	2.37	6.25	7.81	9.35	11.34	12.84
4	0.21	0.30	0.48	0.71	1.06	3.36	7.78	9.49	11.14	13.28	14.86
5	0.41	0.55	0.83	1.15	1.61	4.35	9.24	11.07	12.83	15.09	16.75
6	0.68	0.87	1.24	1.64	2.20	5.35	10.65	12.59	14.45	16.81	18.55
7	0.99	1.24	1.69	2.17	2.83	6.35	12.02	14.07	16.01	18.48	20.28
8	1.34	1.65	2.18	2.73	3.49	7.34	13.36	15.51	17.53	20.09	21.96
9	1.73	2.09	2.70	3.33	4.17	8.34	14.68	16.92	19.02	21.67	23.59
10	2.16	2.56	3.25	3.94	4.87	9.34	15.99	18.31	20.48	23.21	25.19
11	2.60	3.05	3.82	4.57	5.58	10.34	17.28	19.68	21.92	24.72	26.76
12	3.07	3.57	4.40	5.23	6.30	11.34	18.55	21.03	23.34	26.22	28.30
13	3.57	4.11	5.01	5.89	7.04	12.34	19.81	22.36	24.74	27.69	29.82
14	4.07	4.66	5.63	6.57	7.79	13.34	21.06	23.68	26.12	29.14	31.32
15	4.60	5.23	6.27	7.26	8.55	14.34	22.31	25.00	27.49	30.58	32.80
16	5.14	5.81	6.91	7.96	9.31	15.34	23.54	26.30	28.85	32.00	34.27
17	5.70	6.41	7.56	8.67	10.09	16.34	24.77	27.59	30.19	33.41	35.72
18	6.26	7.01	8.23	9.39	10.87	17.34	25.99	28.87	31.53	34.81	37.16
19	6.84	7.63	8.91	10.12	11.65	18.34	27.20	30.14	32.85	36.19	38.58
20	7.43	8.26	9.59	10.85	12.44	19.38	28.41	31.41	34.17	37.57	40.00
21	8.03	8.90	10.28	11.50	13.24	20.38	29.62	32.67	35.48	38.93	41.40
22	8.64	9.54	10.98	12.34	14.04	21.34	30.81	33.92	36.78	40.29	42.80
23	9.26	10.20	11.69	13.09	14.85	22.34	32.01	35.17	38.08	41.64	44.18
24	9.89	10.86	12.40	13.85	15.66	23.34	33.20	36.42	39.36	42.98	45.56
25	10.52	11.52	13.12	14.61	16.47	24.34	34.38	37.65	40.65	44.31	46.93
26	11.16	12.20	13.84	15.38	17.29	25.34	35.56	38.89	41.92	45.64	48.29
27	11.81	12.88	14.57	16.15	18.11	26.34	36.74	40.11	43.19	46.96	49.65
28	12.46	13.57	15.31	16.93	18.94	27.34	37.92	41.34	44.46	48.28	50.99
29	13.12	14.26	16.05	17.71	19.77	28.34	39.09	42.56	45.72	49.59	52.34
30	13.79	14.95	16.79	18.49	20.60	29.34	40.26	43.77	46.98	50.89	53.67
40	20.71	22.16	24.43	26.51	29.05	39.34	51.80	55.76	59.34	63.69	66.77
50	27.99	29.71	32.36	34.76	37.69	49.33	63.17	67.50	71.42	76.15	79.49
70	43.28	45.44	48.76	51.74	55.33	69.33	85.53	90.53	95.02	100.42	104.22
100	67.33	70.06	74.22	77.93	82.36	99.33	118.50	124.34	129.56	135.81	140.17

LAMPIRAN 17

(Tabel Perhitungan Faktor Kelonggaran "Usulan")

- Tabel Perhitungan Faktor Kelonggaran "Usulan" Stasiun *Expand*
- Tabel Perhitungan Faktor Kelonggaran "Usulan" Stasiun *Forming* 2A
- Tabel Perhitungan Faktor Kelonggaran "Usulan" Stasiun *Forming* 2B
- Tabel Perhitungan Faktor Kelonggaran "Usulan" Stasiun *Machining*

Faktor Kelonggaran "Usulan" Stasiun *Expand*

Variabel kelonggaran	Keadaan	Nilai kelonggaran (%)
Tenaga yang dikeluarkan	Sangat ringan	6
Sikap kerja	Berdiri diatas satu kaki	2.5
Gerakan kerja	Agak terbatas	2
Kelelahan mata	Pandangan yang hampir terus menerus	6
Keadaan temperatur tempat kerja	Normal	2
Keadaan atmosfer	Baik	1
Keadaan lingkungan yang baik	Siklus kerja berulang 0-5 detik	1
Kebutuhan pribadi	Operator pria	2.5
Hambatan tak terhindarkan	Tidak ada	0
Total		23.00

Faktor Kelonggaran "Usulan" Stasiun *Forming* 2A

Variabel kelonggaran	Keadaan	Nilai kelonggaran (%)
Tenaga yang dikeluarkan	Dapat diabaikan	4
Sikap kerja	Duduk	1
Gerakan kerja	Agak terbatas	2
Kelelahan mata	Pandangan yang hampir terus menerus	6
Keadaan temperatur tempat kerja	Normal	2
Keadaan atmosfer	Baik	1
Keadaan lingkungan yang baik	Siklus kerja berulang 0-5 detik	1
Kebutuhan pribadi	Operator pria	2.5
Hambatan tak terhindarkan	Ada	0
Total		19.50

Faktor Kelonggaran "Usulan" Stasiun *Forming* 2B

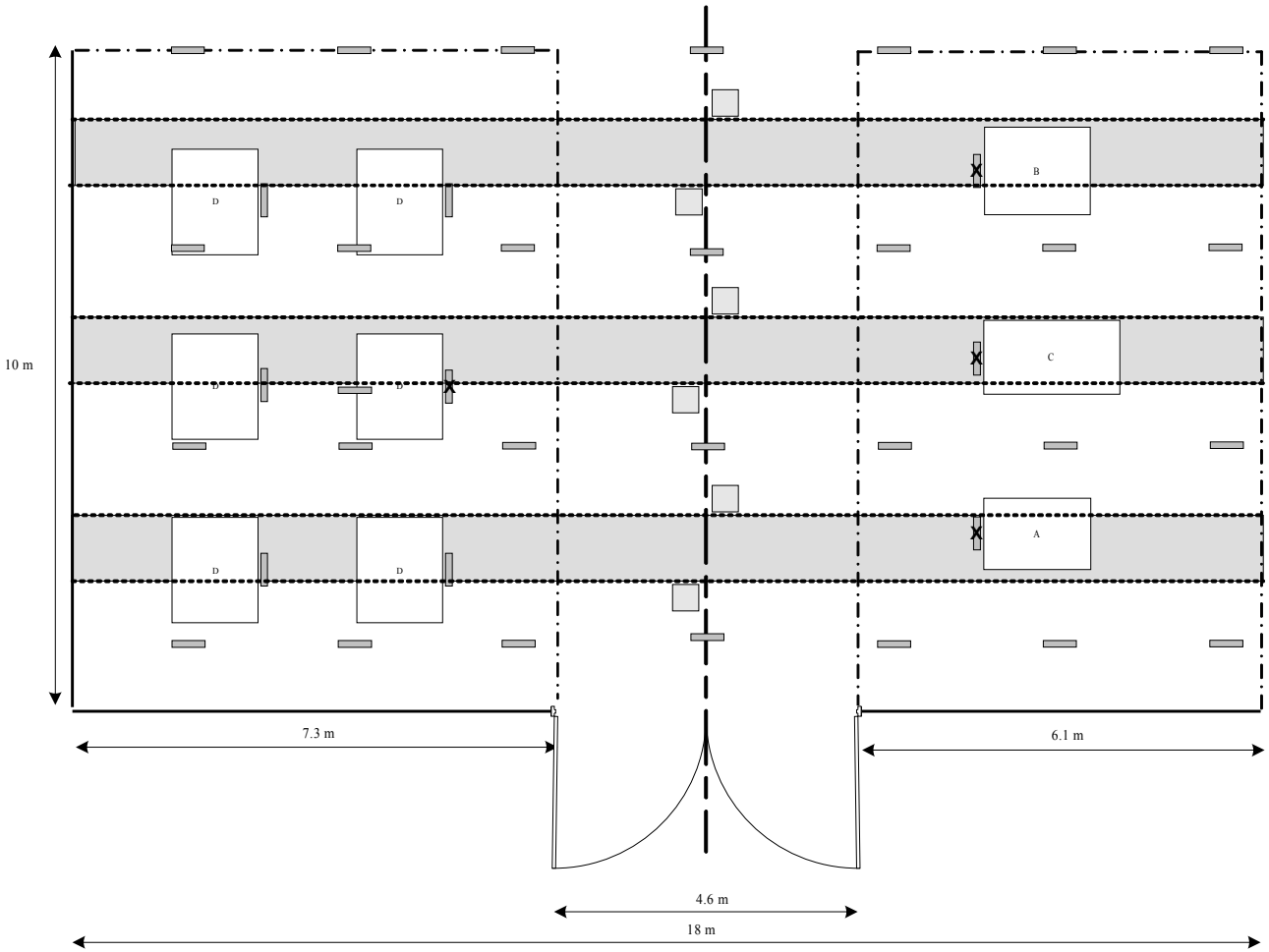
Variabel kelonggaran	Keadaan	Nilai kelonggaran (%)
Tenaga yang dikeluarkan	Dapat diabaikan	4
Sikap kerja	Duduk	1
Gerakan kerja	Agak terbatas	2
Kelelahan mata	Pandangan yang hampir terus menerus	6
Keadaan temperatur tempat kerja	Normal	2
Keadaan atmosfer	Baik	1
Keadaan lingkungan yang baik	Siklus kerja berulang 0-5 detik	1
Kebutuhan pribadi	Operator pria	2.5
Hambatan tak terhindarkan	Tidak ada	0
Total		19.50

Faktor Kelonggaran "Usulan" Stasiun *Machining*

Variabel kelonggaran	Keadaan	Nilai kelonggaran (%)
Tenaga yang dikeluarkan	Dapat diabaikan	4
Sikap kerja	Duduk	1
Gerakan kerja	Agak terbatas	2
Kelelahan mata	Pandangan yang hampir terus menerus	6
Keadaan temperatur tempat kerja	Normal	2
Keadaan atmosfer	Baik	1
Keadaan lingkungan yang baik	Siklus kerja berulang 0-5 detik	1
Kebutuhan pribadi	Operator pria	2.5
Hambatan tak terhindarkan	Tidak ada	0
Total		19.50

LAMPIRAN 18

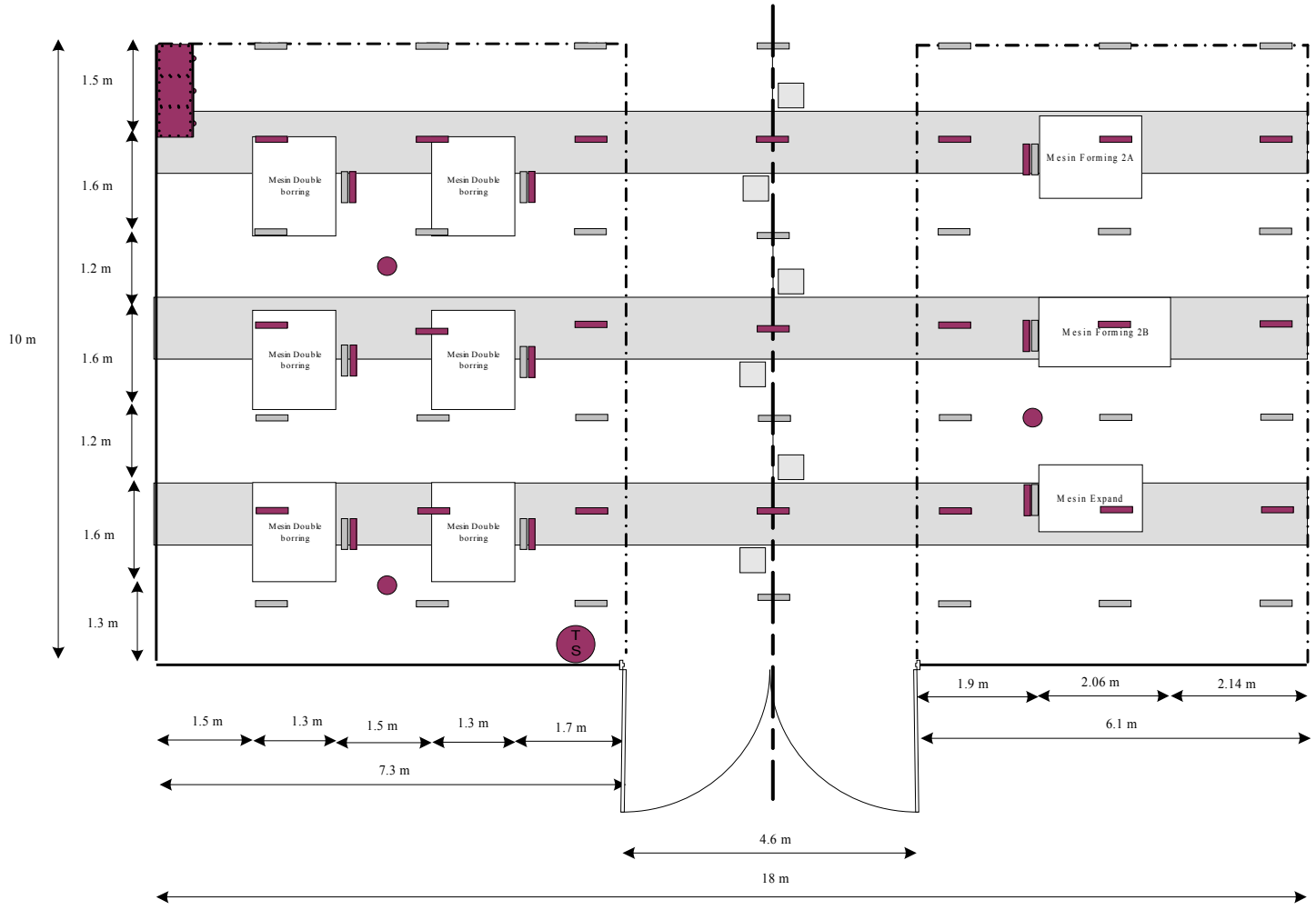
(Layout keseluruhan letak pengukuran lampu)



Skala 1 : 100

LAMPIRAN 19

(Layout Keseluruhan“Usulan”)


1.5 m
1.6 m
1.2 m
1.6 m
1.2 m
1.6 m
1.3 m
10 m
Mesin Double borring
Mesin Double borring
Mesin Double borring
Mesin Double borring
Mesin Double borring
Mesin Double borring
Mesin Forming 2A
Mesin Forming 2B
Mesin Expand
T
S
1.5 m
1.3 m
1.5 m
1.3 m
1.7 m
7.3 m
1.9 m
2.06 m
2.14 m
6.1 m
4.6 m
18 m

Skala 1 : 200