Penerapaan ventilasi industri di suatu area kerja

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AGENDA PEMBAHASAN

Universitas Esa Unggul

Contoh Desain Ventilasi Industri di Pabrik Asbes

1.1 DATA AWAL

I. Idustri asbestos, dengan jenis bahan serat crysotile

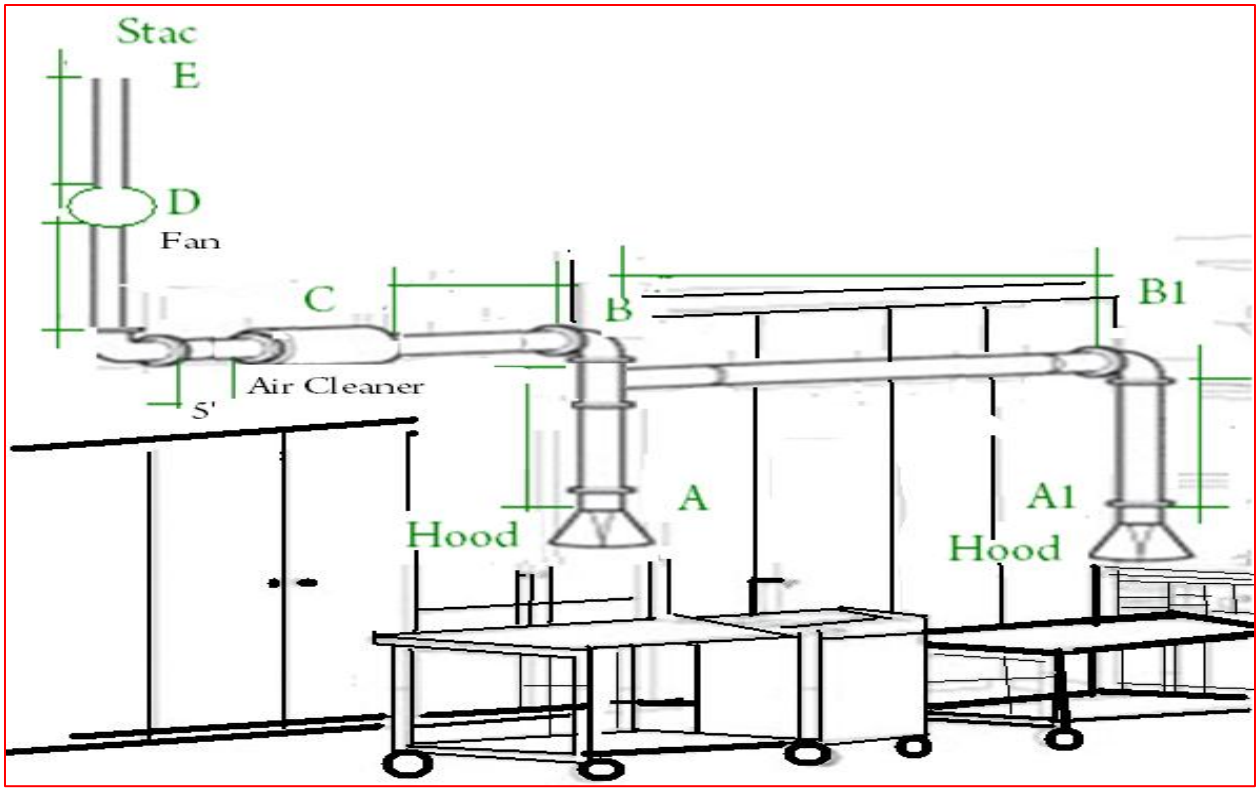
2. Unit produksi pada unit Crusing, dengan data sebagai berikut :

- Tipe hood enclosure
- Generatian rate ---------- 200 fiber/cc/60 menit
- TLV-TVWA (asbestos ---------- 2 fiber/cc
- Faktor K ---------- 2
- Volume ruang (8 x 7 x 3 = 168 m^3)-------.....5.880 ft^3
- Air flow slots velocity ---------- 400 fpm
- Duct velocity ---------- 3.500. fpm

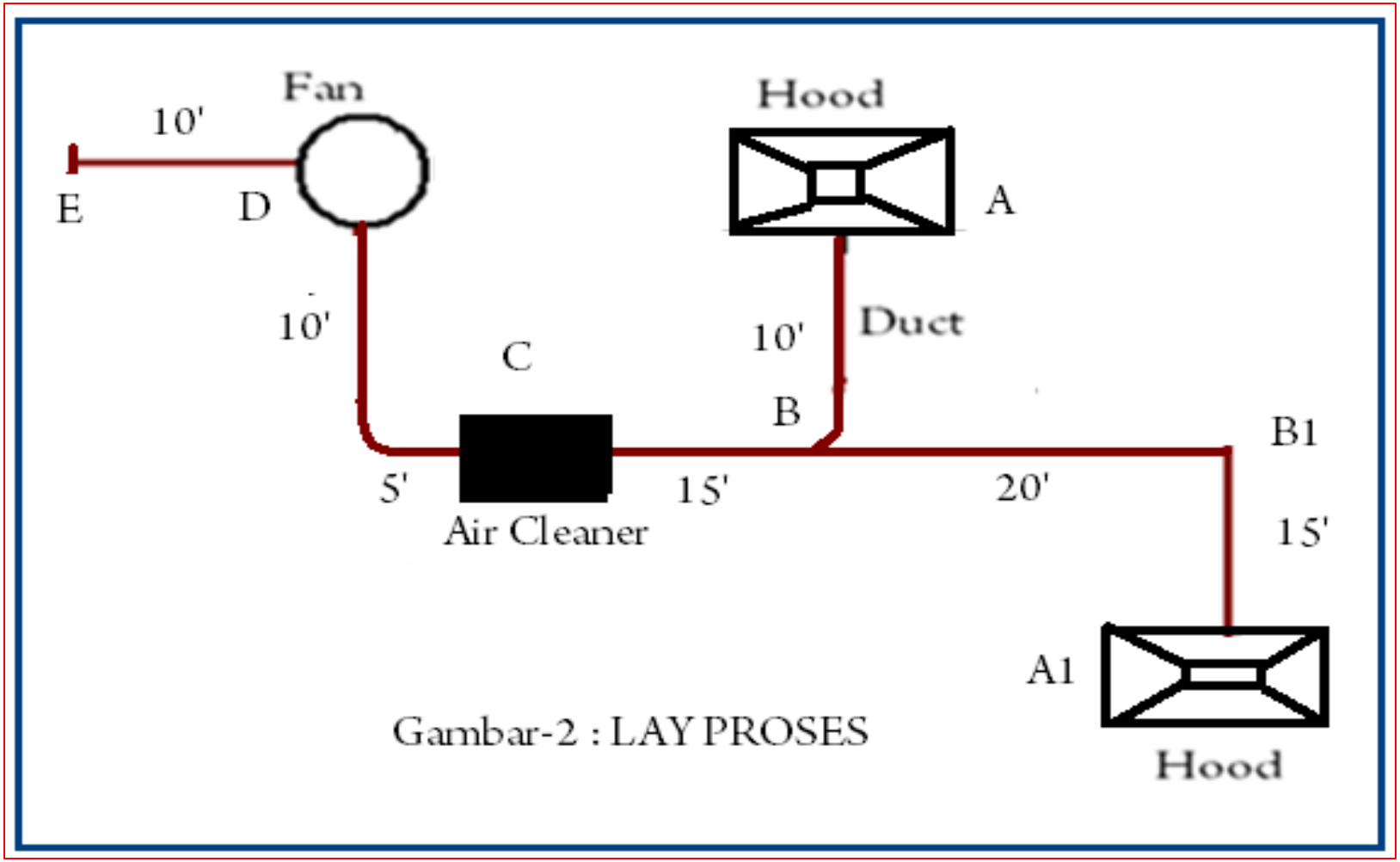
3. Elbow
   - R/D = 2
   - loss coefisient: ---------- 0,24
4. Entry
   - Entry sudut Ø = 30^0
   - Entry loss coefisien ---------- 0,28

1.2. BENTUK DAN LAY PROSES OPERASI RUANG KERJA

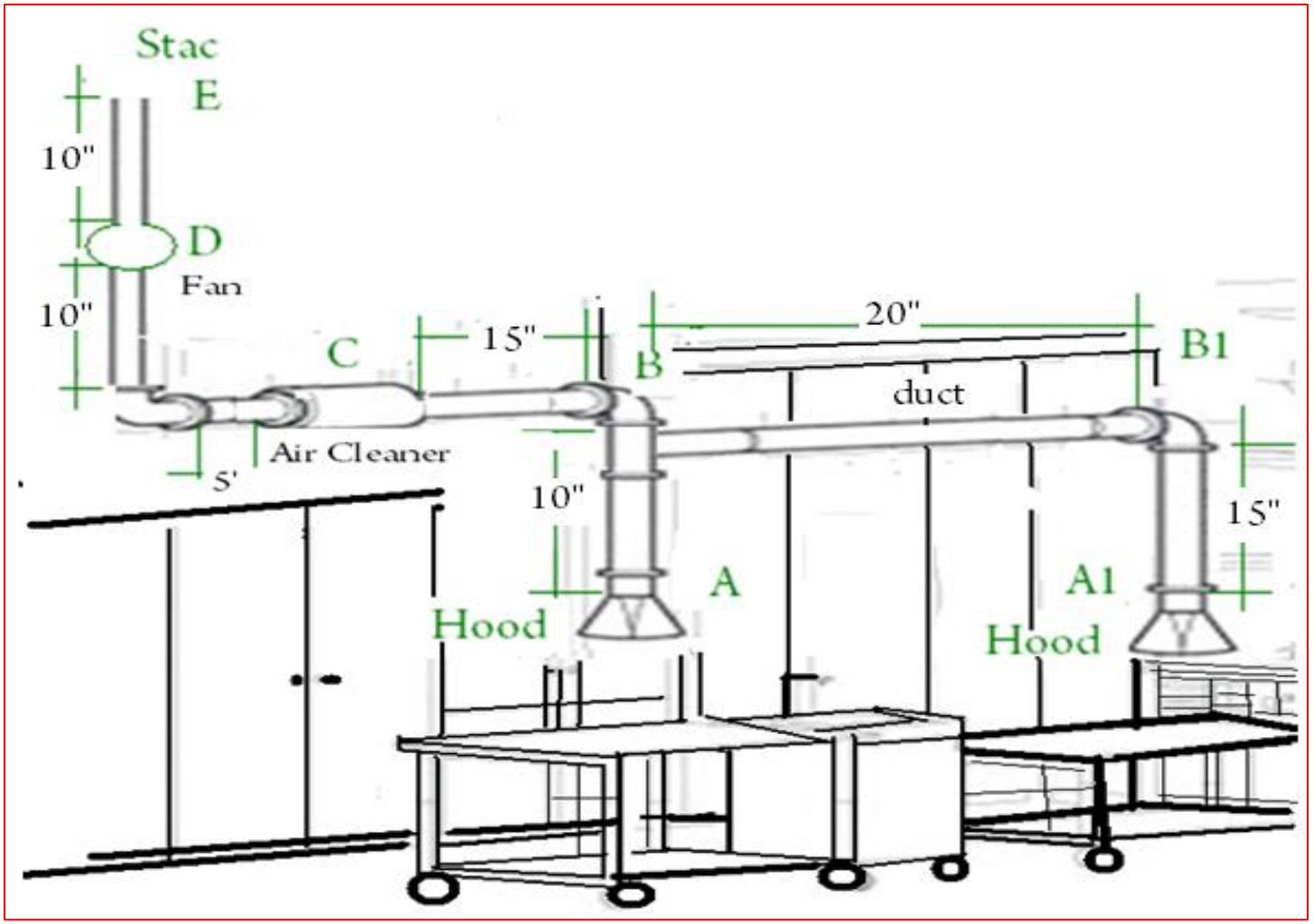
Pertimbangan desain sangat tergantung bentuk dan lay out peores operasi, ruang kerja dan bentuk kontruksi bangunan



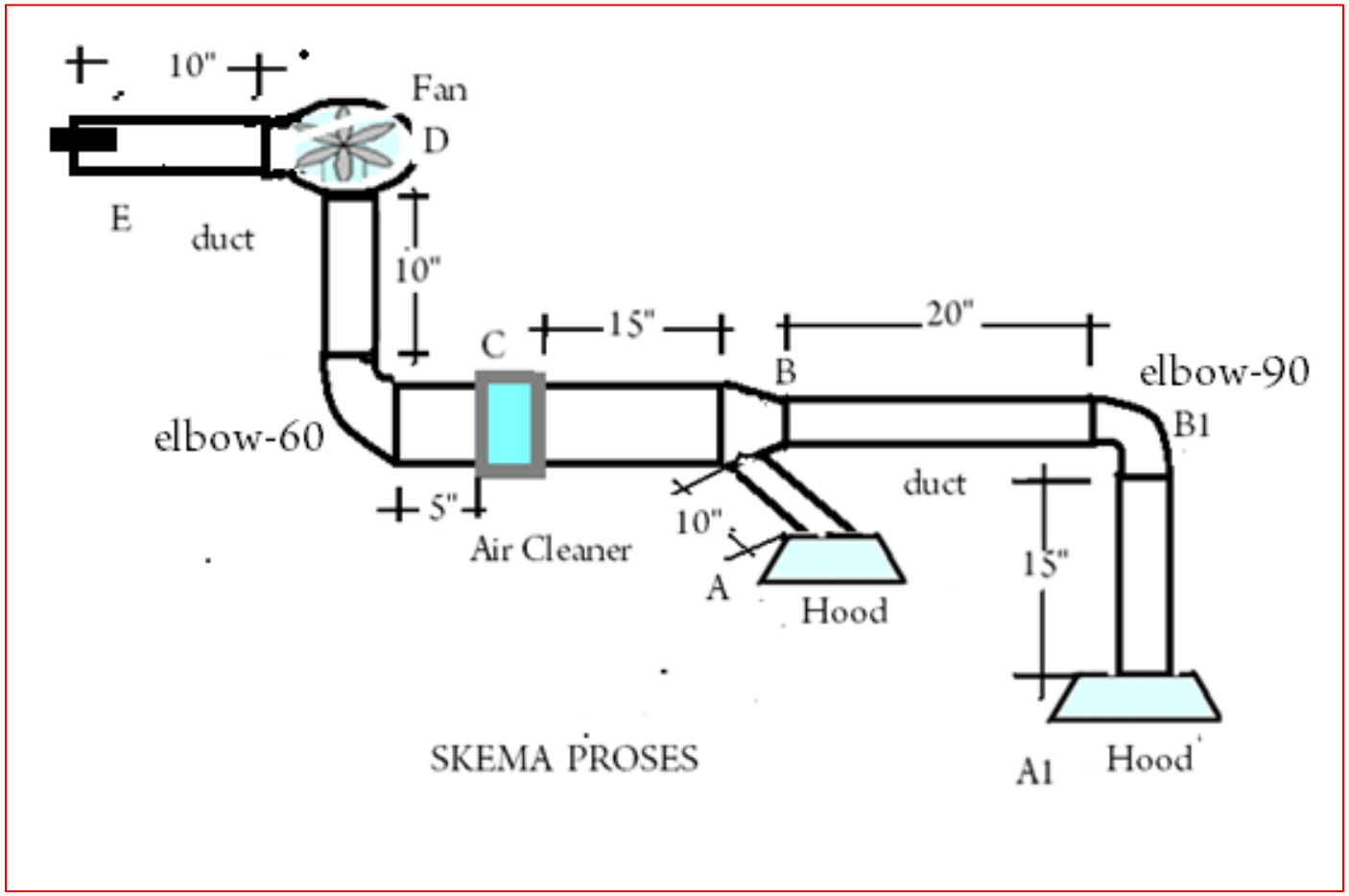
Gambar -1 : BENTUK KONTRUKSI BANGUNAN



Gambar – 2 : SKEMA SISTEM SALURAN PIPA



Gambar- 3 : UKURAN LAY PROSES OPERASI



Gambar – 4 : BENTUK DESAIN VENTILASI

2.2.. PENENTUAN DEMENSI

Dari data awal yang diketahui dan bentuk dan ukuran kontruksi bangunan pada gambar 1 s/d gambar 4, maka ditetapkann sebagai berikut, pada table- 1.1.

Tabel- 1.1. Ukuran nomor detail, flow rate, diameter dan panjang pipa , elbow dan enteries

Nomor Detail	Cfm Required	Duct Diameter inches	Panjang/ Strainght Run, ft	Elbows	Entries
A1-B1	4500	19	15		
B1-B	4500	19	20		
A1- B	4500	19	35	$1 - 90^0$	$1 - 30^0$
A – B	3600	13.	10	$1 - 30^0$	$1 - 30^0$
B – C	19.600	29	15		
C (air cleaner)					
C – D	19.600	29	15	$1 - 60^0$	$1 - 30^0$
D (fan)	19.600	33			
D – E	19.600	30.	10		

II. PENENTUAN UKURAN –UKURAN UTAMA

2.1. PENENTUAN FLOW RATE SUPLAY (Q)

Untukmenghitung flow rate di gunakan rumus :

$$Q = \frac{\text{volume ruang x generation rate x K}}{\text{TLV}}$$

$$Q = \frac{(5.880 \text{ x} 200)/60 \text{ x } 2}{2}$$

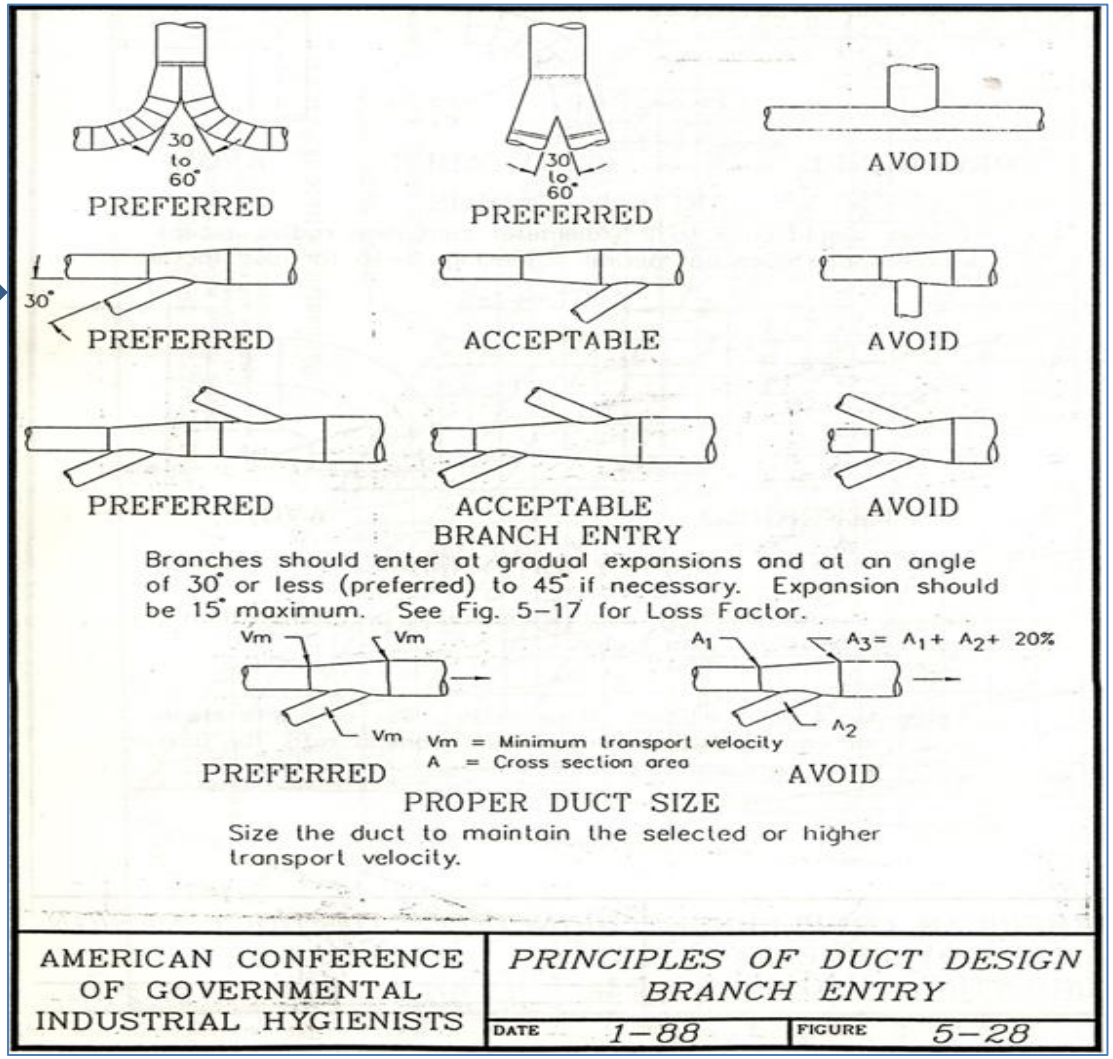
Q = 19.600 cfm

Dimana :

Volume ruang	=	5.880 ft^3
TLV	=	2 fiber/cc
Generatian rate	=	200 fiber/cc/60 menit
Faktor K	=	2

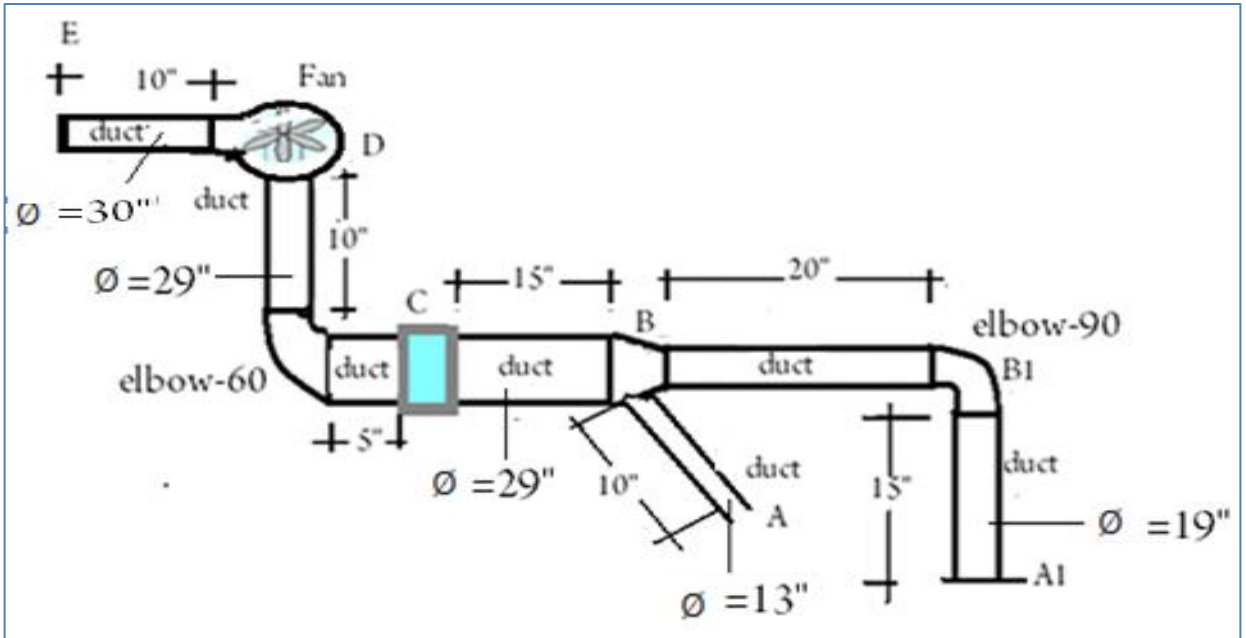
3.2. PEMELIHAN ALTERNATIF BRANCH ENTRY

Pemilihan alternative bentuk brach entry tergantung pada bentuk kontruksi, saluran pipa yang dinginkan , pada desain ini diambil bentuk prefereddengan sudut maximal $\theta = 30^0$, gambar 5.28 indutrial ventilation ACGIH edition 20. Ukuran data yang diambil seprti digambarkan pada Gambar – 6,



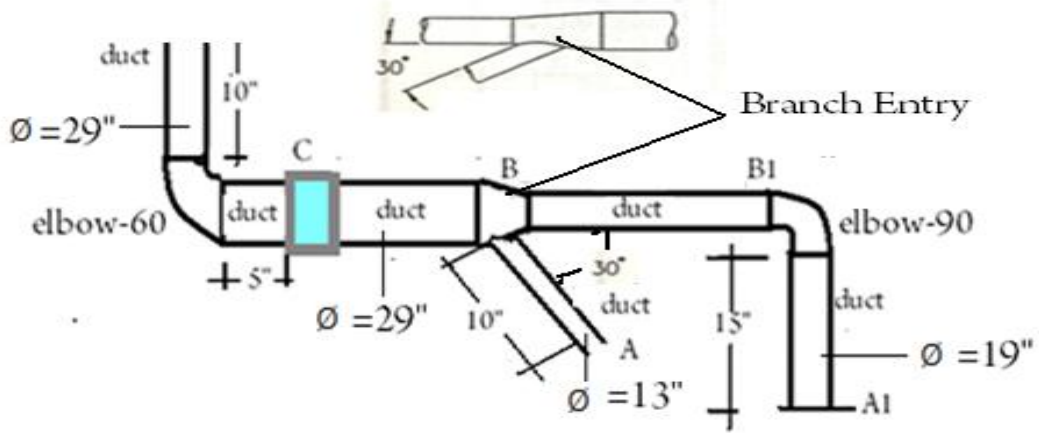
III. DESAIN PROSEDUR

3.1. DESAIN DUCT

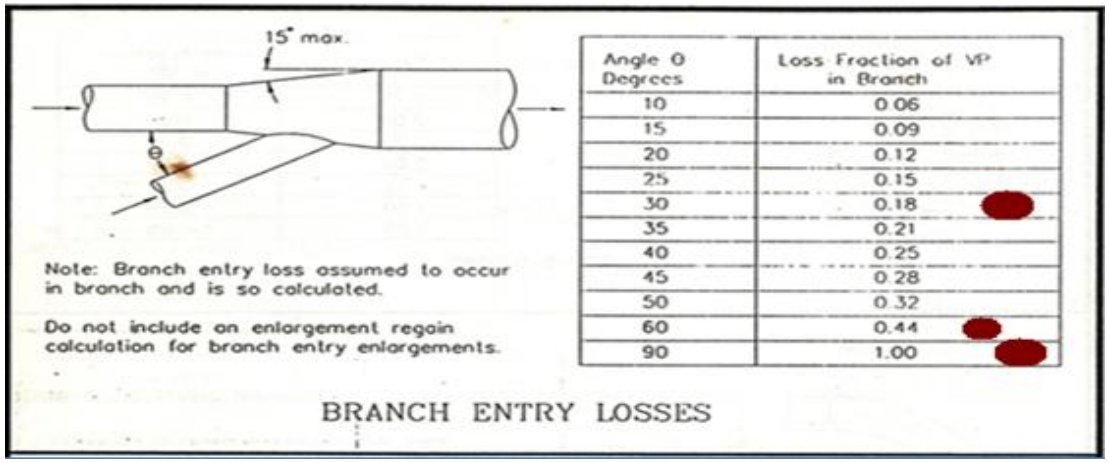


Gambar - 5 : POTONGAN

UKURAN	POTONGAN				
	A1 – B	A – B	B – C	C - D	D - E
Diameter (inci)	19	13	29	29	30
Panjang (ft)	35	10	15	15	10



Gambar - 6 : BRANCH ENTRY

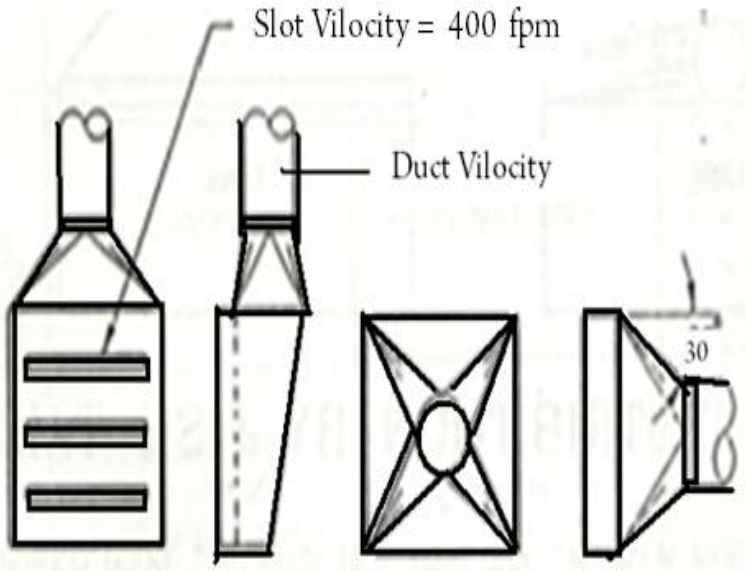


Angle θ Degrees	Loss Fraction of VP in Branch
10	0.06
15	0.09
20	0.12
25	0.15
30	0.18
35	0.21
40	0.25
45	0.28
50	0.32
60	0.44
90	1.00

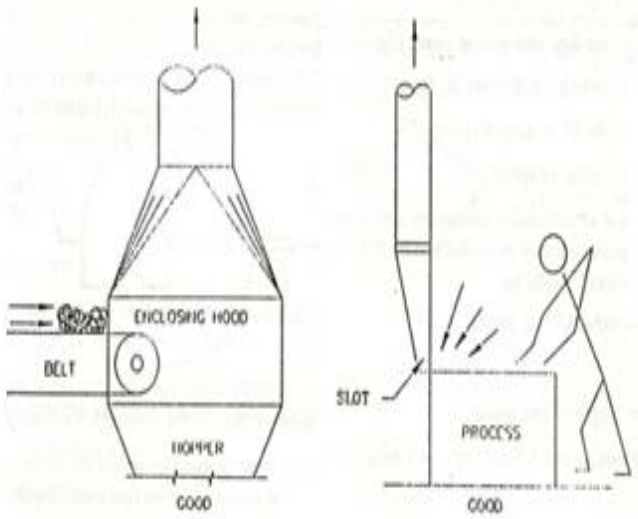
BRANCH ENTRY LOSSES

Nomor Detail	Elbows	Entries	Los friction
A1- B	1- 90^0	1 - 30^0	1,00
A – B	1 - 30^0	1 - 30^0	0,18
C – D	1-60^0	1 - 30^0	0,44

3.3.. DESAIN DETAIL HOOD - SLOT



Gambar - 7 : DETAIL HOOD - SLOT



Gambar- 8 : TIPE HOOD ENCLOSURE

IV. PERHITUNGAN

Metode perhitungan yang digunakan dalam desain ini adalah menggunakan metode desain Perhitungan Kecepatan Tekanan atau Velocity Pressure Method Calculation Sheet

4.1. METODE KECEPATAN TEKANAN

Dari hasil perhitungan yaitu untuk mengetahui distribusi volume flow rate, duct velocity, slot velocity, slot static pressure, hood static pressure, duct SP loss, dan qumulatif static pressure, Fan SP dan Fan TP. Denagan data hasil perhitungan besar daya , dan putaran Fan yang akan digunakan.

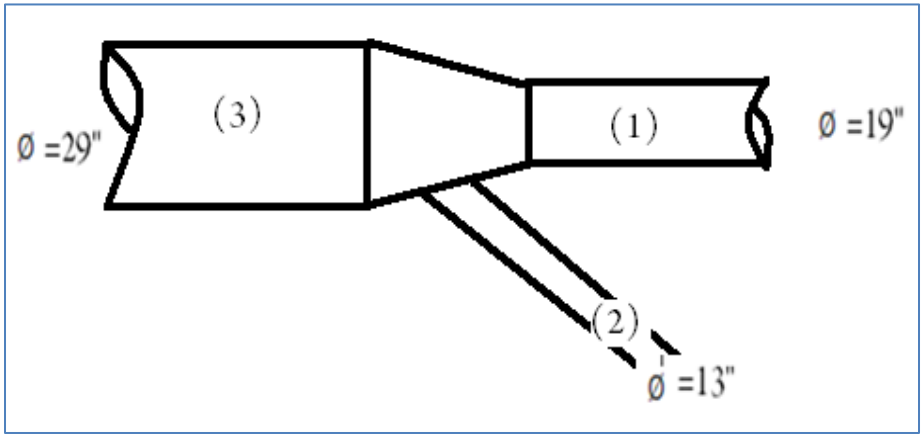
4.1.1. Hasil Perhitungan

Velocity Pressure Method Calculation Sheet

Plant Name: _ **CONTOH TUGAS** Elevation: _____ Date: __15 januari 2011_____
Location: _____ Temp: _____ Drawing #.:_____
Department: _____+ Factor: _____ Designer: _____

					A1-B	A-B	B - C	C	C - D	D	D-E
1	Duct Segment Identification				A1-B	A-B	B - C	C	C - D	D	D-E
2	Target Volume Flowrate, Q = V*A- Chap 10			cfm	4500.0	3600.0	19600.0	19600.0	19600.0	19600.0	19600.0
3	Min. Transport Velocity, V Chap 10			fpm	3500	3500					
4	Maximum Duct Diameter (D= ((4*144*Q)/(pi			inches	19.00	13.00	29.00	A	29.00	33.00	30.00
5	Selected Duct Diameter			inches	19.00	9.00	29.00	I	29.00		30.00
6	Duct Area (pi*(D/12)^2/4)			sq. ft	1.9689	0.9218	4.5869	R	4.5869	5.9396	4.9087
7	Actual Duct Velocity			fpm	2285.5	3905.6	4273.0		4273.0	3299.9	3992.9
8	Duct Velocity Pres, VP = (V/4005)^2			"wg	0.3256	0.9510	1.1383	C	1.1383	0.6789	0.9940
9	H		Maximum Slot Area = (2/11)	sq ft				L			
10	O		Slot area selected	sq ft				E		F	
11	O	S	Slot Velocity, Vs Chap 10	fpm	400.00	400.00		A		A	
12	D	L	Slot Velocity Pres, VPs=(Vs/4005)^2	"wg	0.0100	0.0100		N		N	
13		O	Slot Loss Coefficient, Chap 10, Chap 3		1.78	1.78		E			
14		T	Acceleration Factor	0 or 1	0	0		R			
15	S	S	Slot Loss per VP (13+14)		1.78	1.78					
16	U		Slot Static Pressure (12*15)	"wg	0.0178	0.0178					
17	C	Duct Entry Loss Factor F5-12, Chap 10			0.250	0.250	0.250		0.250		0.250
18	T	Acceleration Factor (1 at hoods)		1 or 0	1	1	1		1		1
19	I	Duct Entry Loss per VP (17 + 18)			1.25	1.25	1.25		1.25		1.25
20	O	Duct Entry Loss (8 * 19)		"wg	0.407	1.189	1.423		1.423		1.242
21	N	Other Losses		"wg				0.400			
22		Hood Static Pressure SPh (16+20+21)		"wg	0.425	1.206	1.423	0.400	1.423		1.242
23	Straight Duct Length			ft	35.0	10.0	15.0		15.0		10.0
24	Friction Factor (Hf)				0.0110	0.0168	0.0062		0.0062		0.0060
25	Friction Loss per VP (23 * 24)				0.3853	0.1679	0.0937		0.0937		0.0602
26	No. of 90 degree Elbows				1.00	0.18			0.44		
27	Elbow Loss Coefficient (Bottom of Page)				0.24	0.24			0.24		
28	Elbow Loss per VP (26*Loss Factor)(bottom of page)				0.2400	0.0432			0.1056		
29	No. of Branch Entries			(1 or 0)	1.00	1.00	1.00		1.00		1.00
30	Entry Loss Coefficient				0.28	0.28	0.28		0.28		0.28
31	Entry Loss per VP (29*Loss Factor) (Branch)				0.28	0.28	0.28		0.28		0.28
32	Special Fittings Loss Factors										
33	Duct Loss per VP (25 + 28 + 31 + 32)				0.9053	0.4911	0.3737		0.4793		0.3402
34	Duct Loss (8*33)				0.2948	0.4670	0.4253		0.5455		0.3382
35	Duct SP Loss (22 + 34)				0.720	1.674	1.848	0.400	1.968		1.581
36	Other Losses										
37	Cumulative Static Pressure			"wg	-0.720	-1.674	-1.848	-2.248	-4.216		5.797
38	Governing Static Pressure (at TO location)			"wg	-1674.000	-1.848					
39	Corrected Volumetric Flowrate			cfm							
40	Corrected Velocity			fpm							
41	Corrected Velocity Pressure			"wg							
42	Resultant Velocity Pressure			"wg							

4.1.2. Hasil Perhitungan Brach Entry



No, Duct	Diameter (inci	Duct Area (sq.ft)	Q (cfm)	V (fpm)	VP (“wg)	SP (‘wg)
(1)`= A1 – B	19	1,9689	4500	2285,5	0,3256	-0,720
(2) = A – B	13	0,9218	3600	3905,6	0,9510	-1,674
(3) = B - C	29	4,5869	19.600	4273,0	1,1383	-1,848

FSP-------8,8747 “wg			BHP ---- 10,14 hp	
FTP-------9,8687 “wg			RPM ----- 1894	
Daun Propeler/jumlah blades (n) = 3			Hz	
Data	Bln, Januari	Th, 2011	Dapertemen	Produksi

V. PERHITUNGAN DAYA FAN

Data yang diperlukan untukmenentukan besarnya daya HP= House Power dan Putaran (rpm), Fan yang digunakan dalam desain ini adalah :

- ✓ N = jumlah blades,
- ✓ Q=volumemetric flow rate,
- ✓ FSP = Fan Static Pressure,
- ✓ FTP = Fan Total Pressure

Rumus yang digunakan sebagai berikut :

$$FSP = SP_{out\ let} - SP_{in\ let} - VP_{inlet}$$

$$FTP = FSP + VP_{out\ let}$$

$$BHP = (FTP * Q)/(6356*n)$$

Dari hasil perhitungan pada hasil perhitungan dengan data sbb :

- $SP_{out\ let}$ = 5, 797 “wg
- $SP_{in\ let}$ = - 4,216 “ wg
- $VP_{in\ let}$ = 1,1383 “wg
- $VP_{out\ let}$ = 0,9940 “wg
- Q =19.600 cfm
- N = 3

FSP = 5,797 – (-4,216) – 1,1383

FSP = 8,8747 “wg

FTP = 8,8747 + 0,9940

FTP = 9,8687 “wg

$$BHP = \frac{(9,8687 \times 19.600)}{(6356 \times 3)}$$

BHP = 10,14 HP

RPM = 1894

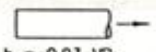
Untuk BHP = 10,14 HP nilai RPM diambil pada (table 6.1. Example of multi rating table, Buku Industrial Ventilatin ACGIH 20 th ediion 1988)

TABLE 6-1. Example of Multi-Rating Table

Inlet diameter: 13" O.D. | Wheel diameter: 22⅝"
Outlet area: .930 sq. ft. inside | Wheel circumference: 5.92 ft.

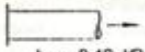
CFM	OV	2"SP		4"SP		6"SP		8"SP		10"SP		12"SP		14"SP		16"SP		18"SP		20"SP		22"SP	
		RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
930	1000	843	0 57	1176	1 21	1434	1 93	1653	2 75	1846	3 64	2021	4 59	2184	5 62	2333	6 68	2475	7 81	2610	9 01	2738	10 2
1116	1200	853	0 67	1183	1 35	1439	2 12	1656	2 98	1848	3 90	2022	4 89	2182	5 95	2333	7 07	2473	8 23	2606	9 45	2733	10 7
1302	1400	866	0 77	1191	1 51	1445	2 33	1660	3 22	1852	4 20	2025	5 23	2183	6 31	2333	7 47	2474	8 68	2606	9 95	2731	11 2
1488	1600	882	0 89	1201	1 69	1453	2 56	1668	3 50	1857	4 51	2030	5 59	2188	6 72	2337	7 92	2474	9 13	2606	10 4	2734	11 8
1674	1800	899	1 01	1213	1 88	1463	2 81	1676	3 81	1863	4 86	2035	5 98	2194	7 16	2340	8 38	2479	9 67	2610	11 0	2735	12 4
1860	2000	917	1 14	1227	2 09	1474	3 09	1685	4 13	1872	5 24	2040	6 39	2199	7 62	2344	8 89	2484	10 2	2613	11 6	2735	13 0
2046	2200	937	1 29	1242	2 32	1484	3 37	1694	4 48	1879	5 63	2048	6 84	2206	8 13	2351	9 43	2487	10.8	2618	12 2	2741	13 6
2232	2400	961	1 45	1257	2 56	1497	3 68	1704	4 85	1889	6 07	2056	7 33	2212	8 64	2357	10 0	2493	11 4	2622	12 8	2745	14 3
2418	2600	984	1 62	1275	2 81	1513	4 02	1717	5 25	1900	6 53	2065	7 84	2222	9 22	2364	10 6	2501	12 1	2631	13 6	2750	15 1
2790	3000	1038	2 02	1313	3 36	1543	4 73	1744	6 11	1924	7 52	2088	8 96	2241	10 4	2383	12 0	2517	13 5	2644	15 1	2766	16 7
3162	3400	1099	2 50	1358	3 99	1580	5 52	1775	7 05	1952	8 60	2115	10 2	2265	11 8	2405	13 4	2538	15 1	2665	16 8	2783	18 5
3534	3800	1164	3 07	1407	4 69	1620	6 37	1812	8 09	1984	9 79	2144	11 5	2290	13 3	2428	15 0	2562	16 8	2684	18 6	2803	20 5
3906	4200	1232	3 75	1462	5 48	1665	7 31	1851	9 19	2018	11 0	2174	12 9	2320	14 8	2458	16 8	2587	18 7	2708	20 6	2825	22 5
4278	4600	1306	4 56	1520	6 39	1717	8 38	1894	10 4	2058	12 4	2209	14 5	2355	16 5	2489	18 6	2614	20 6	2736	22 7	2852	24 8
4650	5000	1380	5 49	1582	7 41	1770	9 53	1941	11 7	2100	13 9	2247	16 1	2390	18 3	2521	20 5	2645	22.7	2766	25 0	2883	27 3
5022	5400	1457	6 56	1647	8 57	1827	10 8	1990	13 1	2146	15 5	2291	17 8	2428	20 2	2558	22 6	2681	25 0	2798	27 3		
5394	5800	1535	7 79	1719	9 93	1885	12 2	2045	14 7	2194	17 2	2334	19 7	2469	22 2	2594	24 7	2717	27 3	2830	29 8		

Performance shown is for fans with outlet ducts and with inlet ducts. BHP shown does not include belt drive losses.



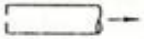
h_e = 0.93 VP

PLAIN DUCT END



h_e = 0.49 VP

FLANGED DUCT END

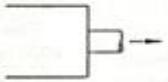


h_e = 1.78 VP Orifice

SHARP-EDGED ORIFICE

h_e = 2.3 VP Duct, (when duct velocity = slot velocity)
Better: 1.78 VP Orifice + 0.49 VP Duct

ORIFICE PLUS FLANGED DUCT
(Many slot types)



h_e = 0.50 VP

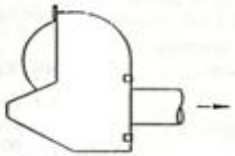
DIRECT BRANCH-BOOTH

h_e = 0.06 VP to 0.10 VP

BOOTH PLUS ROUNDED ENTRANCE

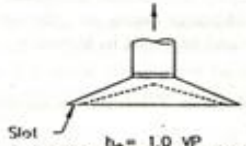
h_e = 1.5 VP

TRAP OR SETTLING CHAMBER



h_e = 0.65 VP

STANDARD GRINDER HOOD



h_e = 1.0 VP

DOUBLE (inner cone) HOOD

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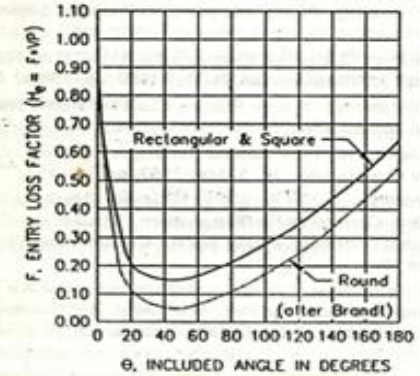
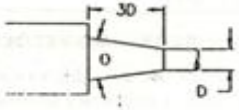


Face area at least 2 times duct area

TAPERED HOODS

Flanged or unflanged; round, square or rectangular. θ is the major angle on rectangular hoods.

θ	ENTRY LOSS ROUND	RECTANGULAR
15°	0.15 VP	0.25 VP
30°	0.08 VP	0.16 VP
45°	0.06 VP	0.15 VP
60°	0.08 VP	0.17 VP
90°	0.15 VP	0.25 VP
120°	0.26 VP	0.35 VP
150°	0.40 VP	0.48 VP



MISCELLANEOUS VALUES

HOOD	ENTRY LOSS, F
Abrasive blast chamber	1.0
Abrasive blast elevator	2.3
Abrasive separator	2.3
Elevators (enclosures)	0.69
Flanged pipe plus close elbow	0.8
Plain pipe plus close elbow	1.60

VP = Velocity Pressure in Duct
SP = Static Pressure at Throat, "wg
h_e = Entry Loss, "wg
Q = Volumetric Flowrate, cfm
A = Cross Section at Throat, ft^2

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

HOOD ENTRY LOSS FACTORS

DATE 7-89

FIGURE 5-15

Terima kasih &
Sampai Jumpa di Pertemuan Selanjutnya