

BAB IV

PENUTUP



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P E N U T U P4.1. Kesimpulan.

Dari hasil analisa teknis terhadap pemilihan sistem penyejatan udara yang dipasang pada kapal General Cargo 4000 DWT yaitu kapal Caraka Jaya III, maka dapat disimpulkan sebagai berikut :

- Pemilihan kapasitas beban pendingin, daya kipas dan daya kompresor penyejatan udara yang dipilih pada masing-masing ruang cukup sesuai. Hal ini dapat dilihat pada tabel dibawah ini :

Sistem Terpasang :

NAMA RUANG	KAPASITAS BEBAN PENDINGIN (kcal/h)	KAPASITAS BEBAN PENDINGIN (kJ/h)	DAYA KIPAS (KW)	DAYA KOMPRESOR
Wheel House	8100	33915	0.400	2.20
Captain Room	2400	10049	0.025	0.75
Chief Eng. R.	2400	10049	0.025	0.75
Off. Mess Room	5100	21354	0.200	1.50
Crew Mess Room	5100	21354	0.200	1.50
Eng. Control R.	8100	33915	0.400	2.20
TOTAL	31200	130635	1.250	8.90

Sistem I :

NAMA RUANGAN	KAPASITAS BEBAN PENDINGIN (kcal/h)	KAPASITAS BEBAN PENDINGIN (kJ/h)	DAYA KIPAS (KW)	DAYA KOMPRESSOR
Wheel House	7550.33	31613	0.330	1.923
Captain Room	2296.92	9617	0.101	0.585
Chief Eng. R.	2296.92	9617	0.101	0.585
Off. Mess Room	4744.59	19866	0.159	1.208
Crew Mess Room	4877.59	20422	0.171	1.242
Eng. Control R.	7340.60	30735	0.277	1.869
TOTAL	29106.95	121870	1.139	7.412

Sistem II :

NAMA RUANGAN	KAPASITAS BEBAN PENDINGIN (kcal/h)	KAPASITAS BEBAN PENDINGIN (kJ/h)	DAYA KIPAS (KW)	DAYA KOMPRESSOR (KW)
Wheel House	13500	56525	1.500	3.750
Captain Room				
Chief Eng. R.	13500	56525	1.500	3.750
Off. Mess Room				
Crew Mess Room	7340	30733	0.139	1.864
Eng. Control R.				
TOTAL	34340	143783	3.139	9.369

Sistem III :

NAMA RUANGAN	KAP. BEBAN PENDINGIN (kJ/h)	DAYA KIPAS (KW)	DAYA KIPAS RUANGAN (KW)	DAYA KOMP. (KW)
Wheel House	127964	2.200	0.330	7.500
Captain Room			0.101	
Chief Eng. R.			0.101	
Off. Mess Room			0.159	
Crew Mess Room			0.171	
Eng. Control R.			0.277	
TOTAL	127964	2.200	1.139	7.500

- Penurunan tekanan pada saluran udara yang dipasang di Wheel House, Crew Mess Room dan Officer Mess Room dapat diatasi oleh kipas yang terpasang pada penyegar udara tersebut.
- Untuk sistem yang pertama yaitu jenis Duct Connection mempunyai keuntungan dalam hal teknis pengoperasiannya yaitu dapat menghidupkan mesin penyegar udara ruangan yang dikehendaki tanpa menghidupkan mesin penyegar udara yang lain.

Jadi kalau dibandingkan antara sistem yang dipasang dengan alternatif yang direncanakan penulis bila ditinjau dari segi teknisnya adalah sebagai berikut:

1. Bila ditinjau dari kapasitas pendingin yang dipilih dari alat penyegar udara yang tersedia maka untuk ruangan yang melayani satu Paket AC terdapat kelebihan kapasitas pendinginan yaitu :
 - Wheel House $\pm 500\text{kcal/h} = 2094 \text{ kJ/h}$
 - Captain Room $\pm 100\text{kcal/h} = 418.7 \text{ kJ/h}$
 - Chief Engineer Room $\pm 100\text{kcal/h} = 418.7 \text{ kJ/h}$
 - Officer Mess Room $\pm 350\text{kcal/h} = 1465 \text{ kJ/h}$
 - Crew Mess Room $\pm 200\text{kcal/h} = 837.4 \text{ kJ/h}$
 - Engine Control Room $\pm 760\text{kcal/h} = 3182 \text{ kJ/h}$

Jadi kapasitas beban pendingin yang digunakan berkisar antara 90% sampai 99% dari kapasitas penyejuk udara yang terpasang, dimana beban kalor ruangan dianggap dalam kondisi maksimum.

Bandingkan pada sistem yang kedua adalah sebagai berikut :

- Wheel House, Captain dan Chief Engineer Room
 $\pm 500 \text{ kcal/h} = 2094 \text{ kJ/h}$
- Crew dan Officer Mess Room $\pm 33000 \text{ kcal/h} = 138171 \text{ kJ/h}$
- Engine Control Room $\pm 760 \text{ kcal/h} = 3182 \text{ kJ/h}$

Pada pemilihan penyejuk udara pada ruangan Crew Mess Room dan Officer Mess Room terdapat kelebihan kapasitas pendingin yang cukup besar, sehingga kelebihan kapasitas pendingin tersebut dapat dimanfaatkan untuk ruang disebelahnya yaitu Saloon Room.

2. Bila ditinjau dari segi teknis pengoperasian maka pada sistem yang pertama yaitu untuk tiap ruangan satu Paket AC mempunyai beberapa keuntungan antara lain ; untuk menghidupkan mesin penyejuk udara untuk mengkondisikan ruangan Officer Mess Room maka langsung dapat dioperasikan dengan menghidupkan peralatan penyejuk udara didalam

ruangan tersebut, ditambah dengan sistem Paket AC yang menggunakan pendingin air laut ini sangat efisien, karena semua peralatan kompak menjadi satu paket dan di dinginkan dengan air laut jadi tidak perlu terdapat unit yang berada diluar paket.

Sistem Paket AC yang di produksi oleh Daikin untuk sistem ini sangat mendukung dalam pekerjaan instalasinya, karena pipa inlet dan outlet telah disiapkan pada paket tersebut sebagaimana diperlihatkan dibrosur.

Sedangkan untuk sistem yang kedua maka perlu menghidupkan diruangan Crew Mess Room, hal ini karena Paket AC tersebut diletakkan diruangan Crew Mess Room. Begitu juga dengan ruangan Whell House, Captain dan Chief Engineer.

3. Untuk sistem yang ketiga, diperlukan Paket AC yang lebih besar selain itu masih harus ditambah lagi dengan sistem ducting, jika dilihat dari segi instalasinya cukup rumit.

Dalam pengoperasiannya dapat menggunakan katup disetiap saluran yang menuju ruangan sehingga apabila ruangan yang tidak terpakai dapat di stop salurannya, namun demikian Paket AC tetap

beroperasi penuh, sehingga kurang efisien dalam pengoperasiannya.

4.2. Saran.

Berdasarkan hasil kesimpulan diatas, maka perlu disarankan hal-hal sebagai berikut :

- Dalam hal pemilihan sistem penyejar udara type Packaged Air Conditioners jenis Duct Connection ini, harus teliti dalam perhitungan kapasitas beban pendingin, daya kipas dan daya kompresor agar tidak terjadi kelebihan atau kekurangan kapasitas pendinginan yang cukup besar.
- Saluran isap yang menghubungkan lubang isap masuk dan lubang keluar kipas udara hendaknya dirancang dengan metode tekanan total. Pada umumnya, kesulitan yang utama terletak pada pemilihan bentuk dan ukuran saluran isap, untuk menjamin keseimbangan tekanan antar lubang isap yang terjauh dari kipas udara dan lubang isap lainnya.
- Perlu diupayakan literatur yang membahas secara khusus masalah-masalah sistem penyejar udara dikawal, karena salah satu faktor yang penting untuk keberhasilan dalam melaksanakan suatu

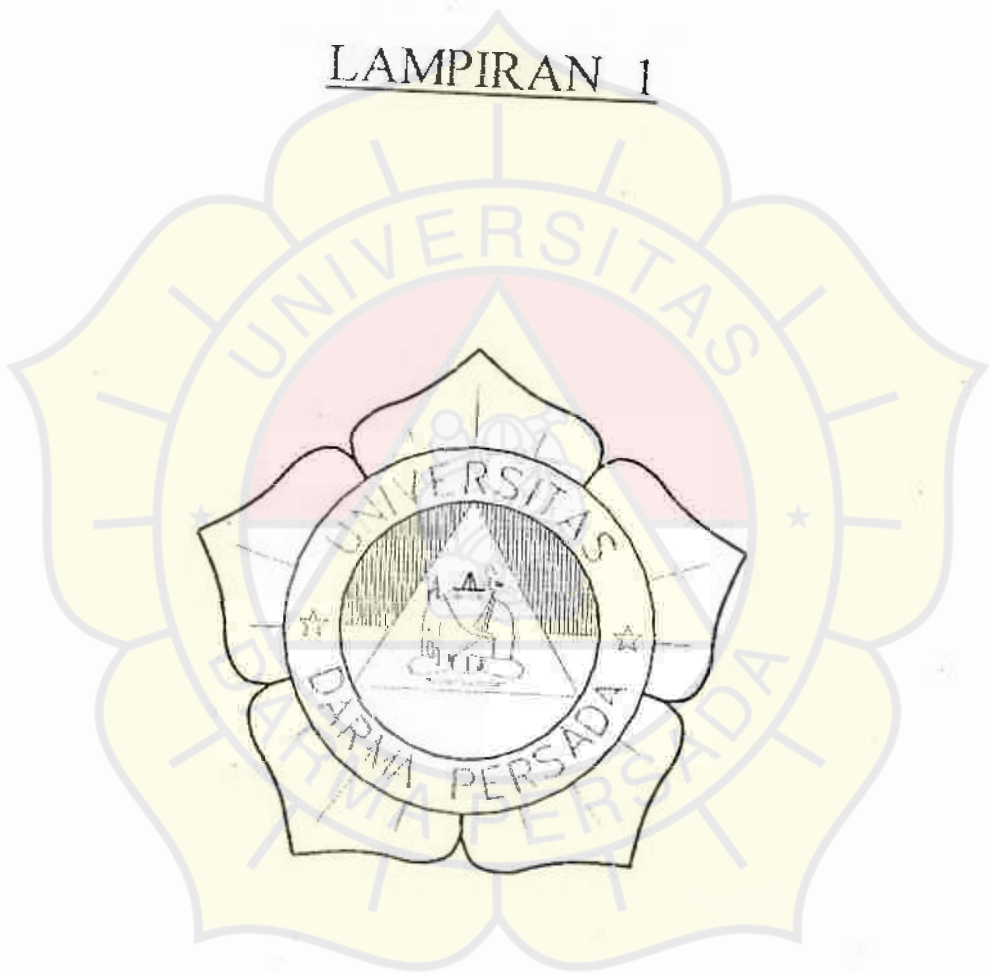
pekerjaan adalah kenyamanan suatu ruangan kerja tersebut.



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LAMPIRAN 1



Air-conditioning and ventilation of accommodation spaces on board ships — Design conditions and basis of calculations

1 Scope and field of application

This International Standard specifies design conditions and suitable methods of calculation for air-conditioning and ventilation of accommodation spaces and the radio cabin on board seagoing merchant ships for all conditions except those encountered in extremely cold or hot climates (i.e. with a lower or higher enthalpy than that stated in 4.2 and 4.3).

Annex A provides guidance and details of good practice in the design of ventilation and air-conditioning systems in ships.

Annex B gives the thermal conductivities of commonly used construction materials.

NOTE — Users of this International Standard should note that, while observing the requirements of the Standard, they should at the same time ensure compliance with such statutory requirements, rules and regulations as may be applicable to the individual ship concerned.

References

- ISO 31/4, *Quantities and units of heat.*
- ISO 3258, *Air distribution and air diffusion — Vocabulary.*

Definitions

For the purposes of this International Standard, the definitions given below, together with those in ISO 31/4 and ISO 3258, apply:

1 accommodation spaces: Spaces used as public rooms, cabins, offices, hospitals, cinemas, games and hobby rooms, hair-dressing saloons and pantries containing no cooking appliances.

2 air-conditioning: Form of air treatment whereby temperature, humidity, ventilation and air cleanliness are all controlled within limits prescribed for the enclosure to be air-conditioned.

3.3 ventilation: Provision of air to an enclosed space, sufficient for the needs of the occupants or the process.

3.4 relative humidity: In humid air, the ratio, expressed as a percentage, of the water vapour actual pressure to the saturated vapour pressure at the same dry bulb temperature.

3.5 dry bulb temperature: The temperature indicated by a dry temperature-sensing element (such as the bulb of a mercury-in-glass thermometer) shielded from the effects of radiation.

4 Design conditions

4.1 General

The system shall be designed for the indoor air conditions specified in 4.2 and 4.3 in all accommodation spaces defined in 3.1 at the stated outdoor air conditions and the outdoor supply airflow, ventilation, and air balance given in 6.2.1, 6.2.2 and 6.5 respectively.

NOTE — All temperatures stated are dry bulb temperatures.

4.2 Summer temperatures and humidities

Outdoor air: + 35 °C and 70 % relative humidity

Indoor air: + 27 °C and 50 % relative humidity

NOTE — In practice, the indoor air conditions obtained, especially humidity, can be different from those stated.

4.3 Winter temperatures

Outdoor air: - 20 °C

Indoor air: + 22 °C

NOTE — This International Standard does not specify requirements for humidification in winter.

or air

quantity of outdoor air shall be not less than total air supplied to the spaces concerned.

ancy

of persons to be allowed for in the various accom-
modations shall be as follows, unless otherwise stated by

maximum number of persons for which the cabin

mess- or dining-rooms and recreation rooms:
1 person who can be seated or, when this is not
the purchaser:

100/2 m² floor area for saloons;

100/1,5 m² floor area for mess- or dining-rooms;

100/5 m² floor area for recreation rooms.

and chief engineer's day room: 4 persons.

Chief steward's, first engineer's, chief steward's and other
rooms: 3 persons.

number of beds plus 2.

game room: 4 persons.

2 persons.

persons.

5 Calculation of heat gains and losses

5.1 Applicability

For the calculation of summer conditions, 5.2 to 5.5 inclusive shall apply.

For the calculation of winter conditions, 5.2 only shall apply.

5.2 Heat transmission

5.2.1 Method of calculation

The following formula shall be used for calculating the transmission losses or gains ϕ , in watts, for each separate surface.

$$\phi = \Delta T [(k_v \cdot A_v) + (k_g \cdot A_g)]$$

where

ΔT is the difference in air temperature, in kelvins (for the difference of air temperature between air-conditioned and non-air-conditioned internal spaces, see 5.2.2);

k_v is the total heat transfer coefficient in watts per square metre kelvin, for the surface A_v (see 5.2.3);

A_v is the surface, in square metres, excluding side scuttles and rectangular windows (glazing + 200 mm) (see figures 1 and 2);

k_g is the total heat transfer coefficient in watts per square metre kelvin, for the surface A_g (see 5.2.3);

A_g is the area, in square metres, of side scuttles and rectangular windows (glazing + 200 mm) (see figures 1 and 2).

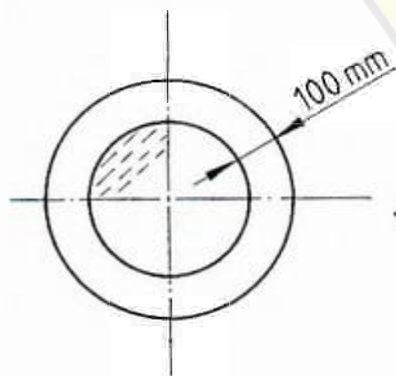


Figure 1 — Side scuttles

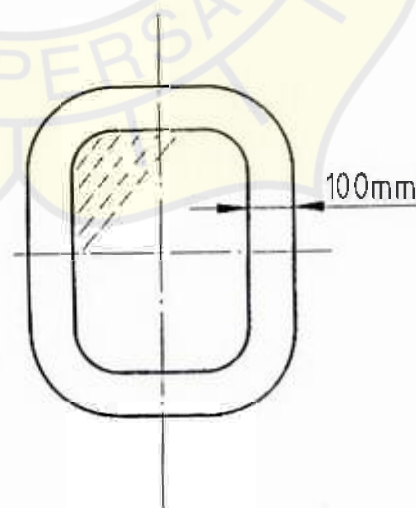


Figure 2 — Rectangular windows

2.2 Temperature differences between adjoining internal spaces

Temperature differences of air temperature, ΔT in kelvins, between air-conditioned and non-air-conditioned internal spaces, see table 1.

Table 1 – Temperature differences between adjoining internal spaces

Deck or bulkhead	$\Delta T, K$	
	Summer	Winter
Deck against tank provided with heating	43	
Deck and bulkhead against boiler room	28	17
Deck and bulkhead against engine room and against non-air-conditioned galley	18	
Deck and bulkhead against non-heated tanks, cargo spaces and equivalent	13	42
Deck and bulkhead against laundry	11	17
Deck and bulkhead against public sanitary space	6	0
Deck and bulkhead against private sanitary space		
a) with any part against exposed external surface	2	0
b) not exposed	1	0
c) with any part against engine/boiler room	6	0
Bulkhead against alleyway	2	5

NOTE – It is understood that means of heating are provided in exposed sanitary spaces.

2.3 Total heat transfer coefficients

The values for the total heat transfer coefficients, k , in watts per square metre kelvin given in table 2 assume that adequate thermal insulation is provided on all surfaces exposed to outdoor conditions or adjoining hot or cold spaces, or hot equipment or pipework.

The values given in table 2 shall be used where appropriate, unless otherwise advised by the purchaser. For other cases a method of calculation of coefficient is given in 5.2.4.

2.4 Calculation of heat transfer coefficient

The heat transfer coefficient shall be calculated as follows:

$$\frac{1}{k} = \sum \frac{1}{\alpha} + \frac{\sum \frac{d}{\lambda} + M_L + M_b}{\mu}$$

where

k is the total heat transfer coefficient in watts per square metre kelvin;

α is the coefficient of heat transfer for surface air, in watts per square metre kelvin :

$\alpha = 80 W/(m^2 \cdot K)$ for outer surface exposed to wind (20 m/s);

$8 W/(m^2 \cdot K)$ for inside surface not exposed to wind (0,5 m/s);

d is the thickness of material, in metres;

λ is the thermal conductivity, in watts per metre kelvin;

M_L is the thermal insulance for an air gap, in square metres kelvin per watt;

M_b is the thermal insulance between different layers of material, in square metres kelvin per watt;

μ is a correction factor for steel structure:

$\mu = 1,2$ for insulation in accordance with figure 3;

$1,45$ for insulation in accordance with figure 4.



Figure 3 – Plane insulation of uniform thickness



Figure 4 – Corrugated insulation of uniform thickness

Table 2 – Total heat transfer coefficients

Surfaces	Total heat transfer coefficient, k W/(m ² ·K)
Weather deck not exposed to sun's radiation and ship side and external bulk heads	0,9
Deck and bulkhead against engine room, cargo space or other non-air-conditioned spaces	0,8
Deck and bulkhead against boiler room or boiler in engine room	0,7
Deck against open air or weather deck exposed to sun's radiation and deck against hot tanks	0,6
Side scuttles and rectangular windows, single glazing	6,5
Side scuttles and rectangular windows, double glazing	3,5
Bulkhead against alleyway, non-sound reducing	2,5
Bulkhead against alleyway, sound reducing	0,9

on values of thermal conductivities of commonly materials is given in annex B.

al insulance, M_L , of non-ventilated air gaps, see

Thermal insulance of non-ventilated air gap

Surfaces of air gap	Air gap thickness, $a^{(1)}$ mm	Thermal insulance ²⁾ $m^2 \cdot K/W$
Surfaces having high	5	0,11
	20	0,15
	200	0,16
One surface having high, other surface low	5	0,17
	20	0,43
	200	0,47
Surfaces having low	5	0,18
	20	0,47
	200	0,51
Insulating surfaces in	0	0,09

es 3 and 4.

m "thermal insulance" is used according to the definition 0 31/4. In many countries this term is known as "thermal with a symbol R .

um foil and other polished surfaces are assumed to have ty (0,2). All other surfaces are assumed to have high ,9).

Measurement of transmission areas

mission area for bulkheads, deck and ship side shall ad from steel to steel.

Heat gain

gain, ϕ_g , is calculated, in watts, as follows:

$$(A_v \cdot k \cdot \Delta T_r) + \Sigma(A_g \cdot G_g)$$

the surface exposed to solar radiation in square metres (side scuttles and rectangular windows are not luded);

the total heat transfer coefficient in accordance with 2.3 or 5.2.4 for a ship structure (deck, outer lkhead, etc.) within the surface A_{v_i} ;

the excess temperature (above the outside mperature of + 35 °C) caused by solar radiation on rfaces as below:

- $t_r = 16$ K for vertical light surfaces;
- 29 K for vertical dark surfaces;
- 12 K for horizontal light surfaces;
- 32 K for horizontal dark surfaces;

the glass surface (clear opening) exposed to solar ation in square metres;

G_g is the heat gain per square metre from glass surfaces:

$$G_g = 350 \text{ W/m}^2 \text{ for clear glass surfaces;}$$

$$240 \text{ W/m}^2 \text{ for clear glass surfaces with interior shading.}$$

For corner cabins the surface which gives the highest ϕ_g shall be chosen for calculation of the heat gain.

Surfaces not included in A_v because of shadow from overhang- ing deck or other means of sun protection shall be calculated at a sun angle of 45°.

NOTES

- 1 If solar radiation reflecting glass is used, G_g may be reduced.
- 2 The excess temperatures for vertical and horizontal surfaces and the additional heat gain from glass surfaces caused by solar radiation are based on the most extreme average temperatures in subtropical climate and give the "worst condition" occurring during a day.

5.4 Heat gain from persons

Values of sensible and latent heat emitted by a person at an indoor temperature of 27 °C are given in table 4.

Table 4 — Body activity and heat emission

Activity	Type of heat	Emission W
Seated at rest	Sensible heat	55
	Latent heat	80
Medium/heavy work	Sensible heat	140
	Latent heat	250

5.5 Heat gain from lighting and other sources

In spaces with daylight, additional heat gain from lighting shall be ignored.

In spaces without daylight, the heat gain from lighting shall be calculated from the rated wattage of the lighting, as advised by the purchaser or as specified by the appropriate authority. Where the rated output is not specified by the purchaser or the appropriate authority, the heat gain from general lighting shall be taken as stated in table 5, with consideration given to special lighting requirements.

Table 5 — Heat gain from general lighting

Space	Heat gain from general lighting W/m^2	
	Incandescent	Fluorescent
Cabins, etc.	15	8
Mess- or dining-rooms	20	10
Gymnasiums, etc.	40	20

Refrigerator output shall be taken as 0,3 W/l storage capacity, unless otherwise specified by the purchaser.

Other sources of heat gain, such as from appliances that are in operation for considerable periods during the day, shall only be taken into consideration if specified by the purchaser.

Temporary electrical appliances such as radio and television sets, hot water urns, etc. shall be ignored.

The heat gain from equipment, etc. in the radio cabin shall be taken as 2,5 kW, unless otherwise specified by the purchaser.

Heat gain from fans shall be taken to give a rise in the temperature of the air of 1 °C/kPa pressure rise.

The rise in the temperature of the air in ducts shall be limited to +2 °C.

6 Airflow calculation

6.1 Volume of space

Volume of furniture, wardrobes, stationary equipment, etc. shall not be deducted in calculating the gross volume of cabins and other spaces.

6.2 Supply airflow

6.2.1 Air supply for air-conditioning

The air supply to each air-conditioned space shall be calculated using whichever of the following criteria gives the highest value:

- airflow to maintain the conditions of 4.2;
- airflow to maintain the conditions of 4.3;
- outdoor supply airflow not less than 0,008 m³/s per person for which the space is designed.

The air supply to cabins with a private sanitary room (bath, shower or W.C.) shall be at least 10 % higher than the exhaust air from the sanitary room.

NOTE — It is to be observed that there are national regulations specifying a minimum number of air changes.

6.2.2 Air supply for ventilation

Supply of conditioned air to ventilated spaces, such as those listed in a) to e), shall be provided directly or by transfer of less conditioned air from an adjacent space, and shall be sufficient to permit the exhaust airflow requirements of 6.4 to be achieved:

- public sanitary rooms (bath, shower, urinal or W.C.);
- laundry;
- drying and ironing rooms;

d) changing rooms;

e) cleaning lockers.

NOTE — It is assumed that supplementary means of heating are provided for ventilated spaces where necessary.

6.3 Temperature of supply airflow

The temperature of the air supplied to the space shall not be more than 10 °C lower than the average temperature nor, for the heating mode, more than 23 °C higher than the average temperature of the space.

6.4 Exhaust airflow

6.4.1 Volume of airflow

The exhaust airflow in saloons, mess- and dining-rooms and common day rooms shall be the same as the supply airflow.

The exhaust airflow in hospitals and pantries shall be at least 20 % more than the supply airflow.

The exhaust airflow in private sanitary rooms (bath, shower or W.C.) shall be 0,02 m³/s or a minimum of 10 air changes per hour, whichever gives the highest value.

The exhaust airflow in common sanitary rooms (bath, shower, urinal or W.C.), laundries, and drying and ironing rooms shall be a minimum of 15 air changes per hour and in changing rooms, wash rooms and cleaning lockers a minimum of 10 air changes per hour.

Public sanitary rooms in passenger ships including ferries shall be given special consideration. The exhaust airflow shall be a minimum of 30 air changes per hour.

6.4.2 Exhaust system

The exhaust air from the spaces listed in a) and b) below shall be fed directly to the open air, and not used for recirculation. Additionally, the exhaust systems for each of these spaces or group of spaces shall be separate from each other:

- hospitals;
- sanitary rooms, laundry, pantry, etc.

6.5 Air balance

The system must be positively balanced. It shall be applicable on every deck.

In rooms where there are tumbler dryer(s), the balance between supply and exhaust air shall be taken into account in consultation with the manufacturer.

Hospitals and pantries shall be maintained at a slightly lower pressure than that in the adjoining accommodation.

Annex A

Guidance and good practice

(This annex does not form an integral part of the Standard.)

System and ducting

Layout of the plant and the duct sizes should allow air supply without recirculation.

Supply air

In hospitals, a non-return flap should be installed in the supply air duct.

Exhaust air

In laundries and drying and ironing rooms, exhaust air devices should be installed over areas with high heat emission and high humidity.

Air movement in the occupied areas

Air movement in the occupied areas should be within limits shown in figure 5.

Velocity for the upper value is applicable only in spaces where people are active.

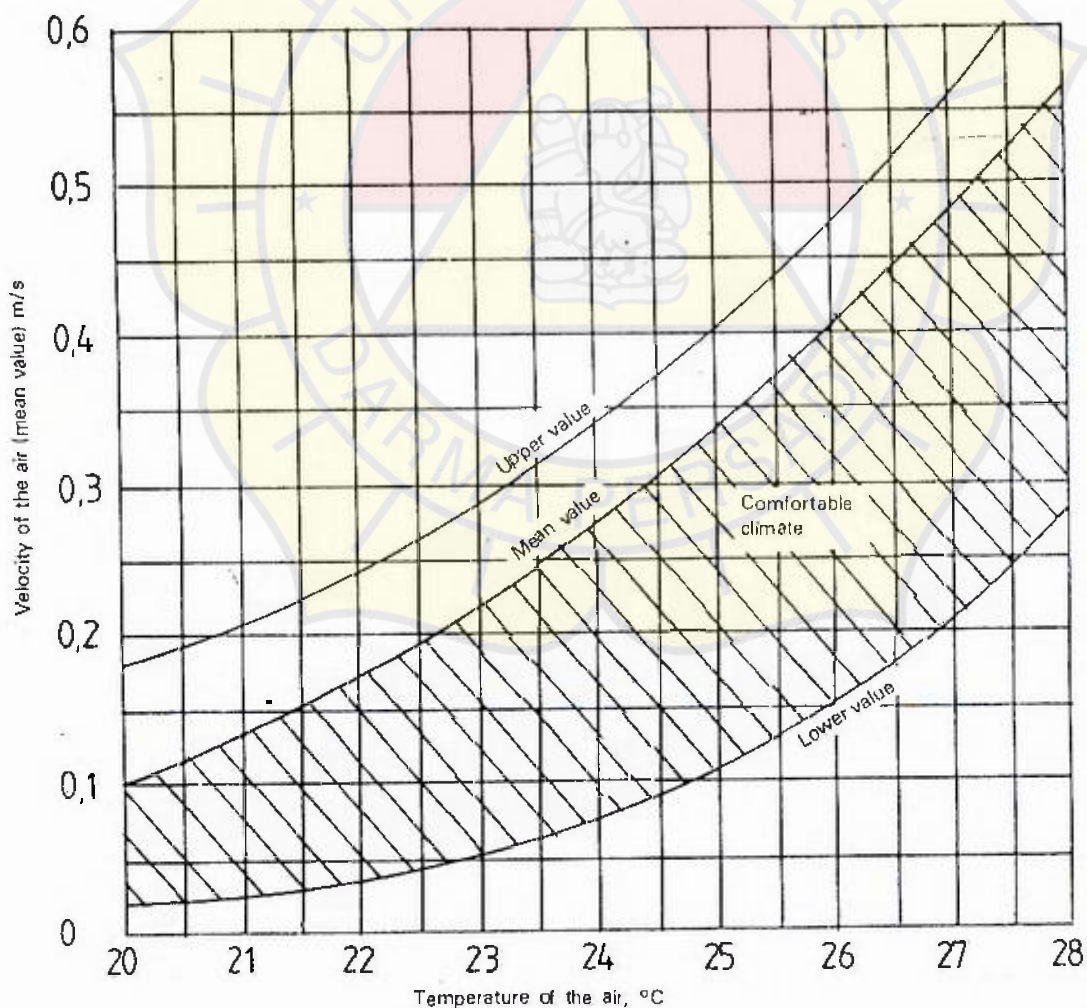


Figure 5 — Air movement in occupied areas

For normal applications for human comfort, the occupied areas are geometrically limited to 0,15 m from all room surfaces with a height of 0,15 m above the floor.

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A.5 Temperature variation in the occupied areas

The maximum difference in temperature between any points within the occupied areas (see A.4) should not exceed 2 K.

A.6 Refrigerating machinery

For a sea-water system, the size of the condenser should be based on an inlet water temperature of + 33 °C, and the compressor motor should be capable of driving the compressor at an inlet water temperature of + 35 °C.

For an indirect cooling system the condenser should be designed for + 36 °C on inlet cooling water and the compressor motor for + 38 °C.

When calculating the total heat transfer coefficient of the condenser, a fouling factor of 0,000 09 m²·K/W should be used.

When calculating the cooling effect, a specific mass of air of 1,20 kg/m³ should be used.

A.7 Sound

The system should be so designed that the A-weighted sound pressure level from the air distributing system measured 1 m from the air terminal device should not exceed 55 dB (A).

A.8 Temperature control

Individual temperature control should be fitted to each accommodation space. This can be obtained by controlling the air flow.

A.9 Humidification during winter

With humidification during the winter, it is strongly recommended that the upper level of humidification be limited to 35 % relative humidity and that the humidification be so controlled that it only takes place during long periods of cold and dry weather. The risk of condensation on cold surfaces and thereby the risk of formation of ice in the insulation should be taken into consideration. Where insulation is fitted on surfaces exposed to the atmosphere, care should be taken to ensure a complete vapour seal, to avoid penetration of warm humid air.

Annex B

Thermal conductivities of commonly used construction materials

(This annex does not form an integral part of the Standard.)

Material	Specific mass of dry material kg/m ³	Practical value of thermal conductivity, λ , at normal moisture content W/(m·K)
Aluminium		160
Mild steel		50
Window glass	2 600	1,05
Wood (heat flow at right angles to fibres):		
— fir, pine	500	0,14
— beech, oak	700	0,16
Chipboard	600 400	0,14 0,12
Wood fibre sheets :		
— hard	1 000	0,13
— medium-hard	600	0,08
— soft	300	0,052
Cork sheet (expanded) 1) 2)	140 210	0,04 0,05
Mineral wool: 1) 3)		
— fibre glass:		
— fibre 6 μ m	15 to 100	0,04
— fibre 20 μ m	40 to 200	0,05
— slag wool, rockwool	35 to 200	0,05
Mineral fibre sheet	400	0,06
Floor coverings :		
— carpet and fibrous underlay		0,045
— cork		0,08
— rubber or plastic tile		0,4
— ceramic tile		1,8

1) The indicated thermal conductivity only applies where a flow of air which can make an appreciable difference to the insulation cannot arise in the material or flow through it.

2) The thermal conductivity indicated is only valid where no airflow is possible in the joints between the sheets.

3) If the insulation is compressed the thickness in the compressed state is to be used as the basis for the calculation of the heat transfer coefficient.

LAMPIRAN 2

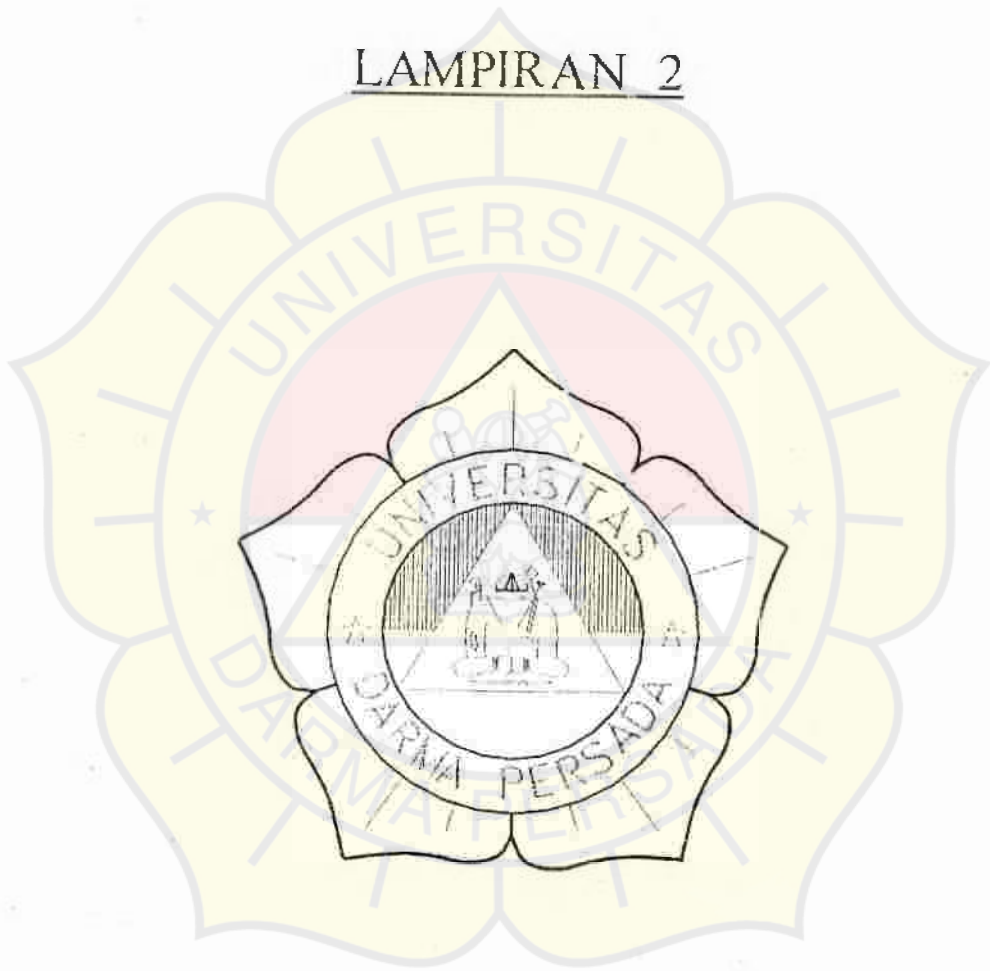


Table B.2 Thermal properties of selected alloys at 293 K (20°C) or 528°R (65°F)

Base metal	% Composition	Specific gravity	Specific heat, c_p		Thermal conductivity, k		Diffusivity, α	
			J/(kg·K)	BTU/(lbm·°R)	W/(m·K)	BTU/hr·ft·°R	m ² /s × 10 ³	ft ² /s × 10 ⁴
Aluminum	94-95 Al, 3-5 Cu	2.787	833	0.152	164	94.7	6.676	7.157
Duralumin	87 Al, 13 Si	2.659	871	0.203	154	94.7	7.093	7.642
Copper	99 Cu, 1 Al	8.660	510	0.0979	81	47.9	2.330	2.508
Al bronze	75 Cu, 25 Sn	8.666	343	0.0819	26	15.0	0.859	0.925
Red brass	85 Cu, 9 Sn, 6 Zn	8.714	325	0.0920	61	35.2	1.864	1.942
Brass	70 Cu, 30 Zn	8.322	385	0.0923	11	64.1	3.412	3.673
German silver	62 Cu, 15 Ni, 23 Zn	8.618	394	0.0941	25.9	14.4	0.733	0.789
Constantan	60 Cu, 40 Ni	8.922	410	0.0979	22.7	13.1	0.612	0.659
Cast iron	4 C	7.272	420	0.160	52	30.0	1.702	1.832
Wrought iron	0.5 CH	7.559	460	0.110	59	34.1	1.656	1.750
Steel								
Carbon steel	1 C	7.801	473	0.113	41	24.8	1.192	1.262
1.5 C	1.5 C	7.753	456	0.116	36	20.8	0.970	1.04
1 Cr	1 Cr	7.765	460	0.110	61	35.2	1.655	1.792
5 Cr	5 Cr	7.833	460	0.110	40	23.1	1.110	1.195
10 Cr	10 Cr	7.835	460	0.110	31	17.9	0.867	0.913
15 Cr, 10 Ni	15 Cr, 10 Ni	7.865	460	0.110	19	11.0	0.572	0.607
nickel steel	20 Cr, 15 Ni	7.833	460	0.110	23	15.0	0.815	0.847
Nickel steel	10 Ni	7.945	460	0.110	26	15.0	0.720	0.775
20 Ni	20 Ni	7.993	460	0.110	19	11.0	0.566	0.600
40 Ni	40 Ni	8.263	460	0.110	10	5.73	0.326	0.360
60 Ni	60 Ni	8.522	460	0.110	19	11.0	0.943	0.991
80 Ni	80 Ni	8.773	460	0.110	17	9.82	0.844	0.893
nickel-chrome steel	40 Ni, 15 C	8.773	460	0.110	17	9.82	0.844	0.893
Manganese steel	1.7 Mn	7.665	460	0.110	30	15.6	0.805	0.854
Silicon steel	5.2 Mn	7.839	460	0.110	23	12.7	0.637	0.686
Silicon steel	1.5 Si	7.959	460	0.110	42	24.3	1.164	1.244
Stainless steel	5 Si	7.917	460	0.110	19	11.0	0.555	0.592
Austenitic	18 Cr, 8 Ni	7.917	461	0.110	14.4	8.32	0.387	0.417
Ferritic	12 Cr	7.817	461	0.110	14.4	8.32	0.387	0.417
Martensitic	1.2 C	7.817	461	0.110	14.4	8.32	0.387	0.417
Tool steel	1.5 C	7.913	448	0.189	66	35.1	1.858	2.020
Tungsten steel	5 W	8.371	435	0.124	51	31.2	1.521	1.612

Notes: 1. Specific gravity is at 293 K (20°C). 2. Specific heat is at 293 K (20°C). 3. Thermal conductivity is at 293 K (20°C). 4. Diffusivity is at 293 K (20°C). 5. Alloy composition is in mass percent.

Table 0.3 Thermal properties of selected building materials and insulations at 293 K (20°C) or 525°R (68°F).

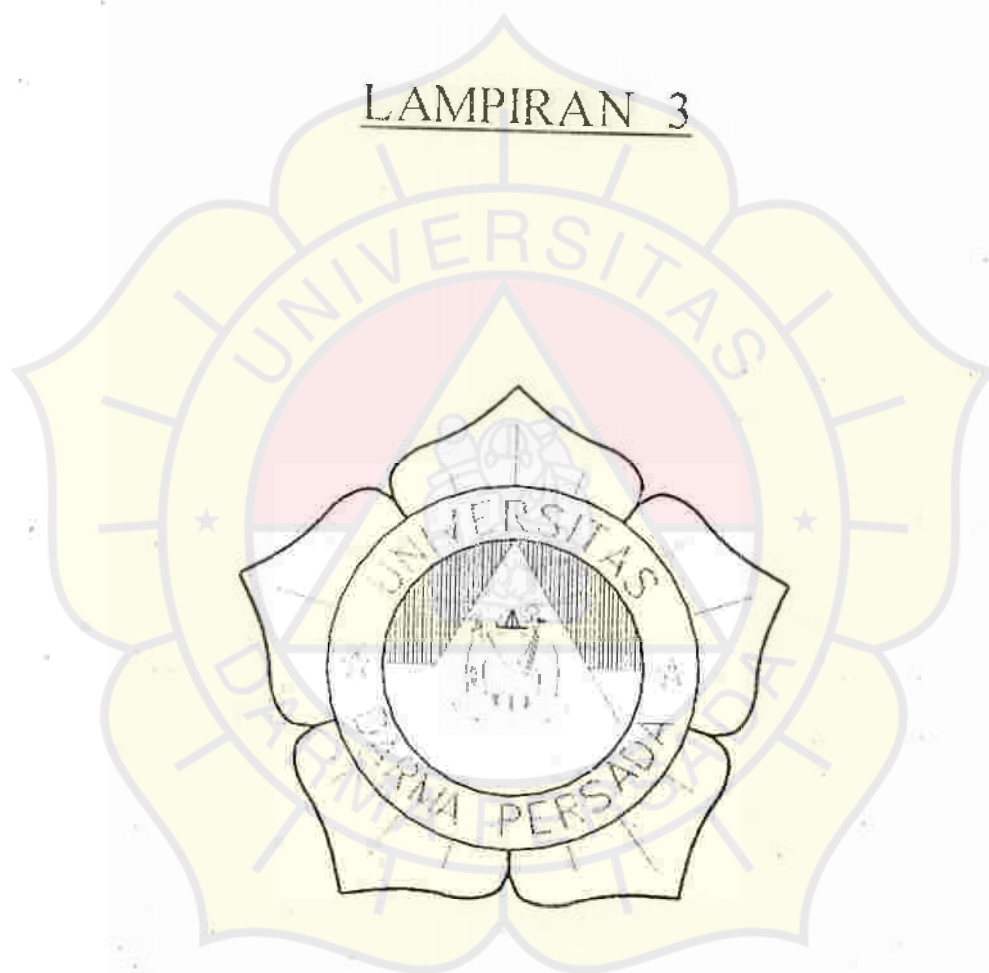
Material	Specific heat, c_p		Thermal conductivity, k		Diffusivity, α	
	J/(kg·K)	BTU/lbm·°R	W/(m·K)	BTU/hr ft·°R	$m^2/s \times 10^3$	$ft^2/s \times 10^6$
Aluminum	0.883	0.195	0.113	0.0613	0.036	3.88
Asphalt	2.120		0.698	0.401		
Bakelite	1.270		0.233	0.131		
Carbonadium (90% SiC)	2.200		5.82	3.36		
Common Magnesite (50% MgO)	1.500	0.201	0.35-0.52	0.22-0.30	0.028-0.034	3.0-3.66
Masonry	2.060		2.68	1.55		
Silica	1.700	0.260	0.658	0.38	0.046	5.0
Cardboard	1.930		1.07	0.611		
Cement (hard)			0.14-0.35	0.08-0.2		
Clay (48.7% moist)	1.545		1.047	0.60		
Coal (anthracite)	1.370	0.210	1.26	0.724	0.101	10.9
Concrete (dry)	0.900	0.301	0.238	0.137	0.013-0.015	1.4-1.6
Cork board	0.190	0.200	0.128	0.074	0.049	5.3
Cork (expanded)	0.120	0.339	0.042	0.0243	0.015-0.044	1.6-4.7
Earth (siliceous)	0.866	0.216	0.636	0.206		
Earth (clay with 5% moist)	1.330		0.176	0.072	0.031	3.3
Earth (sandy with 8% moist)	1.500		1.51	0.87		

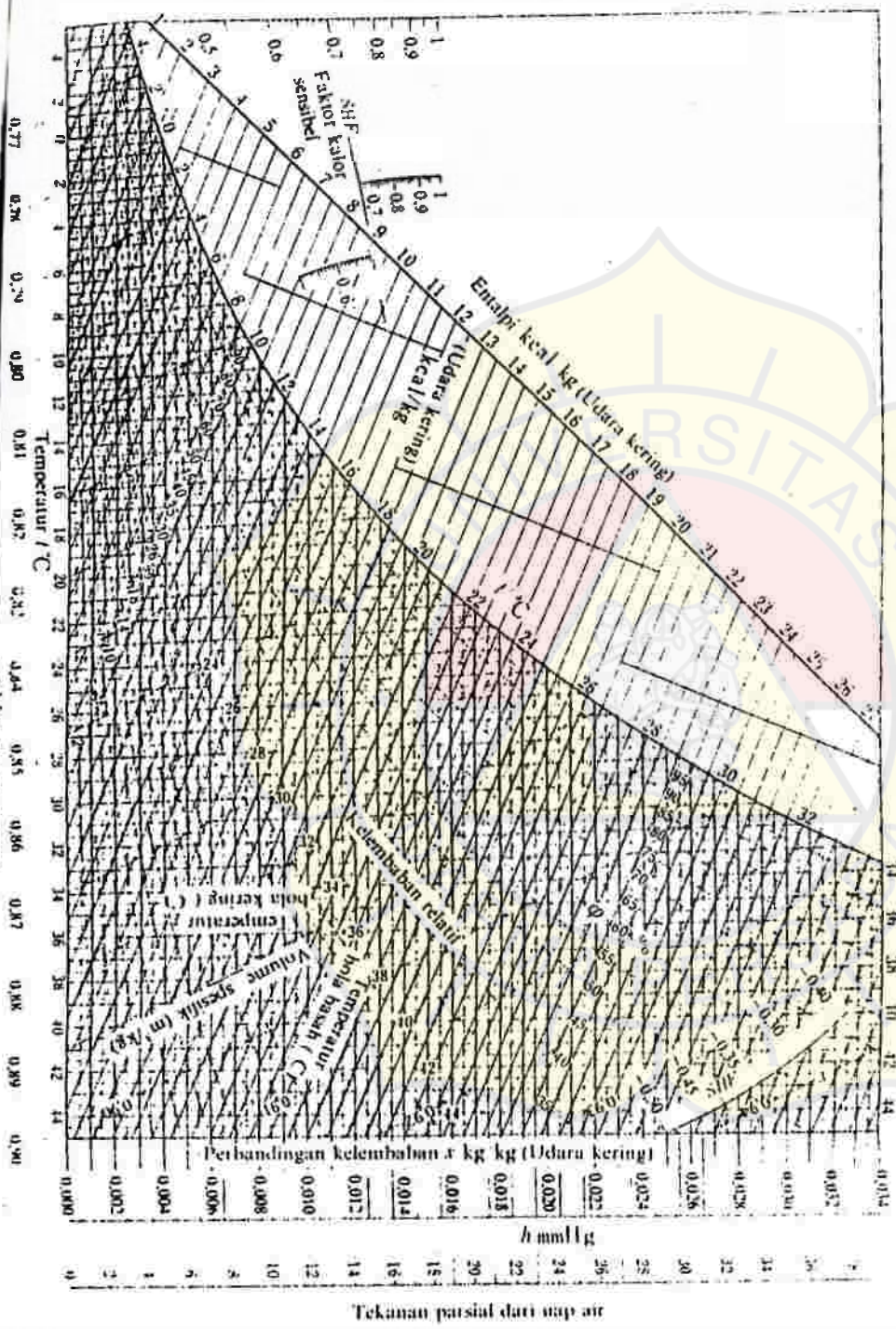
poly urethane foam }
 - Deck composition }
 FRP, FISH, }
 Proben Fish. }
 0.0335 } NICHIGO GYO GYO KAISHA STANDARD.
 0.209 }
 1.00 }
 2.5 } Retrievement fishing on vessel

Glass fiber	0.220			0.035	0.02	
Glass (window pane)	2.800	600	0.191	0.81	0.47	3.66
Glass (wool)	0.200	670	0.160	0.040	0.023	3.0
Ceramic	2.750			3.0	1.73	
Ice at 0°C	0.913	1530	0.437	2.22	1.28	13.3
Asphalt	0.025			0.035	0.02	
Insulation	0.535			0.051	0.047	
Steel	2.600			0.523	0.302	
Fire brick	0.142			0.050	0.046	
Concrete	1.800			0.814	0.47	
Brick	1.180			0.155	0.113	
Wood	0.570			0.109	0.063	
Polystyrene	1.050			0.157	0.0907	
Aluminum	1.200			0.465	0.269	
Brick	1.130	2.009	0.430	0.163	0.0942	0.67
Spongy	0.234			0.055	0.0315	
Lead	1.640			0.582	0.336	
Marble	0.215			1.13	0.653	
Wood				0.071	0.041	
Fireproof						
Concrete	0.411	2720	0.630	0.15	0.087	1.33
Steel	0.755	2390	0.571	0.19	0.11	1.22
Aluminum	0.600			0.035	0.0218	
Fireproof	0.200			0.047	0.0172	
Steel	0.200			0.623	0.0220	

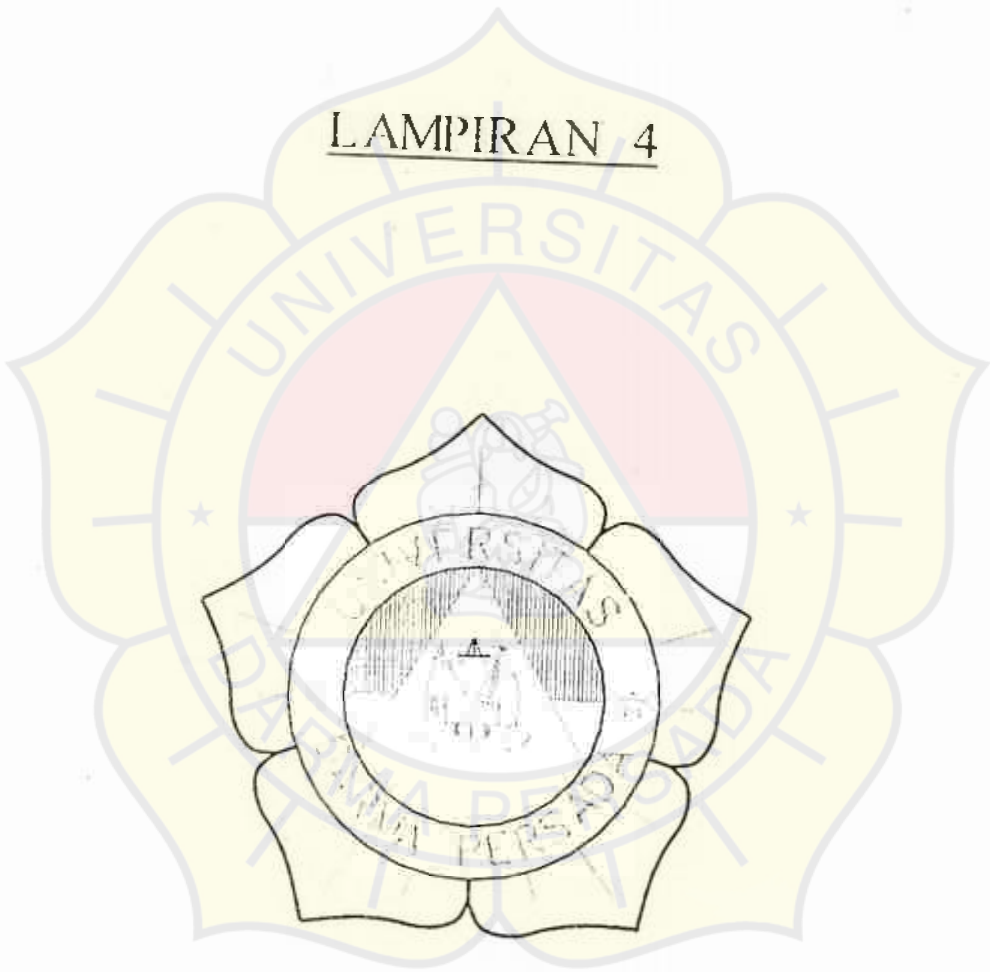
$\rho = \text{Density}$
 $\rho = \text{Specific Gravity} \times 62.4 \text{ lbm/ft}^3$
 $\rho = \text{Specific Gravity} \times 1000 \text{ kg/m}^3$
 $\rho = \text{Specific Gravity} \times 10^3 \text{ kg/m}^3$
 $\rho = 0.016 \text{ kg/m}^3$
 $\rho = 0.016 \times 10^3 \text{ kg/m}^3$
 $\rho = 16 \text{ kg/m}^3$

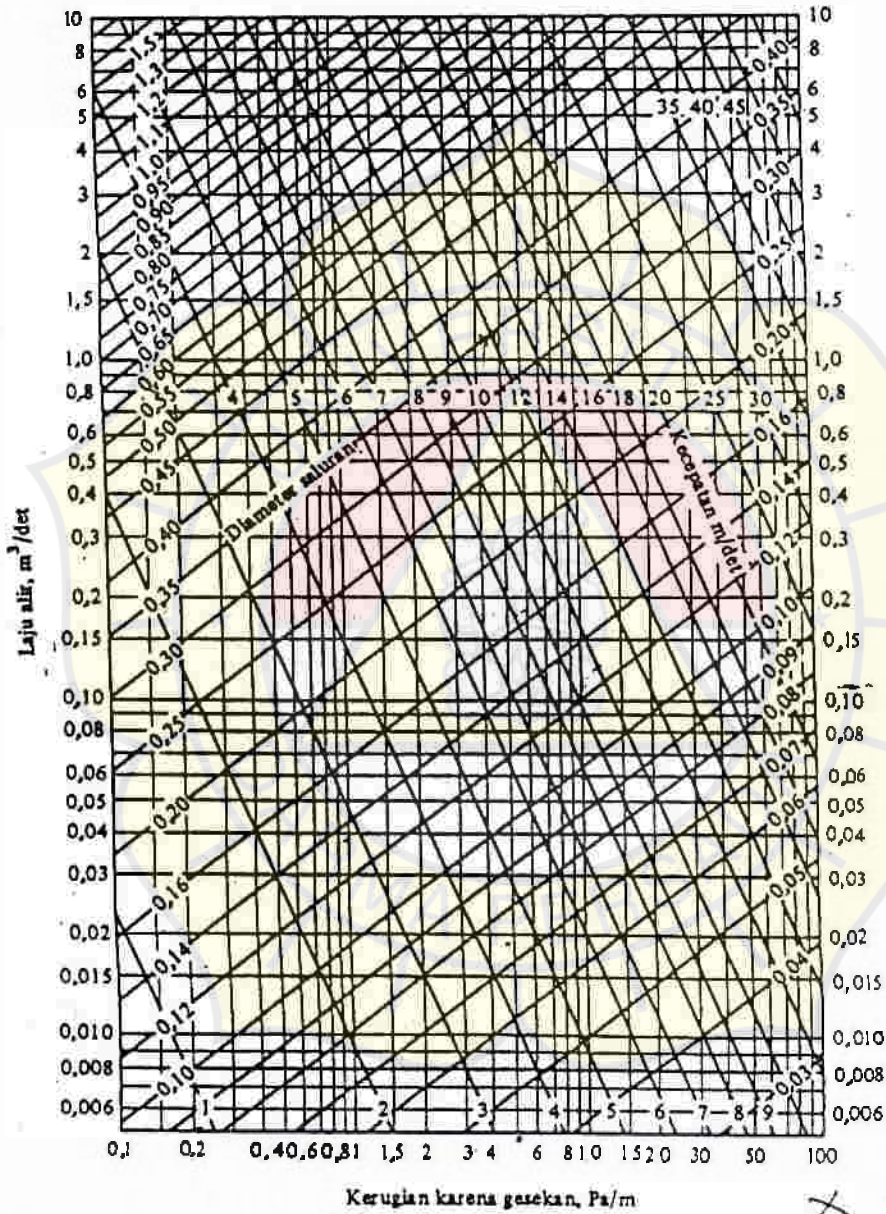
LAMPIRAN 3





LAMPIRAN 4

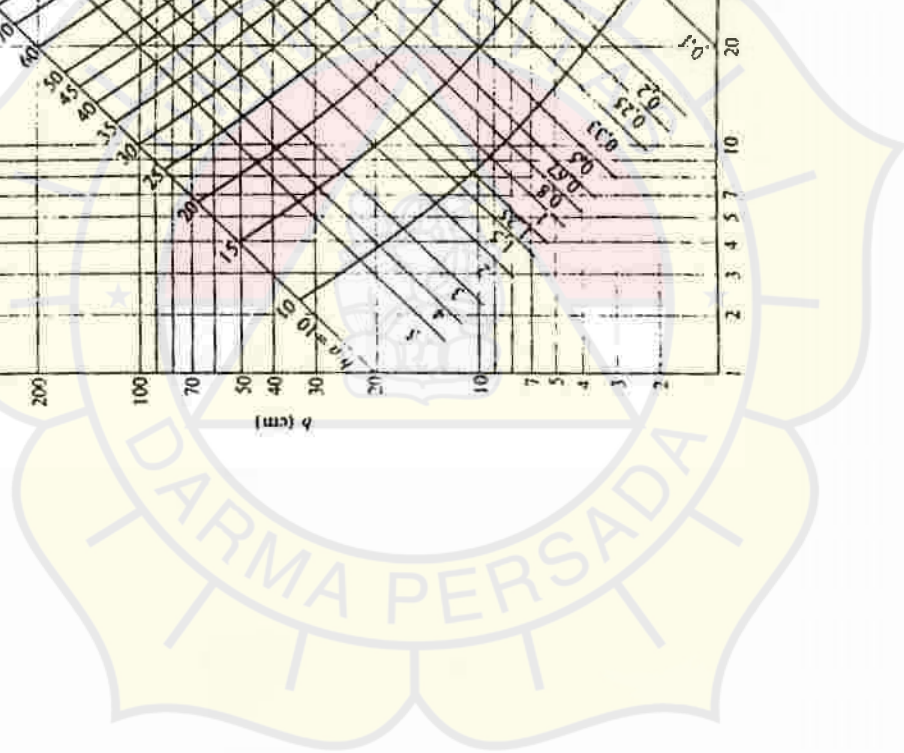
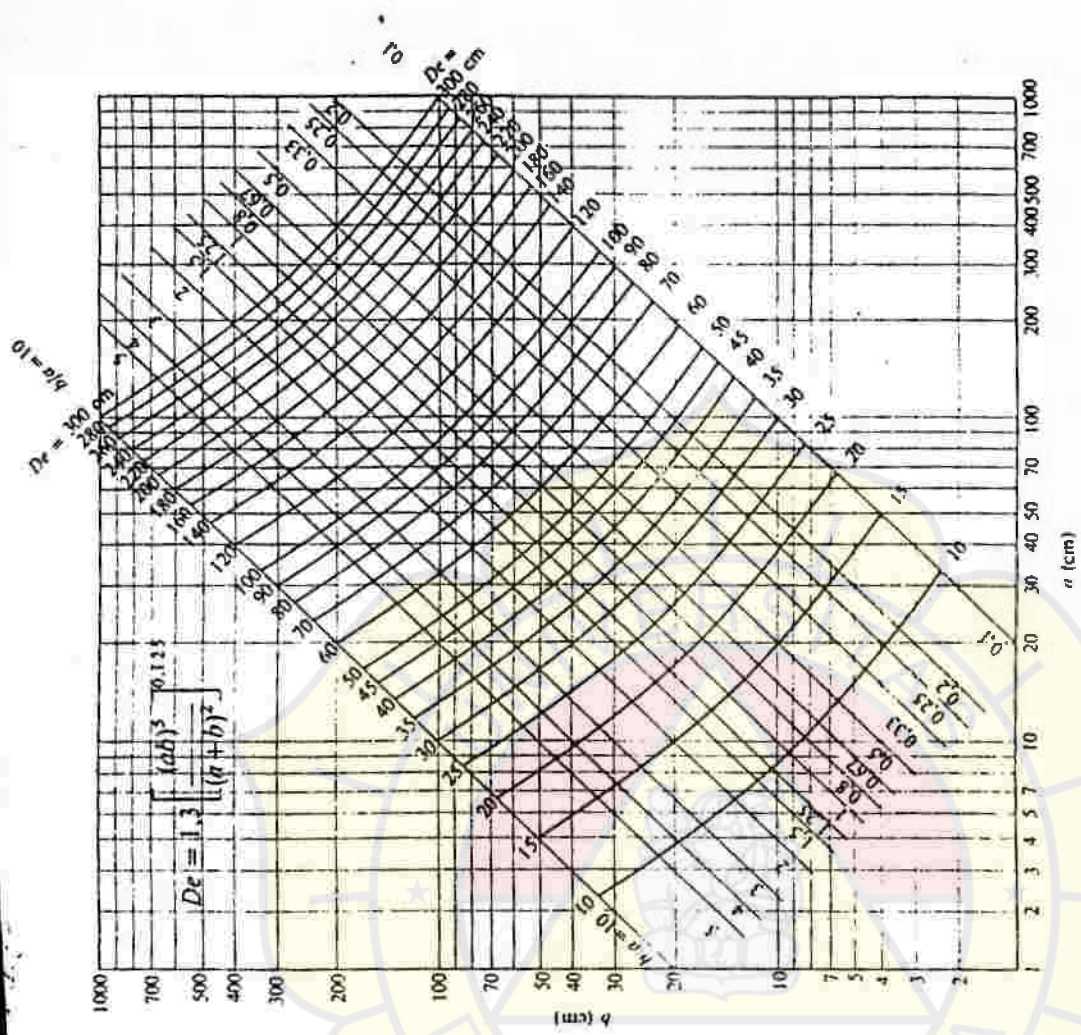




Gambar 6-2 Penurunan tekanan pada saluran udara lurus, bundar, terbuat dari lembaran logam, suhu udara 20°C, kekasaran absolut 0,00015 m

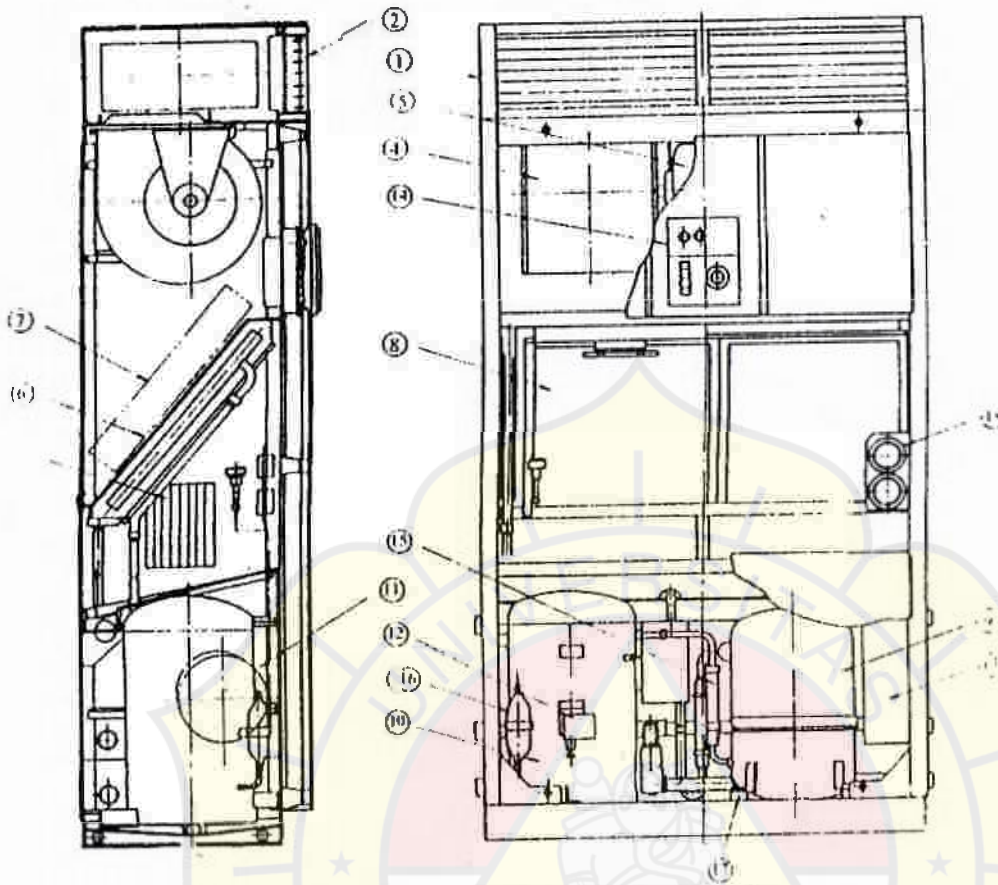
LAMPIRAN 5





LAMPIRAN 6





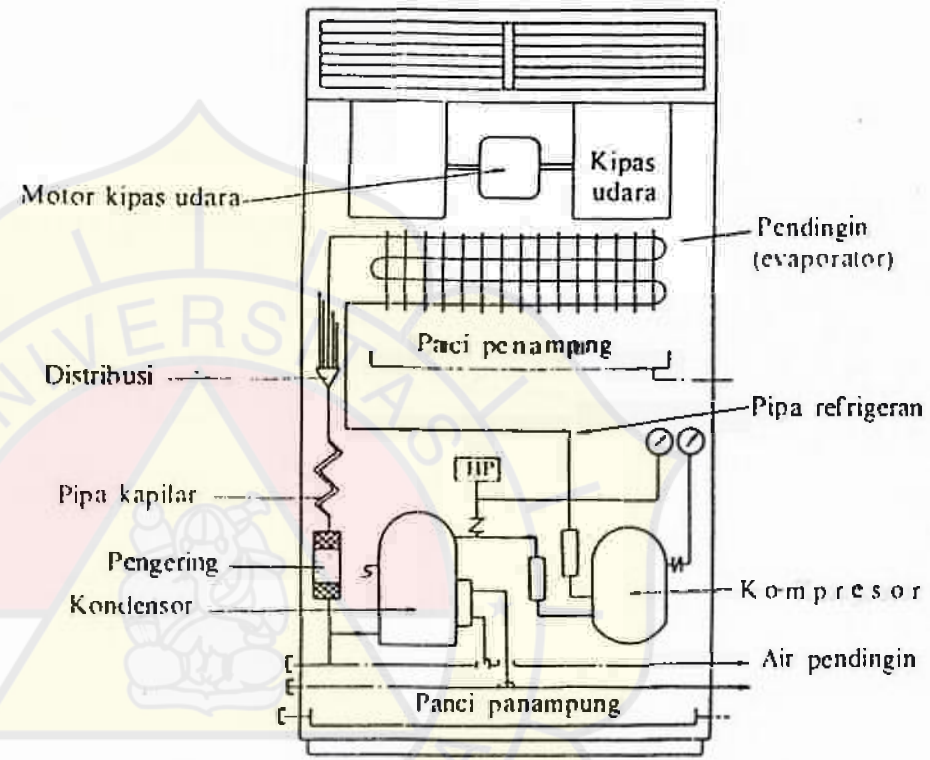
- 1. Ruang plenum
- 2. Gril pengeluaran
- 3. Lubang masuk pembantu
- 4. Kipas udara
- 5. Motor kipas udara
- 6. Pendingin
- 7. Manas
- 8. Saringan udara
- 9. Kompresor

- 10. Kondensor
- 11. Pipa kapilar
- 12. Saklar tekanan/tekanan tinggi
- 13. Kotak saklar elektromagnetik
- 14. Panel kontrol
- 15. Pipa flexibel
- 16. Saringan pengering
- 17. Karet peredam getaran
- 18. Pengukur tekanan campuran

Penyegar udara paket.

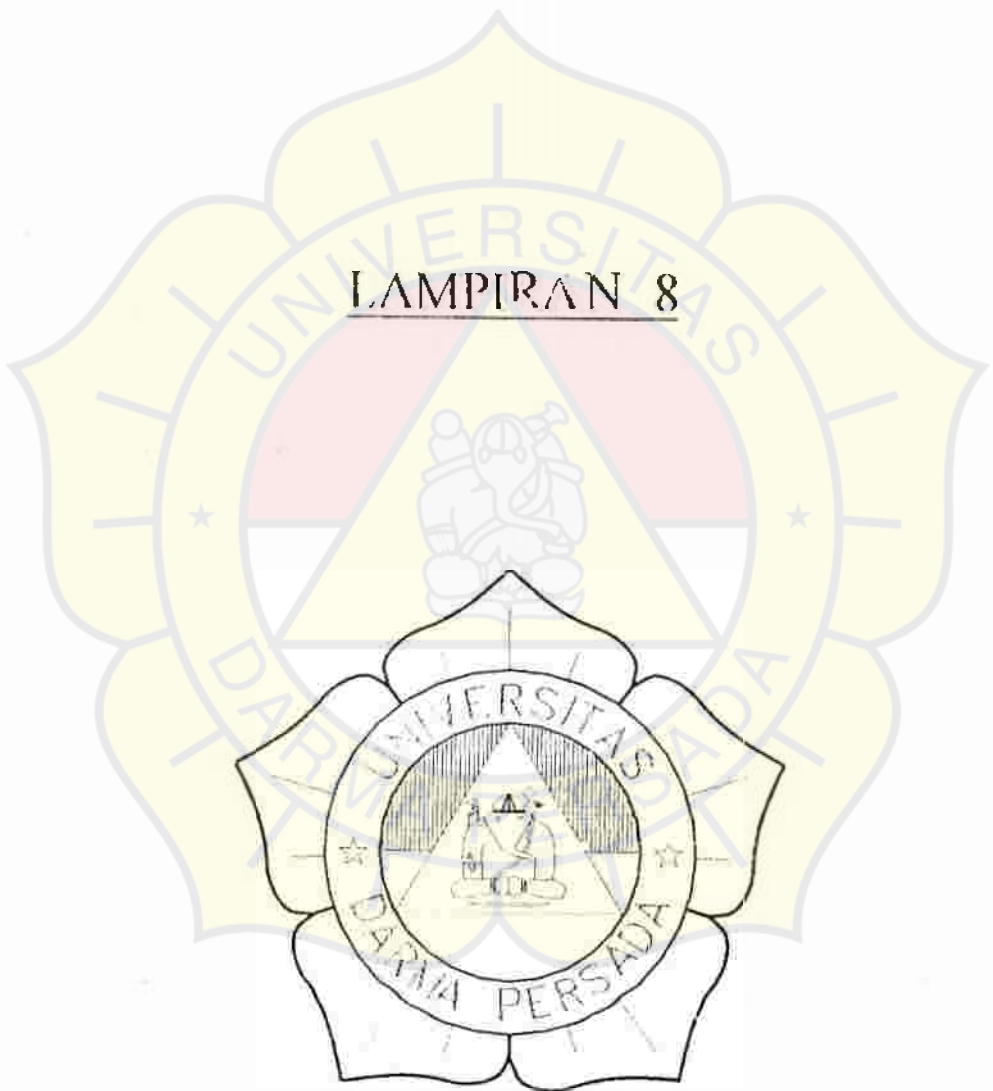
LAMPIRAN 7





Sistem pipa dari penyejuk udara paket.

LAMPIRAN 8

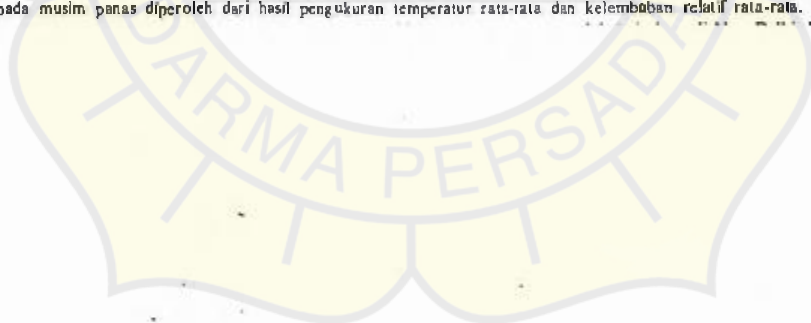


Tabel 3.3 Data cuaca ③ ⑤' di beberapa negara Asia .

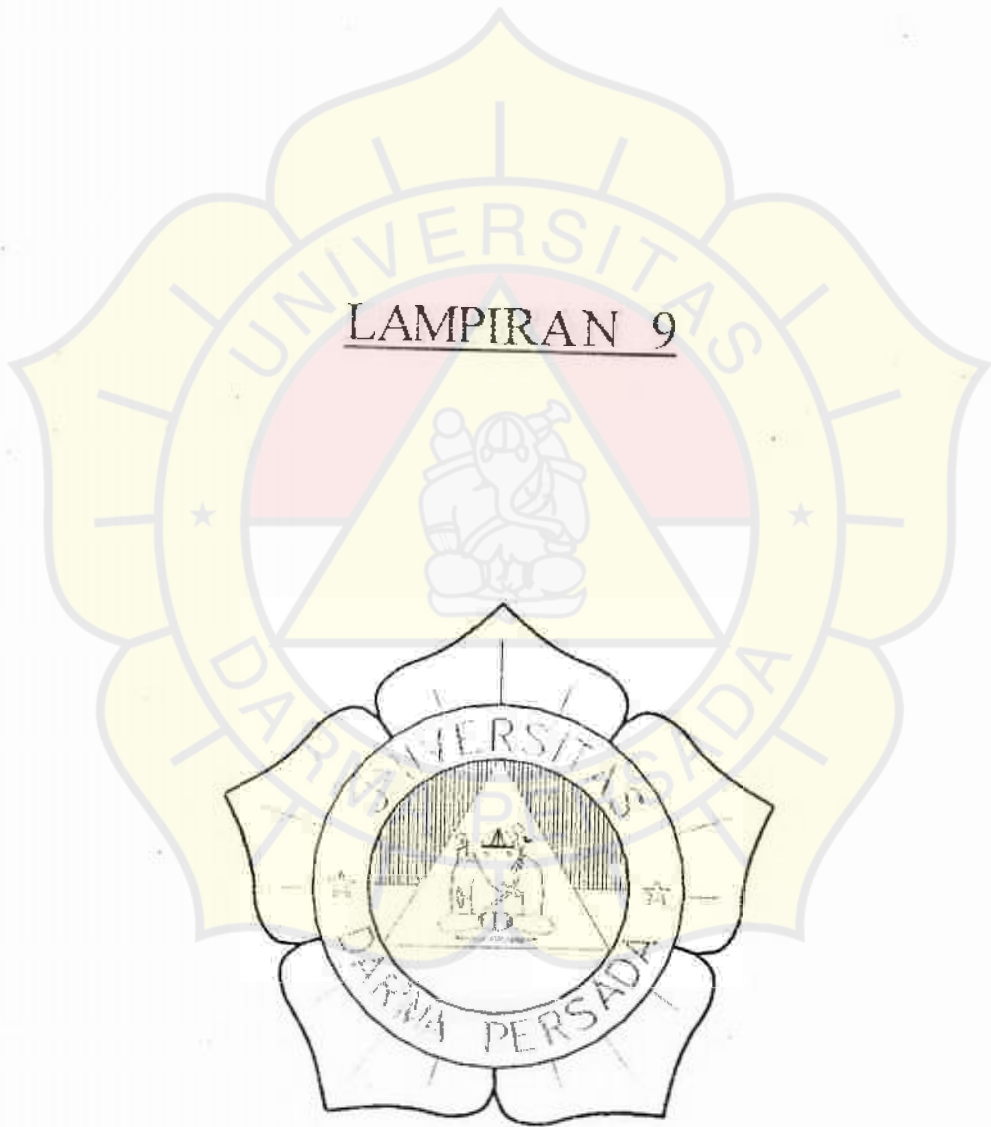
Negara	Kota	Garis lintang (°)	Garis bujur (°)	Elevasi (m)	Musim dingin			Musim panas					6) Perbandingan kelembaban rancangan ③	5) Temperatur bola basah rancangan ⑤	
					Bulan terdingin 2)		Temperatur	Bulan terpanas 2) ③'				Temperatur rancangan			
					Bulan	Temperatur bola basah (°C)	bola kering rancangan 3)	Bulan	Temperatur kering rata-rata (°C)	Perbandingan Kelembaban rata-rata	Kelembaban relatif rata-rata (%)	Penambahan temperatur harian ④)			Temperatur bola kering ②)
Burma	Rangoon	17 N	96 E	23	Jan.	24,3	16,7	April (Musim kemarau) Juli (Musim hujan)	29,8 27,6	0,0175 0,0202	66 86	14 38	38	0,0205	28
Hong Kong	Hong Kong	22 N	114 E	33	Jan.	15,4	8,9	Juli	28,4	0,0204	83	6	33	0,0203	27
India	Calcutta	22 N	88 E	6	Jan.	20,2	11,1	Mei (Musim kemarau)	31,1	0,0198	69	12	37	0,0211	28
	New-Delhi	29 N	77 E	216	Jan.	14,2	3,9	Juni (Musim kemarau) Juli (Musim hujan)	34,5 31,2	0,0135 0,0193	39 67	14 43	43	0,0182	28
Indonesia	Jakarta	6 S	107 E	8	Jan. Musim-hujan	26,2	21,7	Mei September & Oktober (Musim kemarau)	27,3 27,4	0,0187 0,0177	82 77	8	32	0,020	27
Irak	Baghdad	33 N	44 E	34	Jan.	10,1	0	Juli	34,3	0,0077	23	19	45	0,0082	23
Jepang	Tokyo	35 N	140 E	6	Jan.	4,1	-3,3	Agustus	26,7	0,0170	77	8	33	0,0207	27
Malaysia	Kuala Lumpur	3 N	102 E	38	Des.	26,9	21,1	Mei Juni	22,7 22,7	0,0183 0,0176	78 75	11	34	0,0210	28
	Singapore	1 N	104 E	10	Jan.	26,1	21,7	Juni	28,0	0,0190	79	8	33	0,0214	28
Pakistan	Kanachi	25 N	67 E	4	Jan.	19,1	9,4	Juni	30,4	0,0200	83	8	38	0,0195	28
Filipina	Manila	15 N	121 E	15	Jan.	25,4	22,8	Mei	29,4	0,0184	71	11	34	0,0210	28
Saudi-Arabia	Riyadh	25 N	47 E	594	Jan.	14,5	2,6	Juli	33,6	0,0084	26	18	43	0,0133	26
Thailand	Bangkok	14 N	101 E	16	Des.	25,5	16,1	April (Musim kemarau)	30,3	0,211	77	10	36	0,0202	28
Vietnam	Ho Chi Minh	11 N	107 E	10	Des.	23,7	18,1	April	28,8	0,080	72	9	34	0,0243	29
Egipt	Kairo	30 N	31 E	116	Jan.	12,7	7,2	Agustus	27,7	0,0129	55	14	30	0,0132	24

Ketinggian tempat stasiun meteorologi

Perbandingan kelembaban rata-rata pada musim panas diperoleh dari hasil pengukuran temperatur rata-rata dan kelembaban relatif rata-rata. Kondisi dari dua bulan



LAMPIRAN 9



Features and Appearance

Super quiet operation

Through the thorough and complete examination of noise sources of the Daikin Marine Type Packaged Air Conditioners, operation noise of US 1F, 2FC, 3FC, and 5FC is cut extremely low (ex. operation noise of US 3FC is only 53 dbA), breaking down the wall of 70 dbA which is commonly regarded as noise level of marine type packaged air conditioners. In the case of the models installed in a machine room such as US8FC, 10FC 15FA and 20F, various noise prevention measures are completely provided and they have already gained a reputation of super quiet conditioners.

Noise prevention measures/ Adoption of vibration eliminating rubbers for fan and compressor and flexible tubes for suction piping, improvement of acoustic material, lowering fan speed due to enlargement of fan size, development of new compressors, improvement of partition wall in a machine room, and improvement of air passage.

Excellent durability

All the Daikin Marine Type Packaged Air Conditioners are specifically designed in consideration with unique conditions on ships such as bending, torsion, elongation caused by rolling and pitching of ships, corrosion and rust caused by cooling sea water and sea breeze, etc.

Condenser and its relative parts/ Adoption of copper alloy for such parts which are in contact with cooling sea water, Al-brass tubes for cooling water tubes, naval-clad steel for tube plates, and bronze casting for head and rear covers.

Evaporator and its relative parts/ Anti-corrosive treatment on evaporator fins against sea water.

Structure and design/ Application of anti-corrosive paint against sea water and anti-quake structure.

Fan and its relative parts/ Improvement of bearings and reinforcement of fan frame.

Safe measures

If the Daikin Marine Type Packaged Air Conditioners are out of order, their operation is automatically stopped by various safety and protective devices before trouble occurs.

Electric system/ Over-current relay, compressor protective thermostat, pilot lamps for abnormal operation.

Refrigeration circuit/ Dual pressure switch, condenser fusible plug (Safety valve is used for US15AF(TO)-20F(TO))

Wide operative range

Even in middle seasons, if cooling is required because of heat from engines, the units are operative. Furthermore, if cooling is required during winter, a stable cooling operation is obtainable only when engine cooling water (Under 38°C) is used.

Standard specification

Type		Water Cooled Marine Type Packaged Air Conditioners					
Model		With Flare Chamber		Without Flare Chamber			
		US1FC	US2FC	US3FC	US20FC	US30FC	
Power source	50/60Hz	Single phase 100/100, 110V	3 phase 380, 400/400, 440V		3 phase 200/200, 220V		
Cooling capacity	50/60Hz kcal/h	2,400/2,650	3,100/3,700	3,600/4,000	5,100/5,600	5,100/5,600	
Condenser water flow rate	50/60Hz l/min	15/16	28/30	42/45	28/30	42/45	
Condenser head loss	50/60Hz mH ₂ O	0.9/1.0	0.7/0.8	1.3/1.5	1.2/1.4	1.3/1.5	
Running current	50/60Hz A	9.4/9.8	3.8/3.9	5.5/6.5	6.4/7.0	8.5/8.5	
Rating power consumption	50/60Hz kW	0.85/1.1	2.2/2.7	2.8/3.9	17/2.2	24/3.1	
Compressor	Type	Hermetic rotary type			Hermetic reciprocating type		
	Motor output	0.75	1.5	2.2	1.5	2.2	
	Starting method	Direct-on line					
Evaporator		Cross-finned coil type					
Condenser	Type	Shell & bare tube type		Shell & cross finned tube type			
	Motor output	Dual suction multi-blade fans (Stroco fan)					
Fan	Motor output	0.025 x 4P	0.2 x 6P	0.2 x 6P	0.2 x 6P	0.4 x 4P	
	Driving method	Direct drive			Belt drive		
	Air flow	50/60Hz m ³ /min	7/8(HI)	15/18	22/27	18/18	27/27
	External static pressure	50/60Hz mm H ₂ O	—	—	—	9/5	9/19
Filter		Vinylidene chloride fibre (Washable with clean water)					
Refrigerant control		Thermal expansion valve					
Thermostat		For cooling (with reverse contact points for heating)					
Capacity control		100-0%					
Protective devices	For electric wiring	Over-current relay, Reverse phase protector		Over-current relay	Over-current relay, Reverse phase protector		
	For refrigeration circuit	High pressure switch	Dual pressure switch, Fusible plug (attached to condenser)		High pressure switch, Fusible plug (attached to condenser)		
Coating		Cold-rolled steel plate, Melamine resin baked finish, Light blue (Munsell No. approx 7.5BG7/2)					
Refrigerant		R-22					
Refrigerant oil		SUNISO 4GS-D1	SUNISO 4GS-D1	SUNISO 4GS-D1-K	SUNISO 4GS-D1		
Accessories		1 set of sacrificial anode plate, packing for sacrificial anode plate and water cover packing for condenser		Ag for the details, see page 10.			
Connections	Condenser water inlet/outlet	1/2 B (JIS5kg/cm ² with companion flange)		1 B (JIS5kg/cm ² with companion flange)			
	Upper drain pipe	3/4 B female screw					
	Lower drain pipe	3/4 B female screw					
	Safety valve pipe	—	1/2 B (with elliptical companion flange)		—	—	
	Fusible plug pipe	—	—	—	1/2 B (JIS5kg/cm ² with companion flange)		
Power source intake		Ø16 (rubber bush) or 1/2 BS	JIS20b gland	JIS20b gland	Cable connector (For cable of O.D. 12.1-14)		
Wiring outlet for remote operation indication		—	Ø27 (rubber bush)		Ø21 Blind rubber bush		
Net weight	kg	95	160	173	55	165	

1. Cooling capacity is based on evaporator entering air temperature 27°C D.B., 19.5°C W.B. and entering condenser

2. Running current and 3. Rating power consumption are based on single phase 100/110V, 50/60Hz in case of US2FC, 3FC, 5FC, 10FC, 15FC, 20F and three phase 200/220V, 50/60Hz in case of US3FC, 20F, 30F.

understandable operation signal
lamps for power source, running and
normal operation are provided for ease
of operation.

Excellent cooling capacity
Use of the highly efficient condenser
makes it possible to exhibit excellent cooling
capacity. This ensures energy saving
operation.

Compact design
In order to use the internal space of a ship
effectively, all necessary functions for cooling
are packed in a unit, which is constructed
neatly and light.

Easy serviceability
Use of the highly efficient and
compact heat exchanger makes it possible
to charge the volume of the refrigerant
easily. The filter can be easily removed or

Operative with various power sources

A transformer is attached in the controlling circuit so that the units are operative with any power source of the world shown below.

Power source Model	50Hz				60Hz					
	Single phase	3-phase			Single phase	3-phase				
	100V	200V	380V	400V	100V	110V	200V	220V	400V	440V
US1F	●				●					
US2FC			●	●					●	●
US2GCTG			●	●				●	●	
US3FC			●	●					●	●
US3GCTG			●	●				●	●	
US5FC			●	●					●	●
US5GCTG			●	●				●	●	
US6FC			●	●					●	●
US6GCTG			●	●				●	●	
US10FC			●	●					●	●
US10GCTG			●	●				●	●	
US15FA			●	●					●	●
US15FATO			●	●					●	●
US20F			●	●					●	●
US20FATO			●	●					●	●

Plenty of standard accessories

There are plenty of spare parts which are used frequently and they are delivered together with the unit body when delivered. (For the details of 2HP-7.5HP, refer to "Standard accessories on page 10.)

Versatile optional accessories are available for easy alteration

Numerous optional parts are available on request so that the marine type packaged air conditioners can be used for various applications. Use suitable accessories in accordance with the installation conditions.

(As for the details, see Page 10)

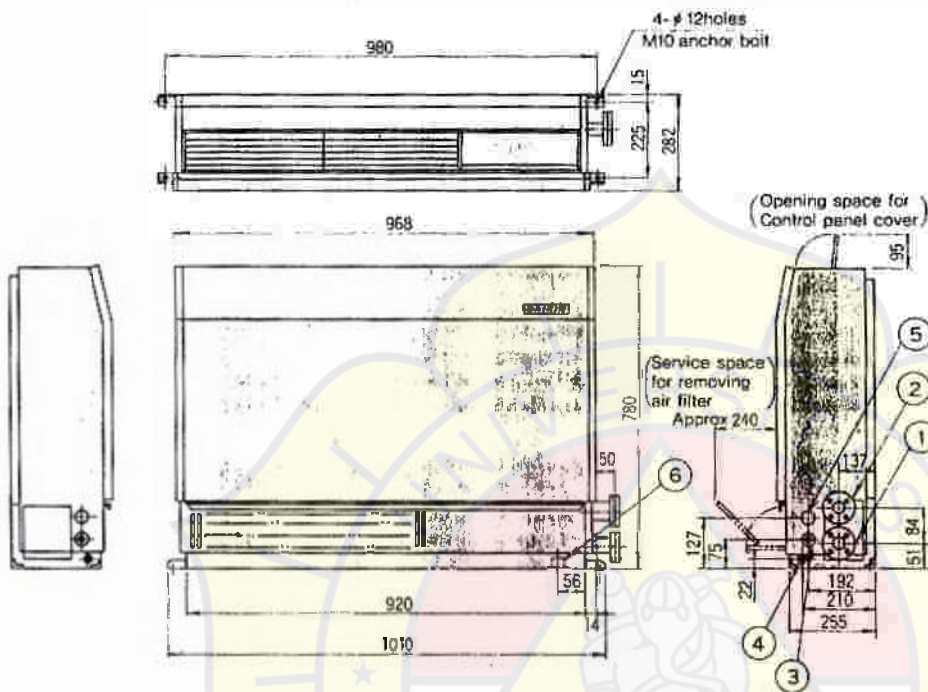
US-GCTG Series-Ideal for middle and small ships and fishing boats
US-GCTG series developed specifically for air conditioning of middle and small ships and fishing boats in which space is valuable. Thus the models in this series are available in 4 models (from 2HP to 7.5HP). They have numerous features, for example, the height of the units is very low for space saving, ducting can be provided for air distribution, all servicing work can be done from the front and the side of the units (US5GCTG, 6GCTG) and many others.

Marine Type Packaged Air Conditioners						
Model	US5GCTG	US6FC	US6GCTG	US10GCTG	US15FA(TO)	US20F(TO)
Power source	3 phase 200/200, 220V	3 phase 380, 400/400, 440V 3 phase 200/200, 220V	3 phase 200/200, 220V	3 phase 380, 400/400, 440V (3 phase 200/200, 220V)		
Capacity	15,000/15,000	20,250/22,550	20,250/22,550	24,000/20,000	24,000/14,000	55,000/60,000
Dimensions (mm)	717/77	91/98	91/98	120/130	207/225	275/300
Weight (kg)	1.9/2.2	1.2/1.4	1.2/1.4	1.4/1.8	1.25/1.45	125/1.45
Refrigerant	21.7/22.5	14.5/18	33.0/34.0	20.6/22.5(44.5/47.9)	25.4/30.6(53.6/61.2)	34.7/39.0(73.1/78.0)
Refrigerant charge (kg)	8.0/7.4	8.4/10.3	9.0/11.2	12.0/14.2(13.0/15.1)	15.2/18.0(15.2/18.9)	19.1/25.0(19.1/25.0)
Compressor type	Reciprocating type			Semi-hermetic reciprocating type		
Compressor displacement (cm ³ /rev)	3.75	5.5	5.5	7.5	11	16
Condenser coil type	Finned tube type					
Condenser fins type	Multi-blade fan (Sirocco fan)					
Condenser fan size	1.5 x 4P	0.75 x 4P	1.5 x 4P	2.2 x 4P	3.7 x 4P	5.5 x 4P
Condenser fan speed (rpm)	50/50	50/60	60/60	87/80	100/120	135/160
Condenser fan voltage	20/42	15/24	24/44	20/31(32/49)	40/60	47/70
Condenser filter	Polyethylene fibre (Washable with clean water)				Polyolefin fibre	
Expansion valve	Thermostatic expansion valve with reverse contact points for heating					
Compressor protection	Relay, thermostat for compressor motor					
High pressure switch (condenser)	High pressure switch, Low pressure switch, Fusible plug, (attached to condenser)	Dual pressure switch, Fusible plug (attached to condenser)	High pressure switch, Low pressure switch, Fusible plug, (attached to condenser)	Dual pressure switch, Fusible plug (attached to condenser)	Dual pressure switch, Safety valve, Relief valve (used for US20F(TO))	
Control panel	Melamine resin baked finish, Light blue (Munsell No. approx 7.5BG 7/2)					
Compressor	NK-K					
Compressor terminals	See page 10.			1 set of sacrificial anode plate, packagings, anode plate, screw for sacrificial anode plate, and water cover packing for non-drill use		
Companion flange	2B (JIS5kg/cm ² with companion flange)			2 1/2B (JIS5kg/cm ² with companion flange)		
Companion flange	1/2B (with elliptical companion flange)			1/4B (with elliptical companion flange)		
Companion flange	1/2B (with elliptical companion flange)			1/4B (with elliptical companion flange)		
Companion flange	JIS206 gland	JIS206, 20c gland	JIS306 gland	JIS206, 20c gland (JIS206, 20c gland)	JIS206, 20c gland (JIS206, 20c gland)	JIS206, 20c gland (JIS206, 20c gland)
Companion flange	285	395	360	490	670	830

Compliance with NK standards. The products which passed the NK standards are marked with the combination issued by NK. US15FA and 20F Accord with the NK standards (Q, 3GCTG, 5GCTG, 6GCTG).

Outline drawing

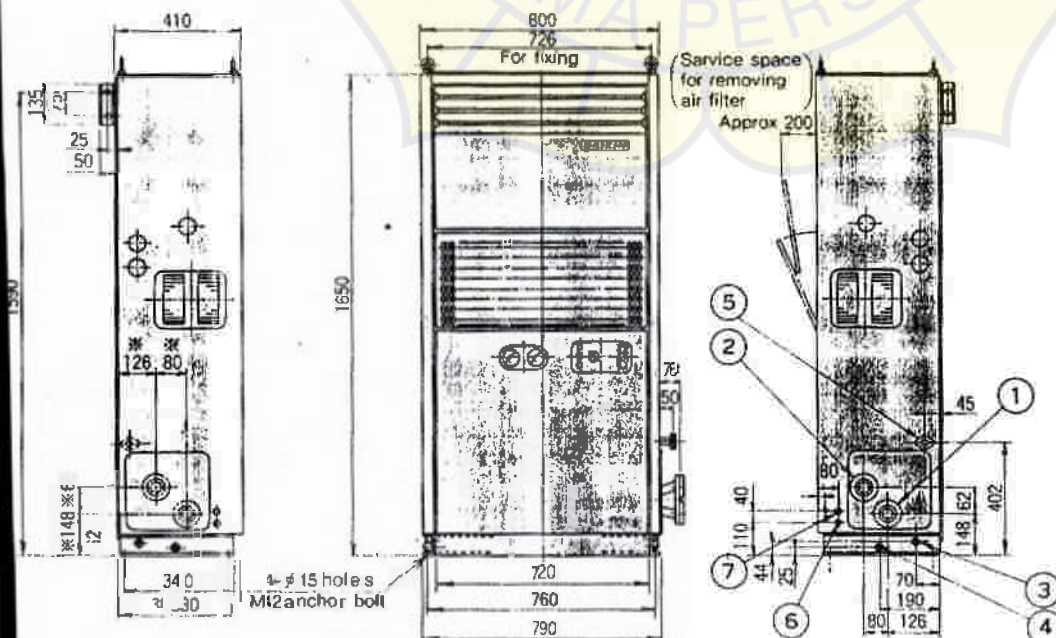
US1F



- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Main power intake
- ⑥ Main power intake

Notes:
 1. Standard piping connections are made on the right side of the unit.
 2. Take in main power from either of ⑤ or ⑥ hole.

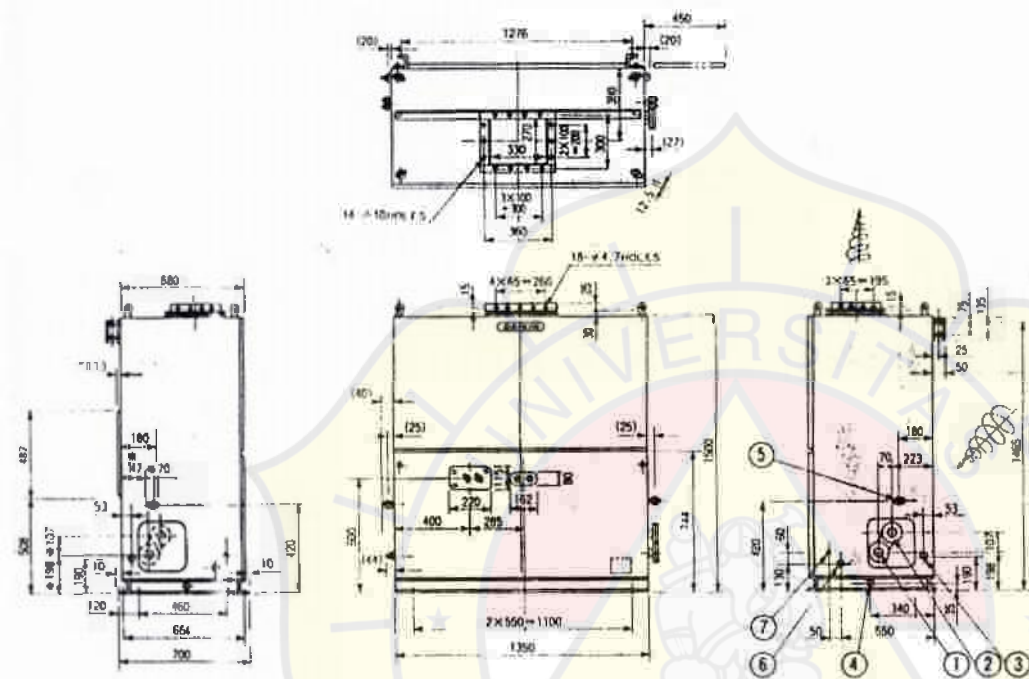
US2FC • US3FC



- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Pipe connection for safety valve
- ⑥ Main power intake
- ⑦ Wire outlet for remote operation indication

Notes:
 1. Standard piping connections are made on the right side of the unit.
 2. * shows the location of condenser water pipe connection in case of left side piping.

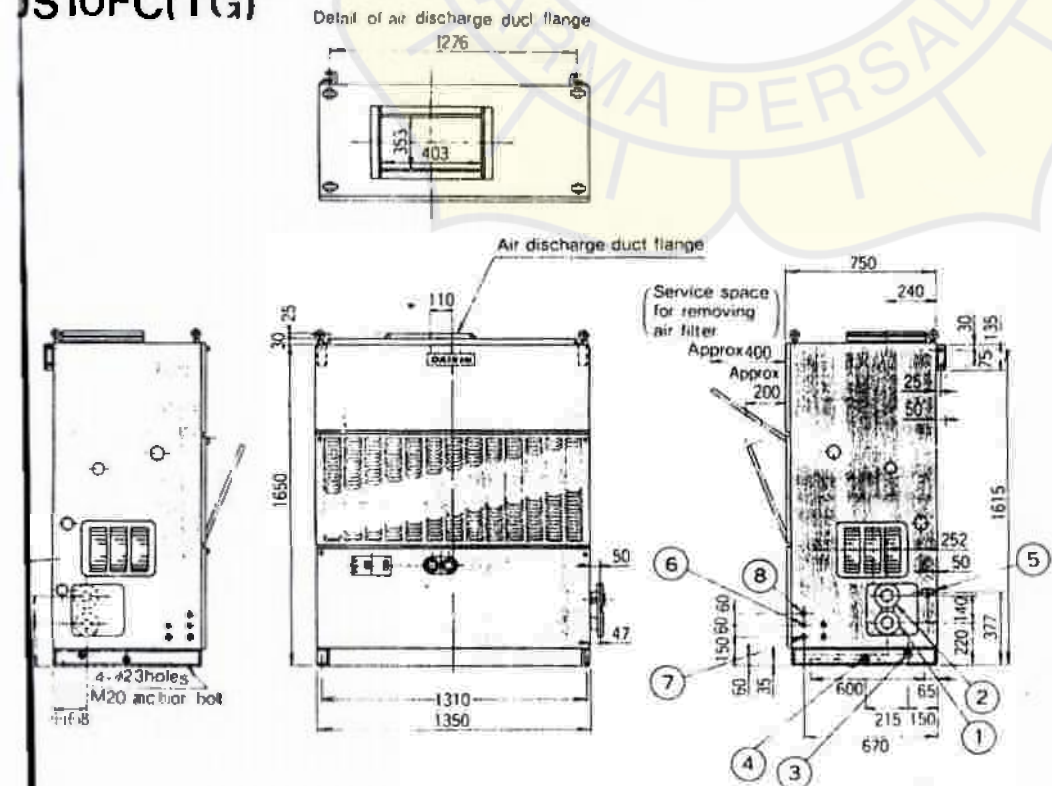
JS8GCTC



- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Pipe connection for safety valve
- ⑥ Main power intake
- ⑦ Wire outlet for remote operation-indication

Notes:
 1. Standard piping connections are made on the right side of the unit.
 2. *show the location of condenser water pipe connection in case of left side piping.

JS10FC(TG)

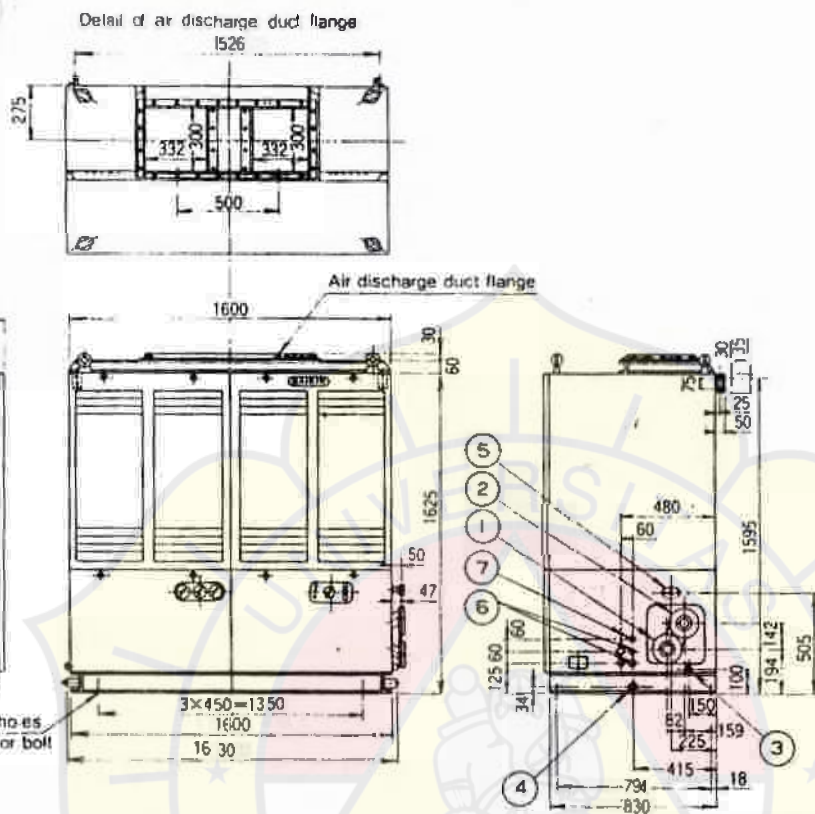


- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Pipe connection for safety valve
- ⑥ Main power intake for fan motor
- ⑦ Main power intake for compressor motor
- ⑧ Wire outlet for remote operation-indication

Notes:
 1. Standard piping connections are made on the right side of the unit.
 2. *shows the location of condenser water pipe connection in case of left side piping.

Outline drawing

JS15FA(TO)

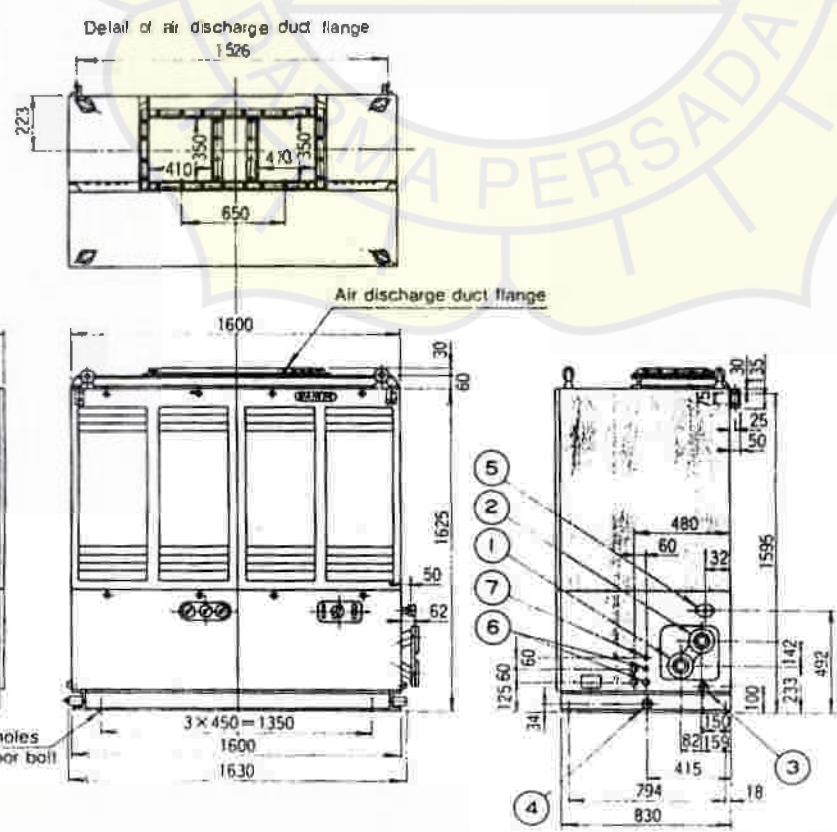


- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Pipe connection for safety valve
- ⑥ Main power intake
- ⑦ Wire outlet for remote operation-indication
- ⑧ Grease charge port
- ⑨ Access panel

Notes:

1. Standard piping connections are made on the right side of the unit.
2. * shows the location of condenser water pipe connection in case of left side piping.

S20F(TO)



- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Pipe connection for safety valve
- ⑥ Main power intake
- ⑦ Wire outlet for remote operation-indication
- ⑧ Grease charge port
- ⑨ Access panel

Notes:

1. Standard piping connections are made on the right side of the unit.
2. * shows the location of condenser water pipe connection in case of left side piping.

atures and Appearance

Quiet operation

Through the thorough and complete elimination of noise sources of the Daikin Marine Type Packaged Air Conditioners, the noise of US 2G, 3G, and 5FC is extremely low (ex. operation noise of US 3G is only 53 dbA), breaking through the wall of 70 dbA which is only regarded as noise level of land type packaged air conditioners. Because of the models installed in a room such as US8FC, 10FC 15FA and 20F, various noise prevention measures are completely provided and they have gained a reputation of super quiet

Noise prevention measures/ Adoption of special eliminating rubbers for fan and motor and flexible tubes for suction and discharge. Improvement of acoustic material, reduction of fan speed due to enlargement of fan diameter, development of new compressors, installation of partition wall in a machine room and improvement of air passage.

Excellent durability

All the Daikin Marine Type Packaged Air Conditioners are specifically designed in consideration with unique conditions on ships such as bending, torsion, elongation caused by rolling and pitching of ships, corrosion and rust caused by cooling sea water and sea breeze, etc.

Condenser and its relative parts/ Adoption of copper alloy for such parts which are in contact with cooling sea water. Al-brass tubes for cooling water tubes, naval-clad steel for tube plates, and bronze casting for head and rear covers.

Evaporator and its relative parts/ Anti-corrosive treatment on evaporator fins against sea water.

Structure and design/ Application of anti-corrosive paint against sea water and anti-quake structure.

Fan and its relative parts/ Improvement of bearings and reinforcement of fan frame.

Safe measures

If the Daikin Marine Type Packaged Air Conditioners are out of order, their operation is automatically stopped by various safety and protective devices before trouble occurs.

Electric system/ Over-current relay, compressor protective thermostal, pilot lamps for abnormal operation.

Refrigeration circuit/ Dual pressure switch, condenser fusible plug

(Safety valve is used for US15FA(TO), 20F(TO))

Wide operative range

Even in middle seasons, if cooling is required because of heat from engines, the units are operative. Furthermore, if cooling is required during winter, a stable cooling operation is obtainable only when engine cooling water (Under 38°C) is used.

Standard specification

		Type	Water Cooled Marine Type Packaged Air Conditioners			
			With Plenum Chamber	For Duct Connection		
		Model	US2G	US3G	US2GDTG	US3GDTG
Capacity	50/60Hz		3 phase 380, 400/400, 440V		3 phase 200/220, 220V	
Capacity	50/60Hz	kcal/h	8,100/9,000	8,100/9,000	8,100/9,000	8,100/9,000
Water flow rate	50/60Hz	l/min	28/30	42/45	28/30	42/45
Water head loss	50/60Hz	mH ₂ O	1.2/1.4	1.3/1.5	1.2/1.4	1.3/1.5
Running current	50/60Hz	A	3.4/3.5	4.6/4.9	6.4/7.0	6.7/9.8
Power consumption	50/60Hz	kW	1.7/2.2	2.3/3.1	1.7/2.2	2.4/3.1
Compressor	Type	Hermetic rotary type				
	Motor output	kW	15	22	15	22
	Starting method	Direct rotary type				
Coil	Type	Cross-finned coil type				
	Tube	Shell & cross finned tube type				
	Fan	Dual suction multi-blade fans (Sirocco fan)				
Motor output		0.2x6P	0.4x4P	0.2x6P	0.4x4P	
Driving method		Bell drive				
Air flow	50/60Hz	m ³ /min	15/18	22/27	18/18	27/27
External static pressure	50/60Hz	mmH ₂ O	—	—	9/15	9/19
Refrigerant	Vinylidene chloride libra (Washable with clean water)					
Expansion valve	Thermal expansion valve					
Control	For cooling (with reverse contact points for heating)					
Control	100-0%					
Safety devices	For electric wiring	Over-current relay, Reverse phase protector				
	For refrigeration circuit	Dual pressure switch, Fusible plug (attached to condenser)			High pressure switch, Fusible plug (attached to condenser)	
Case	Cold rolled steel plate, Melamine resin baked finish, Light blue (Munsell No. approx 7.5BG 7/2)					
Oil	R-22					
Oil	SUNISO 4GS-D1					
Oil	As for the details, see page 10.					
Connections	Condenser water inlet/outlet	1B(JIS5kg/cm ²) With companion flange)				
	Upper drain pipe	3/8 B female screw				
	Lower drain pipe	1/2 B female screw				
	Safety valve pipe	1/2 B (with elliptical companion flange)				
	Fusible plug pipe	—			1/2 B(JIS5kg/cm ²) with companion flange)	
Power source intake		JIS20b gland	JIS20b gland	Cable connector (For cable of O. D. 12, 1-14)		
Wire outlet for remote operation-indication		φ 27 (rubber bush)			φ 21 Blind rubber bush	
Weight	kg	155	185	155	185	

* Cooling capacity is based on evaporator cooling air temperature 27°C D.B./19.5°C W.B. and entering condenser water temperature 32°C.

* 2. *2 Running current and *3 Rating power consumption are based on three phase 380/440V, 50/60Hz in case of US2G, 3G, 5FC, 8FC, 10FC, 15FA, 20F, and three phase 200/220V, 50/60Hz in case of US2GDTG, 3GDTG, 5GDTG, 8GDTG, 10FC, 15FA(TO), 20F(TO).

asily understandable operation signal
 & lamps for power source, running and
 normal operation are provided for ease
 inspection.

Excellent cooling capacity
 option of the highly efficient condenser
 makes it possible to exhibit excellent cooling
 capacity. This ensures energy saving
 operation.

Compact design
 In order to use the internal space of a ship
 effectively, all necessary functions for cooling
 are encased in a unit, which is constructed
 compact and light.

Excellent serviceability
 Development of the highly efficient and
 compact heat exchanger makes it possible
 to reduce charged volume of the refrigerant.
 The air filter can be easily removed or
 mounted.

Operative with various power sources

A transformer is attached in the controlling
 circuit so that the units are operative with
 any power source of the world shown below.

Power source Model	50Hz			60Hz		
	3 phase			3 phase		
	200V	300V	400V	200V	300V	400V
US2G	•	•	•	•	•	•
US2GDTG	•	•	•	•	•	•
US3G	•	•	•	•	•	•
US3GDTG	•	•	•	•	•	•
US5FC	•	•	•	•	•	•
US5GDTG	•	•	•	•	•	•
US6FC	•	•	•	•	•	•
US6GDTG	•	•	•	•	•	•
US10FC	•	•	•	•	•	•
US10FC TG	•	•	•	•	•	•
US15FA	•	•	•	•	•	•
US15FATO	•	•	•	•	•	•
US20F	•	•	•	•	•	•
US20F TO	•	•	•	•	•	•

Plenty of standard accessories
 There are plenty of spare parts which are
 used frequently and they are delivered
 together with the unit body when delivered.
 (For the details of 2HP-7.5HP, refer to "Standard
 accessories on page 10.)

Versatile optional accessories are available for easy alteration

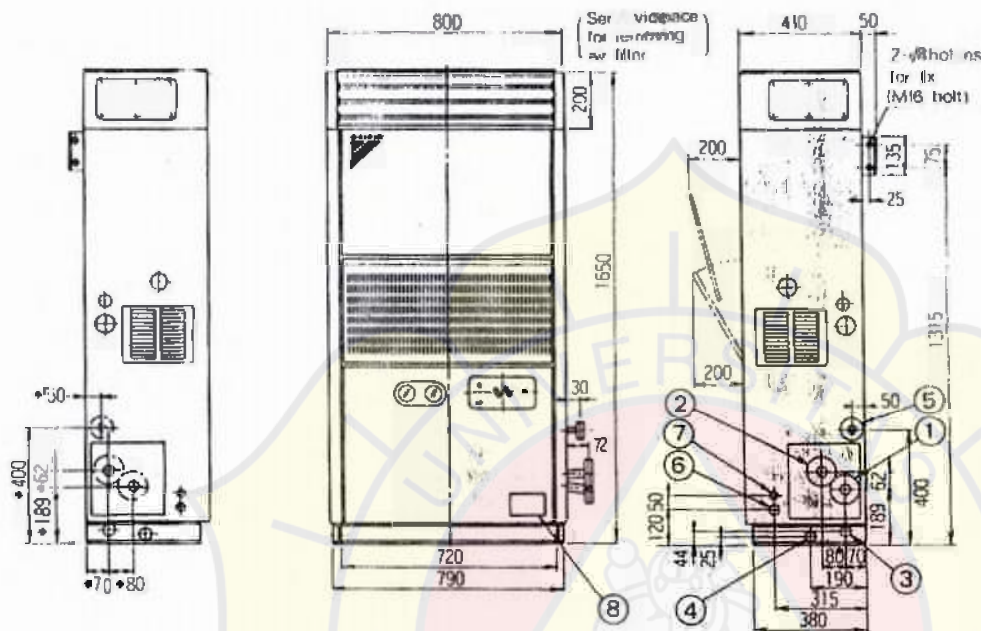
Numerous optional parts are available on
 request so that the marine type packaged air
 conditioners can be used for various applications.
 Use suitable accessories in accordance with
 the installation conditions.
 (As for the details, see Page 10)

US-G(D)TG series is ideal for middle and small ships and fishing boats. US-G(D)TG series is developed specifically for air conditioning of middle and small ships and fishing boats, in which space is valuable. Thus, the models in this series are available in 7 models from 2HP to 7.5HP. They have numerous features, for example, the height of the units is very low for space saving, ducting can be provided for air distribution, all servicing work can be done from the front and the side of the units (US5GDTG, 6GDTG) and many others.

Cooled Marine Type Packaged Air Conditioners						
Plenum Chamber	For Duct Connection					
US5FC	US5GDTG	US6FC	US6GDTG	US10FC TG	US15FATO	US20F TO
3 phase 380, 400/400, 440V	3 phase 200/200, 220V	3 phase 300, 400/400, 440V (3 phase 200/200, 220V)	3 phase 200/200, 220V	3 phase 380, 400/400, 440V (3 phase 200/200, 220V)		
10/15,000	13,500/15,000	20,250/22,550	20,250/22,500	28,000/30,000	42,000/45,000	60,000/60,000
71/77		91/98	91/98	120/130	207/225	275/300
2	1.9/2.2	1.2/1.4	1.2/1.4	1.4/1.6	1.25/1.45	1.25/1.45
0.4	17.4/17.7	14.5/16	23.9/24.5	20.6/22.5 (44.5/47.9)	25.4/30.6 (53.6/61.2)	34.7/39.0 (73.1/78.0)
5	6.0/6.7	8.4/10.3	8.3/6.7	12.0/14.2 (13.0/15.1)	15.2/18.9 (15.2/18.9)	19.1/25.0 (19.1/25.0)
Hermetic reciprocating type					Semi-hermetic reciprocating type	
7.5	3.75	5.5	5.5	7.5	11	15
Coil type						
finned coil type						
cross finned tube type						
fan type						
multi-blade fan (Sioco fan)						
4P	1.5 x 4P	0.75 x 4P	1.5 x 4P	2.2 x 4P	3.7 x 4P	5.5 x 4P
50/50	50/60	60/60	60/60	67/80	100/120	135/160
23/46	15/24	25/44	25/44	20/31 (32/49)	40/60	47/70
polyethylene fibre (Washable with clean water)					Polyolefin fibre	
thermal expansion valve						
heating coil (with reverse contact points for heating)						
100-67-0%						
current relay, thermostat for compressor motor						
pressure switch, fusible plug (attached to condenser)	High pressure switch, Low pressure switch, Fusible plug (attached to condenser)	Dual pressure switch, Fusible plug (attached to condenser)	High pressure switch, Low pressure switch, Fusible plug (attached to condenser)	Dual pressure switch, Fusible plug (attached to condenser)	Dual pressure switch, Safety valve, Relief valve (used for US20F TO)	
stainless steel plate, Melamine resin baked finish, Light blue (Munsell No. approx 7.5BG 7/2)						
3GSDI					SONISO 4GSDI-K	
For details, see page 10.					1 set of sacrificial anode plate, packing for sacrificial anode plate, screw for sacrificial anode plate, and water cover packing for condenser.	
5.5kg/cm ² with companion flange					2B (JIS 5kg/cm ² with companion flange)	2 1/2 B (JIS 5kg/cm ² with companion flange)
1/2" B screw						
1/2" B screw						
1/2" B (with elliptical companion flange)	1" B (with elliptical companion flange)	1" B (with elliptical companion flange)	1" B (with elliptical companion flange)	1" B (with elliptical companion flange)	1" B (with elliptical companion flange)	
1" B (with elliptical companion flange)						
gland	Cable connector	JIS20b, 20c gland	Cable connector	JIS20b, 25a gland, JIS20b, 30a gland	JIS20b, 25b gland, JIS20b, 30b gland	JIS20b, 25b gland, JIS20b, 30a gland
rubber bush	φ21 (rubber bush)	φ27 (rubber bush)	φ21 (rubber bush)	φ27 (rubber bush)		
285	395	380	490	670	830	

Outline drawing

US2G·US3G

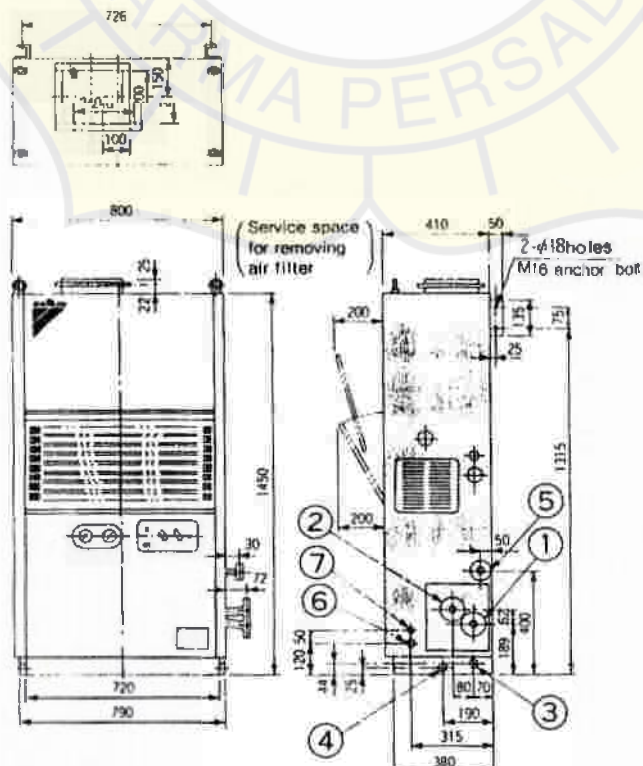


- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Emergency flon gas outlet
- ⑥ Main power intake Wire outlet for
- ⑦ remote operation- indication
- ⑧ Name plate

Notes:

1. Standard piping connections are made on the right side of the unit.
2. * shows the location of condenser water pipe connection in case of left side piping.
3. Plenum chamber: Optional accessory

US2GDTG · 3GDTG

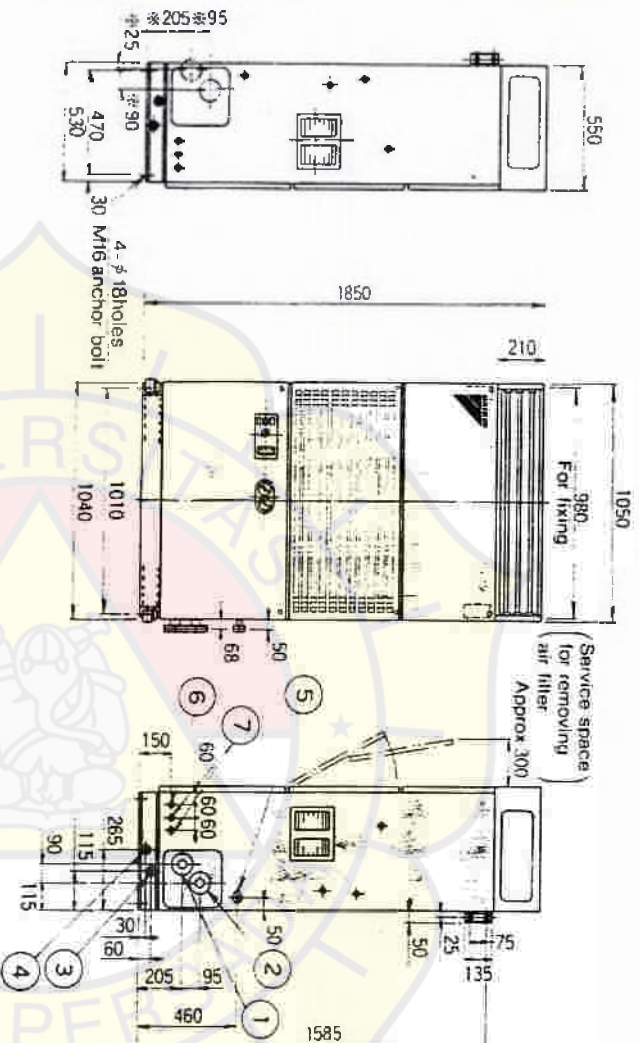


- ① Condenser water inlet.
- ② Condenser water outlet.
- ③ Upper drain outlet.
- ④ Lower drain outlet.
- ⑤ Pipe connection for extraction of refrigerant to atmosphere.
- ⑥ Main power intake.
- ⑦ Wire outlet for remote operation indication.

Notes:

- Standard piping connections are made on the right side of the unit. In case the left-hand piping connections are required, the locations of condenser water connections are the same as those of the right-hand piping.

US5FC

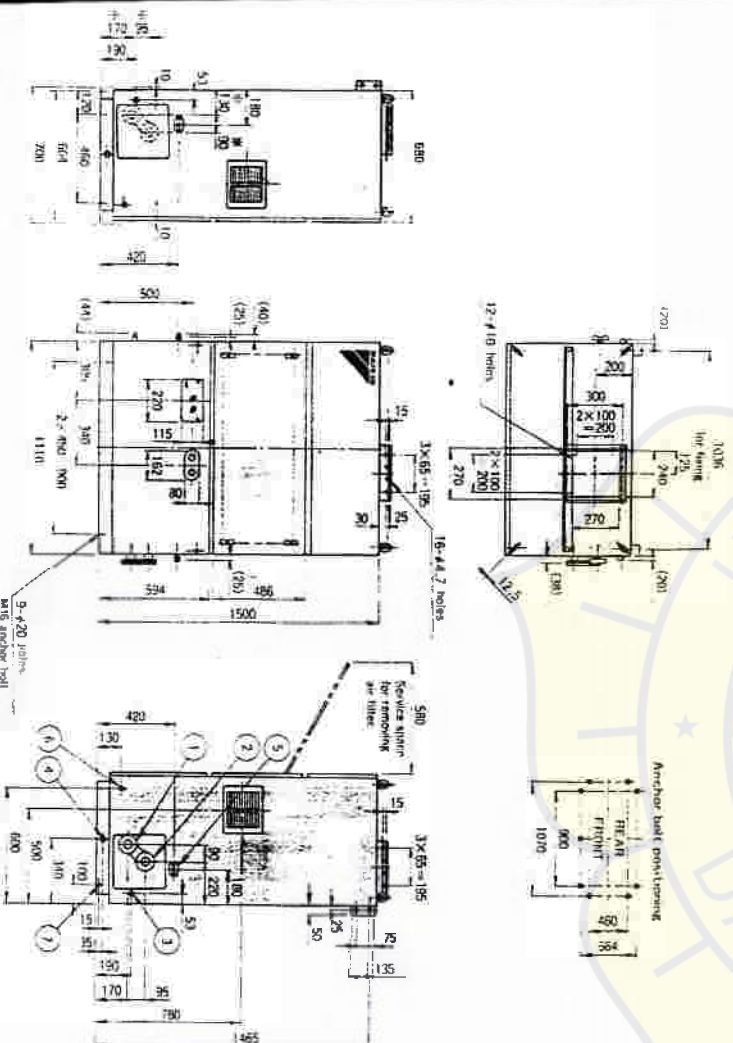


- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Pipe connection for safety valve
- ⑥ Main power intake
- ⑦ Wire outlet for remote operation-indication

Notes:

- 1. Standard piping connections are made on the right side of the unit.
- 2. Plenum chamber: Optional accessory
- 3. * shows the location of condenser water pipe connection in case of left side piping.

US5GDTG



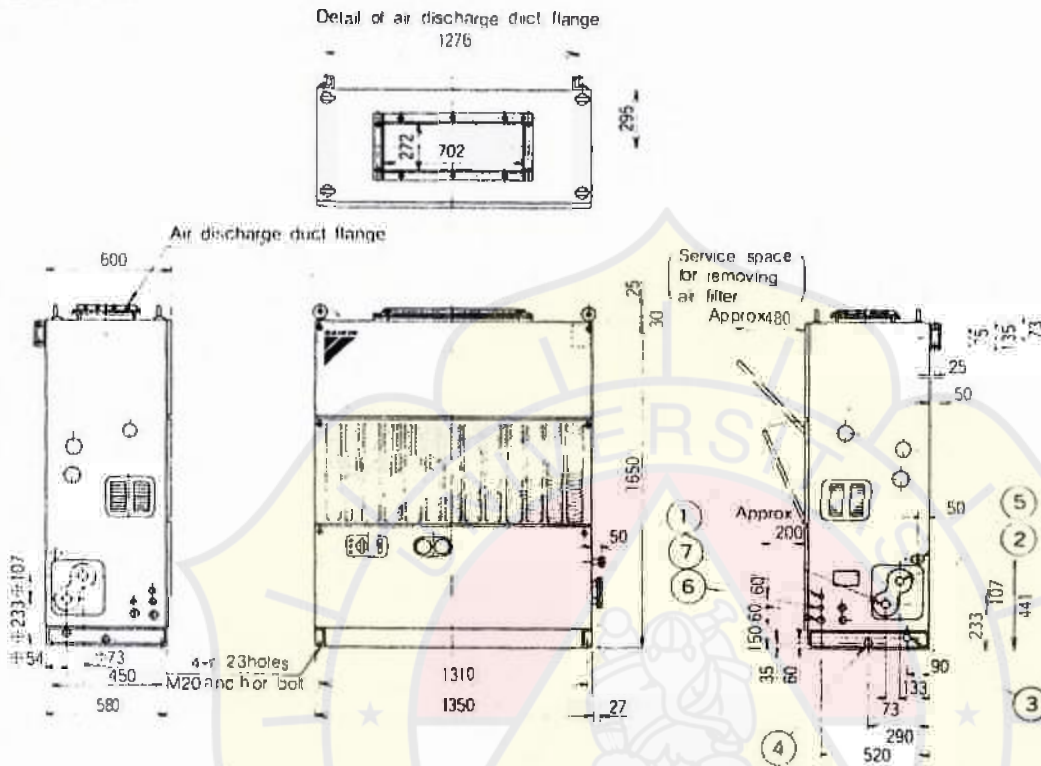
- ① Condenser water inlet
- ② Condenser water outlet
- ③ Upper drain outlet
- ④ Lower drain outlet
- ⑤ Piping fusible plug
- ⑥ Main power intake
- ⑦ Wire outlet for remote operation-indication

Notes:

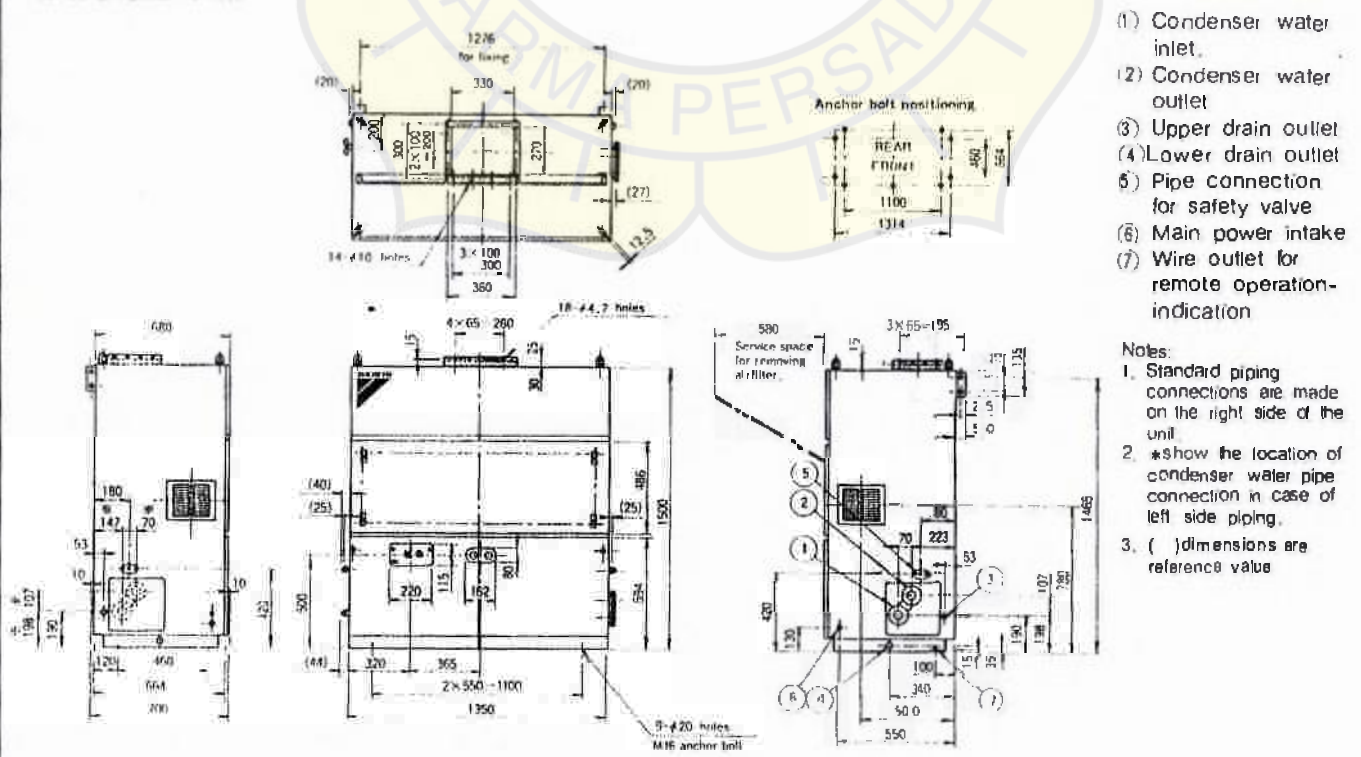
- 1. Standard piping connections are made on the right side of the unit.
- 2. * shows the location of condenser water pipe connection in case of left side piping.

Outline drawing

US8FC

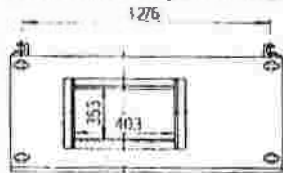


US8GDTG

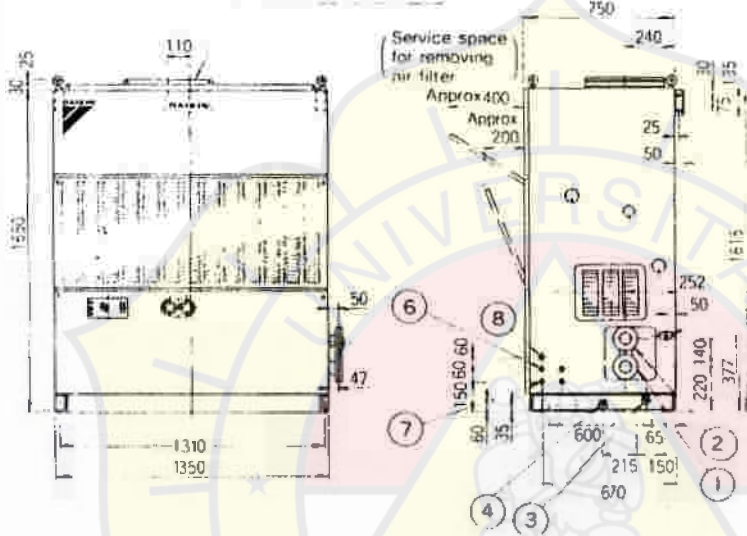


OFC (TG)

Detail of air discharge duct flange



Air discharge duct flange



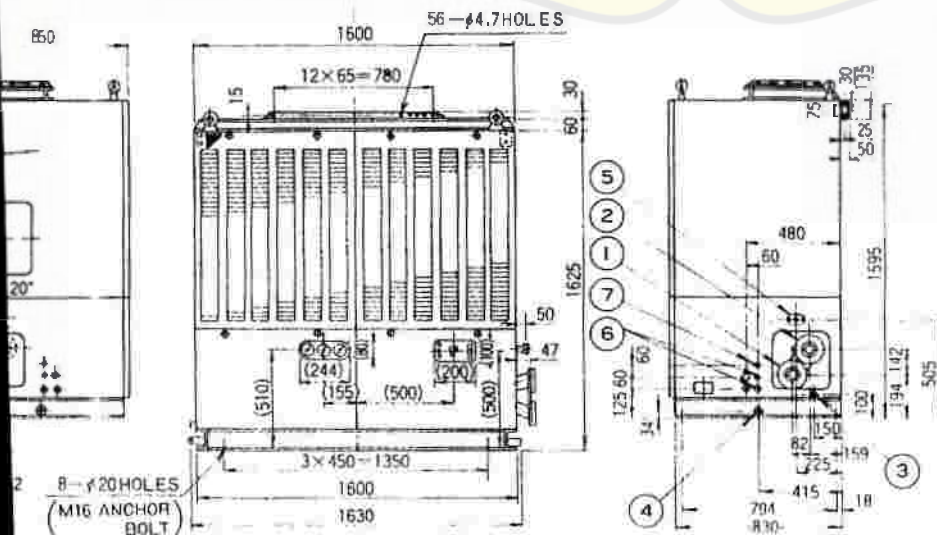
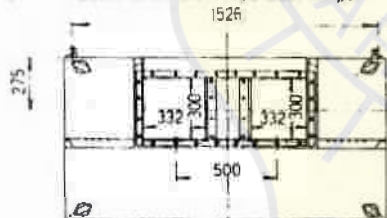
- (1) Condenser water inlet
- (2) Condenser water outlet
- (3) Upper drain outlet
- (4) Lower drain outlet
- (5) Pipe connection for safety valve
- (6) Main power intake for fan motor
- (7) Main power intake for compressor motor
- (8) Wire outlet for remote operation-indication

Notes:

1. Standard piping connections are made on the right side of the unit.
2. * shows the location of condenser water pipe connection in case of left side piping.

FA (TO)

Detail of air discharge duct flange

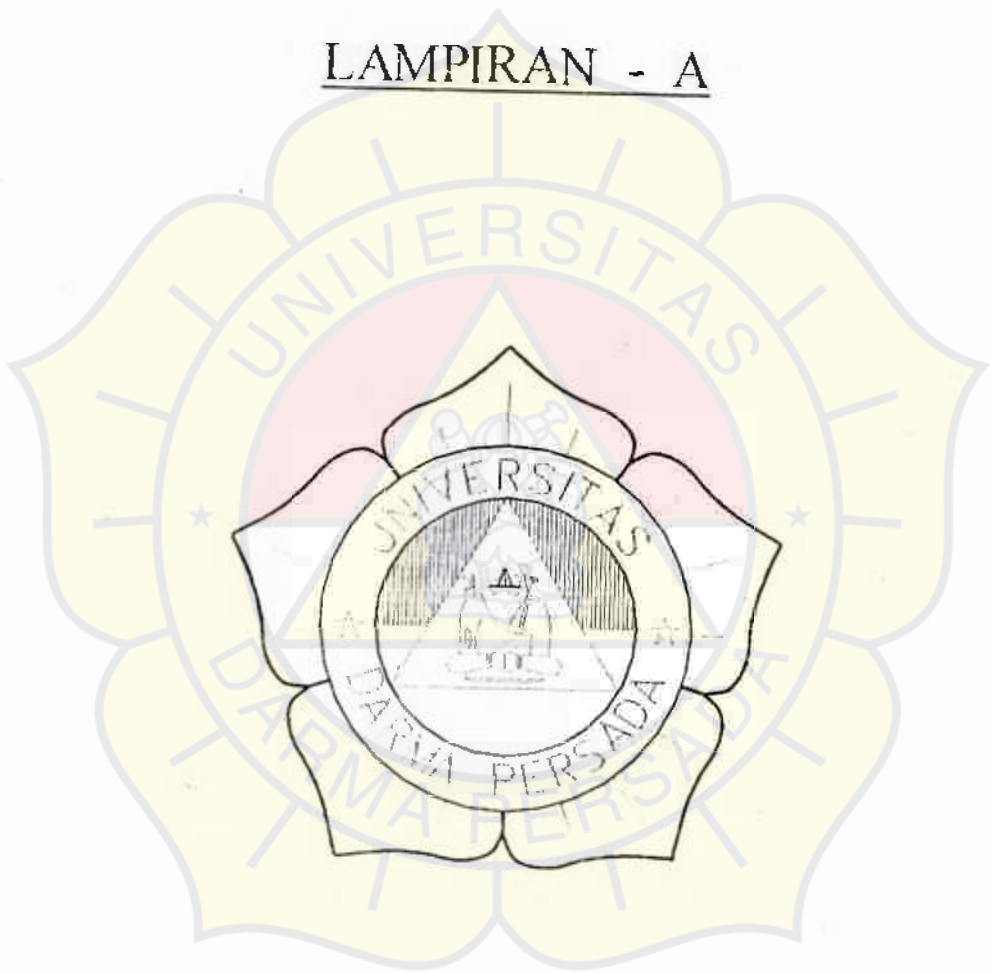


- (1) Condenser water inlet
- (2) Condenser water outlet
- (3) Upper drain outlet
- (4) Lower drain outlet
- (5) Pipe connection for safety valve
- (6) Main power intake
- (7) Wire outlet for remote operation-indication
- (8) Grease charge port
- (9) Access panel

Notes:

1. Standard piping connections are made on the right side of the unit.
2. * shows the location of condenser water pipe connection in case of left side piping.

LAMPIRAN - A



1 KW = 1 KVA

Conversion Factors

(Metric to Imperial / US)

- 1 ar = 0.0247 acres
- 1 at = 1 kg/cm²
= 14.2233 psi
= 28.94 in. Hg
= 393.8 in. in. of water
- 1 Atm = 14.696 psi
= 29.94 in. Hg
= 406.8 in. of water
= 760 mm Hg or Toricelli
- 1 Bar = 10,000 dyn/cm²
= 1.01972 kg/cm²
- degrees C = 32 + (1.8F)
- 1 cal (20 deg.) = 0.003865 BTU
= 4.183 Joule
- 1 cal/cm sec. C = 20.14 BTU/in.h.F
= 0.8064 BTU in./sq.ft. sec. F
- 1 cal/ g C = 1 BTU / lb F
- 1 cm = 0.3937 in
- 1 cm kg = 0.86796 in. lb
- 1 cm/sec = 0.02237 mile / hr
- 1 cm / sec² = 0.0328 ft / sec²
- 1cm² = 0.1549 sq.in
- 1 cm² / sec = 0.1549 sq.in/ sec
= 3.875 sq.ft./hr
- 1 cm³ = 0.061023 cb.ft
- 1 cm³ / sec = 0.227 cu.in/lb
- 1dyn = 1.57366 gr(wt)
- 1erg = 0.002373 foot poundal
- 1 ha = 2.4711 acres
- 1hl = 2.7487 bushels
= 2.8378 bushels (US)
= 2200 gallons
- 1 kcal (15 deg.) = 3.9687 BTU
- 1 kcal (20 deg.) = 3.965 BTU
- 1 kcal/cm² = 25.59 BTU/sq.in
- 1 kcal / kg = 1.8001 BTU / lb
- 1 kcal/ kg deg.C = 1 BTU / lb deg.F
- 1 kcal/ m² = 0.3685 BTU /sq.ft
- 1 kcal/ m² h = 0.3685 BTU /sq.ft. h
- 1 kcal/m³ = 0.1124 BTU/cu.ft.
- 1 kcal / m³ deg.C = 0.06624 BTU/cu.ft. deg. F

$$1 \text{ kcal/m}^3\text{h} = 0.1124 \text{ BTU/cu.ft. h}$$

$$\begin{aligned} 1 \text{ kcal/ m}^3 \text{ h deg.C} &= 0.6711 \text{ BTU / cu.ft. h deg.F} \\ &= 8.0645 \text{ BTU in/sq.ft h deg.F} \\ &= 2.78 \times 1/1,000 \text{ cal/cm s deg.C} \\ &= 4.186 \times 1,000 \text{ Joule/ m h deg.C} \end{aligned}$$

$$1 \text{ kcal/m}^2 \text{ h deg.C} = 0.204 \text{ BTU /sq.ft. h.deg.F}$$

$$1 \text{ kg} = 2.2046 \text{ lbs (av)}$$

$$= 2.6792 \text{ pounds (Troy)}$$

$$1 \text{ kg (wt)} = 70.937 \text{ poundal}$$

$$1 \text{ kg/cm}^2 = 1 \text{ at}$$

$$= 14.2233 \text{ psi}$$

$$= 28.94 \text{ in Hg}$$

$$= 393.8 \text{ in of water}$$

$$1 \text{ kg. h/m}^2 = 737.28 \text{ lb sec. /sq.ft}$$

$$1 \text{ kg/m} = 2.0159 \text{ lb/yd}$$

$$= 0.67197 \text{ lb/ft}$$

$$1 \text{ kg/ m}^2 = 1 \text{ mm column of water}$$

$$= 1.843 \text{ lb/sq.yd}$$

$$= 0.20482 \text{ lb/sq.ft.}$$

$$1 \text{ kg/ m}^3 = 0.008347 \text{ lb/ gal (US)}$$

$$1 \text{ kg/mm}^2 = 0.6349 \text{ tons /sq.in.}$$

$$= 1422.3 \text{ psi}$$

$$1 \text{ kg s/ m}^2 = 0.2048 \text{ lb s/sq.ft.}$$

$$1 \text{ km} = 0.62138 \text{ mile}$$

$$= 0.5396 \text{ nautical mile}$$

$$1 \text{ km / h} = 54.681 \text{ ft/ min}$$

$$= 0.911327 \text{ ft/ sec}$$

$$= 0.631388 \text{ mile / hour}$$

$$1 \text{ km}^2 = 0.3861 \text{ sq.mile}$$

$$1 \text{ kW} = 1.341 \text{ HP}$$

$$1 \text{ kWh} = 3414 \text{ BTU}$$

$$= 850.3 \text{ kcal}$$

$$1 \text{ ltr} = 0.21995 \text{ gallon}$$

$$= 0.2642 \text{ gallon (US)}$$

$$= 1.7598 \text{ pints}$$

$$= 2.113 \text{ pints (US)}$$

$$= 0.8799 \text{ quart}$$

$$= 1.0567 \text{ quart (US)}$$

$$= 33.8147 \text{ fluid ounces (US)}$$

$$= 270.518 \text{ fluid drams (US)}$$

$$= 1.1862 \text{ dry pints (US)}$$

$$= 0.9081 \text{ dry quarts (US)}$$

$$1 \text{ ltr/ m}^2 = 0.184 \text{ gal/ sqyd}$$

	= 0.221 gal/sq.yd (US)
1 ltr / km	= 0.355 gal / mile
	= 0.424 gal/ mile (US)
1 ltr / t	= 0.2237 gal / long ton
	= 0.2397 gal/ short ton (US)
1 m	= 1.0936 yd
	= 3.2808 ft
	= 0.1938 rod (US)
1 mkg	= 0.009296 BTU
	= 7.233 ft.lb
1 m²	= 1.196 sq.yd
	= 10.769 sq.ft
	= 1550sq.in
1 m² / h	= 0.000299 sq.ft/h
	= 10.7639 sq.ft/h
1 m³	= 1.3079 cu.ft
	= 35.3147 cu.ft.
1 mm	= 0.03937 in
	= 39.37 mils
1 mm column of water	= 1 kg / m²
1 mm Hg	= 1 Torr
1 mm / s	= 0.009295 BTU / s
	= 7.233 ft.lb/s
	= 196.85 ft / min
	= 3.2808 ft / s
	= 2.2369 miles/ hour
1 mm²	= 0.00155 sq.in
1 m/sec²	= 2.23696 mile/h.s
1 m² / sec	= 10.7639 sq.ft / sec
1 PS	= 0.9863 HP
	= 542.5 ft.lb/ sec
	= 0.6972 BTU / sec
	= 75 mkg / sec
1 t / m³	= 0.12787 long ton / cu.ft
1 Torr	= 1 mm Hg
1V / cm	= 2.54 x 10,000 V / mil
1 Watt (cf.kW)	= 0.738 ft.lb
1 Watt / sec	= 0.738 ft.lb / sec

Conversion factors (English / US into Metric)

1 acre	= 0.4046 ha
1 barrel	= 0.16366 m ³
1 US barrel	= 0.11924 m ³
1 BTU	= 0.252 kcal
	= 252.2 cal (20 deg.)
	= 0.0002931 kWh
	= 1065 Joules
	= 777.9 ft.lb.
1 BTU / cu.ft.	= 8.8997 kcal/ m ³
1 BTU / cu.ft.h	= 8.8997 kcal/ m ³ h
1 BTU/cu.ft.deg.F	= 16.017 kcal/m ³ deg.C
1 BTU / ft h deg.F	= 1.488 kcal/ m h deg. C
	= 6.234 x 100 J / in h deg.C
1 BTU in/sq.ft. h deg.F	= 0.124 kcal / m h deg.C
	= 519.5 J / m h deg.C
1 BTU / lb	= 0.556 kcal / kg
1 BTU/ lb deg.F	= 1 kcal / kg deg.c
	= 1 cal/g deg.C
1 BTU/min	= 0.233 HP
1 BTU/sec	= 107.58 mkg/ sec
	= 1.434 PS
	= 1062.6 watt
1 BTU/sq.ft	= 2.713 kcal/ m ²
1 BTU/sq.ft h	= 2.713 kcal/m ² h
1 BTU / sq.ft h deg.F	= 4.88 kcal/ m ² h deg.C
1 BTU / sq.in	= 390.75 kcal/ m ²
1 bushel	= 36.367 ltr
1 bushel (US)	= 35.238 ltr
1 carat	= 0.2 g
1 circle inch	= 5.05671 cm ²
1 cu.ft	= 0.02832 m ³
	= 6.229 Br gallons
1 cu.in	= 16.387 cm ³
1 cu.in / lb	= 36.126 m ³ / kg
1 cu.yd	= 0.7646 m ³
	= 168.17 Br gallons
1 cwt (long, Imp.)	= 112 lbs
	= 50.802 kg
1 cwt (short, US)	= 100 lbs
	= 45.359 kg
1 dr	= 1.77184 g
1 dr apothecary (Troy)	= 3.887 g

1 dyne	= 7.233 x 1/1,000,000 poundals
	= 2.247 x 1/10,000 lbs (wt)
	= 0.01573 gr (wt)
	= 0.001019 g (wt)
1 dyne/ cm²	= 1.01972 x 1/100 kg/cm ²
	= 1.4505 x 1/10,000 psi
deg.F	= (deg.F -32) 0.555 deg.C
1 ft	= 0.3048 m
1 ft.lb	= 0.138255 mkg
1 ft.lb/ sec	= 1.355 watt
	= 0.00184 PS
	= 0.13826 mkg/ sec
1 ft/ min	= 0.018288 km/h
	= 0.00508 m/ sec
1 ft. poundal	= 421.403 erg
1ft/ sec	= 1.0973 km/h
	= 0.6818 mile/ hour
1 ft/ sec²	= 0.3040 m/sec ²
	= 30.4796 cm/sec ²
1 gal	= 4.5459 ltr
1 US gal	= 3.785 ltr
1 gill	= 0.142 ltr
1 gill (fluid)	= 0.118 ltr
1 gr	= 59.06 mg
1 gr (US and Troy)	= 64.8 mg
1 gr (wt)	= 63.57 dyn
1 gr/cu.ft	= 2.299 g/m ³
1 gr/gal	= 0.01426 g/ltr
1 gr/ gal (US)	= 0.01712 g/ltr
1 hand	= 4 inches
	= 10.16 cm
1 HP	= 0.7458 kW
	= 1.01382 PS
	= 76.04 mkg/ sec
	= 550 ft.lb/ sec
1 in	= 2.54 cm
1 in.lb	= 1.1521 cm kg
1 in Hg	= 0.0334 Atm
	= 0.03455 atm or kg/ cm ²
	= 13.6 inch of water column
1 in of water	= 0.03613 psi

$$= 0.002458 \text{ Atm}$$

$$= 0.002539 \text{ at. or kg / cm}^2$$

1 kW	= 783 ft.lb / sec
	= 1.341 HP
	= 0.949 BTU/ sec
	= 102 mkg/s
	= 1.360 PS
	= 0.2389 cal/s
1kWh	= 367.1 mkg
	= 860.3 cal (20 deg.C)
	= 3411 BTU
1 Joule	= 1 watts
1lb	= 16oz
	= 0.45359 kg
1 lb apothecary (Troy)	= 12 oz
	= 0.37324 kg
1 lb (wt)	= 32.2 poundals
1 lb/cu.ft	= 0.1602 g/cm²
1 lb.ft	= 1.48816 kg / m
1 lb/ftsec	= 14.882g/cm s
	= 0.1517kg.s/m²
1 lb h/sq.ft	= 4.882 kg h / m²
1 lbs / sq ft	= 478.8 g/cm s
	= 4.881 kgs/m²
1 lb / sq.ft	= 4.882 kg/ m²
	= 0.016 ft of water
1 lb/ sq in (psi)	= 0.068 Atm
	= 0.0703 at. or kg /cm²
	= 2.040 in. Hg
	= 2.312 in of water
1 lb/yd	= 0.49606 kg/m
1 long ton	= 2240 lbs
	= 1016.047 kg
1 long ton/ sq in	= 157.5 at. or kg/cm²
	= 152.4 Atm
	= 1.545 x 100,000,000 dyn/ cm²
1 M ohm / mile	= 1.609 M ohm/ km
1 mil	= 0.001 in
	= 0.00254 cm
1 mile	= 1.60934 km
1 mile (nautical)	= 1.8532 km

1 mile/ hour	= 1.4667 ft/ sec
	= 1.6093 km / h
	= 44.4 cm / sec
1 mile / min	= 26.82 m / sec
1 Minim (US)	= 0.06161 cm ³
1 oz	= 28.35 g
1 oz ap (Troy)	= 31.1 g
	= 20 dwt
1 oz (fluid)	= 0.0283 ltr
1 oz / sq ft	= 305.15 g/cm ²
1 oz/yd	= 31.003 g/m
1 pint	= 1/8 gallon
	= 4 gills
	= 0.5683 ltr
1 pint (US)	= 0.473 ltr
1 pound (lb) avoirdupois (Troy)	= 12 oz
	= 373.241 g
1 poundal	= 0.014097 kg
	= 13.825 dyn
1 psi (lb / sq.in)	= 0.0703 kg /cm²
	= 0.0007031 kg/mm ²
	= 0.068 Atm
1 quart	= 2 pints
	= 1.13649 ltr
1 quart (US)	= 0.94633 ltr
1 quarter (liquid)	= 8 bushels
	= 290.94 ltr
1 quarter (liquid)(US)	= 292.1 ltr
1 quarter (dry)	= 28 lbs
	= 12.70 kg
1 register ton	= 2.8317 m³
1 rod (US)	= 5.0292 m
1 scruple (s.ap)	= 1.2959 g
1 section (US)	= 2.5899 km ²
1 shipping ton (US)	= 1.13268 m ³
1 short ton (US)	= 2,000 lbs
	= 907.185 kg
1 short ton/ sq.in	= 140.62 kg /cm ²
1 span	= 9 in
	= 22.36 cm
1 square	= 100 sq.ft
	= 9.29 m ²
1 sq.ft	= 929.029 cm²

	= 1.3789 x 100,000,000 dyn/cm ²
1sq.in	= 6.452 cm²
1 sq.mile	= 2.58994 km ²
1 sq.rod	= 25.293 m ²
1 sq.yd	= 9 sq.ft
	= 0.8361 m ²
1 stone	= 14 lbs
	= 6.350 kg

1 yd	= 3 ft
	= 0.9144 m
1 yd / lb	= 0.415 mkg

Additional conversions :

1 long ton	= 20 cwt	= 1,016 kg
1 cwt	= 4 quarter	= 112 lbs = 50.80 kg
1 quarter	= 2 stone	= 28 lbs = 12.70 kg
1 stone	= 14 lbs	= 6.350 kg
1 lb	= 16oz	= 0.45359 kg
1 oz	= 16 drams	= 28.350 gr
1 short ton	= 2,000 lbs	= 907.17 kg

1 cable	= 100 fathom
1 shackle	= 15 fathoms = 27.432 m
	= 30 yards
1 fathom	= 2 yards = 1,8288 m
	= 6 feet
1 yard	= 3 feet
1 foot	= 12 inches

1 degree at the equator	= 60 nautical miles
1 League	= 3 nautical miles
1 Nautical mile	= 1 knot = 6080.2 feet
	= 1.152 statute mile
	= 10cable
1 cable	= 100 fathoms
1 statute mile	= 5,280 feet = 1,760 yards
	= 80 chains = 20 furlongs

1 furlong = 4 chains
1 chain = 20 yards
= 100 links
= 0.25 furlong

1 cable = 608 feet
1 Scots mile = 5952 feet = 1984 yards
= 1,021 of a Nautical mile



SI Units

	Metric units	Multiply by	To obtain
Plan angle	° (degrees)	/180	radial
Mass	kg	1	kg
	ton	1,000	kg
Density	g/cm ³	0.001	kg/m ³
Velocity	knot	1852/3600	m/s
Acceleration	G	9.80665	m/s ²
Force	kg	9.80665	N
	ton	9,806,650	N
Torque	kg-m	9.80665	N-m
Pressure (stress)	kg/mm ²	9,8066.5	Pa (N/m ²)
	kg/mm ²	9.80665	Mpa
	kg/cm ²	98,066.5	(N/mm ²) Pa (N/m ²)
Pressure	atm	101,325	Pa
	m H ₂ O	9,806.65	Pa
	mm Hg	133.322	Pa
Energy (Work)	kg-m	9.80665	J
	cal	4.1868	J
	kW-h	366,000,000	J
	PS-h	2,647,800	J
Impact	kg-m/cm ²	9.89665	J/cm ²
Power	kg-m/s	9.89665	W
	W	1	W
	PS	735.5	W
Temperature	°C	+273.5	K

$$1 \text{ ton (force)} = 9.964 \text{ kN}$$

$$1 \text{ lb (force)} = 4.448 \text{ N}$$

$$1 \text{ poundal (pdl)} = 0.3048 \text{ N}$$

$$1 \text{ atm} = 1.013 \text{ bar}$$

$$1 \text{ lbf/in}^2 = 0.06895 \text{ bar}$$

$$1 \text{ in wr gg (wg)} = 2.491 \text{ m bar}$$

$$1 \text{ in wr gg (wg)} = 25.4 \text{ mm}$$

water

$$1 \text{ tonf/in}^2 = 1.544 \text{ h bar}$$

$$1 \text{ lbf/in}^2 = 0.0006895 \text{ h bar}$$

$$1 \text{ hp h} = 0.7457 \text{ kW}$$

$$1 \text{ Btu h}$$

$$1 \text{ ftlbf} = 1.055 \text{ kJ}$$

$$= 1.356 \text{ J}$$

$$1 \text{ hp} = 0.7457 \text{ kW}$$

LAMPIRAN - B

