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9.4 Sheet thicknesses

Minimum sheet thicknesses related to duct longer side and to pressure classification are given in Table 4. (This information is also included in Tables 5 to 8.)

Table 4 Minimum sheet thicknesses – Rectangular ducts

Maximum duct size (longer side)	Sheet thickness	
	Low- and medium-pressure ducts	High-pressure ducts
1	*2*	*3*
mm	mm	mm
400	0.6	0.8
600	0.8	0.8
800	0.8	0.8
1000	0.8	0.8
1250	1.0	1.0
1600	1.0	1.0
2000	1.0	1.2
2500	1.0	1.2
3000	1.2	–

9.5 Longitudinal seams

9.5.1 Types available

Longitudinal seams are illustrated in Figs. 1 to 7. The limits of use, if any, are given with the individual illustrations.

9.5.2 Sealant in longitudinal seams

Sealant shall be used with all longitudinal seams, irrespective of the pressure class. The sealant may be included in the seam during manufacture or be applied as edge sealant.

9.5.3 Welded seams

As the exception to the requirements of 9.5.2, a welded seam is acceptable without sealant, provided that the welding is continuous.

9.6 Cross joints

9.6.1 Cross joint ratings

For cross joints, a system of rating has been used to define the limits of use. The rating for each cross joint is given with its drawing, and the limits applying to that rating, in terms of duct size longer side and maximum spacing, are given in Tables 5 to 8. Other limits on use are given with the individual drawings.

The system of ratings is as follows:

Socket and spigot joints – A1 to A3 (Figs. 9 to 12)
Cleated joints – C1 to C4 (Figs. 20 to 24)
Flanged joints – J1 to J6 (Figs. 33 to 43)

9.6.2 Corners and junctions

Socket and spigot joint corners and junctions are illustrated in Figs. 13 to 19.

Cleated joint corners and junctions are illustrated in Figs. 25 to 32.

Details of the corner treatments of flanged joints are included with their illustrations – Figs. 33 to 43.

9.6.3 Sealant in cross joints

Sealant shall be used between sheet and section in all cross joint assemblies.

With **cleated joints,** the sealant shall be applied during or after the assembly of the joint.

With **socket and spigot joints made on site,** sealant shall be applied during or after assembly of the joint. It is permissible to use chemical-reaction tape or heat-shrink strip (but *not* continuous band) as alternative methods of sealing, provided that close contact is maintained over the whole perimeter of the joint until the joint is completed.

With all **flanged joints,** the sealant between sheet and section should preferably be incorporated during construction at works, but edge sealant is acceptable. The joint between sections of ductwork is then made, using an approved type of sealant or gasket (see Section 27).

9.7 Stiffeners

9.7.1 General

Stiffeners shall be applied so that the true rectangular cross-section of the duct is maintained.

9.7.2 External stiffeners

The sections (including proprietary flanges) suitable for use as **single stiffeners** have been given a rating from S1 to S6 in terms of duct size longer side and maximum spacing. The ratings are specified with the illustrations of the stiffeners, Figs. 44 to 49, and the limits of use are given in Tables 5 to 8. The girth stiffeners for socket and spigot joints covered in Fig. 12 are also applicable to girth stiffeners in general.

9.7.3 Internal stiffeners

Tie bars connecting the flanges of cross joints or intermediate stiffeners are the only form of internal stiffening for rectangular ductwork covered in this specification. (For the use of tie bars in flat oval ductwork, see 16.4.) Other forms of internal stiffening or bracing are not recommended.

The use of tie bars in rectangular ducts shall be authorised by the designer; and if circumstances require the use of internal stiffening in *any* other form, the method to be used shall be approved by the designer.

Alternative methods of attachment of tie bars are shown in Fig. 50.

Examples of the application of the joint and stiffener rating system are given on pages 22 and 23.

Kích thước ngoài của tiết diện ống chữ nhật	Kích thước ngoài của tiết diện ống chữ nhật	Kích thước ngoài của tiết diện ống chữ nhật	Kích thước ngoài của tiết diện ống chữ nhật
250 × 150	500 × 250	800 × 800	1 600 × 800
250 × 160	500 × 315	1 000 × 315	1 600 × 1000
250 × 200	500 × 400	1 000 × 400	1 600 × 1250
250 × 250	500 × 500	1 000 × 500	2 000 × 800
315 × 150	630 × 250	1 000 × 630	2 000 × 1000
315 × 160	630 × 315	1 000 × 800	2 000 × 1250
315 × 200	630 × 400	1 000 × 1000	2 000 × 1500
315 × 250	630 × 450	1 250 × 400	2 000 × 2000

K.3 Độ dày tấm tôn dùng chế tạo ống gió

K.3.1 Để vận chuyển không khí có nhiệt độ dưới 80°C, độ dày của tấm tôn cần lấy theo số liệu dưới đây:

a) Đối với ống gió tiết diện tròn:

- Đường kính 200 mm trở xuống: Độ dày tấm tôn 0,5 mm
- Đường kính từ 200 mm đến 450 mm: Độ dày tấm tôn 0,6 mm
- Đường kính từ 500 mm đến 800 mm: Độ dày tấm tôn 0,7 mm
- Đường kính từ 900 mm đến 1200 mm: Độ dày tấm tôn 1,0 mm
- Đường kính từ 1400 mm đến 1600 mm: Độ dày tấm tôn 1,2 mm
- Đường kính từ 1800 mm đến 2000 mm: Độ dày tấm tôn 1,4 mm

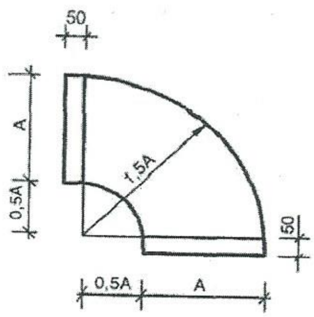
b) Đối với ống gió tiết diện chữ nhật có cạnh lớn:

- Đường kính nhỏ hơn 250 mm : Độ dày tấm tôn 0,5 mm
- Đường kính từ 300 mm đến 1000 mm : Độ dày tấm tôn 0,7 mm
- Đường kính từ 1250 mm đến 2000 mm : Độ dày tấm tôn 0,9 mm

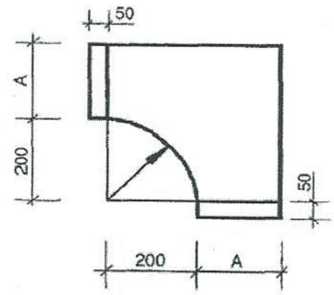
c) Đối với ống gió tiết diện chữ nhật có một cạnh lớn hơn 2 000 mm hoặc tiết diện 2 000 mm × 2 000 mm thì độ dày của tấm tôn để chế tạo ống phải được xác định qua tính toán.

K.3.2 Đối với ống gió gia công bằng phương pháp hàn thì độ dày của tôn được xác định theo yêu cầu của công nghệ hàn.

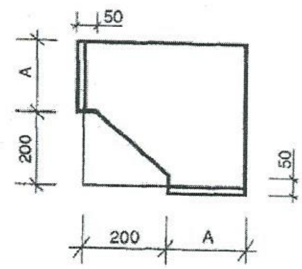
K.3.3 Đối với ống gió dùng để vận chuyển không khí có nhiệt độ trên 80 °C hoặc không khí có lẫn bụi bẩn hay bụi bào mòn thì độ dày của tôn phải được xác định bằng tính toán.



Hình 2 : Ngoặt tiết diện chữ nhật có cung tròn ở cả phía trong và ngoài



Hình 3 : Ngoặt tiết diện chữ nhật có cung tròn ở phía trong



Hình 4 : Ngoặt tiết diện chữ nhật có đường chéo ở phía trong

2.2. Ống gió bằng tôn đen và tôn tráng kẽm

2.2.1. Độ dày tấm tôn để chế tạo ống gió và các chi tiết phải phù hợp với quy định trong bảng 4.

Bảng 4. Độ dày tấm tôn để chế tạo ống gió và các chi tiết

Kích thước tính bằng milimét

Đường kính hoặc độ dài cạnh lớn ống gió	Độ dày của tấm tôn	
	Ống gió thông thường	Ống gió hút bụi
100 ÷ 200	0,50	1,50
220 ÷ 500	0,75	1,50
530 ÷ 1100	0,80	2,00
560 ÷ 1120	1,00	2,00
1250 ÷ 2000	1,20 ÷ 1,50	3,00
1500 ÷ 2000	1,20 ÷ 1,50	3,00

2.2.2. Khi chế tạo ống gió và các chi tiết bằng tôn có độ dày ≤ 1,2mm có thể dùng phương pháp nối ghép mí, > 1,2mm có thể dùng phương pháp nối hàn, nối lật biên hoặc có thể dùng phương pháp hàn hơi.

Ghi chú : Chế tạo ống gió và các chi tiết bằng tôn tráng kẽm chỉ dùng ghép mí hoặc tán đinh.

2.2.3. Quy cách vật liệu làm mặt bích ống gió phải phù hợp quy định trong bảng 5 và bảng 6. Khoảng cách giữa các bulông và đinh tán không được lớn hơn 150mm.

2.2.4. Liên kết ống gió với mặt bích bằng thép góc khi độ dày thành ống nhỏ hơn hoặc bằng 1,5mm có thể dùng phương pháp lật biên đinh tán. Độ dày thành ống lớn hơn 1,5mm, có thể dùng lật biên hàn điểm hoặc hàn kín theo miệng ống. Liên kết ống gió với mặt bích bằng thép dẹt có thể dùng phương pháp liên kết lật biên.

TC — As share.

Table 1 Minimum Thickness of Steel Ducts

All vertical exposed ducts	16 USSG	1.52 mm
Horizontal or concealed vertical ducts		
less than 150 mm	24 USSG	0.62 mm
160 to 300 mm	22 USSG	0.76 mm
310 to 460 mm	20 USSG	0.91 mm
470 to 760 mm	18 USSG	1.21 mm
over 760 mm	16 USSG	1.52 mm

major installations, mock-up tests are often used to establish exacting performance criteria.

Air usually returns from individual small spaces either by a sight-tight louver mounted in the door or by an undercut in the door leading to the passageway. An undercut door can only be used with air quantities of 35 L/s or less. Louvers are usually sized for face velocity of 2 m/s based on free area.

Ductwork on merchant ships is generally constructed of steel. Ducts, other than those requiring heavier construction because of susceptibility to damage or corrosion, are usually made with riveted seams sealed with hot solder or fire-resistant duct sealer, welded seams, or hooked seams and laps. They are made of hot-dipped, galvanized, copper-bearing sheet steel, suitably stiffened externally. The minimum thickness of material is determined by the diameter of round ducts or by the largest dimension of rectangular ducts, as listed in Table 1.

The increased use of high-velocity, high-pressure systems has resulted in greater use of prefabricated round pipe and fittings, including spiral-formed sheet metal ducts. It is important that field-fabricated ducts and fittings be airtight. Using factory-fabricated fittings, clamps, and joints effectively minimizes air leakage for these high-pressure ducts.

In addition to the space advantage, small ductwork saves mass, another important consideration for this application.

Control

The conditioning load, even on a single voyage, varies over a wide range in a short period. Not only must the refrigeration plant meet these load variations, but the controls must readily adjust the system to sudden climatic changes. Accordingly, it is general practice to equip the plant with automatic controls.

Regulatory Agencies

Merchant vessels that operate under the U.S. flag come under the jurisdiction of the U.S. Coast Guard. Accordingly, the installation and components must conform to the Marine Engineering Rules and Marine Standards of the Coast Guard covered under the *Guide to Structural Fire Protection* (USDOT 2010).

Certified pressure vessels and electric components approved by independent agencies (e.g., ASME, UL) must be used. Wherever possible, equipment used should comply with ABS rules and regulations. This is important when vessels are equipped for carrying cargo refrigeration, because air-conditioning compressors may serve as standby units in the event of a cargo compressor failure. This compliance eliminates the need for a separate, spare cargo compressor. The International Convention for the Safety of Life at Sea (SOLAS) (IMO 2009) governs the use of fire-dampers and duct wall thickness when passageways or fire boundaries are crossed.

NAVAL SURFACE SHIPS

Design Criteria

Outside Ambient Temperature. Design conditions for naval vessels have been established as a compromise, considering the large cooling plants required for internal heat loads generated by machinery, weapons, electronics, and personnel. Temperatures of 32°C db and 27°C wb are used for worldwide applications, with 29.5°C seawater temperatures. Heating-season temperatures are –12°C for outside air and –2°C for seawater.

Inside Temperature. Naval ships are generally designed for space temperatures of 26.5°C db with a maximum of 55% rh for most areas requiring air conditioning. The *Air Conditioning, Ventilation and Heating Design Criteria Manual for Surface Ships of the United States Navy* (USN 1969) gives design conditions established for specific areas. *Standard Specification for Cargo Ship Construction* (USMA 1965) gives temperatures for ventilated spaces.

Ventilation Requirements. Ventilation must meet the requirements of ASHRAE *Standard* 62.1-2010, except when ship's specification requires otherwise.

Air-Conditioned Spaces. Naval ship design requires that air-conditioning systems serving living and berthing areas on surface ships replenish air in accordance with damage control classifications, as specified in USN (1969):

- Class Z systems: 2.4 L/s per person
- Class W systems for troop berthing areas: 2.4 L/s per person
- All other Class W systems: 4.7 L/s per person. The flow rate is increased only to meet either a 35 L/s minimum branch requirement or to balance exhaust requirements. Outside air should be kept at a minimum to minimize the size of the air-conditioning plant.

Load Determination

The cooling load estimate consists of coefficients from *Design Data Sheet* DDS511-2 of USN *General Specifications for Building Naval Ships* or USN (1969) and has allowances for the following:

- Solar radiation
- Heat transmission through hull, decks, and bulkheads
- Heat (latent and sensible) gain of occupants
- Heat gain from lights
- Heat (latent and sensible) gain from ventilation air
- Heat gain from motors or other electrical equipment
- Heat gain from piping, machinery, and equipment

Loads should be derived from requirements indicated in USN (1969). The heating load estimate should include the following:

- Heat losses through hull, decks, and bulkheads
- Ventilation air
- Infiltration (when specified)

Some electronic spaces listed in USN (1969) require adding 15% to the calculated cooling load for future growth and using one-third of the cooling-season equipment heat dissipation (less the 15% added for growth) as heat gain in the heating season.

Heat Transmission Coefficients. The overall heat transmission coefficient U between the conditioned space and the adjacent boundary should be estimated from *Design Data Sheet* DDS511-2. Where new materials or constructions are used, new coefficients may be used from SNAME (1980) or calculated using methods found in DDS511-2 and SNAME.

Heat Gain from People. USN (1969) gives heat gain values for people in various activities and room conditions.

Heat Gain from Sources Within the Space. USN (1969) gives heat gain from lights and motors driving ventilation equipment. Heat gain and use factors for other motors and electrical and electronic equipment may be obtained from the manufacturer or from Chapter 18 of the 2009 *ASHRAE Handbook—Fundamentals*.

Equipment Selection

The equipment described for merchant ships also applies to U.S. naval vessels, except as follows:

Fans. A family of standard fans is used by the navy, including vaneaxial, tubeaxial, and centrifugal fans. Selection curves used for system design are found on NAVSEA *Standard Drawings* 810-921984, 810-925368, and 803-5001058. Manufacturers are