

Chapter 3

General Manufacturing Information

1. Company Information

This topic will be describing full details of the sample case company especially on the manufacturing department. The information will cover about company background, organization structure, products, factory environment, process flow and etc.

1.1 Background

Since Department of Alternative Energy Development and Efficiency is authorized by Ministry of Energy under Thai Government. It strives to encourage public sector and government sector about usage of energy. The department must promote ways to use energy efficiently, supply for alternative energy and also educate people how energy play an important role for their life. So the company considers the possibilities of doing business that deals with energy development and conservation, in which it can make high profit in niche market.

As we known, Thailand is a country situated in the tropical zone with the weather being warm to very hot in most parts of country. Moreover, the surroundings in most of Thai urban centers are becoming increasingly polluted, equally with the awareness in regarding to the benefits of consumers in environment and energy conservation on the rise.

BNB Inter Group Co, Ltd. was a new comer of air conditioner providers. It is established in 3rd October 1997 by a group of investors who are experts in air conditioning fields. The company consists of a headquarter office and the final assembling factories located in different places.

There is only one corporate goal for the business in everyone's mind, which is being the leader of domestic air conditioning system and energy conversion products. The group realizes that resources such as materials, employee, and efficiency in manufacturing industry within Thailand are capable of investing profitably no less than other countries. With the idea of making air conditioning systems domestically instead of importing which cost almost twice higher, BNB facilitates in complying Thai's intellectual and technology. The company is successful in gaining support from government agencies and increasing market share in private sector continuously.

The BNB management team decided to build up the manufacturing factory named S-PAK Asia Manufacturing Co., Ltd. with the registered capital of

36,000,000 baht. Therefore, S-Pak is established in order to response to the situation that mentioned above. The company is the producer of environmental friendly and energy saving air conditioning. It produces air conditioning unit and supplies under S-Pak brand name. Finished goods from S-Pak manufacturing factory will be dispatching right from the factory to customer through each distribution's channel.

Under the operation of BNB management team with their abilities and their good connection with authorized people, the most important distribution's channel of the company is the bidding project through the government and many organizations. However, the company is trying to open more market channels to household customer.

1.2 Products and Services

Since two years of approximation, engineering teams of S-Pak research and develops functional systems of their air condition by focusing on energy conservation of the products. Advance technologies are involved in the operation processes to satisfy present market demands. Government and customers support an energy saving product to save money. This rapidly becomes an order winning for the company to beat existing competitors.

To satisfy this, they connect an energy saving device called APR to the condensing unit in refrigerating system. Since the old pipe systems cause difficulties in refrigerant flow, the new system is good looking and has more efficiency. S-Pak bought many high tech controlling devices such as PCO board, oil separator, and hot gas bypass system, which all have been test and receive certificate by national industrial standard CE Mark.

Throughout the year since S-Pak was established, the company was trying to do research and development on cooling system. It finally overcomes the best solution of hot gas reheat coil and hot gas bypass technology in Precision Air Conditioning System, the air condition that can control both temperature and humidity wisely. Another model is MAC-Series Multi-Evaporator Air Conditioning System, the air conditioner that design by using one condensing unit to support more than two evaporators to complete a perfect model.

The company is experts in the following products and tasks:

1. Production of air-conditioning unit

- Produce all type of split-type air conditioning unit.
- Produce of Multi-Evaporator Air Conditioning System.
- Produce of Precision Air Conditioning System.
- Produce wall-type air conditioning unit.

2. Air conditioning system

- Design and Install air conditioning system for complex building, office building, cold storage room, measuring room, hospital, school, control room and factory etc.
- Split-type air conditioner
- Chiller System
- Ventilation System
- Multi-Evaporator air conditioner
- Precision air conditioner
- Raise floor installation
- Supply for spare parts and equipment of all cooling system
- Air conditioning system maintenance

3. Energy saving

- Design and install all the energy saving equipment such as fluorescence bulb, electronic ballast, reflector, lamp, insulator, film, and high efficiency air conditioner.
- Design and install the solar cell system for rural areas.

4. Facilities system

- Design and install the facilities system for household, office building, complex building, hospital and factory etc.

1.3 Mission Statement

S-Pak is committing to achieve its corporate and operational goals by:

- Supply greater satisfaction to domestic customers by producing the best quality products and services with low price.
- Pursue sound society satisfaction as member of society through company's development by concerning on energy conservative and environmental friendly.
- Realize greater employee satisfaction through company's future growth by gaining higher market share to satisfy more customers with faster delivery time.
- Competing in developing new products and processes continuously.

2. Factory Information

Manufacturing department of BNB is in the responsible of S-Pak Asia Manufacturing. Nowadays S-Pak reliable production is well known for groups of customer, both government sector and public sector. The company has continually developed and increased the efficiency of the whole system for highest customer satisfaction in term of quality, cost, and planning to improve delivery time.

The manufacturing unit is a two-floor medium-size factory with the approximate size of 2,940 square meters. The factory is responsible for assembling split-type air conditioner parts and components into finished goods then distribute to the customers directly from shop floor. It uses labor intensive processes with a queuing system. There are total employees of about 90 people in the factory; 70 blue-collar workers as labors and technicians, 20 staffs as engineers, design teams, accountants, and managers. The engineering and management team is fully experiences in air conditioning field for about ten years so the technical knowledge standard is in advance level.

The manufacturing department is left distinctively from the head headquarter. These because the office is in Bangkok but 3 branches of factory are in other places. The factory is empowered and allowed full authority to determine its own decision about manufacturing management except for receiving required ordered and specification from the office.

2.1 Focused Product: Split-type Air Conditioner

S-Pak consists of few factories separating in different areas of central region in Thailand. The factory in the study is a medium-size factory located in Nakornpathom that manufactures range of split-type air conditioning system with cooling capacity of 12,500, 16,000, and 18,000 BTU respectively. All models use R-22 as refrigerant.

Split type air condition consists of two separate parts; the fan coil unit and condensing unit. It will require both structures to operate.

The fan coil unit is the section that located indoor (roomside). It consists of cool coil to absorb heat inside the room, or cooling area by through the suction air passing the return grille and filter locate on the bottom side (when hanging). Environmental air traveled pass the cooling coil which attaches near a fan motor supported by bracket at the front view of the case to blow refresh air out, ventilating air within the room. S-Pak fan coil specification details are:

- Have four types of model; SFJ-12, SFJ2-12, SFJ-16, SFJ-18
- Power 121 Watts on the first three models (SFJ-12, SFJ2-12, and SFJ-16). The last model (SFJ-18) is 99 Watts.

The condensing unit is the section that located outdoor. It's a square-shape unit. The main function is to transfer heat out of the system. The important elements of condensing unit consist of compressor, condensing coil (hot coil), fan, motor, and suction and liquid pipe. S-Pak condensing unit specifications are:

- Have four types of model; SCJ-12, SCJ2-12, SCJ-16, SCJ-18
- Power 1,173 Watts for SCJ-12 and SCJ2-12 models; power 1,738 Watts for SCJ-16 model; power 1751 Watts for SCJ-18 model.

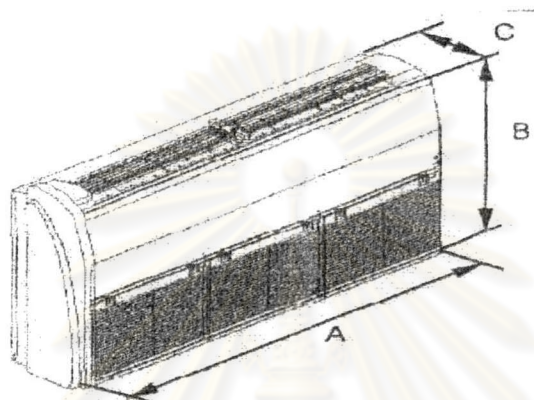


Figure 3-1a; Fan coil unit of split type air conditioner

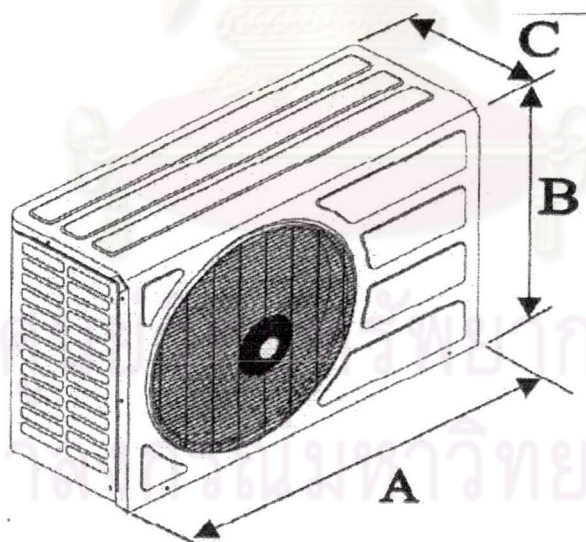


Figure 3-1b; Condensing unit of split type air conditioner

The product mainly used as household product placing in certain areas of the house like living room or can be used to locate in proper ground of huge buildings such as bank, hotel, office, and even some industrial factory. For sales, fan coil and condensing units are customized by matching compatible models (with the same BTUs) after assemble to meet each customer's requirement in working function and outlook style.

With varieties in the product's model, the structures still have similarities among every product except for the component's shape, color, size, and fashionable style to create attractive outlook for customer's selection. Moreover, difference in functional purposes requires different internal parts specification. For example, in table 3-2, the 12,500 BTU condensing unit uses RH207 VHET compressor while 16,000 BTU condensing uses PH28 VNET compressor. However, all units still have the same manufacturing processes.

Table 3-1; Bill of materials of metal components and parts description in fan coil and condensing unit models (also represent in numbers of figure 3-2a to 3-3b)

Item No.	Fan Coil Unit (SFJ-12, SFJ2-12, SFJ-16, SFJ-18)	Condensing Unit (SCJ-12, SCJ-16, SCJ-18)	Condensing Unit (SCJ2-12)
1	Front panel	Panel bottom	Panel top
2	Fan motor bracket	Support control	Panel bottom
3	Drain pan	Support service	Support control
4	Support partition right	Panel ventury	Support service
5	Support partition left	Panel rear	Panel ventury
6	Inside panel right	Panel side right	Panel rear
7	Inside panel left	Panel inner	Panel side right
8	Back panel	Support fan	Panel inner
9	Top panel	Suction valve	Support fan
10	Base panel	Liquid valve	Suction valve
11	Buffer damper	Suction pipe	Liquid valve
12	Support coil left	Liquid pipe	Suction pipe
13	Support coil right		Liquid pipe
14	P/T coil left	Non-metal Parts	
15	P/T coil right	Fan	Fan
16	Support cover front panel	Front sieve	Front sieve
17	Service plate	Base supporting stick	Base supporting stick
18	Support fan motor bracket	Magnetic	Magnetic
19	Support plate	Terminal box	Terminal box
20	Remote control box	Running relay	Running relay
21	Support bracket	Rubber and foam	Rubber and foam

Table 3-2; Bill of materials of plastic and other non-metal components and parts description in fan coil unit models (did not describe in figure 3-2a to 3-2d)

Item No.	Fan Coil Unit (SFJ-12, SFJ-16, SFJ-18)	Quantity	Fan Coil Unit (SFJ2-12)	Quantity
22	Outside panel left	1	Outside panel left	1
23	Outside panel right	1	Outside panel right	1
24	Return short	3	Return short	3
25	Filter short	3	Filter short	3
26	Auto sweep air frame	1	Manual air frame	1
27	Support return long	2	Support return long	2
28	Grille and bleed	3	Grille and bleed	3
29	Support return short	2	Support return short	2
30	Support louver right	1	Support louver right	1
31	Support louver left	1	Support louver left	1
32	Support arm swing	1	Support arm swing	1
33	Plastic for back panel	4	Plastic for back panel	4
34	Rubber drain pan	1	Rubber drain pan	1
35	Housing	2	Housing	2
36	Blower	2	Blower	2
37	Motor	1	Motor	1
38	Motor stepper	1	Control set (thermostat)	1
39	Control set (thermostat)	1	Terminal block	1
40	Terminal block	1	INSL PE/G/A front panel	1
41	INSL PE/G/A front panel	1	INSL PE/G/A buffer damper	1
42	INSL PE/G/A buffer damper	1	INSL PE/G/A back panel	1
43	INSL PE/G/A back panel	1	INSL PE/G/A drain pan	1
44	INSL PE/G/A drain pan	1	INSL PE/G/A support coil	1
45	INSL PE/G/A support coil	1	INSL PE/G/A P/T coil right	1
46	INSL PE/G/A P/T coil right	1	INSL PE/G/A P/T coil left	1
47	INSL PE/G/A P/T coil left	1	INSL PE/G/A in panel right	1
48	INSL PE/G/A in panel right	1	INSL PE/G/A in panel left	1
49	INSL PE/G/A in panel left	1	INSL PE/G/A top panel	1
50	INSL PE/G/A top panel	1	Cooling coil	1
51	Cooling coil	1		

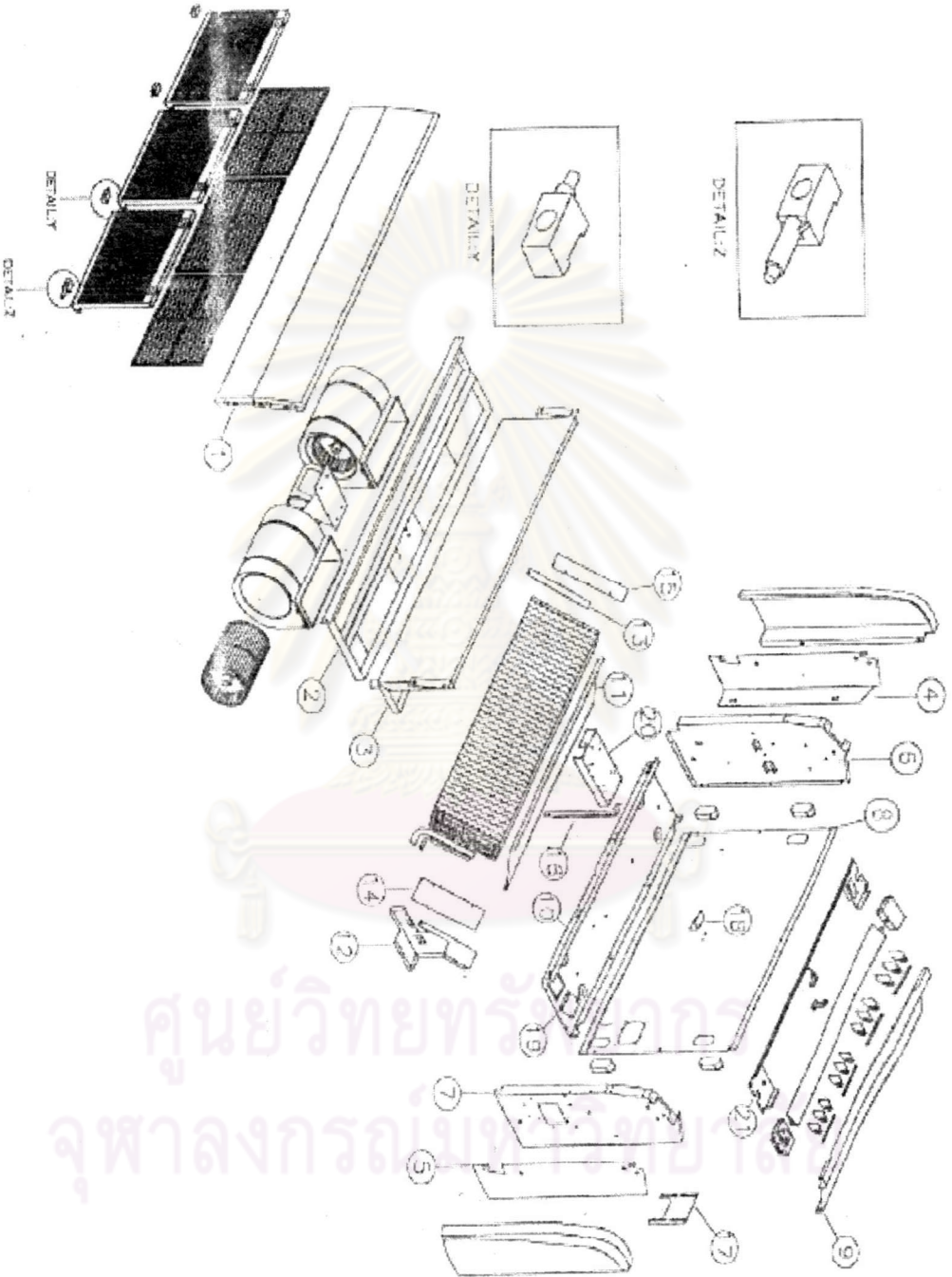


Figure 3-2a; Design parts of fan coil unit of SFJ-12 model

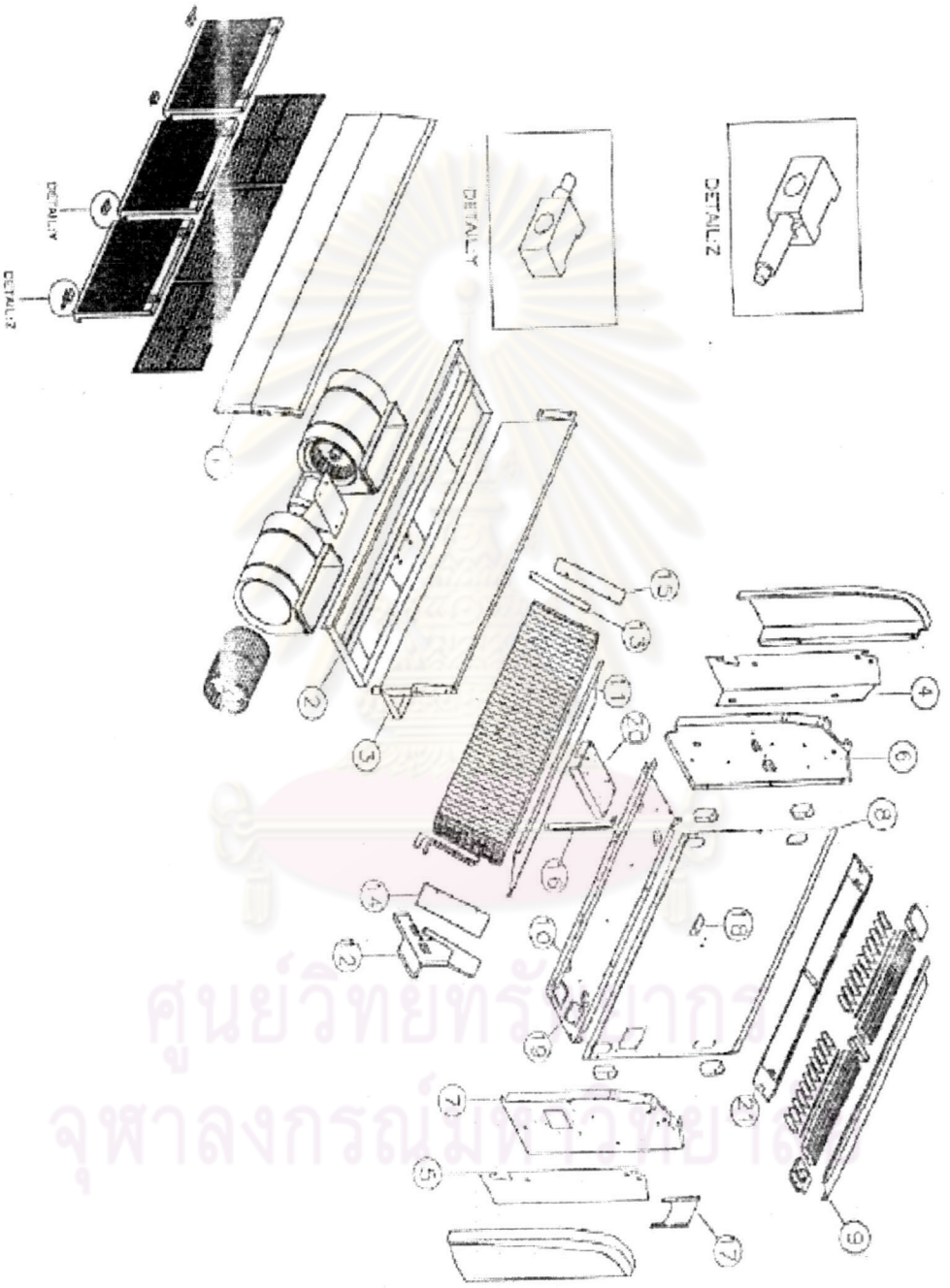


Figure 3-2b; Design parts of fan coil unit of SFJ2-12 model

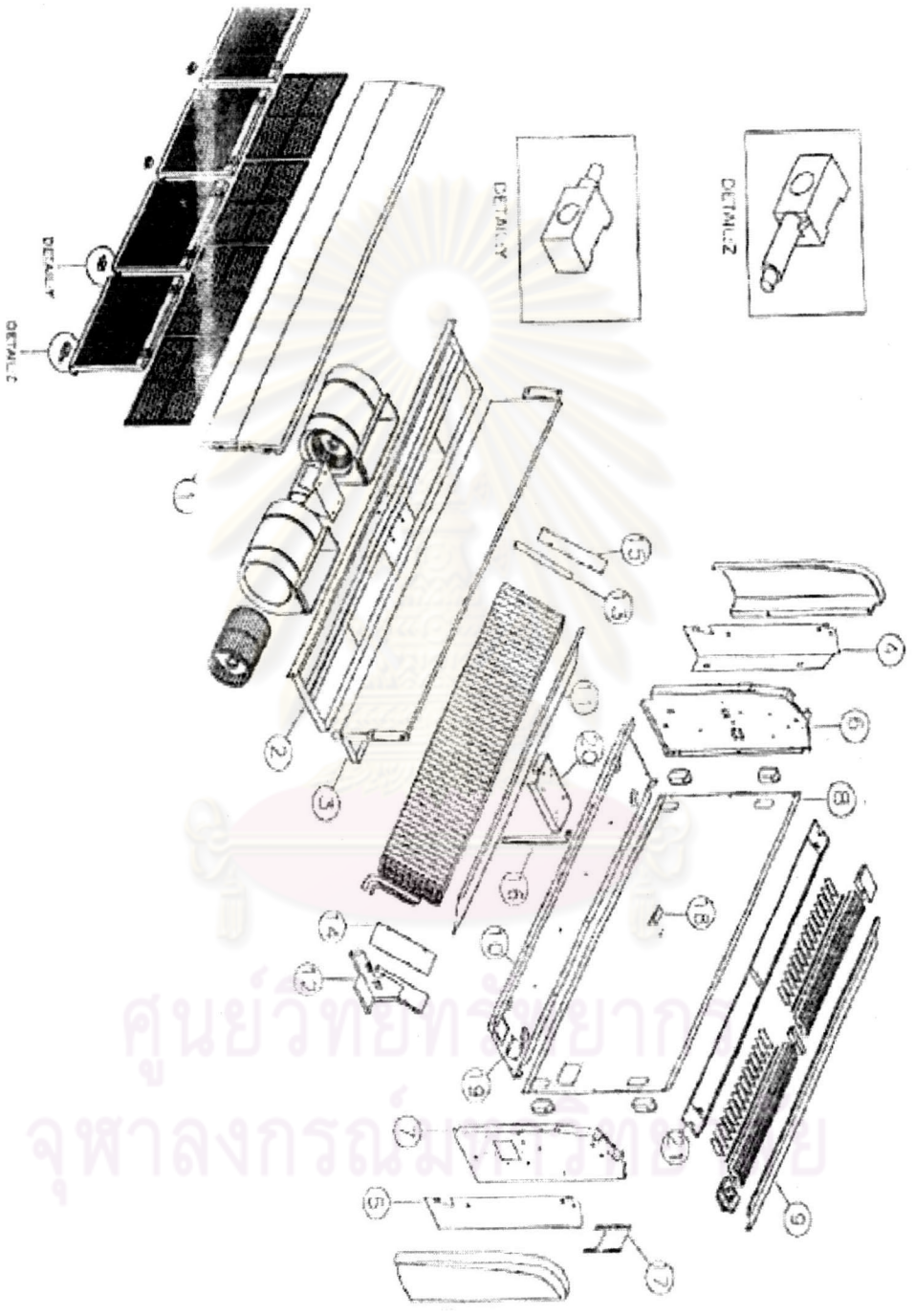


Figure 3-2c: Design parts of fan coil unit of SFJ-16 model

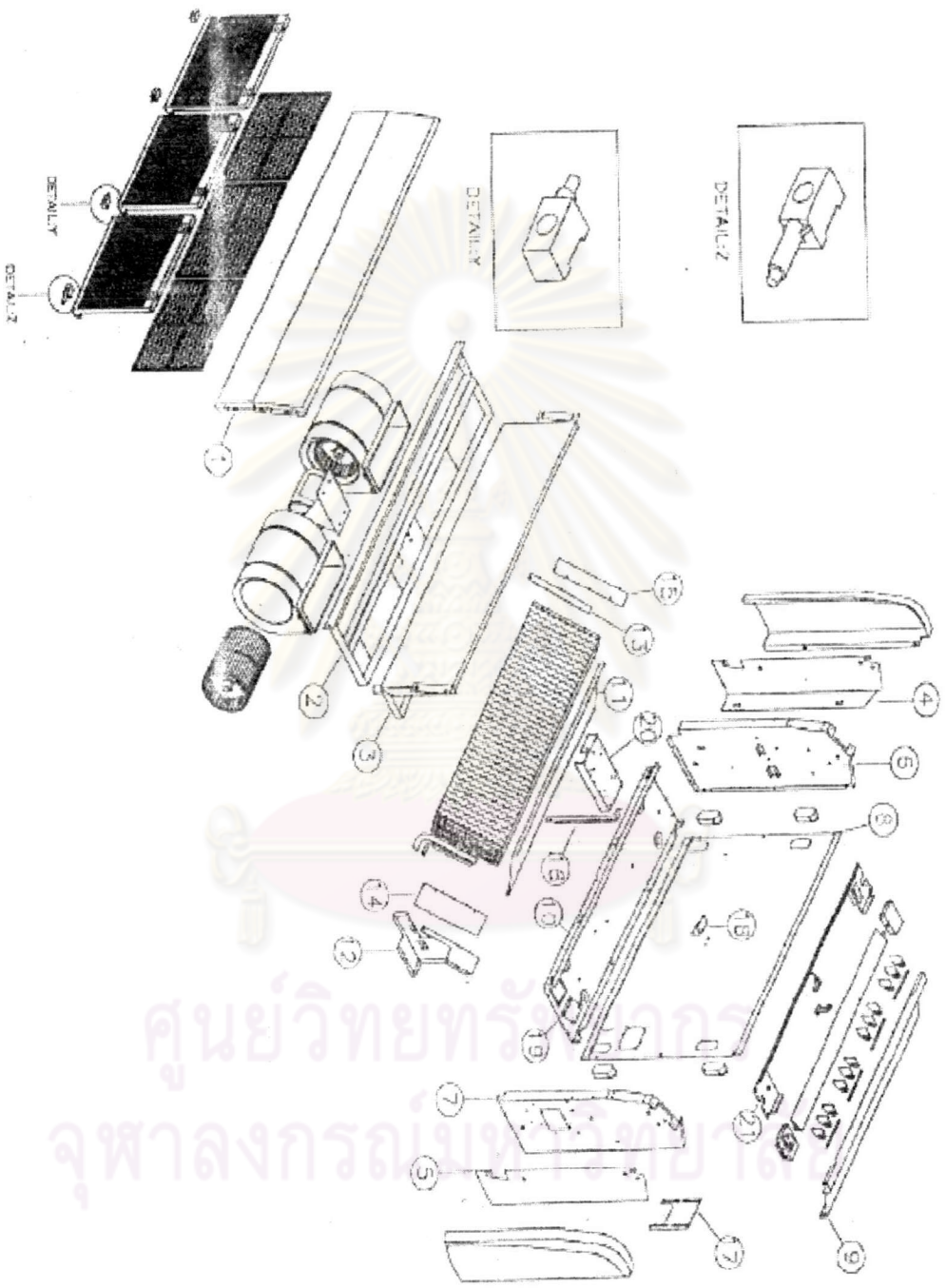


Figure 3-2d; Design parts of fan coil unit of SFJ-18 model

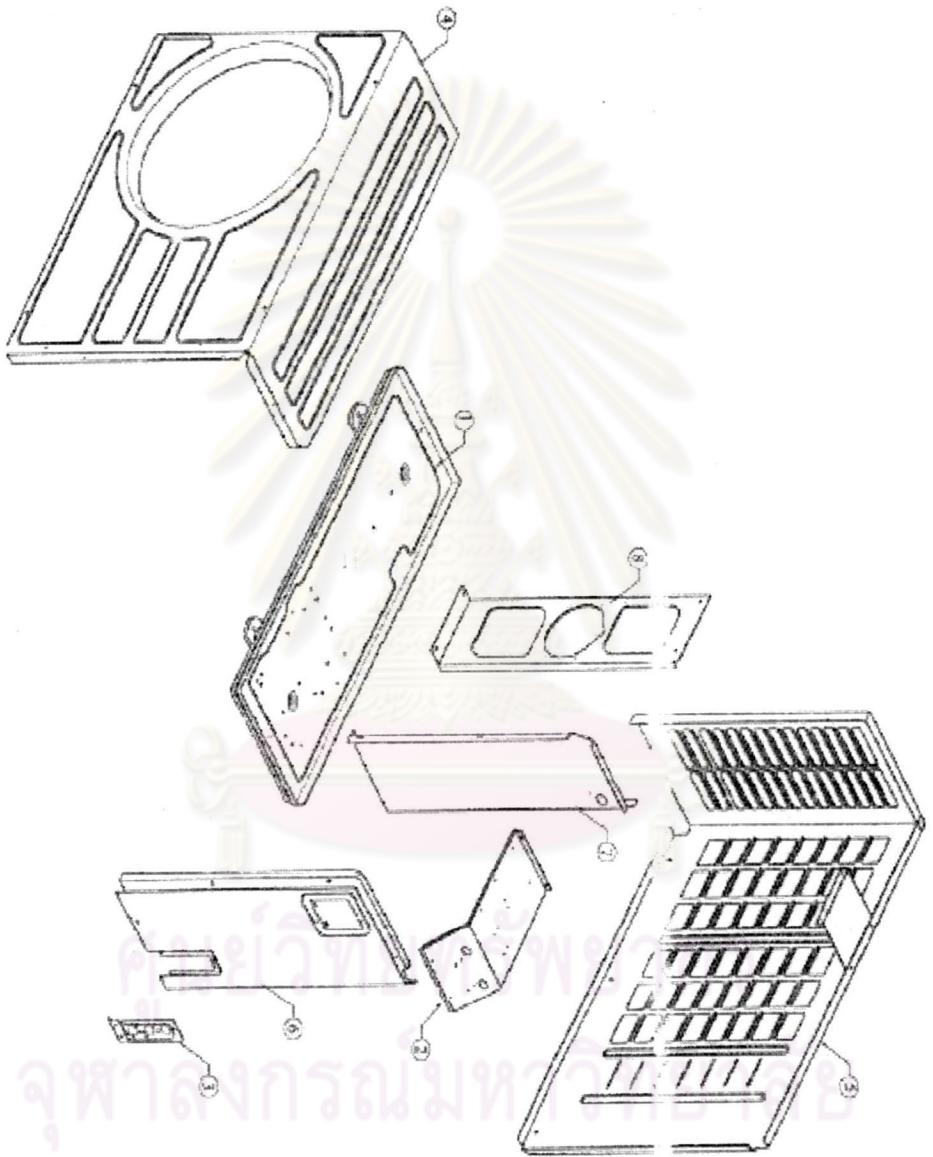


Figure 3-3a; Design parts of condensing unit of SCJ-12, SCJ-16, and SCJ-18 model

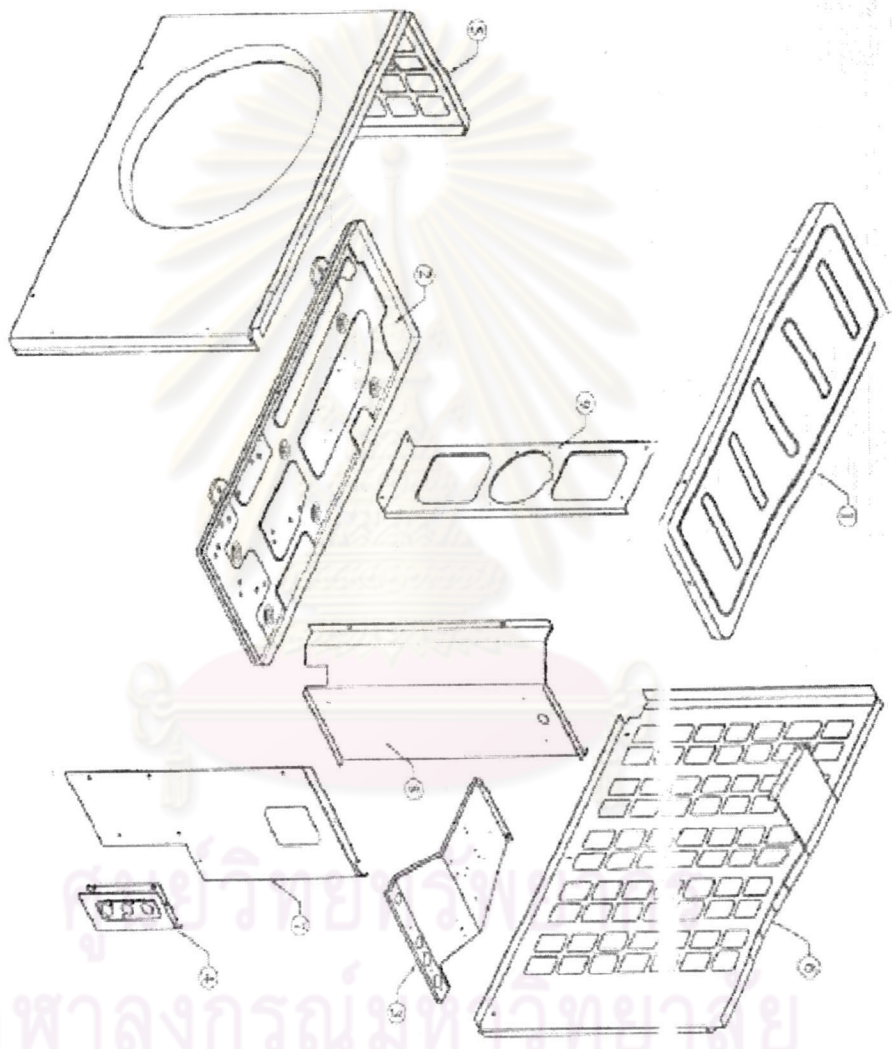


Figure 3-3b; Design parts of condensing unit of SCJ2-12 model

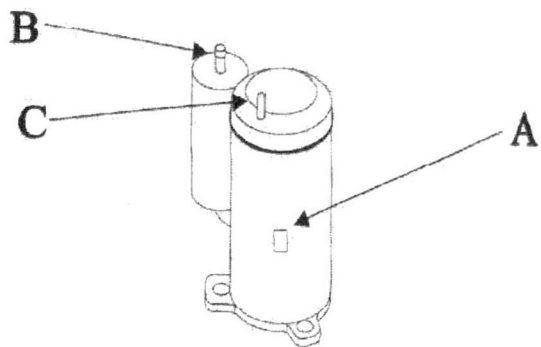


Figure 3-4a; Compressor of a condensing unit

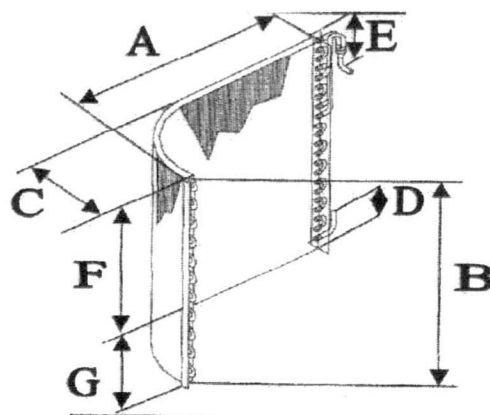


Figure 3-4b; Condenser coil of a condensing unit

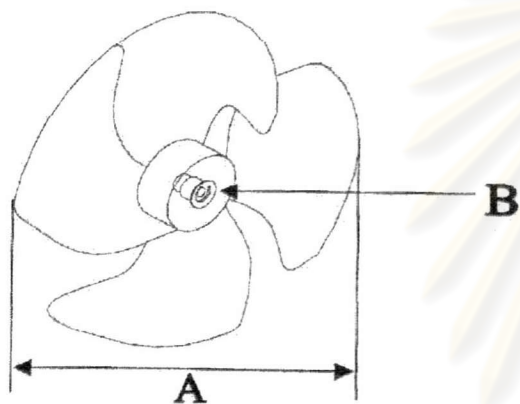


Figure 3-4c; Fan of a condensing unit

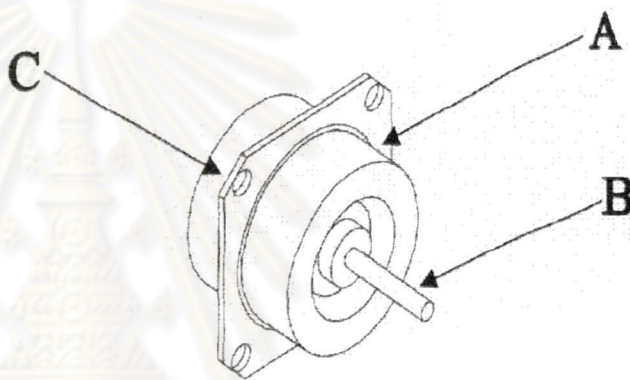


Figure 3-4d; Motor of a condensing unit

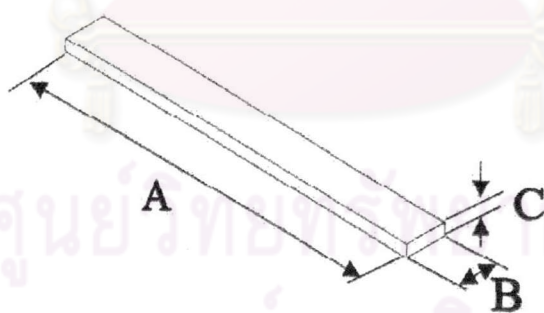


Figure 3-4e; Base supporter of a condensing unit

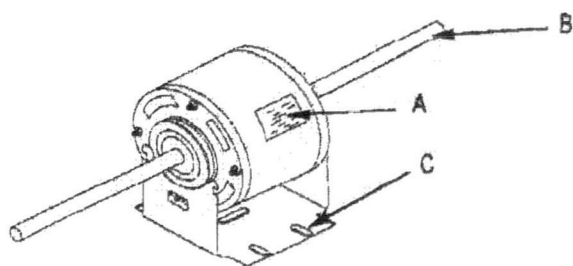


Figure 3-5a; Motor of a fan coil unit

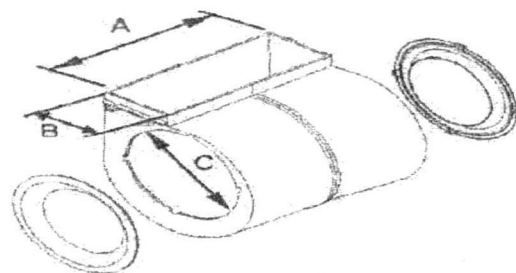


Figure 3-5b; Blower housing of a fan coil unit

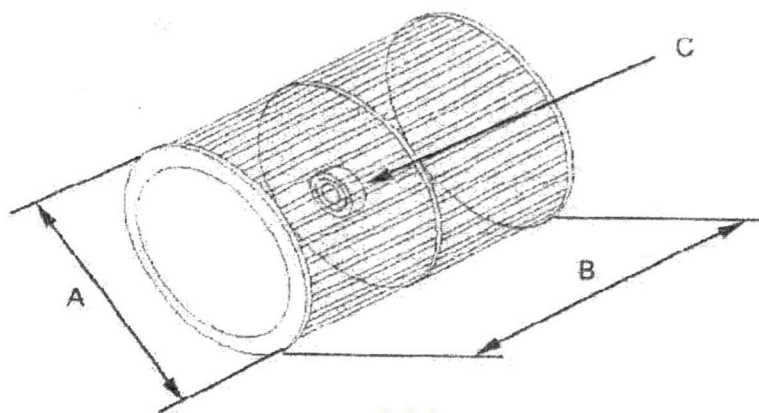


Figure 3-5c; Fan wheel of a fan coil unit

Table 3-3; List of different parts and components in each capacity

Capacity Type / Parts	12,500 BTU	16,000 BTU	18,000 BTU
Fan Coil Unit			
Motor model – size (hp)	M1150 – 1/15	M1100 – 1/10	M1108 – 1/8
Blower size (inch)	6 x 8	6 x 9	6 x 9
Coil fix area (ft ²)	1.69	2.12	2.12
Number of coil row	3	4	4
Number of fin per inch	14	14	14
Type of coil fin	Conjugate fins	Conjugate fins	Conjugate fins
Fan speed (rpm)	1,250	1,250	1,310
Condensing Unit			
Compressor model – size (BTU)	RH207 VNET – 12,500	PH28 VNET – 16,000	PH31 VNET – 18,000
Motor model – size (hp)	M3110124 – 1/8	M3110124 – 1/8	M3110126 – 1/6
Fan size (inch)	16	18	20
Coil fix area (ft ²)	4.17	5.75	6.12
Number of coil row	2	2	2
Number of fin per inch	16	14	16
Type of coil fin	Conjugate fins	Conjugate fins	Conjugate fins
Fan speed (rpm)	900	1,000	1,250
Split-type AC Unit			
Cooling capacity (BTU/hour)	12,500	16,000	18,000
Power usage (Kilo Watt)	Unknown	1,650	1,700

2.2 Organization Chart

The organization chart of the company consists of departments in responsible for each job in producing and selling air conditioners. The overview chart (figure 3-6a) represents organization structure of BNB Inter Group that divided into office work responsible for strategic planning, marketing, and purchasing activities. The remaining departments are mainly related with manufacturing activities such as production, quality, and research & development division. Both buildings are highly separated from each other.

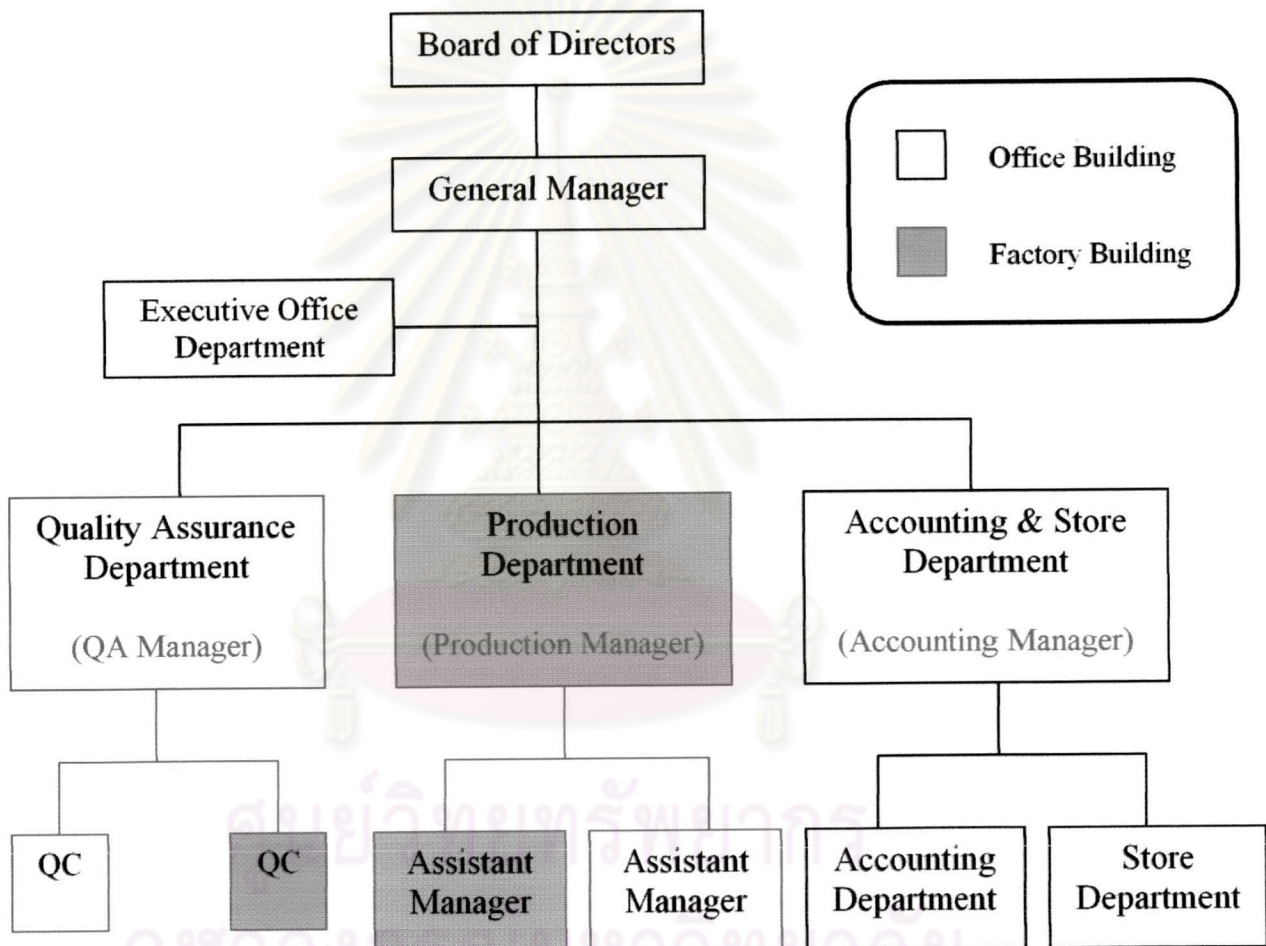


Figure 3-6a; Organization chart of BNB Inter Group Co, Ltd.

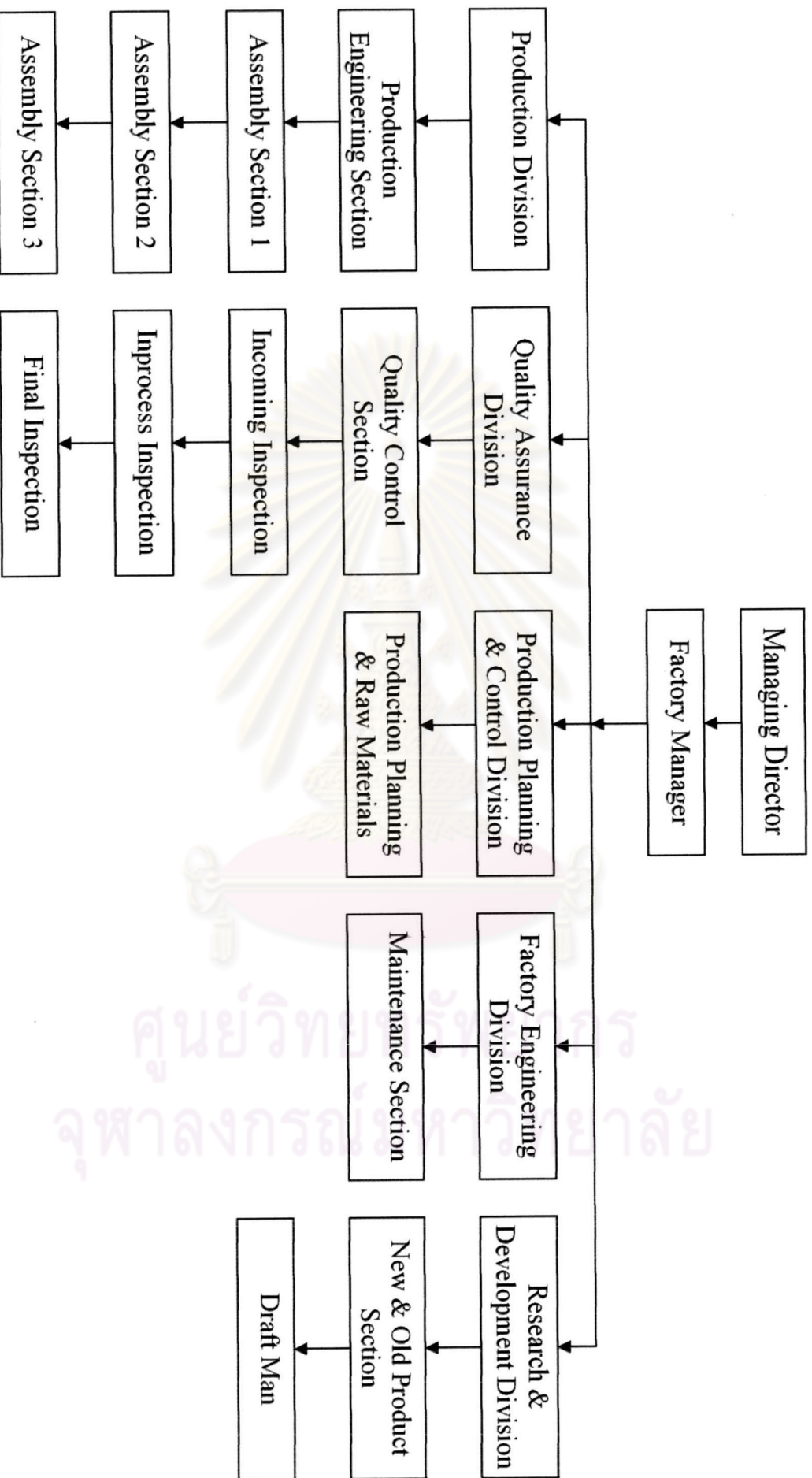


Figure 3-6b, Manufacturing operation organization chart

3. Process Flow

S-Pak factory only provide final assembly to finish goods. There are no productions of any parts or sub-assemblies to concern. The manufacturing processes involved with three main issues which are purchasing, assembling, and distributing in terms of business flow represent in figure 3-7.

The first step of the process is contracting with suppliers to buy parts and materials from them. The accounting & store department is responsible for this in both headquarter and in the factory. After that the division of production planning will decided to introduce a new product or not. While transferring material along the assembling stages there will be a little quality inspection and corrective action by preventative maintenance through the work flow. The final check is done before storing finished goods prepared to deliver to customers. Some production activities will be cooperating with the customers to solve problems.

Figure 3-8 represents a more delicate flow chart of an operation stages within the factory since receiving raw materials till distribution. After all parts are bought, the factory separates parts into two groups; the metal parts and plastic parts.

Both types will access through the same operations of receiving, reviewing contract, and storing initially in raw material storages before transporting to workstations. Parts will move through manufacturing stages, except for some metal parts which need to pass the chemical and painting procedures. These parts are air condition cases.

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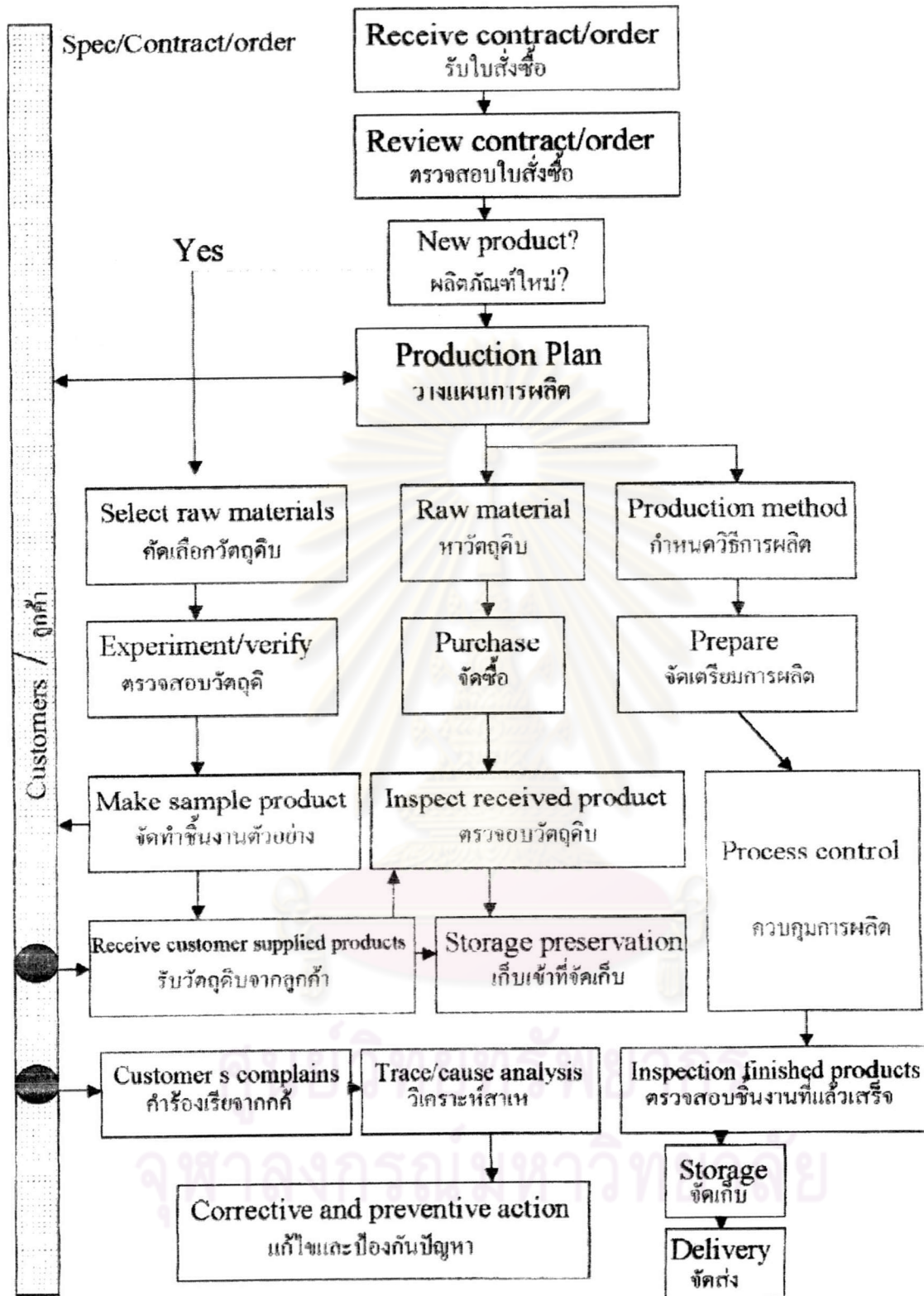


Figure 3-7; Picture of manufacturing business flow

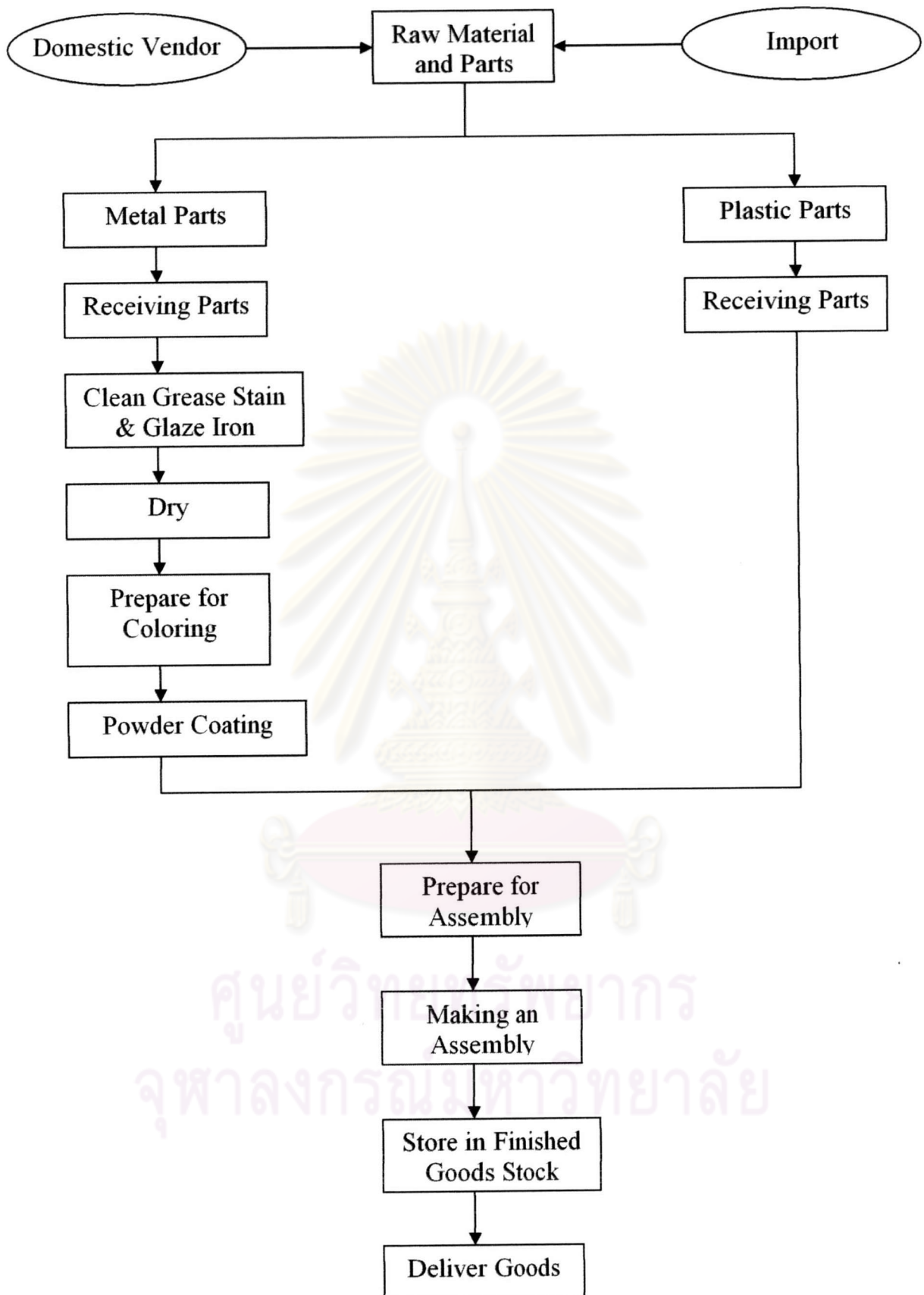


Figure 3-8; Overall picture of assembling processes flow

4. Working Procedures

4.1 Spraying Metal Parts

Only metal parts of split-type air conditioner require coloring. These parts are mostly outside construct of the product that customers can see clearly. The device and equipments for this operation are:

- A spray gun
- Power coating
- Furnace
- Chemical detergent and phosphate
 - SIP-CLEAN 910
 - SIP-CLEAN 350
 - SIP-PHOS 408
- Chemical rust protector SIP-COND 140

4.1.1 Operation Detail

Cleaning & Washing Stage

Numbers of metal parts is brought in from raw material stock by the production order lists. Clean all parts that require coloring with water and then clean grease with phosphate detergent liquid. After that another chemical liquid named SIP-PHOS 408 is used to cover on the part's surface to protect rust. The covered parts are then again immersed in phosphate glazing for higher durability and make the parts more shinny.

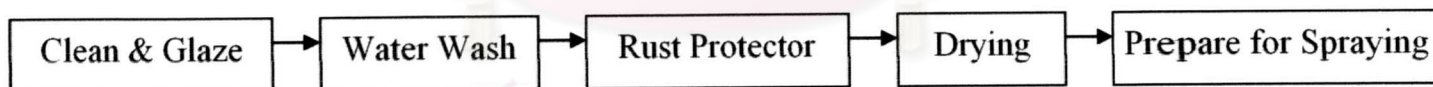


Figure 3-9; Procedures of cleaning stage

Table 3-4; Detail of cleaning and glazing iron phosphate

Water Volume 2,300 L	T.A. = 20 pt. No refill	Chemical Density Level (pt.)											
		19	18	17	16	15	14	13	12	11	10	9	8
Amount of chemical (kg)	SIP-CLEAN 910	3.5	7	10.5	14	17.5	21	24.5	28	31.5	35	38.5	42
	SIP-CLEAN 350	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7	7.7	8.4
	SIP-PHOS							Add 2 kg daily					

Table 3-5; Detail of rust protector

Water Volume (L)	SIP-COND 140	Density Level
2,300	1-2 %	1,000 L of water mix with 10-20 kg of SIP-COND 140

Table 3-6; Chemical control of coloring process

Procedures	Chemical	Mixture (kg)	Control Level	Temp (°C)	Time (minute)	Chemical Addition
Clean + Glaze	SIP-CLEAN 910 SIP-CLEAN 350 SIP-PHOS 408	150 kg 20 kg 10 kg	T.A.=15-20 pt.	Normal	15-20	Add T.A. = 1 pt. Add # 910 = 3.5 kg Add # 350 = 0.5 kg
Washing	Clean water	-	-	Normal	2	-
Rust Protector	SIP-COND 140	20 kg	Ph = 6-7	Normal	10	Add 2 kg daily

The process dipped 30 – 50 units for each part's type and then shifts to another part one by one until achieving every items. That's means there will be 7 shifts daily to achieve 3 fan coil panels and 4 condensing panels.

Drying Stage

After cleaning process is completing, the next step is the drying process. This stage has nothing much to do. Parts are place separately for around 10 – 15 minutes in the position where air is ventilated to ensure they are dry enough before hanging them in an automatic conveyor. The hanging front and side panel (of the case) will be blown by huge fan to eliminate dust.

Coating Stage

There are two blue-collar workers who will use a spray gun to spray powder coating, which is a type of dry paint, on the hanging parts. Both workers stand on the opposite side of each other. There is a fix range between each part distance but workers must hang part within 1-2 minute per piece. The first person will use his spray gun to shoot paint into one side of the part and the next person will use another gun shoot the remaining side. The electrical current used in coating and conveyer is 95-100 MA.

The parts that need to be painted for fan coil unit are:

- Top panel
- Front panel
- Base panel

The parts that need to be painted for condensing coil unit are:

- Top panel (SCJ2-12 model)
- Right side panel
- Ventury panel
- Rear panel

Heating Stage

While spraying powder coating on the materials, the conveyor will move along the straight line passing the furnace for heat-treatment process, which will make the powder completely melt adhesively into the part's surfaces. The oven temperature is between 220-225 °C. There is a pattern of conveyer flow. In the output of the furnace another worker will pick the colored parts and sent to quality control (QC) staffs to check them in the WIP inventory.

Testing Stage

The QC staffs will test the color thickness with measurement device. It is a random test concerning with statistical techniques. The test requires 5 pieces of part per lot. When an unqualified is found, the staffs will investigate the entire lot and rejected that defect part for rework.

4.2 Product Assembly: Fan Coil Unit

The assembling parts of fan coil unit consist of metal and plastic parts that are taken out from raw material stocks. Metal parts must already be painted from spraying station. The raw material stock is well-adjusted, sorting for each components types and function.

The assembling process in converting into finished goods ready for distribution consists of 36 operations, 5 inspections, 1 mixture of operation and inspection, and 1 finished goods stock. The WIP stocks are kept along the line. The below assembling process chart will clarify sequences of activities in the form of queuing system, step by step. The process flow will be shown in continuous symbols.

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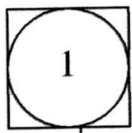
Table 3-7; Symbols used in the assembling process chart

Production process chart symbol	
→	Motion
○	Operation
□	Overall inspection
◻	Operation and inspection
▽	Finished goods stock

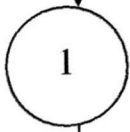
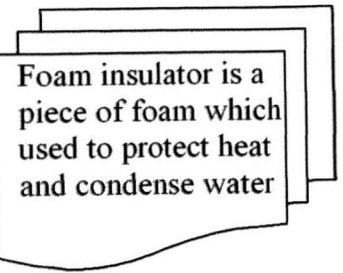
Note: No WIP stock will be describe in the operation process flow

Eventually, there is no processes planning in the assembling department according to no operation documents are available. The process chart is daftly written giving only overview scope of the operation performance shown in figure 3-7 and 3-8.

Apart from that, the technical task's manual sheets were sticks at the work station explaining workers what they have to do with supervisors walk around guiding them and solving occurrence problems. Traditional manufacturing system is an experience-based performance, depending on staff's knowledge and intuition. The manager and supervisor give commands on what they think is appropriate for the job, pointing fingers and give command, not the workers who own the decision to find the most convenient ways by themselves. No work stations have been divided. Each person is performing their job, mining their own business. The process is implemented straight over through the line.

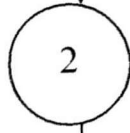


1
Cut out foam insulator

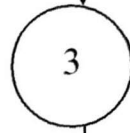


1
Stick foam insulator to all fan coil constructions; right-left panels, left-right coil supporter, back panel, front panel, buffer damper, drain pan, and right-left P/T coil

Use adhesive glue



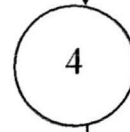
2
Attach 4 plastic plugs with the back panel



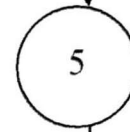
3
Connect service plate with back panel

Screw type 8 x 3/8

Service plate is a small piece of metal used to close the refrigerant pipe hole at the back panel, not to let air enter.

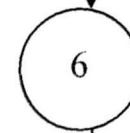


4
Connect back panel as the first body frame



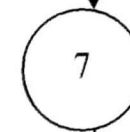
5
Attach right hand coil supporter with the right inside panel

Screw type 8 x 3/8



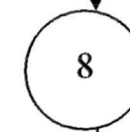
6
Connect inside right panel with back panel

Screw type 8 x 3/8



7
Attach left hand coil supporter with the left inside panel

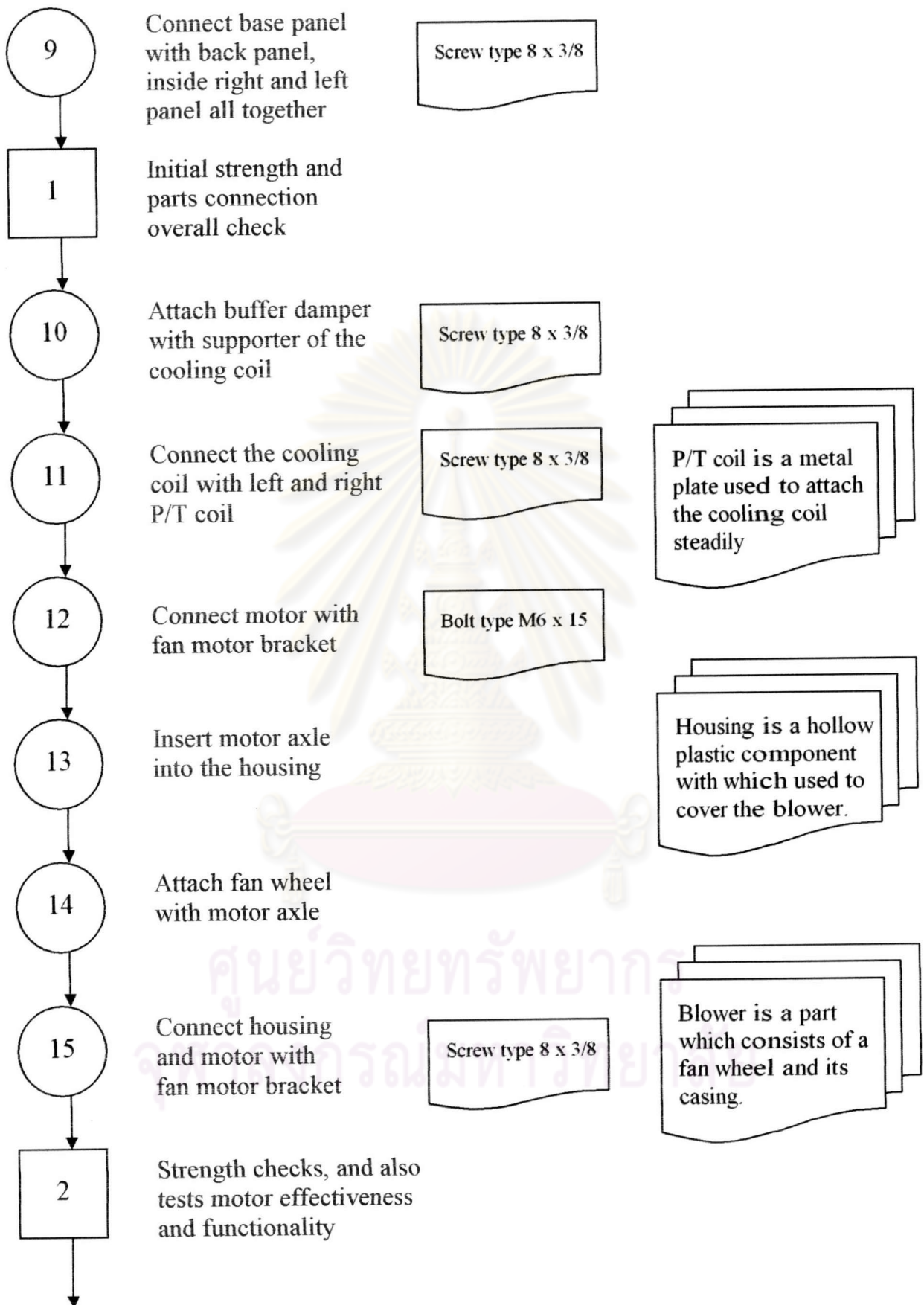
Screw type 8 x 3/8

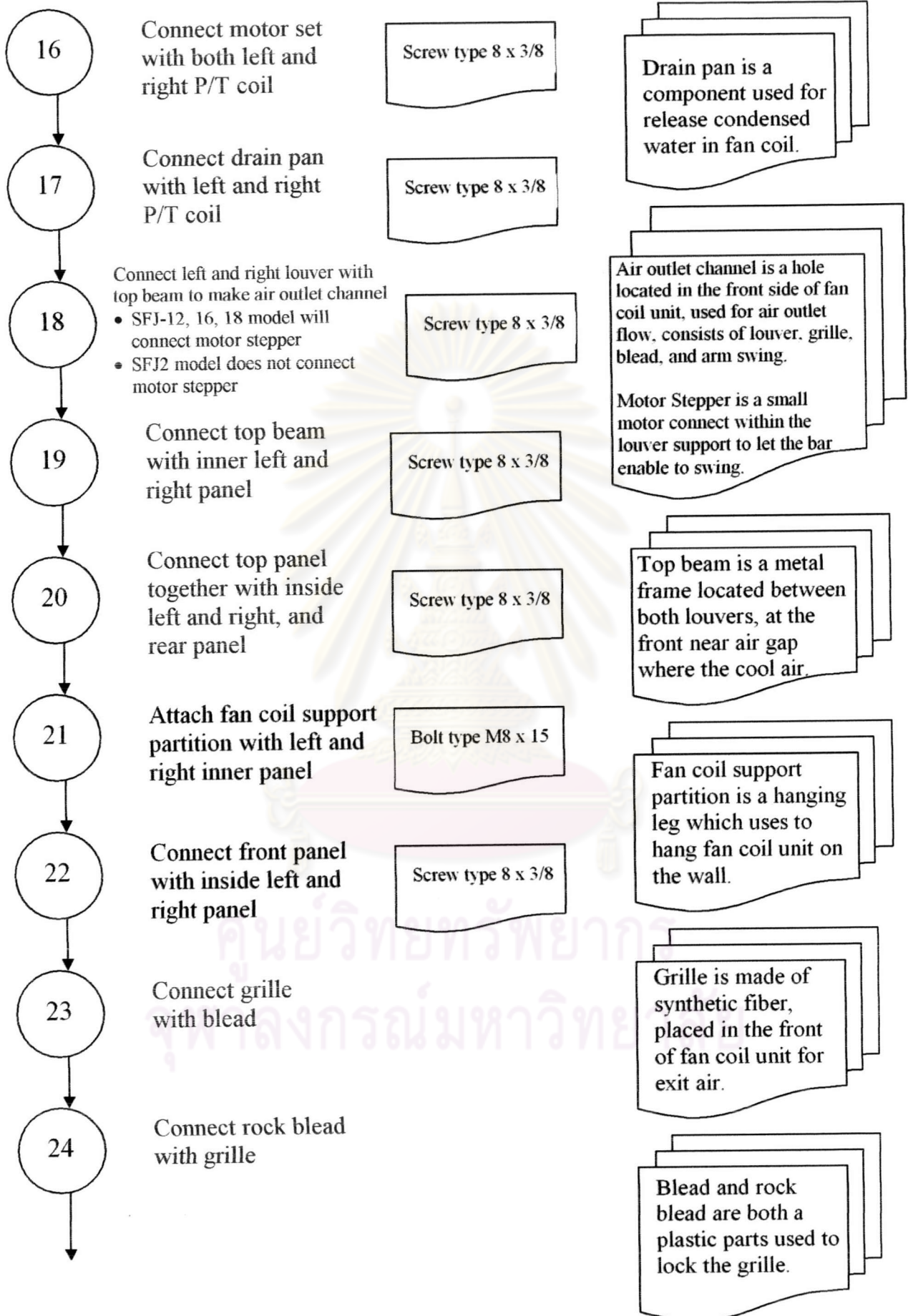


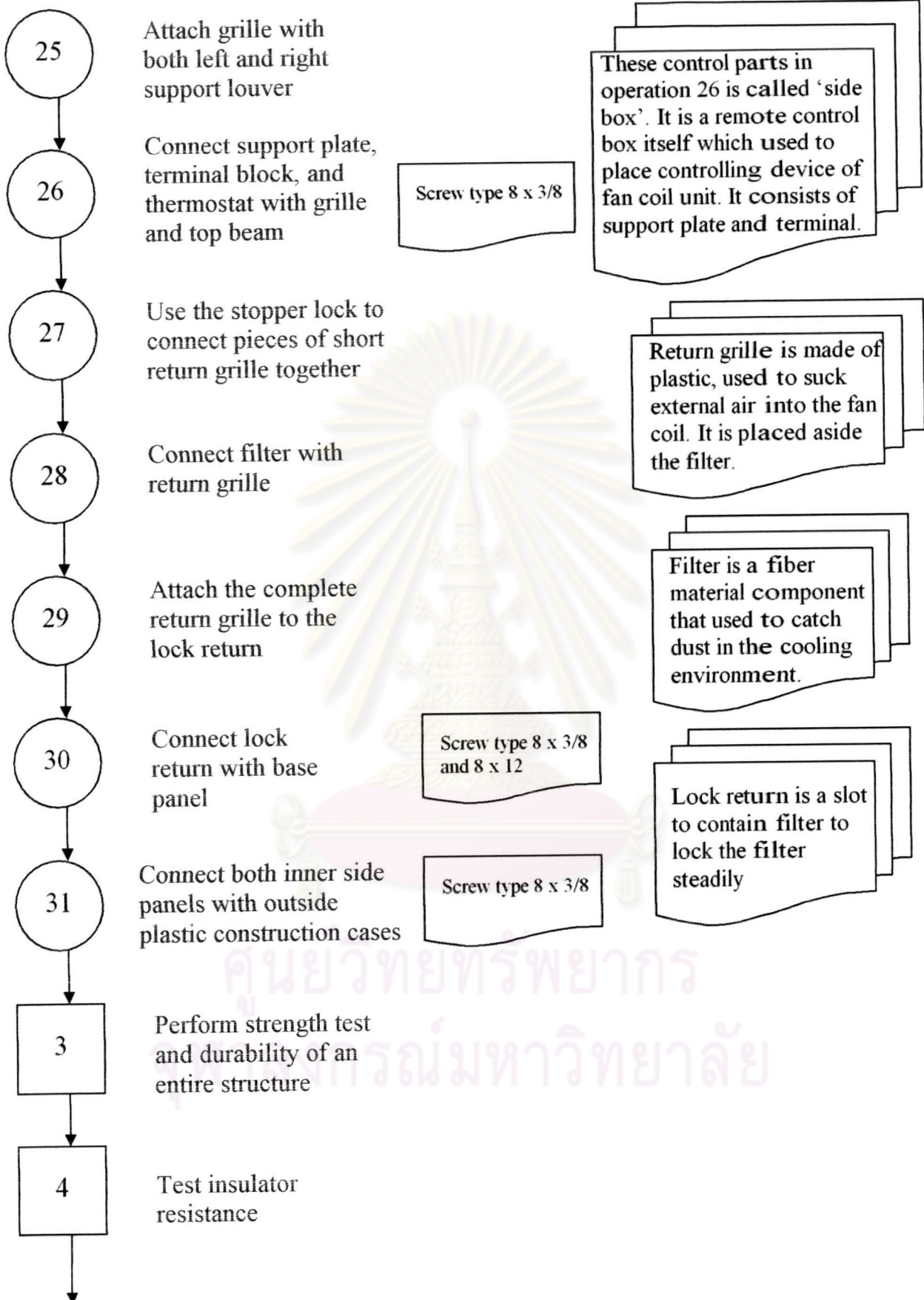
8
Connect inside left panel with back panel

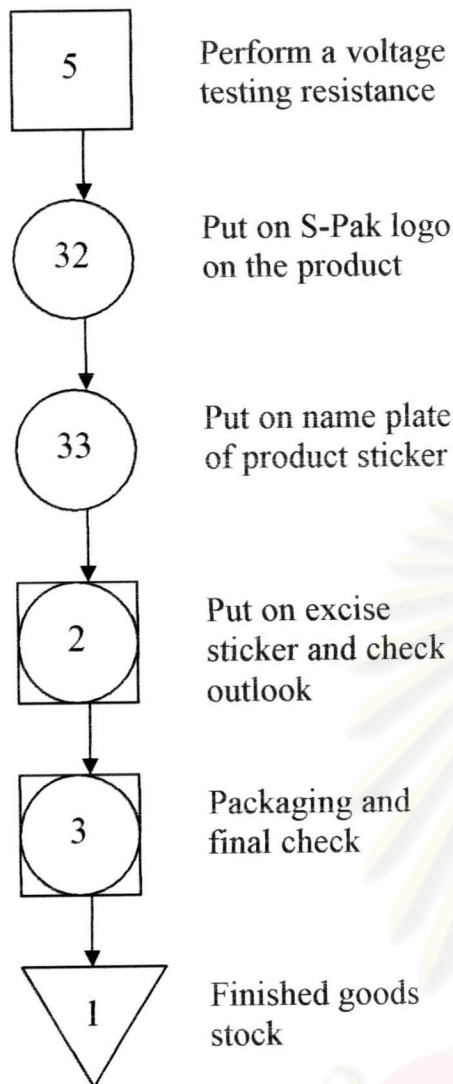
Screw type 8 x 3/8







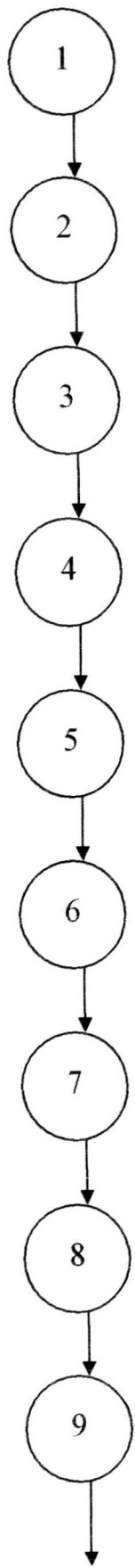




4.3 Product Assembly: Condensing Unit

The assembling of condensing coil unit consists of metal and plastic parts that are taken out from raw material stocks. Metal parts must already be painted from spraying station.

The assembling process in making complete condensing unit involved with 28 operations, 4 inspections, and a finished goods stock. There are slightly process differences between both condensing models in the 23rd operation. The WIP stocks are also kept along the line separated from fan coil unit stocks. The process chart will clarify sequences of activities step by step.



1 Attach bottom panel with two pieces of base supporters

2 Connect compressor with the bottom panel including rubber supporter

3 Place condenser on the bottom panel

4 Attach support service with the bottom panel

5 Connect service valve in the suction side with support service

6 Connect service valve of the liquid side with support service

7 Connect inlet and outlet refrigerant pipeline to the compressor and service suction valve

8 Connect refrigerant pipe of the liquid side with both condenser and liquid valve

9 Adjust motor into the support fan middle slot

Use spiral head screw

Use spiral head screw

Use spiral head screw

Use spiral head screw

Weld

Weld

Using spiral screw

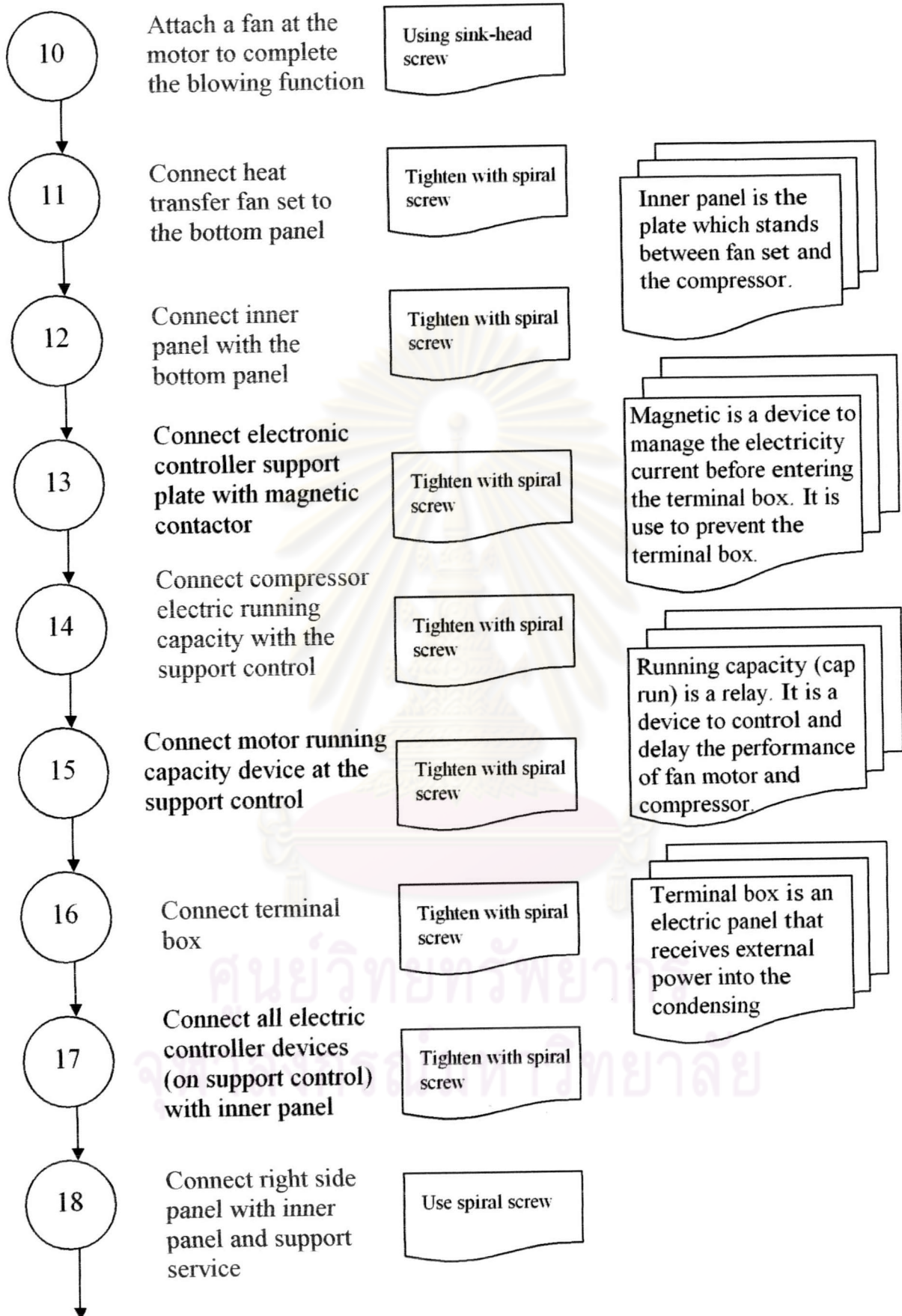
Base supporters are wooden stick to screw under the condenser. They will be remove at customer's hand

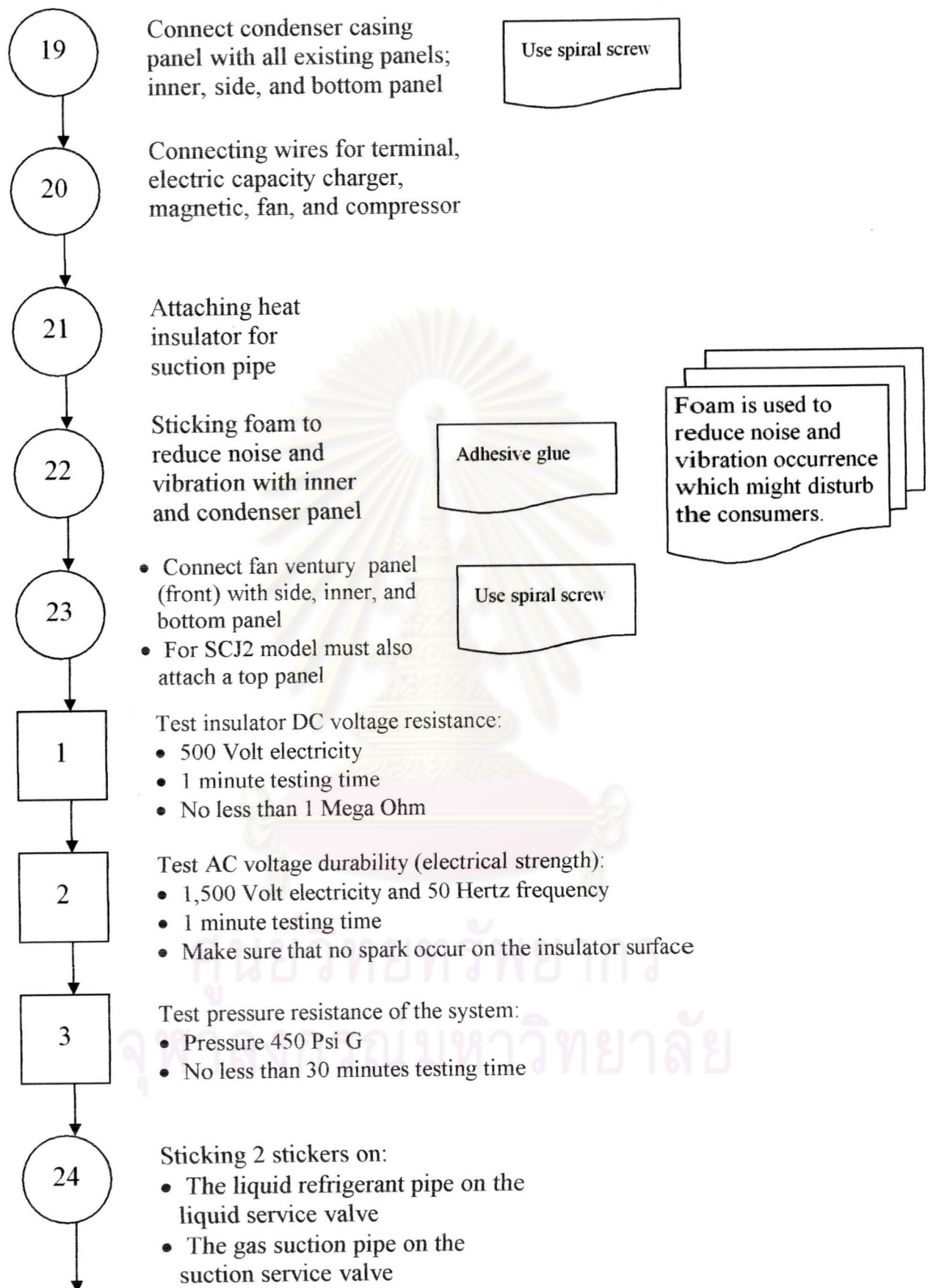
Support service is a small plate which has 3 holds for pipe lines

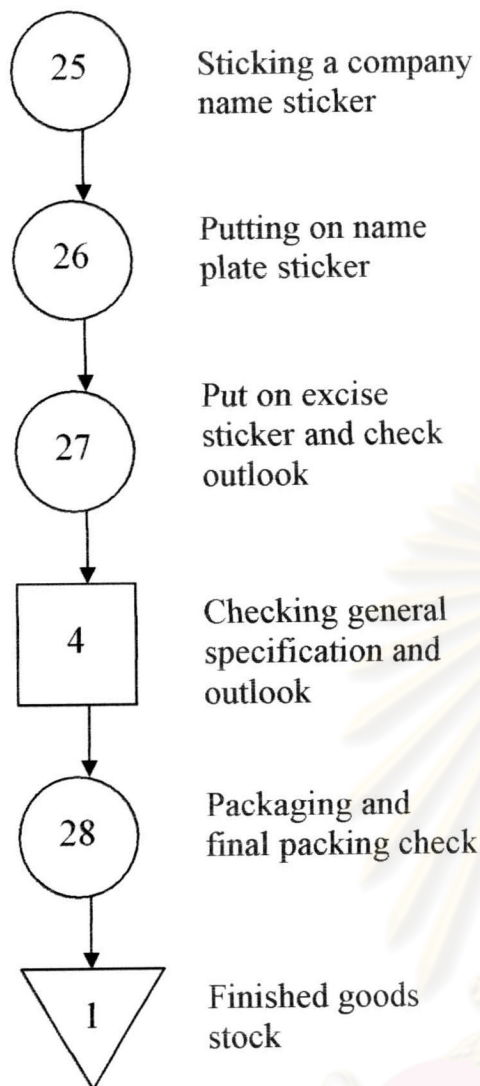
There are three main pipes in the condensing unit

- Pipe entering compressor (5/8 inches)
- Pipe out of compressor and enter hot coil (3/8 inches)
- Pipe out of the hot coil (3/8 inches)

Support fan is a three slot plate that used to hold the condensing fan set.







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