



## CHAPTER III

# CURRENT SYSTEM

### Product Description

There are three main products in plant two, which are CRT, DY, and ITC. Only deflection yoke product that is one main component of the Integrated Cathode Ray Tube component is focused in this thesis. DY consists of two deflecting coils: Horizontal (H-coil) and Vertical (V-coil). Its function is to produce an extremely low frequency (ELF) electromagnetic field that allows for constant adjustment for the direction of the electron beam.

Deflection yoke of the company are produced in three sizes, which are 14", 20", and 21", and each size is produced in several models as follows:

DY size 14" is produced in 25 models which are 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 14, 15, 16, 20, 21, 24, 26, 29, 30, 36, 44, 55, and 63.

DY size 20" is produced in 25 models which are 01, 02, 03, 04, 05, 06, 07, 08, 09, 11, 12, 13, 14, 16, 17, 18, 19, 23, 24, 29, 30, 37, 38, 43, 46, 48, 63, 66, 83, and 86.

DY size 21" is produced in 20 models which are 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 15, 17, 20, 22, 23, 45, 50, and 70.

As mentioned above, there are totally 76 models of DY products. Bill of material (BOM) of each model is listed in the Appendix A and DY product is presented in Figure 3.1 as follows:

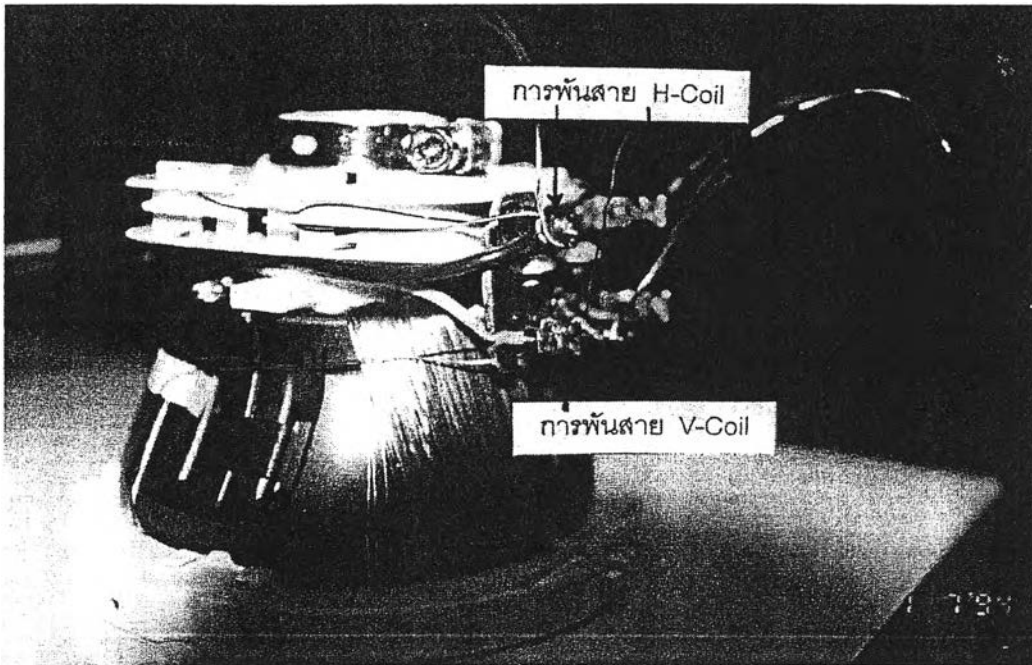


Figure3.1: Deflection Yoke product

## **Deflection yoke process**

### **1. H-coil winding**

First of all, enamel wires are wound by saddle winding machine (H-coil machine) as horizontal coils (h-coil). After finish winding, the machine automatic moves h-coil into the basket, and a machine operator will mark on each h-coil to identify the coil type, winding machine, and die used to produce such coil. Finally, wound coils are moved to WIP waiting for sub-assembly. Two h-coils are required for one DY and sixty h-coils on the same winding are produced as one lot.

In capacity view, wound h-coils are classified in accordance with the number of turns. (different number of turns take time to wind h-coils differently)

### **2. V-coil winding**

V-coil is wound by Toroidal coil winding machine ( V-coil machine) and two v-coils are also required for one DY. First of all, the machine operator will load two ferrite cores on the V-coil machine's jigs and the machine will feed and wind the wires on the ferrite cores to be wound v-coils. After unloads wound v-coil , the operator fix the winding lead by acetate tape, marks the coils on the ferrite cores to identify number of winding machine , and then moves the v-coils to WIP area waiting for assembly.

### 3. H-coil taping

After h-coils are wound by the h-coil machine, the winding leads need to be taped one and a half turnful on the upper part of bridging wire in order to fix the leads with the h-coils. Figure 3.2 shows h-coil taping as follows:

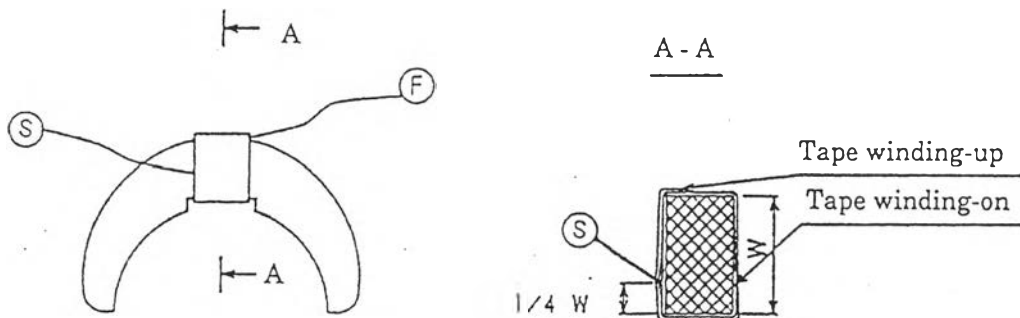


Figure 3.2: H-coil taping

### 4. H-coil peeling off

After taping winding lead, the insulating layer on the lead of h-coils will be peeled off for the purpose that provides for checking Air-L and soldering. 10-12 h-coils are done by wire polisher on the tip remaining a length of 40-50 mm. from the tip of the bridging wire.

## 5. Checking Air-L

H-coils need to be checked Air-L and classified according to their inductance values so as to provide the same inductance h-coils to assembly to be DY.

Checking Air -L is needed to operate in *only size 20" and 21"*.

## 6. H-coil assembling separators

Firstly, two pieces of h-coils will be bonded and attached with two units of separators letting their hooks be coupled each other. There are four winding leads that need to be relocated as shown in Figure 3.3.

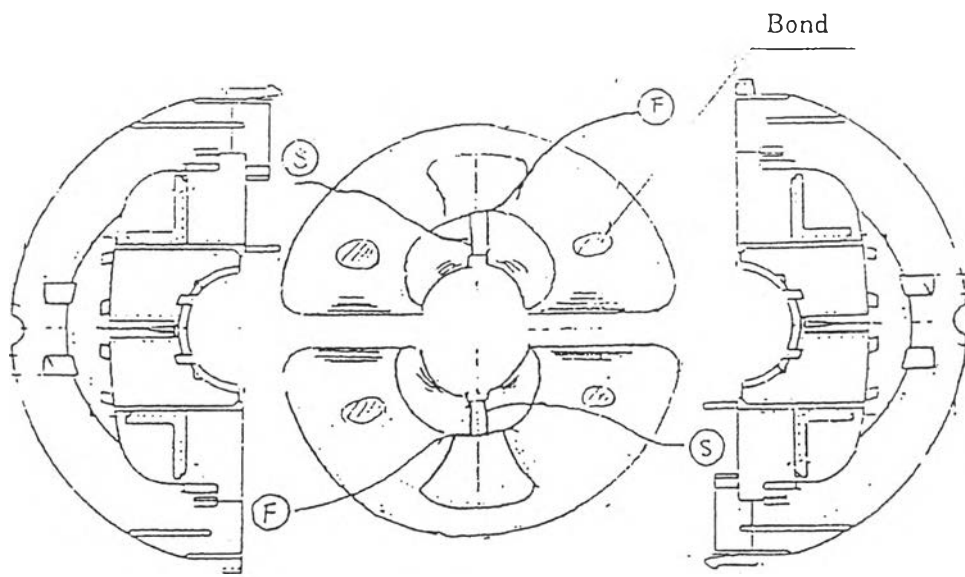


Figure3.3 : H-coil assembling separators

As shown in the Figure 3.3, winding-up lead (F) will let penetrate through the window for lead draw-out of the separator, and winding-on lead (S) will be inserted into the slot given on the upper part of separator.

## 7. Magnetic plate assembling

- **Internal magnetic plate assembling**

In this step, the pins extrude on the both sides of the separator are bonded and two internal magnetic plates will be attached on the separator. To fix the position of the magnetic plates, the assembly operator will insert the holes on the center of magnetic plate with the pins of the separator exactly and then fix the plates by acetate tape.

- **Magnetic plate for VCR correction assembling**

This operation is needed for only *h-coil size 14"*. Two magnetic plates will be inserted and bonded in the guide of grooves of the separators as shown in the Figure 3.4

## 8. V-coil assembling

In this operation, two pieces of v-coils will be built in the separator. The core crips are inserted into the core slots and then the cores (of v-coil) will be combined to meet each other. Figure3.5 shows v-coil assembling as follows:

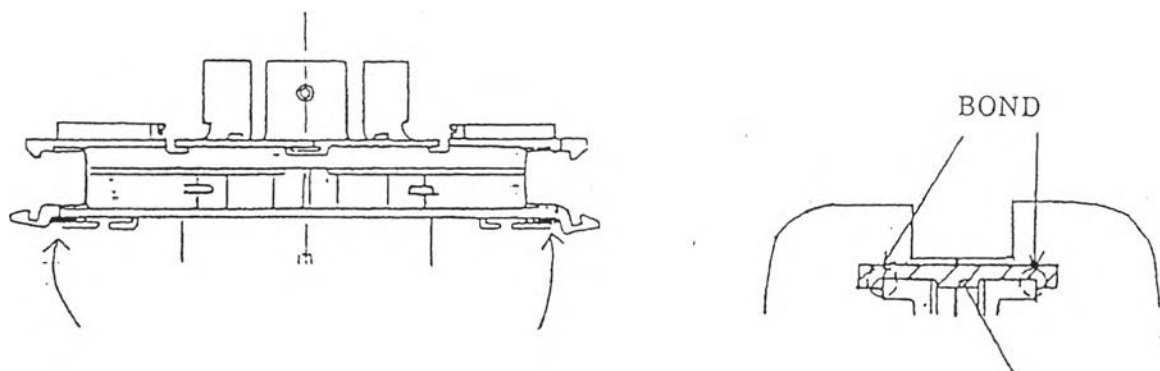


Figure3.4: Magnetic plate assembling for h-coil size 14"

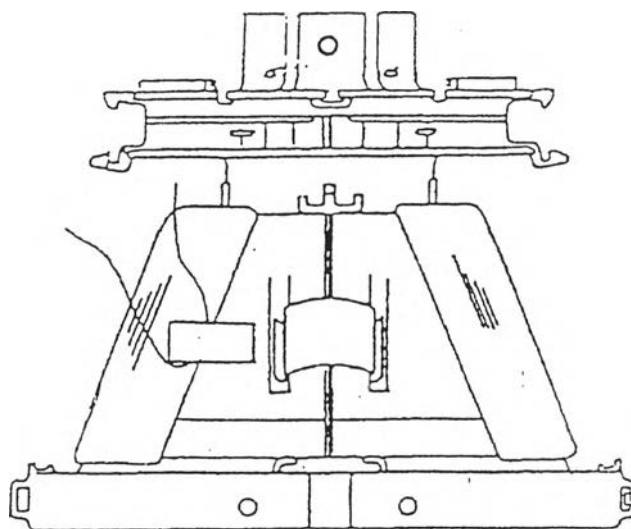


Figure3.5: V-coil assembling

## 9. Lead/board terminal assembling

In this step, the operator may assembly either terminal lead or terminal board depending on the product specifications. To fix terminal board on the separator, the assembly operator inserts the square hole provided on the terminal board completely up to the root so as to the hook on the separator be coupled. For assembling terminal lead, it takes more time to arrange the directions of the color leads as shown in the Figure 3.6. And specification of all products are presented in Appendix A (*Bill of material*)

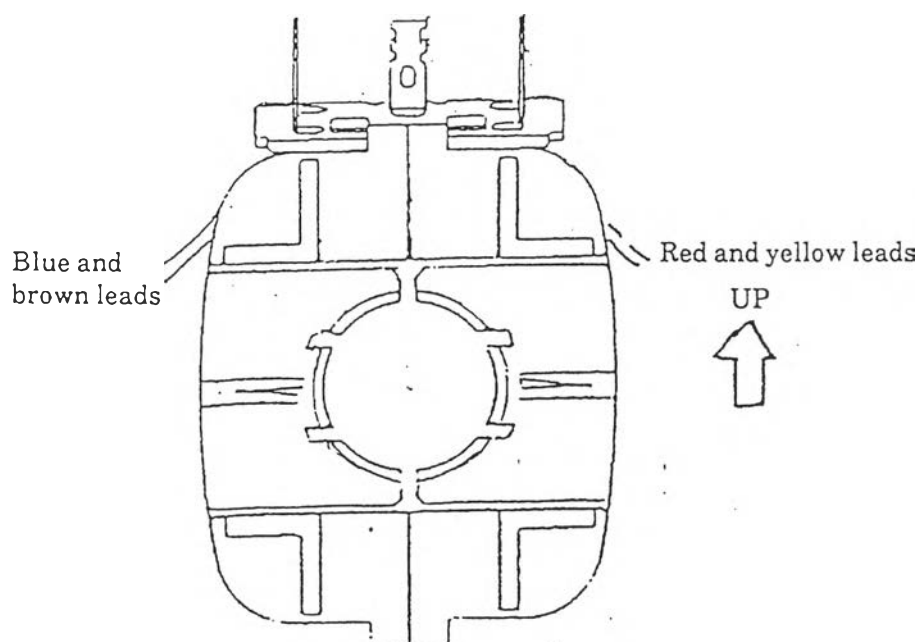


Figure3.6: Lead/board terminal assembling



## 10. Neckband Attaching

In this step, the assembly operator will attach and fasten the neckband on the separator neck. This operation is done for all types of products.

## 11. H-coil terminal winding

Before winding h-coil leads on the terminal, the leads need to be arranged that are inserted into the slot on the separator and held stretched without slacking. For terminal winding operation, the h-coil leads will be wound without slacking on the terminal on roundful at two locations as shown in the Figure 3.7

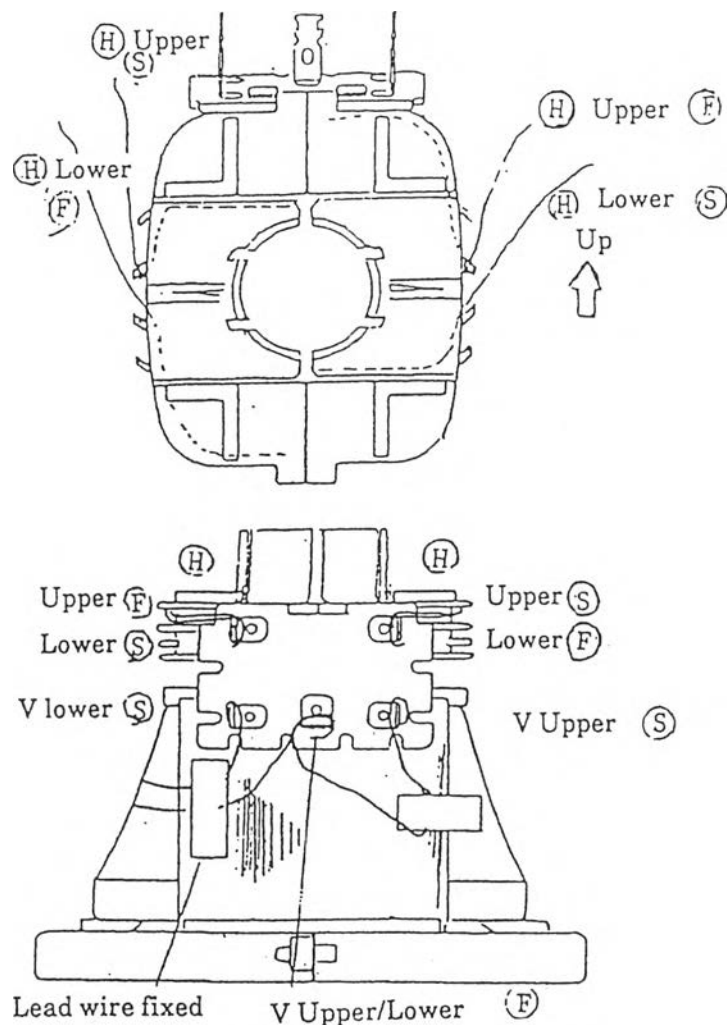


Figure 3.7: H-coil terminal winding

## 12. V-coil terminal winding

In this step, the assembly operator winds the v-coil leads on the terminal on roundful at three locations as shown in the Figure 3.7 above. After finishing terminal winding, the operator trims the excessive leads of all terminals.

## 13. Lead wire taping

This operation will be performed only *for terminal lead assembling products*. The assembly operator will bind the color lead wires with Vinyl-Tape-UL at the location shown in the Figure 3.8

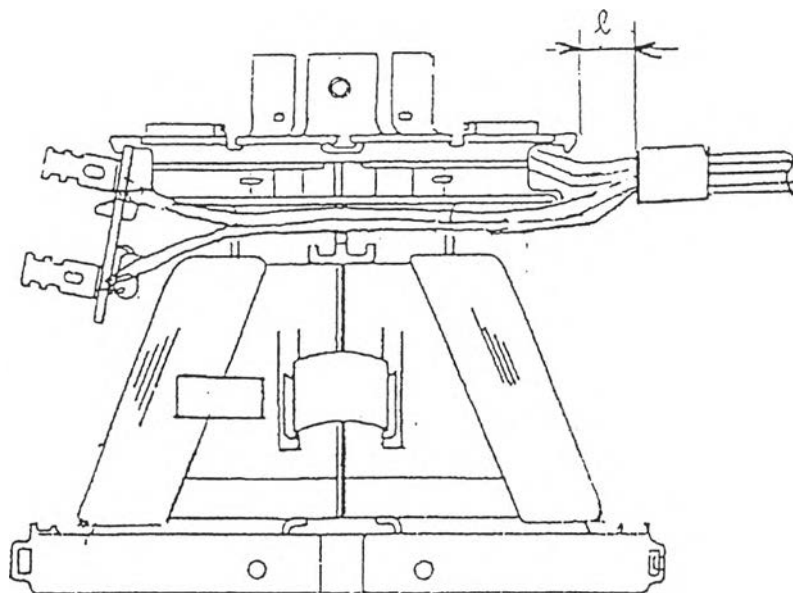


Figure3.8: Lead wire taping

#### **14. Label attaching**

In this step, label is attached on the specified location of the sub-product (DY) to identify time to produce, line to product and also group of the product.

#### **15. Soldering**

After finished terminal winding, the terminal board is soldered on five locations where the windings have been wound on the terminals. The operator will solder at least one turnful on all terminals until finish with acceptable brightness, wait until the terminals dry, and then send to the next operation.

#### **16. Check withstand voltage**

In this operation, the operator will take DY into the withstand voltage device so as to test Corona and Inductance ( $L_H$ ) of DY product. The device takes time to test approximately 8 second before signal finishing test for acceptable DY. After that the operator will take the DY off and send to further assembly in the next stage.

#### **17. Magnets assembling**

This operation is required only for product *size 20" and 21"*. In this step, the assembly operator will install the magnets to the specified positions and then coat the magnet mounting ribs with the adhesive bond. For product size 20", two magnets will be installed to positions shown in the Figure 3.9 , and, for product size 21", four magnets are required to install to positions shown in the Figure 3.10.

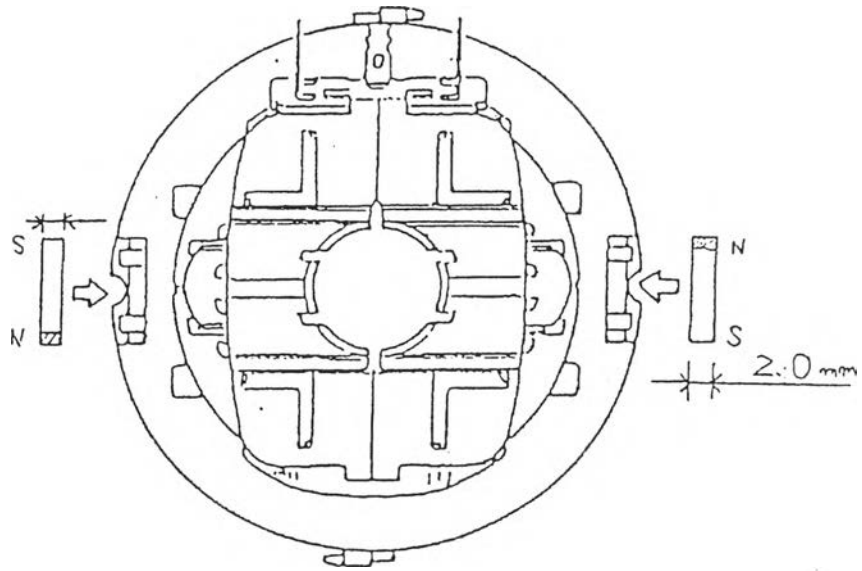


Figure3.9: Magnets assembling for DY size20”

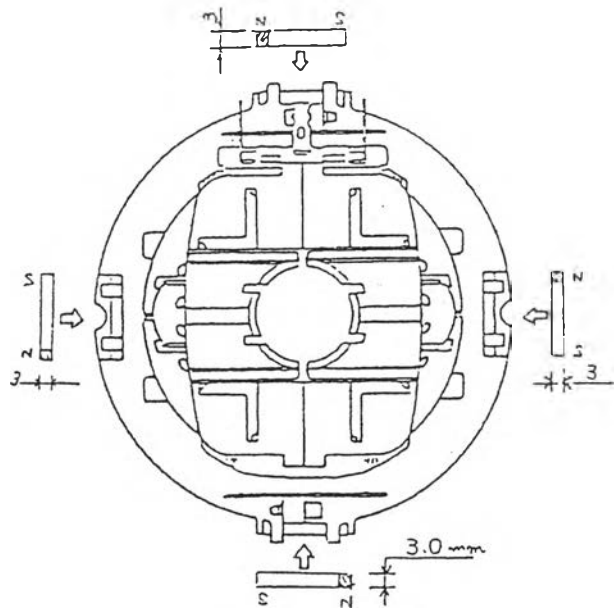


Figure3.10: Magnets assembling for DY size21”

## 18. Hot shrinking tube attaching

In the same way as lead wire taping operation, this operation will be performed *only for terminal lead assembling products*. In this step, the operator will take the heat shrinking tube cover the red lead wire side of h-coil terminal and finally shrinks it by hot air blaster.

## 19. Cross talk adjustment & hot melt fixing

In this operation, the operator will connect DY with the cross talk adjustment device and tries to adjust combined v-coil so as to make minimum cross talk output. After finished adjustment, v-coil will be fixed tentatively at two locations by hot melt adhesive.

## 20. Inspection

After DY already passed assembly process, it needs to be inspected and correct its characteristics if necessary. In this step, the inspection operator will take assembled DY on the CRT neck and also connect it to the operation tester so as to inspect its characteristics.

If its characteristics are in specification, DY will be sent further to bonding operation to do finishing works. Otherwise, the testing operator needs to take some corrections until the characteristics meet acceptable specification.

Presently, the inspection operator judges whether DY characteristics meet the acceptable specification or not by visualization. Additionally, the characteristic

corrections need skillful operators to do it correctly as well as quickly. Then, it can be said that skill of the operator is critical issue for this process.

## **21. Bonding**

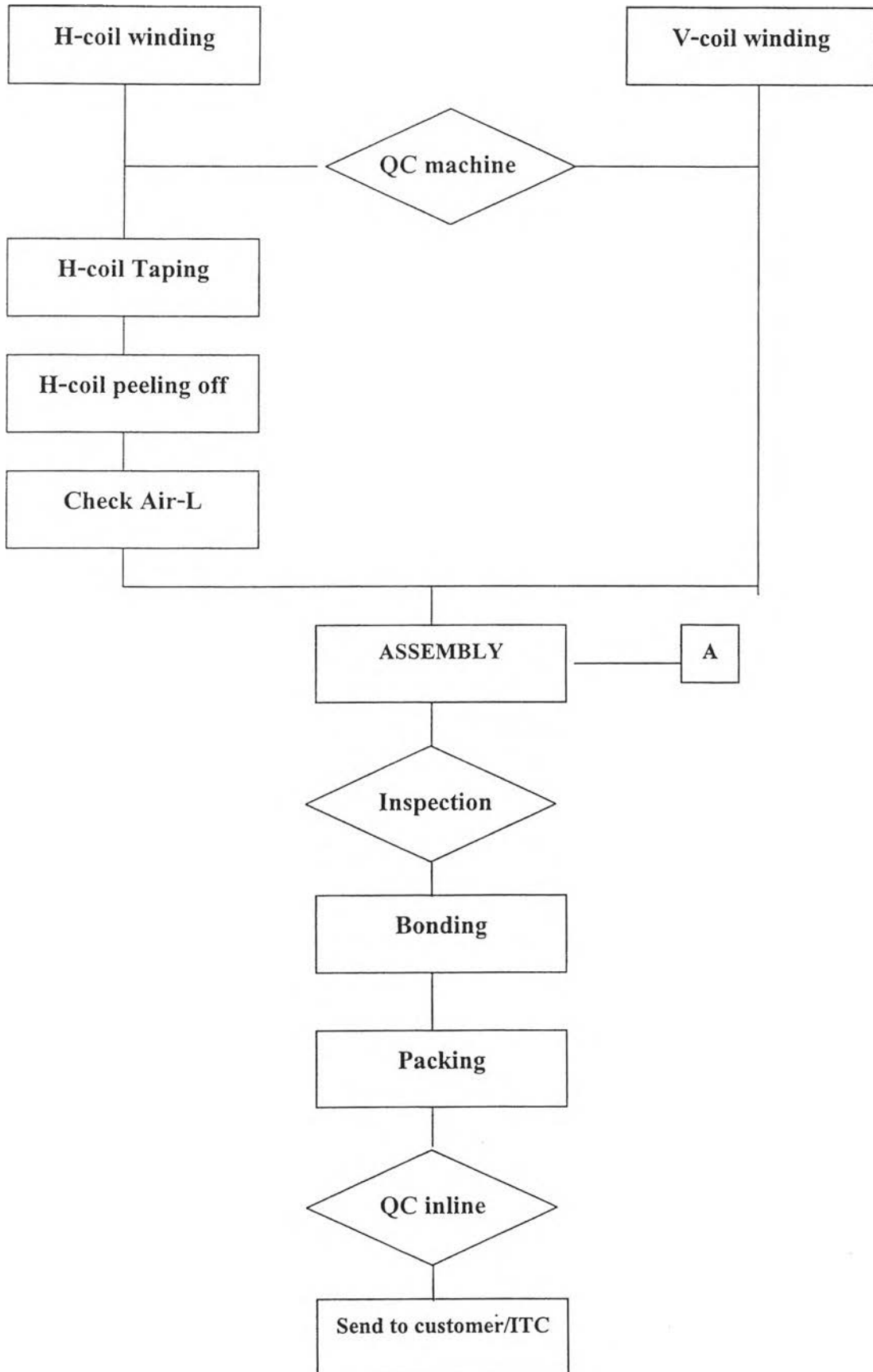
After acceptable DY products passed in the inspection successfully, they will be performed the finishing work before sent to packing. In this step, the operator performs two main tasks that are bonding some assembling and correcting material parts and also attaching tape on the specified locations. Finishing work content varies upon correcting materials performed by inspection operation and also differs between bonding for ITC and bonding for external customers.

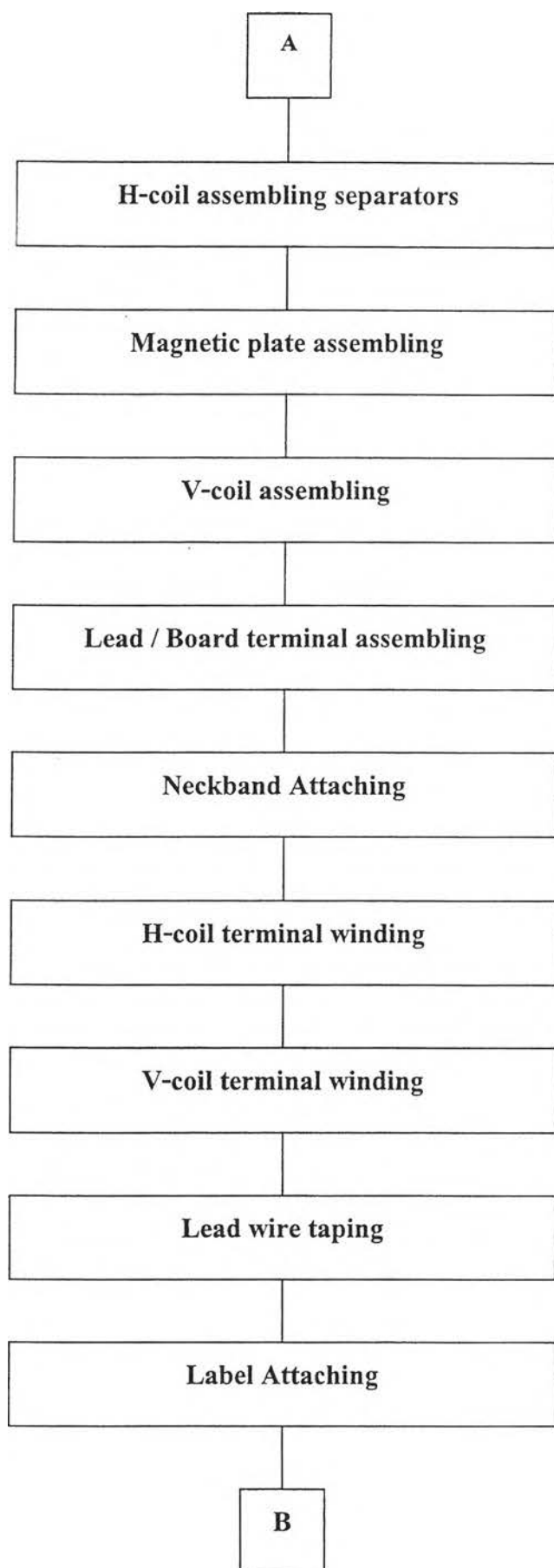
## **22. Packing**

In the same way as bonding operation, there are different work content between packing for ITC and packing for external customers. The packing operator will perform finally visual inspection, and then pack DY products into specified container. For external customer, the operator takes more time to weigh and label the sealed package.

The flow diagram of Deflection yoke process is shown in chart as Figure 3.11 and process mapping of all DY products are also illustrated in detail as shown in Appendix B

*Figure 3.11: Process Flow Diagram of Deflection Yoke*







**B**

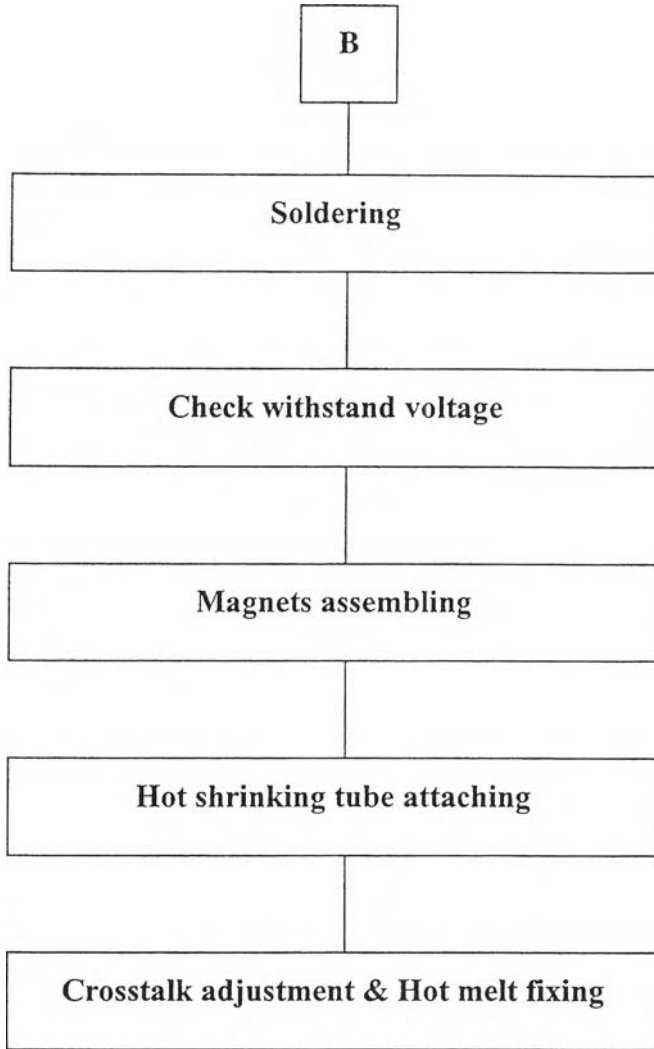
**Soldering**

**Check withstand voltage**

**Magnets assembling**

**Hot shrinking tube attaching**

**Crosstalk adjustment & Hot melt fixing**



## Current system and problem identification

After studying product description, process flow, and work elements of DY processes in detail, standard time is set by using time study which its calculation is not explained in this thesis. Additionally, all work standards are also allocated into Sequence of Event (as shown in appendix C) to identify work content required and non added value operation and movement for the purpose that review and find the way for improvement.

In defection yoke assembly process, there are two assembly lines which one line is used to produce DY 14” and the other line is used to produce DY20”&21”. As mentioned earlier, the company produces totally 70 DY models and assembly processes of each model have different total work contents depend on criteria as follows:

Processes	Criteria
1. Sub assembly	<ul style="list-style-type: none"> <li>• <b>Product size</b> which is 14”, or 20&amp;21”</li> </ul>
2. Assembly	<ul style="list-style-type: none"> <li>• <b>Product size</b> which is 14”, 20”, or 21”.</li> <li>• <b>Terminal type</b> which is terminal board, or terminal board with leads.</li> <li>• <b>Inspection process</b> which is inspection for customer or inspection for ITC.</li> </ul>

According to the current operation of the company, all DY models can be grouped based on the criteria into 12 types that have different total task time, bottleneck, and line efficiency as follows:

Table 3.1: Line efficiency of the current system

Size	Terminal type	Inspection for	Total task time (secs)		Assy Bottleneck	Daily throughput	Assy Line Eff (%)
			Subassembly	Assembly			
14"	Terminal Lead	CUS	27.32	272.40	Magnetic plate assembling	8,149	87.23%
	Terminal Brd	CUS	<b>27.32</b>	<b>258.27</b>	Inspection	<b>8,165</b>	<b>82.87%</b>
	Terminal Lead	ITC	27.32	227.30	Magnetic plate assembling	8,149	77.33%
	Terminal Brd	ITC	<b>27.32</b>	<b>213.17</b>	Withstand voltage checking	<b>8,947</b>	<b>79.63%</b>
20"	Terminal Lead	CUS	<b>39.70</b>	<b>266.57</b>	Inspection	<b>8,165</b>	<b>85.53%</b>
	Terminal Brd	CUS	39.70	256.46	Inspection	8,165	82.29%
	Terminal Lead	ITC	<b>39.70</b>	<b>221.47</b>	Withstand voltage checking	<b>9,282</b>	<b>85.83%</b>
	Terminal Brd	ITC	39.70	214.33	Withstand voltage checking	8,553	76.54%
21"	Terminal Lead	CUS	<b>39.70</b>	<b>286.04</b>	Inspection	<b>8,165</b>	<b>91.78%</b>
	Terminal Brd	CUS	39.70	271.91	Inspection	8,165	87.24%
	Terminal Lead	ITC	<b>39.70</b>	<b>239.84</b>	Magnetic plate assembling	<b>8,222</b>	<b>82.34%</b>
	Terminal Brd	ITC	39.70	221.23	Withstand voltage checking	9,127	84.30%
<b>Total</b>						<b>8,438</b>	<b>83.58%</b>

(As see detail in appendix D: DY capacity study of current system)

As shown in the Table3.1, the current system can produce DY approximately 8,400 units/ day with average 83.58% line efficiency. The bottlenecks occurred in inspection station in case of producing DY for external customer, and withstand voltage-checking station in case of producing DY for internal customer (ITC). However, the DY demands in the future are increasing to 10,000 units/ day. The company tries to reduce bottleneck problem, non added value operation and idle time to improve line efficiency and productivity for the purpose that can achieve potential demand with reasonable price.

## **Problem Identification**

### **Bottleneck problem**

For bottleneck problem at inspection workstation, it is found that an inspection operator takes different time to inspect and correct DY characteristics to meet acceptable specification level. The ranges are between 90-130 sec/ piece DY in case of producing DY for external customer, and between 40-80 sec/ piece DY in case of producing DY for ITC. The root causes of the different inspection time can be identified as follows:

- **Inconsistent quality of wound H-coils**

Because quality of wound h-coils affects directly to DY characteristic, and as explained in inspection process earlier that an inspection operator inspects, trial corrects and judges whether DY characteristics meet the acceptable specification or not by visualization. If quality of wound h-coils are inconsistent, it causes the operator take time to trial correct the characteristic differently.

- **Different matching up wound h-coils with wound v-coils**

Because one DY, that consists of specific two wound h-coils and two wound v-coils, has one characteristic, if h-coils of one h-coil winding machine match up with v-coils from different v-coil winding machine, it affects to different DY characteristic.

In current system, 60 h-coils produced by one h-coil winding machine will be assembled with 60 v-coils produced by one v-coil winding machine to be 30

assembled DY products. 30 assembled DY are equally divided and transferred to inspection operators, which are approximately 5-6 pieces/ person. When the assembly process repeats, another 5-6 pieces DY are transferred to inspection operators again. However, the latter assembled DY may have different characteristic from the former assembled DY if they come from different h-coil and v-coil winding machines. (The current system has totally 13 h-coil winding machines and 10 v-coil winding machines in the current process)

Practically, an inspection operator can use the previous DY as a guide pattern to correct the characteristic if the DY have same characteristic, however, the current way to supply assembled DY make a possibility to supply different characteristic in every 5-6 piece DY. This affects the inspection operator to not be able to use the previous DY to be a guideline to correct the characteristic, but need trial correct the different characteristics.

For bottleneck problem at withstand voltage checking workstation, it occurred because work contents are allocated inappropriately. However, after studying in detail, it found that there are different bottlenecks and idle time occurred depends on different 12 product types. Balancing line at a required capacity cannot be focused on one product type balancing, but should be mixed model balancing to achieve reduce idle time, and then improve line efficiency.

## **Non added value movement problem**

- **Non added value movement in subassembly process**

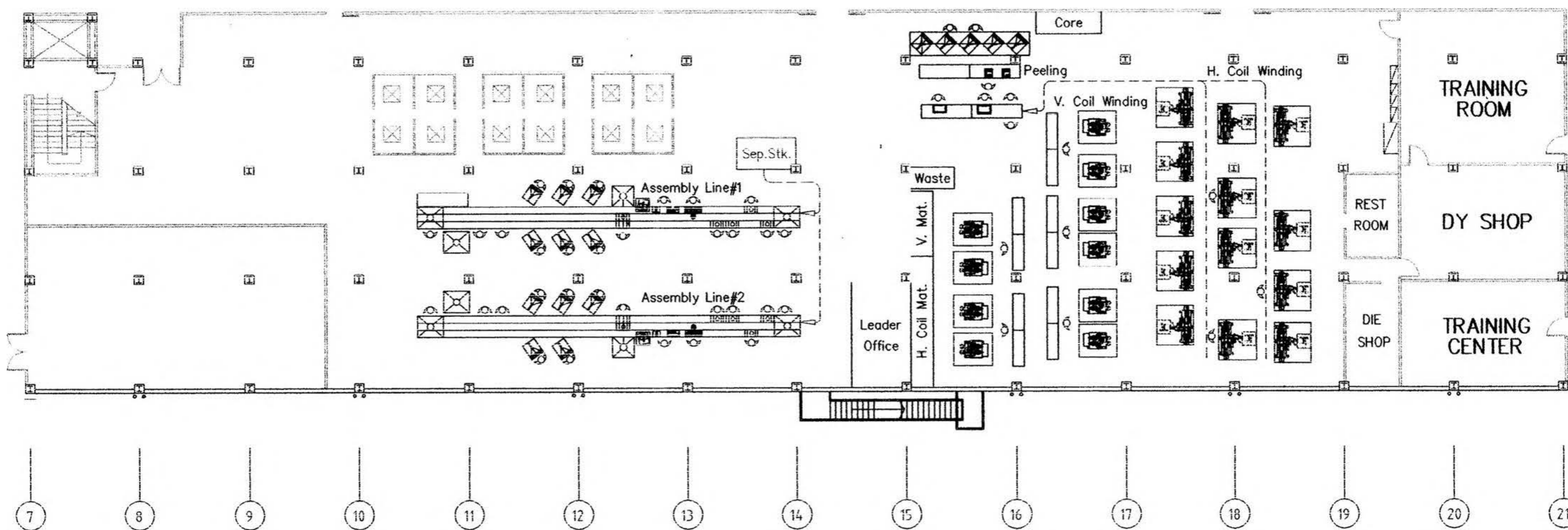
After studying work element in sub assembly process in detail, it is found that unnecessary movements are done which their proportion are 18% of total task time in

case of DY14”, and 13% of total task time in case of DY 20” and 21”. (as see detail in appendix E) Consequently, loses due to excessive movement occurred in the process. Moreover, the current sub assembly layout is not effective because peeling machines are located separately from other operation as show in the Figure 4.2 in the next chapter.

- **Non added value movement due to ineffective process layout**

Because the machines and some operations in the current process are located inappropriately and separate from the main assembly line, non-value-added movement occurred in the process. The current process layout of the company is shown below.

# Current Layout



- H-coil flow
- Sub assembly flow
- V-coil flow
- Seperator flow