CHAPTER 4

PROBLEM IDENTIFICATION AND CURRENT SITUATION ANALYSIS

The scope of the selection will focus on the transportation of the raw material since it arrive the raw material warehouse through the production and come out to the finished goods store as a finished goods. The study will concentrate on the production of HGA and HSA.

Currently, at Teparuk production sites the production of HGA and HSA are combined into one production line called HGSA production.

Figure 4-1 shows the material flow of HGSA production. In HGSA manufacturing, there are 8 stages of material handling needed. We will consider for the most appropriate system for each stage in the following parts.

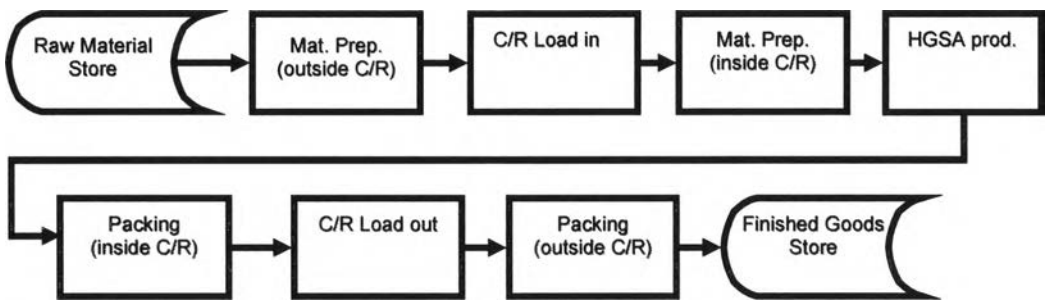

Figure 4-1: HGSA Material Flow

4.1 Material Handling System for HGSA Manufacturing

For Teparuk plant, the layout the production building is shown in figure 4-2. The warehouse is on the left side of the picture. Raw material is loaded form the raw material warehouse on the left side to the production in the middle of the picture. When the raw material is completely processed, it will be sent out to the finished goods warehouse beside the raw material warehouse on the left side. The following part will explain and find out the appropriate material handling system for each portion.

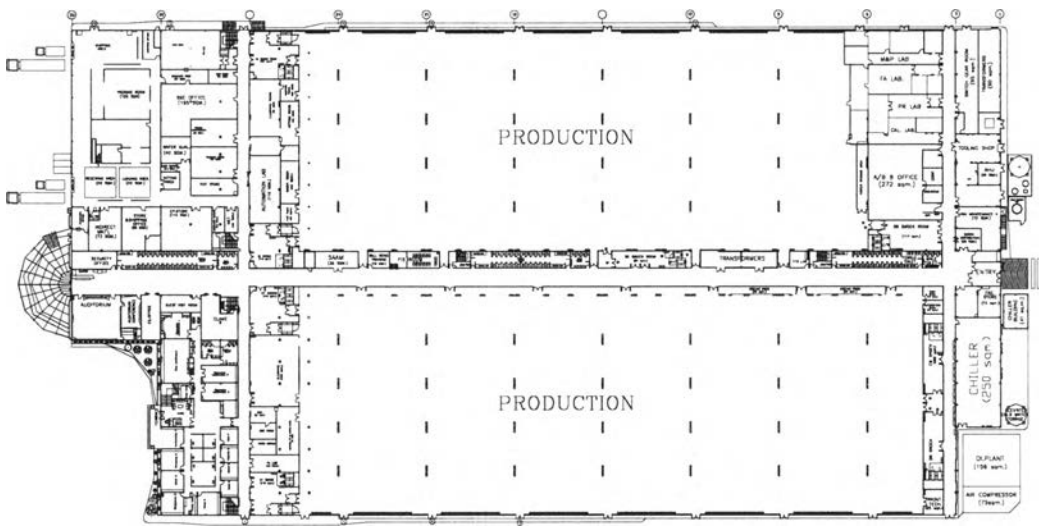

Figure 4-2: Teparuk Manufacturing Layout

Part I: From Raw Material Store to Preparation Area Outside Cleanroom

The first stage of raw material handling transfers the raw material from Raw material store to Material preparation area outside Cleanroom. The raw material will be requested on the system and operator at Raw material store (Green area in figure 4-3) will prepare the requested material on the pallet and transfer to Material preparation area (Red area in figure 4-3).

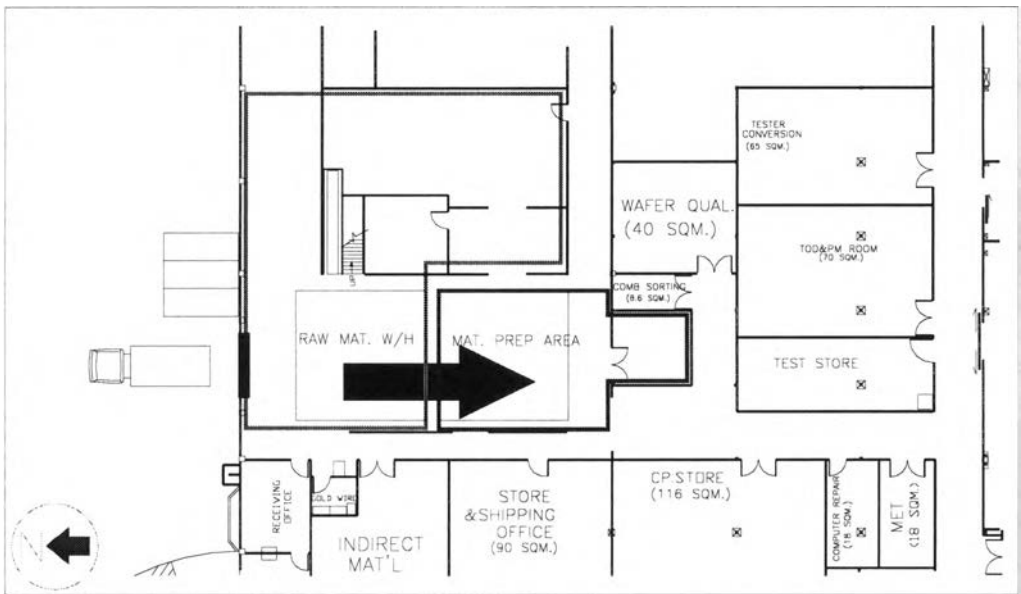

Figure 4-3: Raw Material Store to Preparation Area Outside Cleanroom

Material to be transferred: Raw Material in Carton boxes on wooden pallets (54 boxes/pallets).

Requirement (10K/day): 48 boxes/hr. (0.89 pallet of Raw material or 480 HGSA/hr.)

Average Distance: 10 meters

Existing transfer method: Hand Lift 1 set, capacity 20 pallets/hr. (Raw materials for 10,800 HGSA/hr)

System concept: Transfer raw material pallets from Raw Material warehouse to Material Preparation area.

Environment constraint: Normal Air-conditioned.

Part II: From Preparation Area Outside Cleanroom to Cleanroom Load in

The second stage of raw material handling transfers the raw material from Preparation Area Outside Cleanroom to Cleanroom Load in. At Preparation area (Green area in figure 4-4), operators cut the carton box and put the raw material out and place into tote boxes. The tote boxes will be loaded on the 4 wheels hand truck and transfer to Cleanroom Load in area (Read area in figure 4-5).

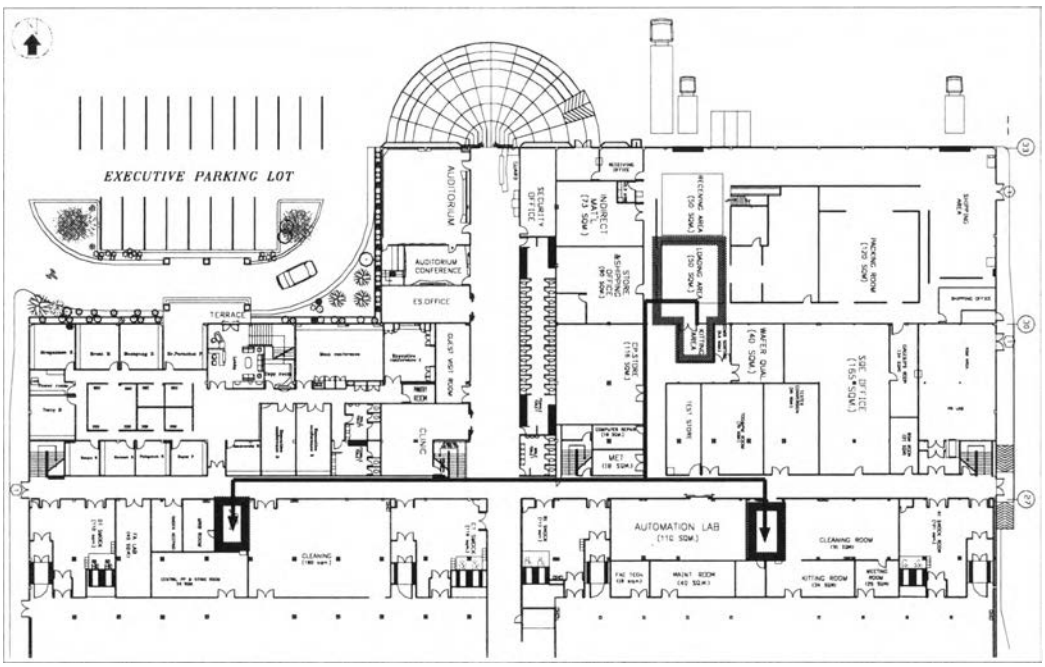

Figure 4-4: Preparation Area Outside Cleanroom to Cleanroom Load in

Material to be transferred: Raw Material in Tote boxes.

Requirement (10K/day): 48 boxes/hr.

Average Distance: 65 meters

Existing transfer method: 7 sets of four wheels hand truck, capacity 604 boxes/hr. (Raw material for 6,040 HGSA/hr)

System concept: Transfer raw material tote boxes from Material Preparation area to Cleanroom load in area.

Environment constraint: Normal Air-conditioned.

Part III: From Cleanroom Load in to Material Preparation inside Cleanroom

The third stage of raw material handling transfers the raw material from Cleanroom Load in to Material Preparation inside Cleanroom. The Cleanroom Load in area (Green area in figure 4-5) is the connection point of normal air condition environment and cleanroom environment. At this point operator loads the tote boxes onto conveyor linked between Load in area and Material preparation area inside cleanroom (Red area in figure 4-5).

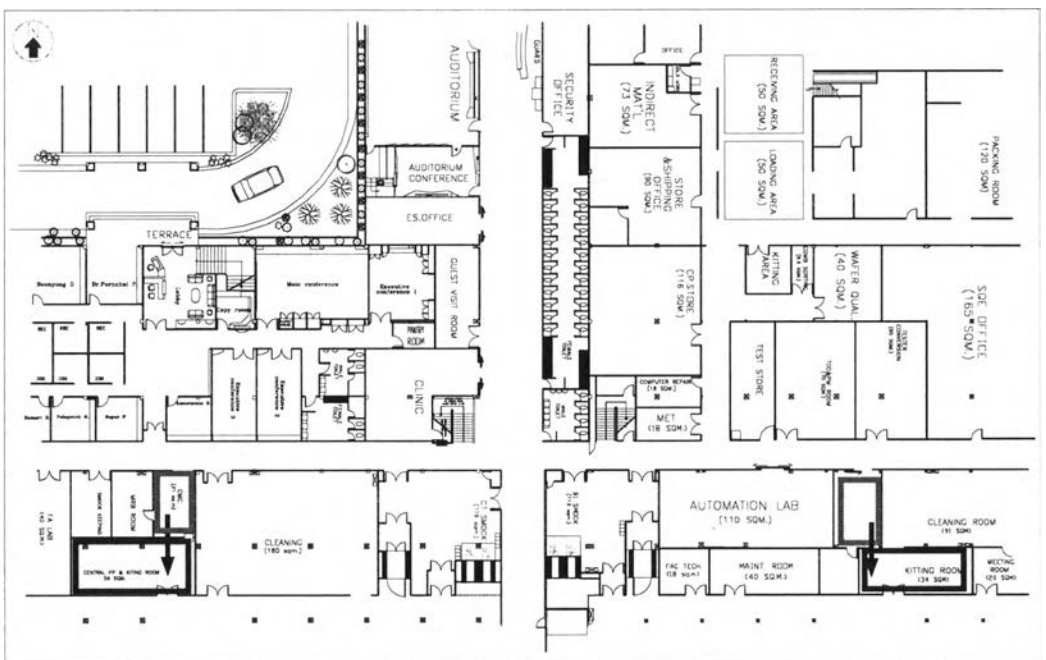

Figure 4-5: Cleanroom Load in to Material Preparation inside Cleanroom

Material to be transferred: Raw Material in Tote boxes.

Requirement (10K/day): 48 boxes/hr.

Average Distance: 5 meters

Existing transfer method: 2 lines of Polycord conveyor, capacity 1,440 boxes/hr. (Raw material for 14,400 HGSA/hr)

System concept: Transfer raw material tote boxes from Cleanroom Load in to Material Preparation inside Cleanroom.

Environment constraint: Cleanroom class 10K.

Part IV: From Material Preparation inside Cleanroom to HGSA Production

The last stage of raw material handling transfers the raw material from Material Preparation inside Cleanroom to HGSA Production. When the raw material is required, the signal will be automatically sent to Material Preparation area inside Cleanroom. The request signal will identify the line location and the requested material part number. Operator at the preparation area (Green area in figure 4-6) will prepare the material and send to the request location inside HGSA Production area (Red area in figure 4-6) by the conveyor.

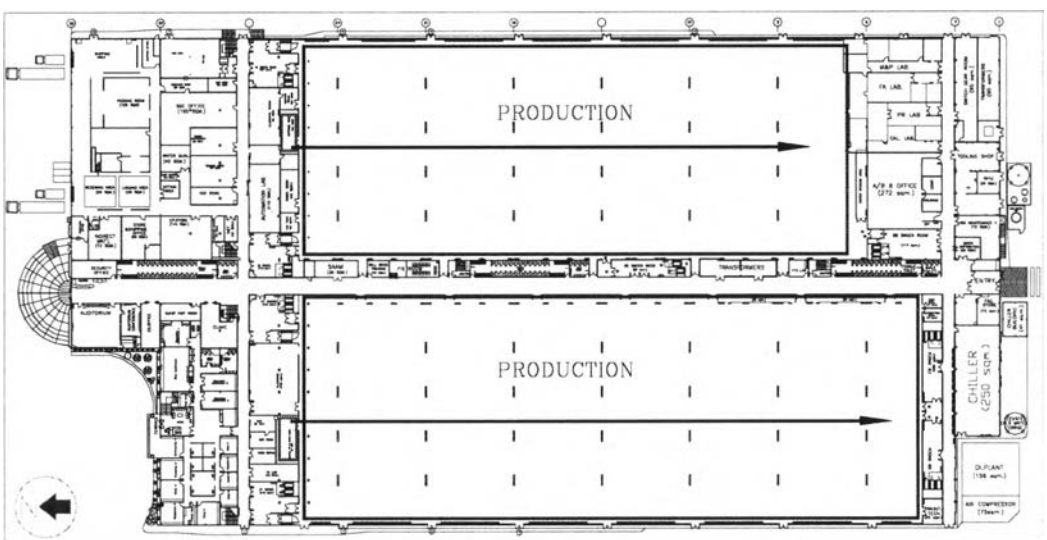

Figure 4-6: Material Preparation inside Cleanroom to HGSA Production

Material to be transferred: Raw Material in Tote boxes.

Requirement (10K/day): 48 boxes/hr.

Average Distance: 70 meters

Existing transfer method: 2 lines of Free flow conveyor, capacity 1,440 boxes/hr. (Raw material for 14,400 HGSA/hr)

System concept: Transfer raw material tote boxes from Material Preparation inside Cleanroom to HGSA Production.

Environment constraint: Cleanroom class 10K.

Part V: From HGSA Production to Packing Area inside Cleanroom

The first stage of finished goods handling transfers the finished goods from HGSA Production to Packing Area inside Cleanroom. After the raw material was completely manufactured, the HGSA finished goods will be sent from the production line (Green area in figure 4-7) to the Packing Area inside Cleanroom (Red area in figure 4-7) by conveyor, at the Packing area the finished goods will be sealed before sending out of cleanroom environment to normal air condition environment.

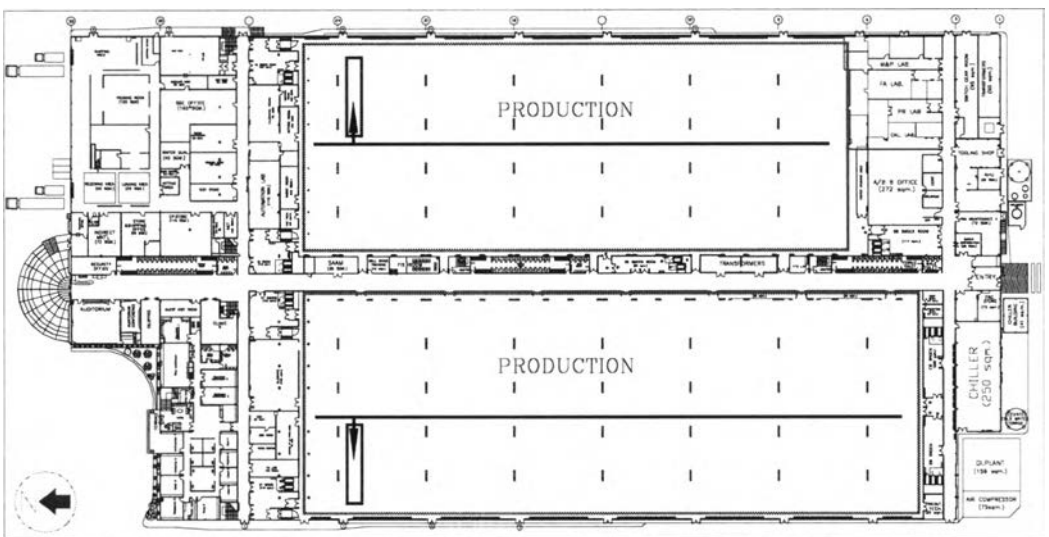

Figure 4-7: HGSA Production to Packing Area inside Cleanroom

Material to be transferred: Finished Goods in Tote boxes.

Requirement (10K/day): 14 boxes/hr.

Average Distance: 60 meters

Existing transfer method: 2 lines of Free-flow conveyor, capacity 600 boxes/hr. (21,600 HGSA/hr)

System concept: Transfer finished goods tote boxes from HGSA Production to Packing Area inside Cleanroom.

Environment constraint: Cleanroom class 10K.

Part VI: From Packing Area inside Cleanroom to Cleanroom Load out

The second stage of finished goods handling transfers the finished goods from Packing Area inside Cleanroom to Cleanroom Load out. At the Packing Area inside Cleanroom (Green area in figure 4-8), the sealed finished goods will be loaded onto conveyor and sent to Cleanroom Load out area (Red area in figure 4-8) linked cleanroom environment and normal air condition environment.

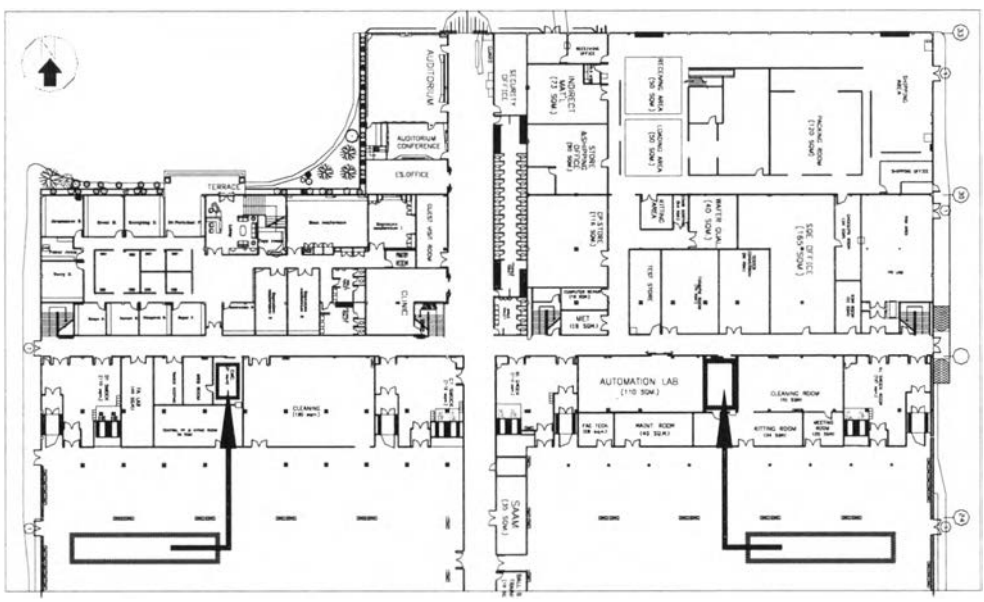

Figure 4-8: Packing Area inside Cleanroom to Cleanroom Load out area

Material to be transferred: Finished Goods in Tote boxes.

Requirement (10K/day): 14 boxes/hr.

Average Distance: 25 meters

Existing transfer method: 2 lines of Polycord conveyor, capacity 600 boxes/hr. (21,600 HGSA/hr)

System concept: Transfer finished goods tote boxes from Packing Area inside Cleanroom to Cleanroom Load out area.

Environment constraint: Cleanroom class 10K.

Part VII: From Cleanroom Load out area to Packing Area outside Cleanroom

The third stage of finished goods handling transfers the finished goods from Cleanroom Load out area to Packing Area outside Cleanroom. The packed finished goods sent out of cleanroom will be load on 4 wheels hand truck at Cleanroom Load out area (Green area in figure 4- 9) and be transferred to Packing area outside Cleanroom (Red area in figure 4-9) and will be packed into carton box at this location.

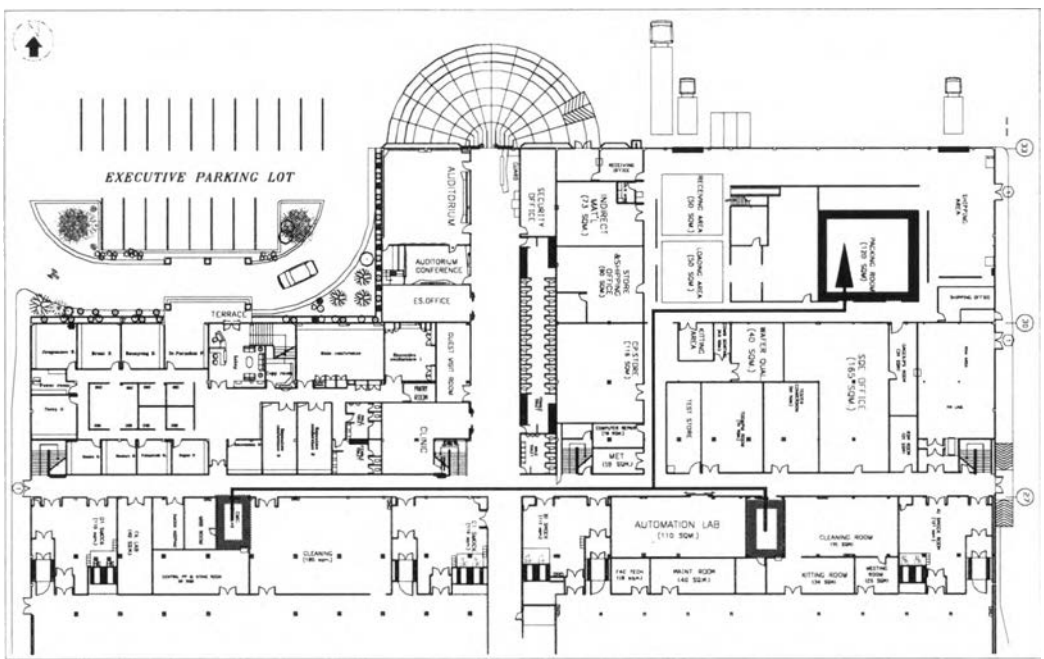

Figure 4-9: Cleanroom Load out area to Packing Area outside Cleanroom

Material to be transferred: Finished Goods in Tote boxes.

Requirement (10K/day): 14 boxes/hr.

Average Distance: 90 meters

Existing transfer method: 3 sets of four wheels hand truck, capacity 216 boxes/hr. (7,776 HGSA/hr)

System concept: Transfer finished goods tote boxes from Cleanroom Load out area to Packing Area outside Cleanroom.

Environment constraint: Normal Air-conditioned.

Part VIII: From Packing Area outside Cleanroom to Finished Goods Store

The last stage of finished goods handling transfers the finished goods from Packing Area outside Cleanroom to Finished Goods Store. The packed carton boxes will be loaded onto pallet, wrapped and transferred from Packing area outside Cleanroom (Green area in figure 4-10) to Finished Goods Store (Red area in figure 4-10) waiting for shipment.

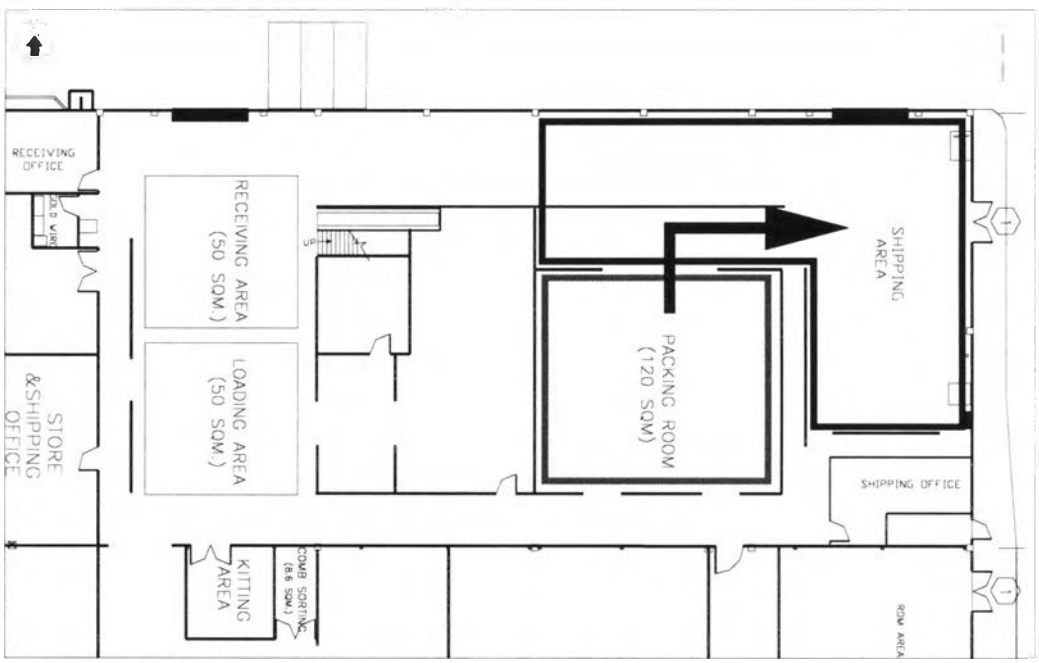

Figure 4-10: Packing Area outside Cleanroom to Finished Goods Store

Material to be transferred: Finished Goods in Carton boxes on wooden pallets (54 boxes/pallets).

Requirement (10K/day): 14 boxes/hr. (0.26 pallet or 504 HGSA/hr.)

Average Distance: 10 meters

Existing transfer method: Hand Lift 1 set, capacity 20 pallets/hr. (38,880 HGSA/hr)

System concept: Transfer finished goods pallets from Packing Area outside Cleanroom to Finished Goods Store.

Environment constraint: Normal Air-conditioned.

4.2 State of nature and Selection criteria

In this study the state of nature of manufacturing operation is the production volume. It can reflect the requirement of the material handling system because each system configuration can be matched only some range of production volume.

4.2.1 Addressing Selection Criteria (Using Critical Success Factor)

For HGSA manufacturing, the material handling system must be carefully selected. Therefore, the selection criteria should be precisely chosen. We use critical success factor as a base on selection criteria addressing.

4.2.1.1 Mission statement: Provide the most appropriate Material handling for each step of Teparuk plant material handling system.

4.2.1.2 Goal from top level: first level; provide the most effective system, second level; provide the system that conforms to the product and production environment requirement.

Since there are a number of material handling systems available in the market, In order to come up with the appropriate selection criteria, the following basic requirements to meet the second level goal must be taken into account.

- Capacity of the transfer system.
- Product delicacy.
- Environment of handling.
- Building construction constraint.
- Safety of the system.

Other than the stated requirement, we need to have the other selection criteria to compare the systems that can meet the basic requirement. The selection criteria must meet the first level requirement that reflect to the performance and

value of the handling system. The criteria that can indicate the profit the handling system are:

- Space occupied
- Utility consumption
- Investment
- Level of Work in process
- System maintenance requirement
- Labor required

For the selection criteria, to compare the proposed system, we use handling cost per unit built to make decision on the system selection. The handling cost per unit can be calculated from the stated selection criteria; occupied space, impacted space, facility cost, investment, scrap cost, WIP (work in process), maintenance cost, and labor cost. The cost per unit from each particular system will be different depending on the production volume.

For Teparuk operation, each proposed material handling system will consist of eight steps of handling stage start from raw material warehouse and finish at finished goods store as described in the previous part. In order to select the handling system for Teparuk plant, each alternative system will be compared at each level of the state of nature.

4.2.2 Condition of State of nature of the system

As stated in the previous part, the production volume build can suggest the requirement of the material handling system. At studied site, currently, the production of HGSA is in the transition phase of manual production to automation production.

In the past, the manual production can produce HGSA to the maximum capacity of 90K units per day while the machine of the automation production can increase the production rate of HGSA to the maximum capacity of 250K units per day.

With the existing material handling configuration, the handling cost per unit built can be calculated as in the following detail:

1. From Raw Material Store to Preparation Area Outside Cleanroom.

Existing system: Hand lift truck.

Quantity: 1 set.

Max. Capacity support: 226.8 K units/day.

Handling cost

Occupied floor space: 2 sq.m. ($15/sq.m./month)	$1.15 /day
Facility cost:	$0.00 /day
Investment: $375 (12 months)	$1.20 /day
WIP: 54 boxes of raw material (540 HGSA)	$10.38 /day
Maintenance cost: $5/year	$0.02 /day
Labor cost: $250/month	$9.62 /day
Part 1 Total Handling cost	**$22.37 /day**
Handling cost based on volume build:	
- 50 K units/day	$0.00045 /unit
- 100 K units/day	$0.00022 /unit
- 150 K units/day	$0.00015 /unit
- 200 K units/day	$0.00011 /unit
- 250 K units/day	Cannot support

2. From Preparation Area Outside Cleanroom to Cleanroom Load in.

Existing system: four wheels hand truck.

Quantity: 7 sets.

Max. Capacity support: 126.8 K units/day.

Handling cost

Occupied floor space: 37 sq.m. ($15/sq.m./month)	$28.85 /day
Facility cost:	$0.00 /day
Investment: $2,100 (12 months)	$6.73 /day
WIP: 96 boxes of raw material (960 HGSA)	$18.46 /day
Maintenance cost: $35/year	$0.11 /day
Labor cost: $750/month	$28.85 /day
Part 2 Total Handling cost	**$83.00 /day**

Handling cost based on volume build:

- 50 K units/day	$0.00166 /unit
- 100 K units/day	$0.00083 /unit
- 150 K units/day	Cannot support
- 200 K units/day	Cannot support
- 250 K units/day	Cannot support

3. From Cleanroom Load in to Material Preparation inside Cleanroom.

Existing system: Polycord conveyor.

Quantity: 2 lines.

Max. Capacity support: 302.4 K units/day.

Handling cost

Occupied floor space: 10 sq.m. ($15/sq.m./month)	$5.77 /day
Facility cost:	$0.29 /day
Investment: $25K (60 months)	$16.03 /day
WIP: 4 boxes of raw material (40 HGSA)	$0.77 /day
Maintenance cost: $250/year	$0.80 /day
Labor cost: $250/month	$9.62 /day
Part 3 Total Handling cost	**$33.27 /day**

Handling cost based on volume build:

- 50 K units/day	$0.00067 /unit
- 100 K units/day	$0.00033 /unit
- 150 K units/day	$0.00022 /unit
- 200 K units/day	$0.00017 /unit
- 250 K units/day	$0.00013 /unit

4. From Material Preparation inside Cleanroom to HGSA Production.

Existing system: Free flow conveyor.

Quantity: 2 lines.

Max. Capacity support: 302.4 K units/day.

Handling cost

Occupied floor space: 140 sq.m. ($15/sq.m./month)	$80.77 /day
Facility cost:	$4.04 /day
Investment: $350K (60 months)	$224.36 /day
WIP: 32 boxes of raw material (320 HGSA)	$6.15 /day
Maintenance cost: $3.5K/year	$11.22 /day
Labor cost: $500/month	$19.23 /day
Part 4 Total Handling cost	**$345.77 /day**

Handling cost based on volume build:

- 50 K units/day	$0.00692 /unit
- 100 K units/day	$0.00346 /unit
- 150 K units/day	$0.00231 /unit
- 200 K units/day	$0.00173 /unit
- 250 K units/day	$0.00138 /unit

5. From HGSA Production to Packing Area inside Cleanroom.

Existing system: Free flow conveyor.

Quantity: 2 lines.

Max. Capacity support: 453.6 K units/day.

Handling cost

Occupied floor space: 120 sq.m. ($15/sq.m./month)	$69.23 /day
Facility cost:	$3.46 /day
Investment: $300K (60 months)	$192.31 /day
WIP: 4 boxes of HGSA finished goods (144 HGSA)	$27.69 /day
Maintenance cost: $3K/year	$9.62 /day
Labor cost: $500/month	$19.23 /day
Part 5 Total Handling cost	**$321.54 /day**

Handling cost based on volume build:

- 50 K units/day	$0.00643 /unit
- 100 K units/day	$0.00322 /unit
- 150 K units/day	$0.00214 /unit
- 200 K units/day	$0.00161 /unit
- 250 K units/day	$0.00129 /unit

6. From Packing Area inside Cleanroom to Cleanroom Load out.

Existing system: Polycord conveyor.

Quantity: 2 lines.

Max. Capacity support: 453.6 K units/day.

Handling cost

Occupied floor space: 50 sq.m. ($15/sq.m./month)	$28.85 /day
Facility cost:	$1.44 /day
Investment: $125K (60 months)	$80.13 /day
WIP: 4 boxes of HGSA finished goods (144 HGSA)	$27.69 /day
Maintenance cost: $1.25K/year	$4.01 /day
Labor cost: $250/month	$9.62 /day
Part 6 Total Handling cost	**$151.73 /day**

Handling cost based on volume build:

- 50 K units/day	$0.00303 /unit
- 100 K units/day	$0.00152 /unit
- 150 K units/day	$0.00101 /unit
- 200 K units/day	$0.00076 /unit
- 250 K units/day	$0.00061 /unit

7. From Cleanroom Load out area to Packing area outside Cleanroom.

Existing system: four wheels hand truck.

Quantity: 3 sets.

Max. Capacity support: 163.3 K units/day.

Handling cost

Occupied floor space: 17 sq.m. ($15/sq.m./month)	$9.81 /day
Facility cost:	$0.00 /day
Investment: $900 (12 months)	$2.88 /day
WIP: 48 boxes of HGSA finished goods (1,728 HGS	$332.31 /day
Maintenance cost: $21/year	$0.07 /day
Labor cost: $500/month	$19.23 /day
Part 7 Total Handling cost	**$364.30 /day**

Handling cost based on volume build:

- 50 K units/day	$0.00729 /unit
- 100 K units/day	$0.00364 /unit
- 150 K units/day	$0.00243 /unit
- 200 K units/day	Cannot support
- 250 K units/day	Cannot support

8. From Packing area outside Cleanroom to Finished Goods Store.

Existing system: Hand Lift truck.

Quantity: 1 set.

Max. Capacity support: 816.5 K units/day.

Handling cost

Occupied floor space: 2 sq.m. ($15/sq.m./month)	$1.15 /day
Facility cost:	$0.00 /day
Investment: $375 (12 months)	$1.20 /day
WIP: 54 boxes of HGSA finished goods (1,944 HGSA)	$373.85 /day
Maintenance cost: $5/year	$0.02 /day
Labor cost: $250/month	$9.62 /day
Part 8 Total Handling cost	**$385.83 /day**

Handling cost based on volume build:

- 50 K units/day	$0.00772 /unit
- 100 K units/day	$0.00386 /unit
- 150 K units/day	$0.00257 /unit
- 200 K units/day	$0.00193 /unit
- 250 K units/day	$0.00154 /unit

From the information above, with the existing material handling system, the maximum production volume of Teparuk plant is at 126.8K units per day. The limited capacity is caused by the weakest part of the current material handling system, 4 wheels hand truck transferring HGSA raw material from material preparation area outside cleanroom to cleanroom load in area.

Moreover, many parts of the existing system cannot support the maximum production capacity of the production at 250K units per day. That means the current material handling cannot support the production capacity if the production line is completely changed to automation production that has the maximum capacity at 250K units per day. The limitation in production amount will be caused by the material handling system.

In order to prevent the production capacity constraint caused by existing material handling system, we need to look for the approach either to modify the current system or put in the new system to prevent the declared trouble.

In the next chapter, we will discuss about the other alternatives of the material handling system that can match each step of the material carrying. The proposed systems will be consisted of various systems that can support the required capacity. Moreover, the information will include the handling cost per unit built of the proposed system that is the important part in system selection decision.