Department of Land Transport
Ministry of Transport

Cold chain quality standard for truck operation (Q Cold Chain)

Second Edition

Abstract

Currently, food loss is recognized as a global issue, which greatly incurs economic, social and ecological loss. Therefore, cold chain is an important topic in managing the logistics and value chain of agri-food in national and international market places. Specifically, effective cold chain can improve the produce quality and the revenues of farmers and sellers. It also adds values to and support the development of the Thai agriculture and food sectors.

According to the report from the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, 30 per cent of the food loss in Thailand is due to ineffective transport and storage, such as non-hygeinic storage at an inappropriate temperature. Besides cuasing the damage to the produce, it could be harmful to consumers. Hence, the transport that meets the international standard quality level is critical to the development of the logistic industy, particularly the transport, in Thailand.

Consequently, the Department of Land Transport (DLT) has acknowledged the importance of supporting and developing the national agri-food transport. DLT has engaged with the development of Cold chain quality standard for truck operation (Q Cold Chain), which is instrumental for transport operators to enhance their potentials in agri-food transport at the international standard level. To effectively enhance their understanding and ability to transport agri-food, DLT has developed the Q Cold Chain manual to prepare the transport operators for the Q Cold Chain application from DLT.

DLT sincerely hopes that the agri-food transport operators will appreciate the significant benefits of the Q Cold Chain, and work together in improving Thai agri-food transport to meet the international standard level.

Freight Transport Bureau,
Department of Land Transport

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Introduction

Agriculture and food industry is crucial for driving Thai economics and society. The government has thus envisaged Thailand to become "Kitchen of the World" and "World Fruit Capital". However, the industry is facing several challenges; particularly, the quality of the produce does not meet the standards on freshness and contamination. The reasons include, for example, inappropriate product arrangement during consignment, delay in transport, transport condition inappropriate for controlling the produce quality due to the ineffective temperature controlling system and information flow between a consignee and a consignor. The result is a reduced shelf life. Therefore, Quality service standards for transport is instrumental in keeping the produce quality, necessitating cold chain management to enhance and support the competitiveness of the logistics management in agri-food transport. The standards will increase the values of agri-food, whilst responding to the needs for quality and safety of customers and consumers.

Quality Service Standard for Truck Operation (Q Mark) and Cold Chain Quality Standard for Truck Operation (Q Cold Chain) will bring the country's transport operation up to standard. They will support the product safety and quality control, which will improve the performance and offer an opportunity for sustainable competitiveness in cold chain businesses.

Definitions

The definition of terms in Cold Chain Quality Standard for Truck Operation is:

- "Cold Chain Quality Standard for Truck Operation (Q Cold Chain)" represents Cold Chain Quality Standard for agri-food truck operation according to the annex of the announcement of Department of Land Transport on accrediting Q Cold Chain B.E. 2562 (2019)
    - **"Agri-food"** refers to agricultural and food produce (Figure 1.1), classified according to the temperature control as follows:
    - Fresh vegetables and fruits stored at (0)°C – (15)°C
    - Chilled food stored at (0)°C – (8)°C (Note that the temperature for ready-to-eat products should not be more than (5) °C)
    - Frozen food stored at (-18)°C or lower

    Source: *Thailand Supply Chain Management Professionals (TSCMP) and the interviews with relevant figures in cold chain industry in Thailand*

Figure 1.1 Examples of temperature-controlled agri-food

- “**Temperature-controlled truck**” refers to the truck that transports livestocks and goods, in accordance with the Land Transport ACT, equipped with a cooling unit to control the temperature. It must have the fundamental components of a refrigerated truck as shown in Figure 1.2 and 1.3

Figure 1.2 Example of a temperature-controlled truck

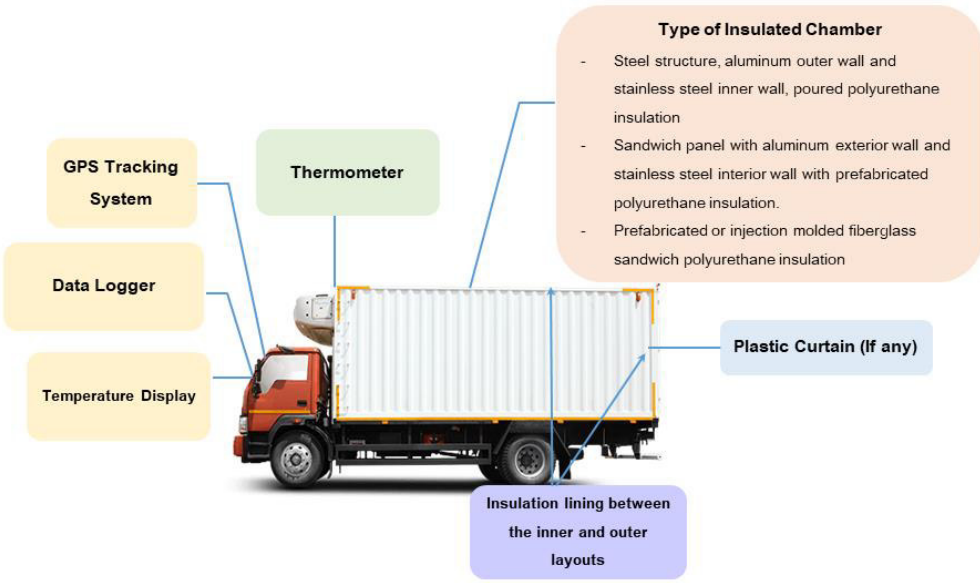


Figure 1.3 Fundamental components of a refrigerated truck

2

Cold Chain Quality Standard for Truck Operation

2.1 Concept

Cold Chain Quality Standard for Truck Operation (Q Cold Chain) aims to enhance and improve the effectiveness of Thailand's agri-food transport system to meet the international standard. Q Cold Chain will enhance the performance of Thai transporters in customer service to compete at an international level. It will also implant the stability and safety for Thailand's food, which is in line with the opportunity and growth in trading and exporting Thailand's agri-food in the future.

Q Cold Chain is the standard developed further from Q Mark. The regulations address 4 aspects, including 1) transport operation, 2) cleanliness, 3) refrigerated truck standard and maintenance, and 4) human resource development (Figure 2.1)

Figure 2.1 Q Cold Chain Requirements

2.2 Benefits

Following the requirements of Q Cold Chain will benefit transport operators and relevant parties in the agri-food industry thoughout the value chains, namely farmers, merchants, transport operators, traders and exporters, and consumers (Figure 2.2)

Figure 2.2 Beneftis from following Q Cold Chain standard

2.3 Statutory Rights and Development Guideline

Transport operators who get Q Cold Chain accreditation will get the statutory rights (figures 2.3) as follows:

1) Receive the symbol as specified by Department of Land Transport as in the pictures below

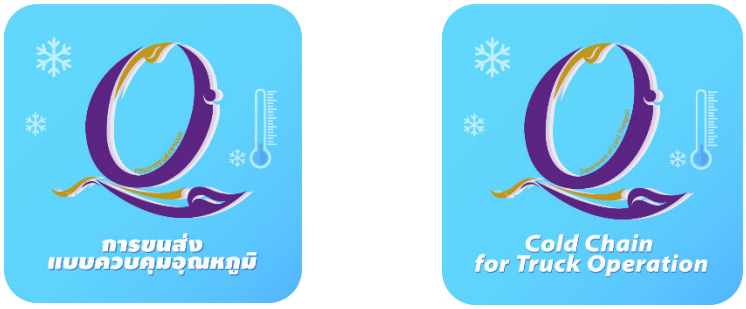


Figure 2.3 Examples of the symbols of Q Cold Chain standard

2) Promoting the organization through www.thaitruckcenter.com/tdsc and printed media related to Department of Land Transport
3) Receiving news about Q Cold Chain services from Department of Land Transport
4) Attending seminars or workshop organized by Department of Land Transport to enhance the transport performance

In particular, Department of Land Transport aims to improve and enhance the performance of agri-food transport of Thailand through cold chain management so as to raise its competitiveness inside and outside the country. As a result, Thai transport operators will reap the benefits in the future (Fiture 2.4) as follows:

1) Enrolled on Q Cold Chain Management Information System developed by Department of Land Transport - a platform to link trading opportunities between consignees and consignors.
2) Be a member of the cold chain network among operators and different stakeholders, namely manufacturers, warehouses, and distributors. The network will facilitate an integral system in agri-food logistic management. For example, the network will match consigness and consignors, as well as yielding an opportunity for cost reduction of backhauling

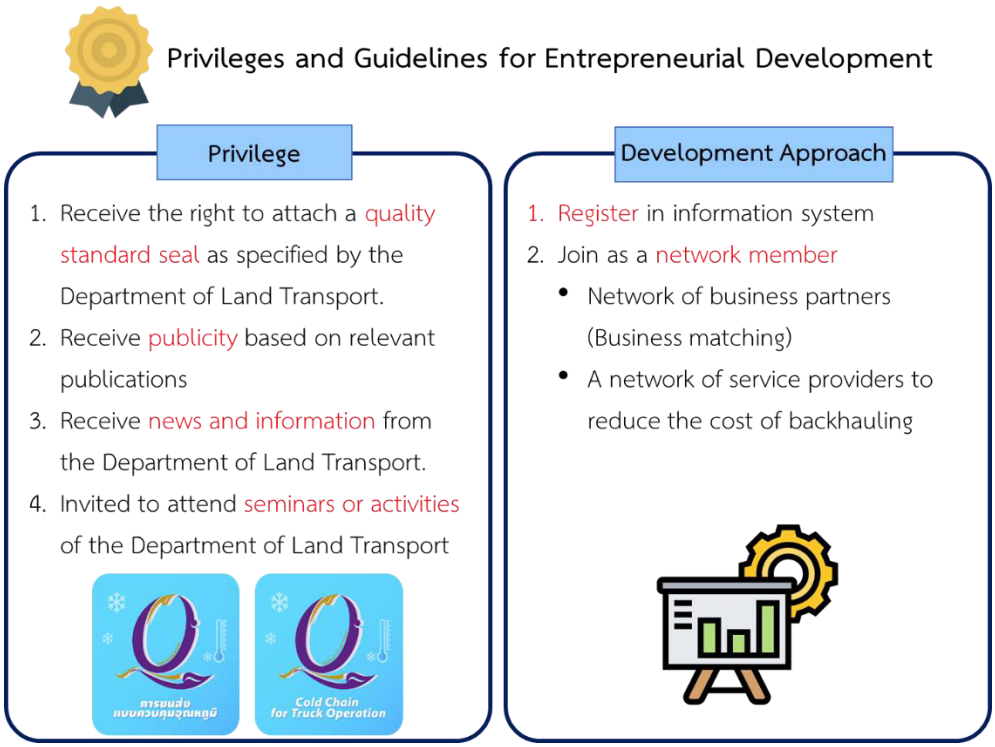


Figure 2.4 Statutory Rights and Development guideline for transport operators

3

Regulations and Evaluation Guideline

Four aspects of Q Cold Chain regulations include: 1) transport operation, 2) cleanliness, 3) refrigerated truck standard and maintenance, and 4) human resource development. In total, it has 10 regulations (Figure 3.1)

Figure 3.1 Aspects of Q Cold Chain Standard for agri-food transport

3.1 Transport Operation

No.	Requirements	Evaluation Guideline
1.1	Transport operators evaluate their competence and readiness prior to employment	• Transport operator can present the business management structure about their own trucks and joint-venture trucks (type and number) to demonstrate the overall organisation structure. • Transport operator must have evidence that shows the method and the process of preparation and readiness self-assessment before consignment to ensure that they can transport goods as required by the client. For example, contact and email correspondence, minutes of meeting checklist or self-evaluation form. This could include the following: 1) Type and amount of goods including its specification and condition such as goods storage duration before delivery 2) Temperature range and/or humidity during transportation 3) Temperature logging technology during transportation 4) Type of truck and capacity in transportation 5) Packaging used during transportation 6) Insurance and warranty limit 7) Transport type (Single goods or Mixed-goods transport) and relevant person who is responsible for loading and unloading goods 8) Knowledge and ability of staff from the point of origin to the destination 9) Coordination plan between the company and relevant parties (if any) prior to the consignment • In case of regular customers, truck operator must show the method they will use to track and assess their current transport requirement to satisfy any changes in the future.

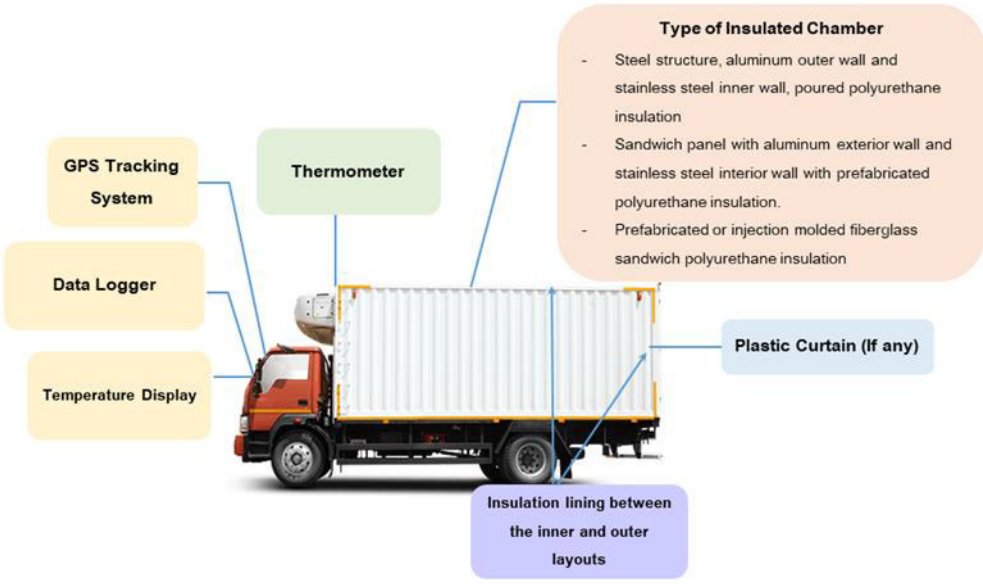
No.	Requirements	Evaluation Guideline
1.2	Transport operators have an operation manual, which specifies the overview and relations of key processes related to goods transport from order taking to delivery	• An operation manual for agriculture goods and foods transportation by refrigerated trucks, covering logistic issue such as 1) Truck and refrigerated chamber check before taking goods 2) Pre-cooling method 3) Temperature control method during transport 4) Transporting goods with cooling materials and validating their effectiveness in controlling temperature (in case of transportation with cooling materials) 5) Goods arrangement and loading-unloading method 6) Temperature logging method during transport 7) Goods pick-up and delivery method 8) Evaluation of the condition and cleanliness of reefer container before transportation (for reefer container operator)
1.3	Transport operators have an emergency plan and emergency handling procedures in case that the refrigerated truck or cooling units malfunctions during transport. Also, each incident is recorded and promptly reported to relevant parties to prevent any reoccurrence.	• Plan and readiness preparation for any emergency incident such as 1) Arrange a mobile service unit 2) List of a relevant operator network such as cooling unit service providers, refrigerated truck operator, and correspondence information such as contact number or other suitable platforms. • Specify the process for emergency management with a clear scope of preliminary solution ability, including required time for solving the problem. • Record each unusual incident with problem identification and solution guideline when refrigerated trucks or cooling units break down. • Providing to relevant persons training on preliminary emergency planning and management (evidence of training in accordance with 4.1 must be present)

3.2 Cleanliness

No.	Requirements	Evaluation Guideline
2.1	Cleaning inside the refrigerated chamber and its components appropriately and regularly	● Specify the method of cleaning inside a refrigerated chamber ● Train the method of cleaning inside a refrigerated chamber to relevant parties (provide training evidence in accordance to 4.1) ● Record the investigation check of the refrigerated chamber after cleaning ● Randomly check cleanliness inside the refrigerated chamber such as floor, wall, draining pipe and plastic curtain ● A reefer container operator, must proceed and provide evidence as follow: ○ Training drivers about document and reefer container condition check before delivery such as Equipment Interchange Receipt (EIR) (provide training evidence in accordance to 4.1) ○ Evidence showing reefer container condition check before delivery such as Equipment Interchange Receipt (EIR)
2.2	Disinfectants used inside a cooling unit must be hygienic and safe for goods and consumers.	● Specify the type of cleaning agents used inside a refrigerated chamber, which is safe to goods and consumers, and leaves no odor residuals, according to Food and Drug Administration (FDA), Thailand ● A reefer container operator must provide guideline about cleaning inside a refrigerated chamber to ensure that the operator has knowledge and understanding of, and pay attention to cleanliness. The guideline should include: 1) Cleaning method 2) Example of cleaning agents that is safe to goods and consumers (The guideline can be stated inside an operation manual in accordance to 1.2)

3.3 Regrigerated Truck Standard and Maintenance

No.	Requirements	Evaluation Guideline
3.1	Installation and appraisal of temperature loggers that are appropriate for temperature controlling inside a refrigerated chamber	• Randomly check refrigerated trucks, considering the following items: 1) A refrigerated chamber (inside) 2) A cooling unit 3) Inside-chamber temperature display 4) Plastic curtain (if any) 5) Etc. • Randomly check the temperature logging devices installed inside a refrigerated chamber such as 1) GPS 2) Data Logger (Temperature and/or relative humidity) 3) RFID (Radio Frequency Identification) • Record the temperature during transportation. The data recorded from GPS can be used as evidence.



No.	Requirements	Evaluation Guideline
3.2	A plan and report of the maintenance of cooling unit and temperature measuring and logging devices to ensure its effectiveness in controlling the temperature.	● A preventive and maintence plan of cooling unit and its result. ● A calibration or validation plan of temperature measuring and logging devices and its results. ● When validation is applied to measure the performance of the temperature logging devices, a manual showing the process of the device validation must be presented. ● When the results of the temperature logging device validation or calibration fall outside an acceptance range, adjustment or change of devices must be implemented accordingly.

3.4 Human Resource Development

No.	Requirements	Evaluation Guideline
4.1	Provide training for drivers and relevant staff with knowledge temperature-controlled agri-food transport	● A plan for annual training and educating programmes and other activities to ensure that they have fundamental knowledge and understanding about topics related to agri-food transport via refrigerated truck as follow: 1) Training programme on <u>all of these topics</u> must be organized ○ Knowledge about trucks and refrigerated chamber and emergency management in case of the break-down of the refrigerated truck or cooling uint during transportation. ○ Method or process of cleaning inside a cooling unit** **For a reefer container operator (with no duties to clean inside a refrigerated chamber), there must be a training programme to educate the drivers about checking documents before transportation such as Equipment Interchange Receipt (EIR). 2) The operator needs to organize another training activity on at least one topic beyond those in agri-food transport process via refrigerated trucks to provide additional knowledge,

No.	Requirements	Evaluation Guideline
		understanding and skills in agri-food transport services. For example: ○ How to use, assess and maintain refrigerated trucks and temperature measuring and logging devices ○ How to use, assess and maintain a generator set ○ How to appropriately arrange, loading and unloading goods ○ How to transport specific or special goods such as smelly goods transport, and Halal food transport ○ Personal hygiene ● Provide evidence for staff training and other activities that educates the drivers and relevant staff on cold chain transport
4.2	Health check of drivers and relevant operating staff who are in contact with goods at least once a year, which is additional to Q Mark standards on serious contagious disease or nasty infectious disease or disease carriers according to the Ministry of Public Health, Thailand	● There is a health check result of truck drivers and relevant staff who may be in contact with goods, on serious contagious diseases or nasty diseases, or being a carrier according to Ministry of Health such as: 1) Leprosy 2) Serious stage of tuberculosis 3) Elephantiasis 4) Hepatitis 5) Nasty skin disease etc. ● In case that the health check falls during the first year of transport operation, there must be evidence of a health check of at least 30% of all truck drivers and relevant staff. **Note:** This practice is applied to all drivers of all vehicle types of the operator and all relevant staff who may be in contact with goods. This is to prevent disease infection among them since these contagious diseases according to Ministry of Health can be easily infected and transmitted.
4.3	Guideline in dealing with cases in which drivers or relevant operating staff who may be in contact with goods have such illness as digestive diseases or respiratory-related diseases. They should be refrained from being in contact with goods.	● There is a guideline in managing sick drivers or relevant staff who may be in contact with goods. Those who are diagnosed for digestive diseases or related respiratory diseases should be refrained from working on duties that are in contact with goods.

4

Development guideline for Q Cold Chain application

To apply for Q Cold Chain accreditation, transport operators and relevant staff must have clear knowledge and understanding of the requirements, including appraisal procedures.

Therefore, to ensure that transport operators and relevant staff understand and can implement as well as preparing their readiness to apply for Q Cold Chain accreditation, this chapter will present operation guideline that is aligned with Q Cold Chain and evaluation guideline in Chapter 3. It will also present examples of documents that transport operators can use as a guide to operate and prepare for Q Cold Chain accreditation application.

One should be noted that the documents presented are only a sample of relevant documents. Each organization has different operations such as types of transporting goods, types of transport vehicles, organizational structure and size. Thus, transport operators should adapt and apply to suit their own operations. The operation guideline in line with the 4 aspects has the following details:

4.1 Transport operation

4.1.1 Transport operators evaluate their competence and readiness prior to employment

To ensure that transport operators and consignors have clear understanding of the scope of the employment, and to reduce communication misunderstanding, transport operators should carry out their self-appraisal prior to employment. The issues for preliminary assessment include:

1) Type and quantity of goods, including characteristics and conditions of goods such as duration for goods storage prior to delivery
2) Temperature range and/or relative humidity for transport
3) Technology for measuring and logging temperature during transport (Figure 4.1)

Figure 4.1 Examples of temperature measuring and logging devices

4) Type of vehicle used and transport capacity
5) Packaging used during transport (Figure 4.2)

Figure 4.2 Examples of packaging used in cold chain transport

6) Insurance and scope of responsibilities
7) Types of transport (One goods or mixed-goods transport) and loading/unloading staff.
8) Knowledge and skills of staff from the origin to the destination
9) Coordination plan between the organisation and relevant parties (if any) prior to employment

Transport operators should appraise their capability prior to employment by assessing together with customer. The appraisal documents should be recorded in the customers' data history file when considering the employment contract. The example preminary self-appraisal checklist prior to employment is shared as document 1.

Sample Document 1 Preliminary checklist for employment competence

Date ..... / ..... / .....

General Information

Customer's name : .....

Picking up location : .....

Type of refrigerated truck : ☐ trailer ☐ 10-wheeled truck ☐ 6-wheeled truck

Quantity of truck : ..... Type of product : ..... Quantity of product : .....

Product characteristics : ☐ Packaged product ☐ Product with no packaging

Specification

Temperature during transport : ☐ Frozen: less than (-18) celcius (℃)

☐ Chilled : 0 - 4 celcius (℃) ☐ Fruit and vegetable: 0 - 10 celcius (℃) ☐ etc. ....℃

Temperature data logger : ☐ Required ☐ No required

Product warranty : ☐ No ☐ Required specify insurance ..... Baht

NOTE All types of vehicles of the Company have already been insured for damage according to the type of vehicle. In the event that the insured amount exceeds the sum insured., the Company may charge an additional damage insurance from the capital made as part of the shipping cost by giving written notice along with the shipping cost.*

Picking up / Delivery

Picking up : Date ..... / ..... / ..... Time. .....

Delivery to destination : Date ..... / ..... / ..... Time. .....

Destination of delivery : .....

Long term contract

Beginning of Contract Date..... Ending contract Date .....

Quantity of vehicle per ☐ Day ..... ☐ Month ..... ☐ Year .....

Type of product ☐ Frozen ☐ Chilled ☐ Dry ☐ Other .....

Pick up location Address.....Time.....

Delivery location Address.....Time.....

Distance ..... Kilometer

Others .....

☐ Suitable for employment ☐ Not suitable for employment

Reason : .....

Informant	Manager
.....	.....
(.....)	(.....)
..... / ..... /	..... / ..... / .....

4.1.2 Transport operators have an operation manual, which specifies the overview and relations of key processes related to goods transport from order taking to delivery

To provide staff and relavant transport parties with guideline in effectively operating agri-food transport, transport operators should develop an operation manual that demonstrates the transport processes from picking up order to delivery, which covers topics about agri-food temperature-controlled transport such as

1) Vehicle and refrigerated chamber quality check before picking up the consignment
2) Pre-cooling chamber
3) Transporting goods that use cooling materials and validating their effectiveness in controlling temperature.
4) The arranging goods inside the chamber and loading-unloading method. refrigerated chamber
5) Temperature measuring and logging during transport
6) Goods delivery etc.

These activities are consistent with requirement 1.2 of Q Cold Chain. To ensure that the operation manual complies with Q Cold Chain, it should include the following topics:

Vehicle and refrigerated chamber condition check prior to employment

To check and prepare for readiness prior to employment, truck drivers and relevant parties should check the condition of the vehicle and refrigerated chamber as follows:

1) Truck must be ready to operate.
2) Check the condition of the chamber's wall, insulation, and other components to ensure that they are in good condition with no leakage. This could be assessed by closing the chamber and investigating for any permeating light.
3) Check for cleanliness and odor in the refrigerated chamber
4) Test for the readiness of a compressor to ensure that temperature inside the chamber meets customer's need.

After the condition check, truck drivers and relevant parties should record the results prior to picking up the consignment. A sample of documents is as follows: (Sample Document 2)

Sample document 2 Appraisal report of the condition of a refrigerated truck and its chamber			
General Information	Driver's name		
	Number of license		
	Number of Container		
	Car registration		
The condition of a refrigerated truck and its chamber			
Inspection area	Detail	Result	
		Pass	Fail
Vehicle	Engine oil level		
	Distilled water level		
	Battery		
	Exhaust smoke condition		
Generator set	Thermostat setting		
	Pre-cooling ..... Celcius (°c)		
	Cooling unit		
Chamber	Ceiling		
	Door		
	Walls and insulation		
	Floor		
Cleanliness	Floor (No debris or insect remains)		
	Walls (no debris stuck)		
	Sewer (no dirt accumulated)		
	No odor		
Suggestion			

The condition of a refrigerated truck and its chamber:

☐ Pass ☐ Fail

Reason .....

.....

Inspection by	Approved by
Driver	Manager
.....	.....
(.....)	(.....)
Date...../...../.....	Date..... /...../.....

Pre-cooling

Pre-cooling prior to consignment pick-up ensures that the temperature inside a refrigerated chamber is appropriate before transporting goods into the chamber. Pre-cooling will eliminate any residual heat inside the chamber, and prevent the goods from temperature loss. Indeed, transporting goods into the chamber at an inappropriate temperature will impact the goods quality and safety. Agri-food transport operators should thus pre-cool the chamber before picking up the consignment. The procedure includes:

1) Truck driver checks the employment document (check for the type of goods and the temperature required for transport) and the condition of the truck and the refrigerated chamber.
2) Pre-cooling temperature should be appropriate for types of goods. When temperature is right, a cooling engine should constantly be on to maintain the temperature inside the refrigerated chamber until the truck arrives at the cargo handling area.
3) Refrigerated chamber should be pre-cooled at the temperature specified in the employment agreement.

Note: When handling goods with no docking area, the cooling engine should be switched off to prevent heat and humidity from permeating the chamber. Otherwsie, ice will form on the cold coil, which will reduce the compressor's effectiveness in controlling temperature.

Transporting goods that use cooling materials and validating their effectiveness in controlling the goods temperature

When transporting goods that requires different temperatures during transport such as chilled and frozen goods in the same chamber, the temperature inside the chamber has to be set at the value appropriate for chilled goods and cooling materials are necessary to keep frozen food. Then, these goods can be delivered together. In effect, transport operators should have knowledge about cooling materials that are suitable for each type of goods. There are two main types of cooling materials:

1) **Cooler box**

   Cooler boxes come with different types and sizes. They should be made from thermal and vacuum insulators that can effectively control the temperature to ensure the cooler boxes' effectiveness in keeping the temperature (Figure 4.3)

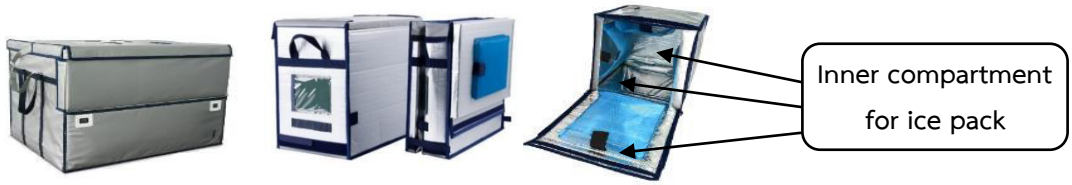


Figure 4.3 Examples of cooler boxes

2) **Ice/gel Pack**

- Ice/gel Pack is used for keeping a cooler box cold. It must be pre-cooled, before using to effectively maintain the cooler box's temperature. At one point, the temperature of cooler box will rise along the use duration.
- There are two types of ice/gel pack: 1) Ice/gel pack for chilled food 2) Ice/gel pack for frozen food (The effectiveness depends on the usage and the quality of Ice/gel pack) (Table 4.1)

Table 4.1 Example of cooling and freezing of cooling material (Ice/gel pack)

	For chilled food	For frozen food
Types of Ice/Gel Pack		
Temperature of Ice/Gel Pack	<-15 °C	<-35 °C
Temperature inside a cooler box	-5 °C	-25 °C

Note: Characteristics and effectiveness of Ice/Gel Pack vary according to the manufacturers.

Source: *https://www.tnk-keepkool.com/icepack*

Transport operators should have a handbook on transporting goods with cooling materials for staff to understand the procedures when transporting these types of goods. Examples of procedure includes:

1) Before use, staff must check that the specification, readiness and temperature of the ice/gel pack is suitable to the type of goods. (Staff may check if ice/gel pack is ready for use from its hardening and opacity)
2) Put ice/gel pack in a cooler box one hour before use for the pre-cooling purpose.
3) After an hour of pre-cooling, take out that ice/gel pack and replace it with a new set of ice/gel pack in a cooler box.
4) Pack goods in a cooler box and seal the box before bringing it onto a truck.
5) In case of multi drop, opening a cooler box during transport will raise the temperature inside the box. Thus, staff should proceed as quickly as possible, avoiding more than 30 seconds per box opening.
6) After use, freeze ice/gel pack again whilst a cooler box should be washed and cleaned.

Note: The number of ice/gel pack per use in a cooler box depends on their effectiveness and the amount of goods being transported in the box. Transport operators must enquire the information from the manufacturers or agent to use it appropriately according to the type and the amount of the goods.

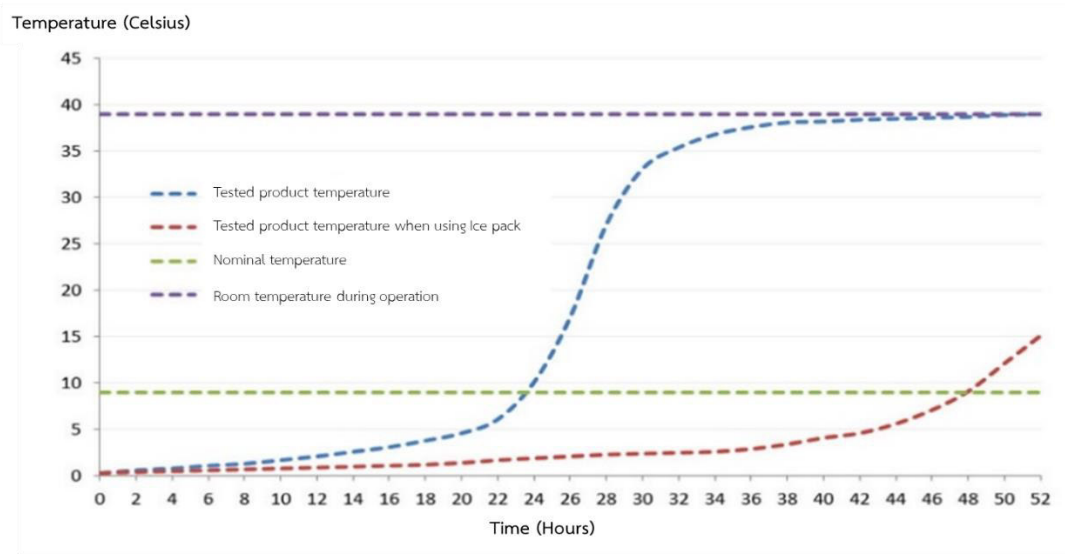
Guideline on validating the effectiveness of cooling materials in keeping the temperature

Transport operators should validate the effectiveness of cooling materials in keeping the cold temperature after purchasing and using for a while. This is to guage the level of effectiveness in keeping the cold temperature. If cooling materials cannot keep the temperature at the acceptable range, they should be replaced.

The example procedure of coolings materials testing (In case the temperature outside the box is 39°C) (Figure 4.4 and 4.5) as following:

1) Place ice/gel pack inside an empty cooler box
2) Place goods in the box.
3) Install a data logger to record the temperature inside the box.
4) Compare the temperature inside the box without ice/gel pack with the temperarue with ice/gel pack.
    - Chilled goods: stop logging when the temperature is higher than 8°C
    - Frozen food: stop logging when the temperature is higher than -18°C

5) Display the data from the data logger in a diagram

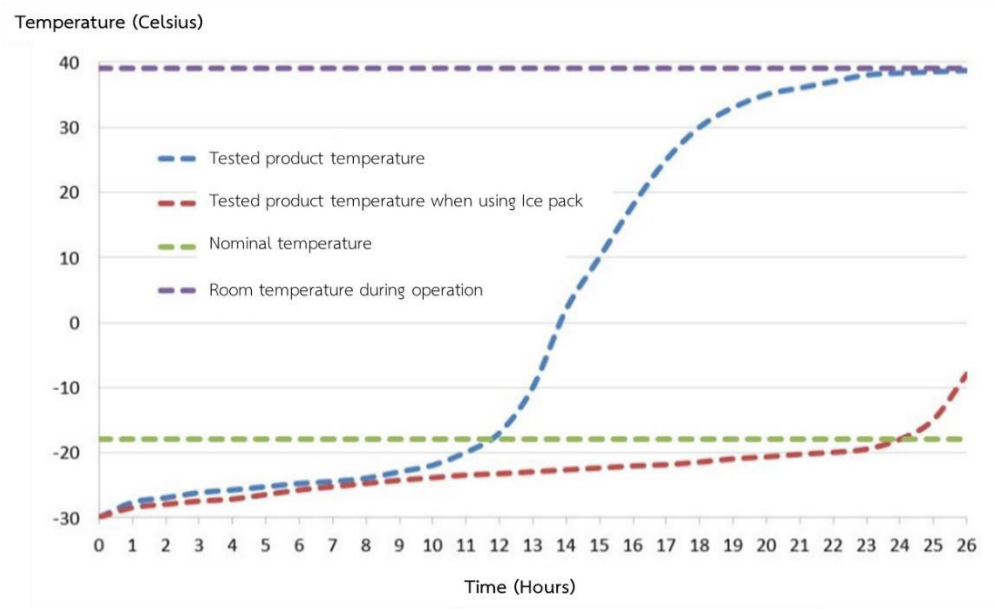


Source: *https://www.tnk-keepkool.com/icepack*

Figure 4.4 Test results of the effectiveness of cooler boxes and chilled products

Diagram presenting temperature of chilled goods

- **Blue line** represents temperature control inside a cooler box without ice pack between 0-8°C for 24 hours.
- **Red line** depicts temperature control inside a cooler box with ice pack between 0-8°C for 48 hours.



Source: *https://www.tnk-keepkool.com/icepack*

Figure 4.5 Test results of the effectiveness of cooler boxes and frozen products

Diagram presenting temperature of frozen food

- **Blue line** represents temperature control inside a cooler box without ice pack between (-30) – (-18) ℃ for 12 hours
- **Red line** depicts the temperature control inside a cooler box with ice pack between (-30) - (-18) ℃ for 24 hours

Note: The capability to control the temperature is also dependent on the temperature outside the cooler box.

Transport and arrangement of goods

The truck driver and relevant staff should understand about loading-unloading and arranging goods before execution. Appropraite goods loading-unloading and arranging into refrigerated chamber enables safe and quality transportation. There are 3 issues to be considered as follows:

1) Loading goods transport into a refrigerated chamber

After checking the chamber's condition and pre-cooled temperature, staff loads goods into the chamber. Preliminary recommendations include:

- Use a hand stacker to arrange goods into the refrigerated chamber to reduce possible goods damage.
- Log the temperature of the goods every time when loading them (see Sample Document 3)
- When the floor groove is less than 2.5 inches (6 cm.), use pallets for goods arrangement for better temperature distribution, which helps maintain the temperature inside the chamber (see Figure 4.6)

Figure 4.6 Pallet stacking in a refrigerated chamber

Sample Document 3 Record of temperature control during transportation	
Date ...../...../..... Name ..... Surname ..... Product type ..... Temperature specified by the customer ..... (℃) Loading Time..... Container/Chamber closing time..... • Pre- cooling .....Celcius (℃) Report time..... • The temperature of the container/chamber after loading..... Celcius (℃) Report time..... • Temperature before delivery..... Celcius (℃) Report time..... Comment	
Driver (.....) Date...../...../.....	**Consignee** (.....) Date...../...../.....

2) Goods arrangement

When arranging goods into a refrigerated chamber, staff should follow these practices:

- Goods should be arranged with the following spaces: 1) a space between the wall and the goods, 2) a space between the floor and the goods, and 3) a space between goods for effective temperature distribution
- Place air packing or foam dunnage bags between the wall and the goods to prevent outside heat from permeating the wall and transfering to the goods, which will damage them.
- Use guard nets when goods are stacked on each other to prevent them from falling during transport.
- Do not stack goods too high. To ensure cold air distribution throughout, there must be a 15-30 cm space (depending on the goods types) from the ceiling. (see Figure 4.7)
- Leave a space at the end of the unit to allow cold air distribution (see Figure 4.7)

Figure 4.7 Product placement in a refrigerated chamber

3) Air circulation inside a refrigerated chamber

The main objective for a space around the goods is to create a cavity for cold air distribution around them. When the chamber does not have floor groove, using pallets will facilitate better air circulation. Furthermore, goods should not be stacked higher than the compressor's air outlet; otherwise, the air at the top will be obstructed from circulating to the back of the unit. Thus, key issues of air circulation include:

- Floor layout and goods arrangement: Increasing air circulation capability inside a chamber is important to ensure that cold air reaches the goods in an effective and speedy manner. Pallets used for goods stacking should have air vents to ensure air circulation from the front to the back of the chamber.
- Goods stacking format: To ensure air circulation throughout, there should be a proper space between the goods and the ceiling. Improper spacing may block the air at the front of the chamber, limiting the air circulation inside. Thus, the goods can be damaged because they get too much or too little cold air.
- Heat vent of a compressor: There must be no obstruction of air circulation. Examples of obstructs are paper, plastic, or other particles sucked into the air vent. Any obstruct could cause insufficient air circulation, which subsequently damages the goods.
- Pallet cleanliness: Pallets inside the chamber should be made of materials that are easy to clean, such as plastics, to prevent any contamination.

Temperature control for each type of goods

Transport operator should have a guideline for temperature measuring and logging during transportation. Temperature control is crucial in agri-food transport. Inappropriate temperature for goods types, such as temperature change during transportation, could damage the goods. Therefore, transport operators should set out a rule, preventing a truck driver to switch off the refrigerator during transportation to prevent temperature deviating from the specified value.

Transport operator should have knowledge and understanding the appropriate temperature for each goods type and should transport goods at the temperature as specified to customers. It is to maintain the quality of goods throughout transportation. Transport operators can gain more knowledge about the appropriate temperature as follows: (Table 4.2 – 4.4)

Table 4.2 Appropriate temperature range for agri-food products

No	Goods Type	Appropriate Temp (°c)
1	Vegetable and fruits	(0)°c – (15)°c
2	Chilled products	(0)°C – (8)°C
3	Frozen food	Below or equal to (-18)°c
4	Ice cream	Below or equal to (-25)°c

Table 4.3 Example of the temperature for preserving some chilled and frozen food

Products	Appropriate temperature (°c)	Relative Humidity (%RH)	Shelf life
Frozen beef	(-23) - (-18)	90-95	6-12 months
Frozen pork	(-23) - (-18)	90-95	4-8 months
Frozen fish	(-29) - (-20)	90-95	6-12 months
Frozen shellfishes	(-29) - (-20)	90-95	3-8 months
Tuna	0-2.2	95-100	14 days
Salmon	0-1	95-100	18 days
Prawn	0-1	95-100	12-14 days
Fresh beef	0-1	88-92	1-6 weeks
Fresh pork	0-1	85-90	3-7 days
Ham	0-1	80-85	3-5 days
Lobster	5-10	95-100	5-7 days
Clams	5-10	95-100	5 days

Table 4.4 Example of the temperature for preserving fresh produces

plant	appropriate temperature (°c)	humidity (%RH)	Shelf life
Lettuce	0	98-100	21-28 days
Spring onion	0	95-100	3-4 weeks
Spinach	0	95-100	-
Broccoli	0	95-100	2 weeks
Cabbage	0	98-100	1-6 months
Strawberries	0	90-95	5-7 days
Sweetcorns	0	95-98	5-8 days
Peas	0	95-98	1-2 weeks
Carrot	0	95-100	120-180 days
Longan	0.5-1	90-95	4-6 weeks
Leafy plants	0-1	95-100	1-2 weeks
Chicori	0-1	90-100	30-90 days
Celeries	0-1	90-100	30-90 days
Watercress	0-1.5	95-100	14-21 days
Cantaloupe	0-4.4	95	2 weeks
Asparagus	2.2	95-100	2-3 weeks
Potatoes	3.3-4.4	90-95	58 months
Green beans	4.4-7.2	95	7-10 days
Wood ear fungus	5-8	90-95	5 days
Orange	5-10	90-95	2-4 weeks
Cucumber	7-10	95	2 weeks
Tomato	7.2-10	90-95	1 week
Okra	7.2-10	95	2 weeks
Sweet peppers	7.2-10	90-95	2-3 weeks
Zucchini	7.2-10	95	1-2 weeks
Nightshade	7.8-12.2	95	1 week
Shitake	9	90-95	14 days
Dragon fruit	10	90-95	15-20 days
Rambutan	10-13	90-95	14-16 days
Basil	12	95-100	14 days
Sweet potato	12.8	90	6-12 months
Mango	13	85-95	15-20 days
Banana	13-14	90-95	14-21 days
Durian	13-15	85-90	14 days
Pomelo	13-15	85-95	8 weeks
Mangosteen	13-15	90-95	14-28 days
Lady finger banana	13-15	90-95	14-21 days

plant	appropriate temperature (oc)	humidity (%RH)	Shelf life
Eggplant	15	90-95	21 days
Mushroom	15	90-95	6-8 days
Sweet basil	15	90-95	14 days
Langsat	15-18	80-85	18-28 days

Source: *Relevant literature review and interviews with key figures in chilled/frozen food industry in Thailand*

Temperature logging during transportation

Truck driver and relevant staff should attend to the temperature inside a refrigerated chamber during transportation to prevent any temperature change, which will damage goods. Transport operator should install temperature data logger inside the chamber to log the temperature, which should be linked to GPS for real-time report during transportation. Besides, the transport operator should have a temperature data display screen so that the driver could observe the temperature inside the chamber during transportation. If there is any issue, the driver could promptly tackle it (see Figure 4.8). (The transport operator can find more information about the technology relevant to temperature-controlled transport from section 4.3 about the standards of the refrigerated truck and maintenance.)

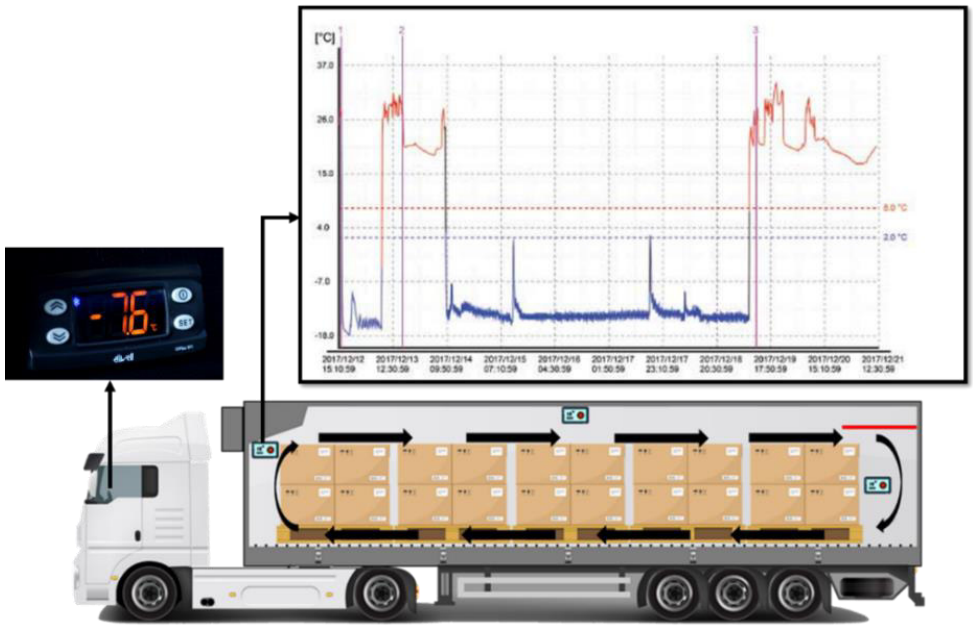


Figure 4.8 Refrigerated truck and temperature monitoring graph

Goods delivery

The truck driver and relevant staff should practice according to the guideline throughout the delivery of the temperature-controlled agri-food. Examples of the guideline include:

1) Check and log the temperature of the refrigerated chamber in the temperature control record form (See Sample document 3)
2) Specify clearly the delivery time, and the delivery must be completed within the specified time.
3) Upon arrival, the temperature of each item must be verified with the consignment order
4) Promptly transfer and deliver goods, taking into account the type of the warehouse as follows:
    - In case that the warehouse has a docking area or ante room, the truck can be parked and loaded/unloaded (Figure 4.9)
    - In case that loading/unloading takes place in an open air or at a warehouse without an ante room, the truck should be parked as close as possible to the cool room to minimize the transfer time and heat exposure. Alternatively, goods should be loaded/unloaded by using cooling materials to maintain the appropriate temperature level (Figure 4.10).
5) After checking goods, the receiver should fill and sign the form, noting the time from arrival until completion. The form can be used as evidence upon request.

Figure 4.9 Stock transfer at a docking area of a warehouse

Figure 4.10 Stock transfer in an open-air warehouse

4.1.3 Planning for emergency and practices

To prevent any liability from an emercency event related to temperature-controlled transport, such as when the refrigerating truck or the compressor malfunctions during transportation, transport operator should have a plan and be prepared for such an emergency. To ensure that relevant staff have knowledge and understanding to promptly handle the situation, there should be a plan in place, including procedures and practices to appraise the situation, including responsibilities and emergency management in a systematic manner. The plan should address the following 3 issues:

1) Planning for emergency events
2) Procedures for dealing with emergency events
3) Guideline for data recording in case of an emergency event

Additionally, transport operator can use the information from the emergency planning to analyse for the cause and solutions to reduce future reoccurence.

Planning for emergency events

Transport operator should plan and be prepared for emergency events as follows:

- Clearly specify staff or parties responsible for emergency management
- Set up a mobile service that suffices the delivery routes.
- Develop a network of relevant Cold chain service providers such as garage for refrigerating trucks, cooling unit manufacturers, and temperature-controlled transport operators.

- Have a list of corresponding details in a truck, such as location and contact numbers so the truck driver can promptly inform the incident to the nearest location when an emergency occurs.
- Install a real-time tracking system such as GPS (Figure 4.11) and enable the driver to inform the incidents via a communication platform such as Group Line and Facebook Messenger

Figure 4.11 Real-time tracking system

Procedures for dealing with emergency events

Goods transport has a clearly specified duration. When an emergency occurs, the truck driver should check for preliminary malfunctions of the compressor. If solutions cannot be found, the driver should inform the company to sort out the issues accordingly. This could include, for example, changing the truck to deliver the goods in time before any damages incurred. The procedures and guideline to deal with an emergency event (Figure 4.12) include:

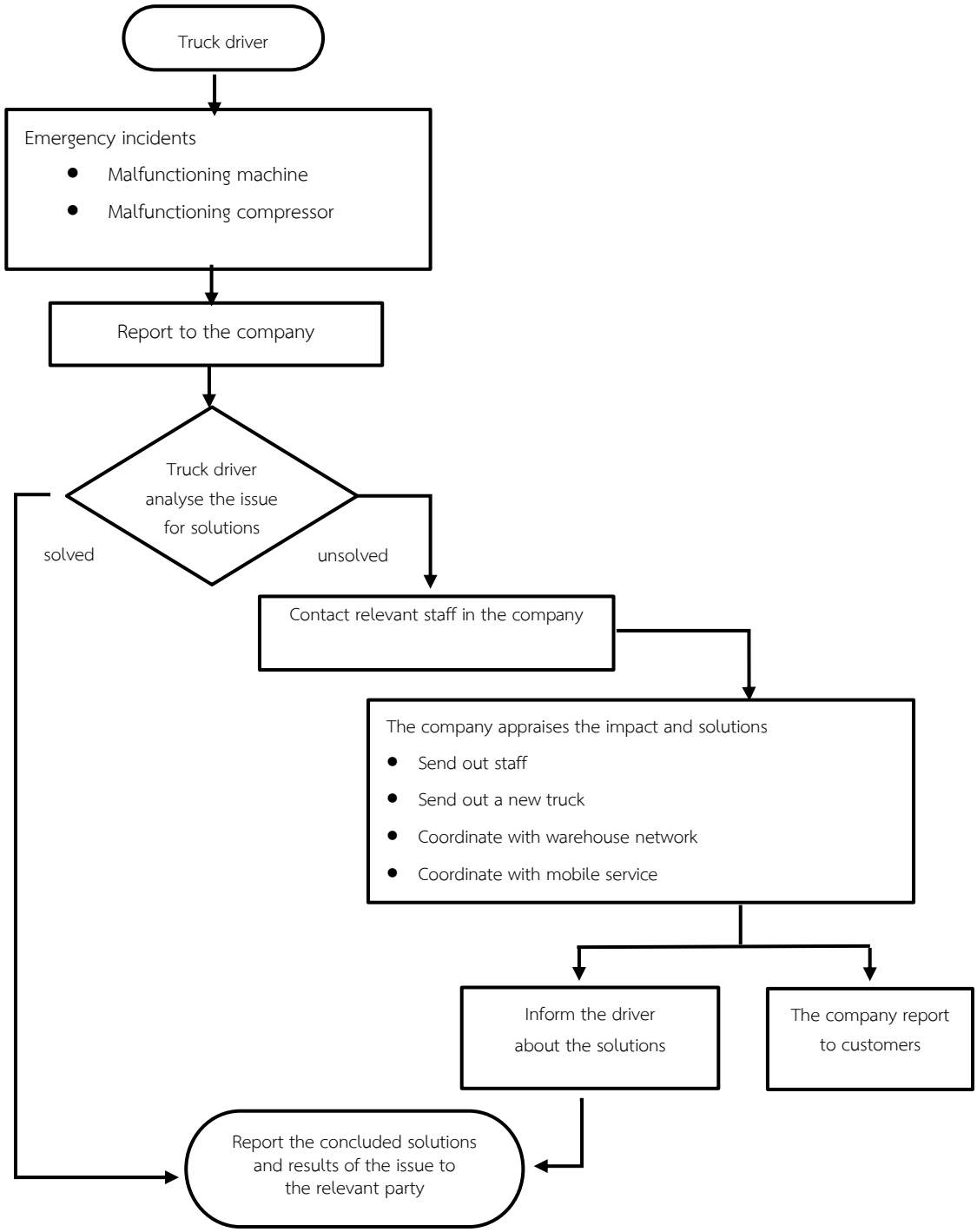


Figure 4.12 Procedures in case of emergency

Guideline for data recording in case of emergency

Transport operator should give the truck driver and relevant staff a form to record data in case of emergency. The data can be analysed for the cause and possible solutions, preventing any future incidents. The form can be used together with the form for accident report (Sample document 4) as follows:

<table>
<tr><th colspan="3">Sample Document 4 Form for emergency recording</th></tr>
<tr><td colspan="3">Date ...../...../.....
Driver name ..... Vehicle registration plate.....
Accident location .....Time.....</td></tr>
<tr><td>Temperature controlled system</td><td colspan="2">☐ Normal ☐ Abnormal</td></tr>
<tr><td colspan="3">Detail</td></tr>
<tr><td colspan="3">Preliminary solve</td></tr>
<tr><td colspan="3">Prevention guidelines</td></tr>
<tr><td>Recipient
.....
(.....)
Date...../...../.....</td><td>Driver
.....
(.....)
Date...../...../.....</td><td>Executive
.....
(.....)
Date...../...../.....</td></tr>
</table>

4.2 Cleanliness

Transport operator must pay a high attention to cleanliess inside a refrigerated chamber and various equipments used in agri-food transportation. Temperature-controlled transport has many different aspects that cause filth and pathogens, contaminating goods and consumers. Therefore, truck operator should use disinfectants approved by FDA, Ministry of Public Health, when cleaning the chamber and equipments, to prevent any dangerous residues to consumers. Moreover, transport operators must highly attend to the environmental impact from cleaning, namely, consideration for wastewater treatment system to prevent polluted water from leaking to the natural water resources.

4.2.1 Cleaning the refrigerated chamber and its components with appropriate process and frequency

Transport operator must appropriately clean the refrigerated chamber and record the cleaning resulte in accordance with requirement 2.1 of Q Cold Chain standards.

Transport operator should clean inside the chamber and its components after delivering goods to prevent any germs and possible contamination, causing damages to goods and safety of consumers. It will also negatively affect the service image and consumer trust. Thus, the transport operator must follow the following practices:

- Specify the process and frequency for cleaining the inside of the chamber and its components (Figure 4.13 and 4.14)
- Record the appraisal results of the cleanliness of the chamber and its components (See sample document 5)
- Specify the cleaning plan. Transport operator must regulate the truck driver to clean the truck after each delivery to prevent and germs and filth. When goods are packed in boxes during transportation, and thus the cooling unit is not dirty, cleaning process could be adjusted accordingly.

Figure 4.13 Cleaning of a refrigerated chamber and its components

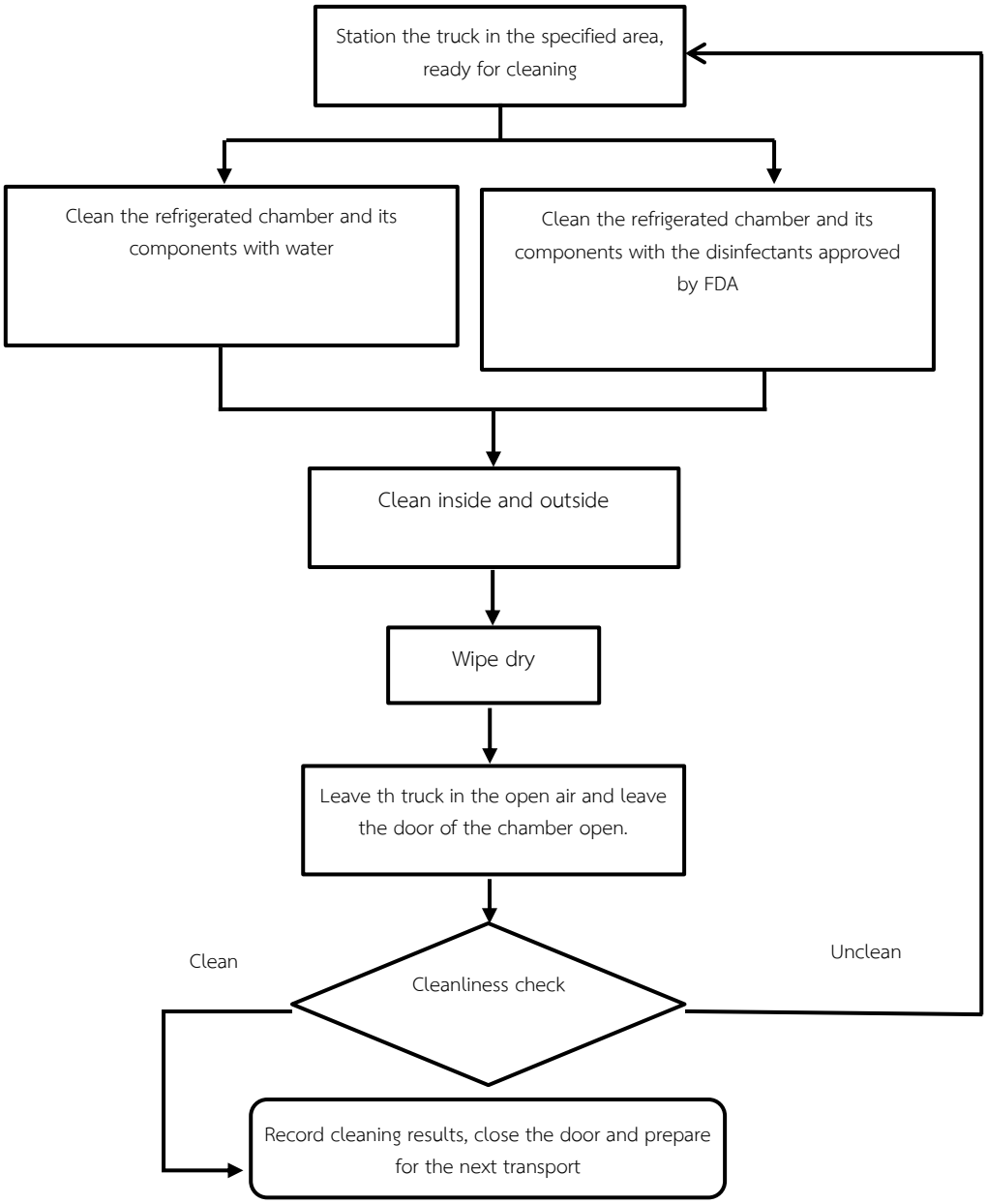


Figure 4.14 Process flow diagram of cleaning tasks

Note: Transport operator must consider the necessity for the appropriate wastewater treatment system (wasted water and detergents) to avoid any environmental impact such as wastewater pipeline construction before the wastes emerge into the environment.

Sample Document 5 Record of refrigerated chamber cleaning				
Date ...../...../..... Vehicle registration plate.....				
No.	Detail	Result		
		Pass	Fail	Note
1	Floor			
2	Wall and ceiling			
3	Door			
4	Plastic curtain			
5	Sewer			
6	General condition, bad smell, humidity			
Cleaning staff ..... Date...../...../.....		Driver ..... Date...../...../.....	Inspector ..... Date...../...../.....	

4.2.2 Disinfectants used in cleaning the refrigerated chamber must be hygienic and safe to goods and consumers.

Transport operator must know about the disinfectants that can be used in cleaning the refrigerated chamber and its components that are safe to goods and consumers. This is in line with requirement 2.2 of Q Cold Chain. The disinfectatns used should be approved by FDA. (Table 4.5)

Table 4.5 Example of the list of harzadous substances annexed to Ministry of Industry announcement

Example of the list of harzadous substances specified by Food and Drug Administration (FDA) **List 4.2 Names of harzardous substances control group**			
No.	**Name of Harzadous substances**	**Type**	**Remark**
1	Acids	3	present in household and health products for disinfection of flooring, wall and tools
2	Chlorhexidine salts	3	
3	Alkalis	3	
4	Nonylphenol ethoxylate	3	
5	Amphoteric surfactants	3	
6	Anionic surfactants	1	
7	Cationic surfactants	3	
8	Nonionic surfactants exceot nonylphenol ethoxylate	1	
9	Aldehydes	3	
10	Chlorine and chlorine releasing substances	3	
11	Phenols and phenolic compounds	3	

For more information about the types of cleaning detergents specified by FDA, transport operator can access the FDA website on Harzadous substances control group at: http://www.fda.moph.go.th/sites/Hazardous/Pages/Main.aspx (Figure 4.15)

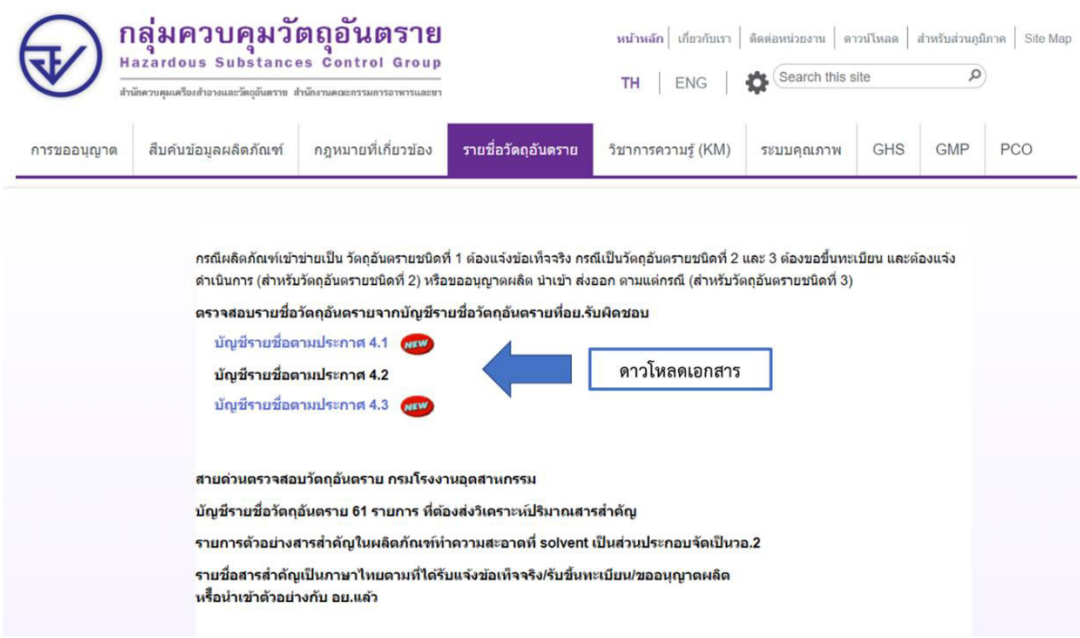


Figure 4.15 List of cleaning detergents in accordance with the requirement of Food and Drug Adminstration (FDA)

Transport operator should keep the document – Material safety data sheet (MSDS) – that represents the chemical substances used in cleaning, harzard, use, storage, first aid, and other management.

When cleaning the refrigerated chamber transporting Halal goods

When transporting Halal products, transport operator must know about Halal goods transportation and refrigerated chamber cleaning in accordance to Islamic provisions. However, Thailand has not yet developed clear standards for Halal food transport. It only adapts the guideline from Hal-Q from Halal Science Center, Chulalongkorn University to suit the Halal food transportation. The procedures include:

1) **Taking order process**

- Taking the order for Halal food transport: Service users who wish for such the process must inform in writing to the marketing team or customer service since service booking. This will specify in the booking that the truck must be suitable for Halal food according to the Hal-Q standards of Halal Science center, Chulalongkorn University.

- When receiving the truck booking, relevant staff must be in contact to prepare for practices that are in line with Hal-Q standards of the Halal Science center, Chulalongkorn University.

2) Cleaning process

- Bring the truck to the washing area. The washman must clean himself (including hands and face) and dress appropriately (including waterproof protective suit, gloves and mask).
- Prepare equipments such as water buckets for clay clean soap mixing according to Islamic provisions, brushes, mops, detergents, and water pressure machine
- Have prohibition signs, such as no pets allowed in the washing area, no food and drinks, only relevant staff allowed in the area, etc.
- Spray thoroughly clay clean soap mixed water on the ceiling, wall and floor. Clean the area with a brush and leave it for 5 minutes. Wash with clean water and drain it. Leave the door open until it is dry.
- Regulations after the refrigerated chamber cleaning must be recorded.

When transport operator is not aware if the chamber has transported what type of goods before, which may not be Halal products, or when the chamber is contaminated with “najis”- filth and other disgusting dirt, which are prohibited in the Islamic provisions such as:

(1) mukhaffafah: less than 2 year-old boy urine

(2) mutawassitah: blood, pus, carcass

(3) mughallazah: dogs, pigs including carcass and droppings of pigs and dogs, etc, which must be washed longer than normal.

For the above cases, transport operator must clean the chamber 7 times, washing with clay soap mixed water once, and wash with clean water at least 6 times.

Disinfectant substances for cleaning the refrigerated chamber for Halal goods transport

When transporting Halal goods, transport operator must use disinfectant substances according to Islamic provisions such as clay soap (Figure 4.16)

Figure 4.16 Disinfectant substances for Halal goods transport

4.3 Refrigerated truck standard and maintenance

The refrigerated truck is crucial for the Cold chain business. Transport operator must have fundamental knowledge about the refrigerated truck, and technologies relevant to temperature measuring and logging inside the refrigerated chamber. Thus, transport operator must plan and record for systematically checking and maintaining the truck. These will ensure the truck is ready for transport with prolonged use, and reduce the maintenance costs.

4.3.1 Installing and checking for the readiness of the temperature data logger for monitoring the appropriate temperature inside the refrigerated chamber

Transport operator should understand the fundamental components of the refrigerated truck and relevant technologies to ensure the right and appropriate choice decision. The transport operator should choose the right materials used in manufacturing and assembling the refrigerated chamber, suitable for controlling the appropriate temperature inside the chamber. This will ensure that the refrigerated truck can effectively maintain and control the temperature. Furthermore, the temperature data logger should properly be installed inside the chamber. This is according to requirement 3.1 of Q Cold Chain standards, which addresses the following details:

- Structure and components of a refrigerated truck (fundamentals) (Figure 4.17)
- Components and materials used in assembling a refrigerated truck (Figure 4.6)
- Knowledge about the technologies relevant to temperature-controlled transport
- Data Logger installation inside the refrigerated chamber

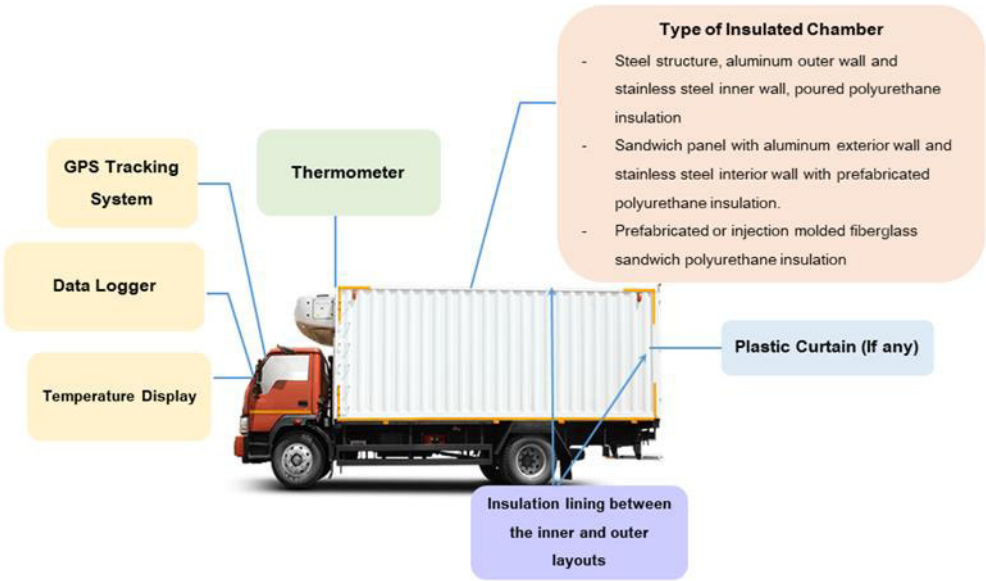


Figure 4.17 Fundamental components of a refrigerated truck

Table 4.6 Components and materials used in assembling a refrigerated truck

<table>
<tr><th colspan="2">Components and materials used in assembling a refrigerated truck</th></tr>
<tr><td>Outside wall</td><td>• Aluminium/fiber (slow heat absorbant and light-weight)
• Painted white to reflect sunlight</td></tr>
<tr><td>Inside wall</td><td>• Stainless (acid resistant) to prevent corrosion from goods - disinfectant substance interaction
• Wavy floor and wall to enable effective cold air distribution inside the chamber
• Corners inside the unit must be curved and smooth with no sharp edge.</td></tr>
<tr><td>Heat insulation</td><td>• Characteristics of effective heat insulation are:
1. Low Thermal Conductivity or K-Value represents effective heat insulation
2. High Thermal Resistance or R-Value
3. Low Water Absorption
4. Durable, light-weight and acid and alkali resistant
5. High Compressive strength
Table comparing K-Value of different types of heat insulation
<table>
<tr><th>Materials</th><th>K-Value</th></tr>
<tr><td>PUF</td><td>0.023</td></tr>
<tr><td>PS</td><td>0.027</td></tr>
<tr><td>Fiberglass</td><td>0.035</td></tr>
<tr><td>Plywood</td><td>0.123</td></tr>
<tr><td>Gypsum board</td><td>0.191</td></tr>
</table>
Source: https://www.wtg.co.th/
However, the K-Value in the table is an estimate because measuring the actual K-Value depends on other factors such as the thickness of the insulation materials and the outside temperature.</td></tr>
<tr><td>Sewage pipe</td><td>• must have at least one at the corner of the chamber</td></tr>
<tr><td>Plastic curtain
(If any)</td><td>Plastic curtain must have the following charateristics:
• Plastic used must be for food contact
• Cold and impact resistance
• More than 2 millimeters thickness
• Clear for easy impurity spotting</td></tr>
</table>

<table>
<tr><th colspan="2">Components and materials used in assembling a refrigerated truck</th></tr>
<tr><td>Refrigeration unit</td><td>Refrigeration unit can be classified into two types:
1) Direct Drive (Small Refrigeration Unit) for small truck, using the truck engine to power the refrigeration unit
2) Sub Engine (Large Refrigeration Unit) for a large truck, using its motor to power its operation. It generates a higher level of coldness than the small unit.

<table><tr><th>Direct Drive</th><th>Sub Engine</th></tr><tr><td>  </td><td>  </td></tr></table></td></tr>
<tr><td>Refrigerant</td><td>Refrigerant used must be in line with Montreal Protocol, which specifies about ozone-destroying chemicals. Thus, transport operator should use CFC-free refrigerant
Examples of HFCs refrigerants
• R407c, R410a, R404a, R507, R32, BPX44, BPX55
This type of refrigerants has a high level of purity, and does not affect Ozone. It is thus safe to use, without toxic, odor and colorants. Because these refrigerants have a low level of boiling point, they are effective in inducing coldness.
Examples of HCFCs refrigerants
• R22, R141b, R142b, R123, R124, R225, R402a, R402b, R408a
These refrigerants are used more or less nowdays, which affect the environment less than CFCs refrigerants. However, these refrigerants are specified in Montreal Protocol. Thailand, thus, plan to reduce HCFCs use and probably refrain from using by 2040.
Examples of CFCs refrigerants
• R11, R12, R13, R14, R500, R502, R503, R113, R114, R115
These refrigerants negatively affect the environment. They are refrained from using.</td></tr>
</table>

Knowledge of technologies relevant to Q Cold Chain

GPS trackers can be applied for a variety of use. It is connected to the electronic equipments in a car or to a data logger, data can be recorded or called upon from sensors. The recorded data can provide information about the temperature and relative humidity inside the cooling unit, and other systems inside a car such as gas level, voltage, speed, engine status, refrigeration unit status and other equipments. (Figure 4.18)

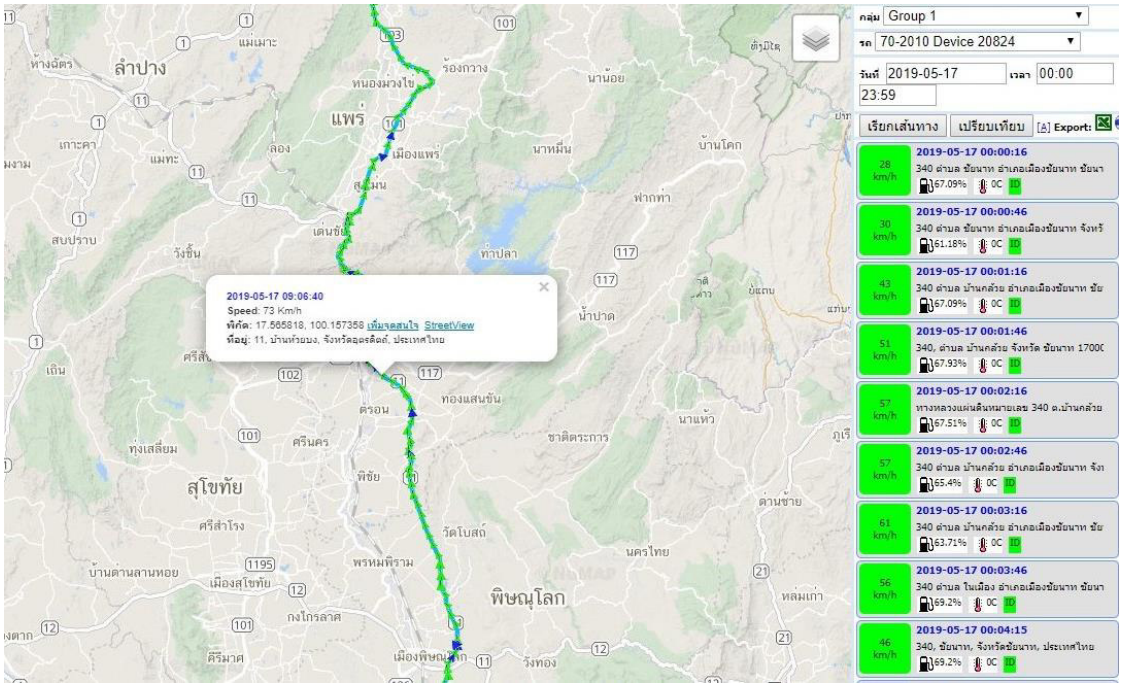


Figure 4.18 GPS Tracking System Output Display when connecting to temperature measuring device

Data Logger is an electronic equipment to record data. It can store data automatically 24/7. In general, data logger is small, battery-powered, and portable. It has an inside memory for data storage, and can be connected to a computer. It also has software to store, display, and analyse data. There are two types of data loggers:

1) Data Logger to measure and log temperature only, such as button data logger, which must use an equipment to call upon the logged data. (Figure 4.19)

Figure 4.19 Temperature Button Data Logger Kit

2) Data Logger that has a variety of functions, simultaneously measuring and recording different values. (Sensor is installed to measure temperature, relative humidity, and vibration, linked to data logger). It has a screen display, including Bluetooth for data transfer and other wireless data sending. (Figure 4.20)

Figure 4.20 Data Loggers

Data logger installation inside a refrigerated chamber

Data logger installation to record the temperature inside a refrigerated chamber should be done properly in conjuction with product placement. Indeed, there must be at least one installation under cold coil (point A), which is where the cold air is circulated back to the refrigeration unit (Figure 4.21)

- Point A: Under cold coil
- Point B: On the left
- Point C: On the right
- Point D: Unit ceiling
- Point E: Back of the unit

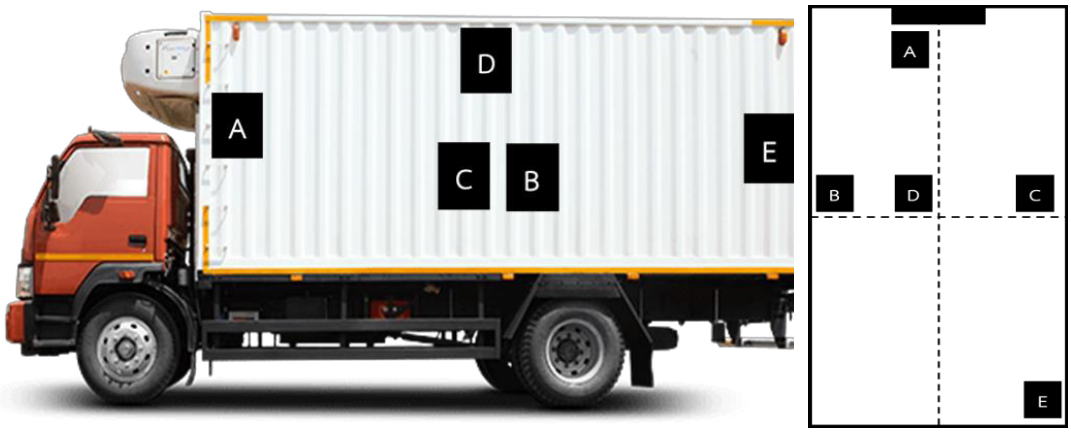


Figure 4.21 5 locations of data loggers installed inside a refrigerated chamber

Furthermore, digital screen display must be installed in a truck driver cabin (figure 4.22). The truck driver should be warned when the temperature inside the chamber falls into the inappropriate range.

Figure 4.22 Digital temperature data display installation in a truck driver cabin

Data from the data logger should be presented as a graph for practical data analysis (Figure 4.23)

Temperature Data Report

Device Specification (1)

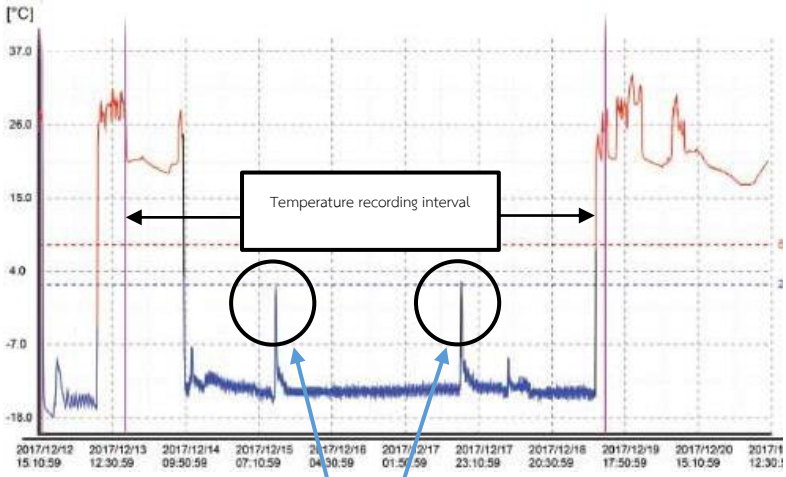
Model No.	Maxilog	Serial Number	SC171200292
Time Base	UTC -08:00	Sampling Rate	10m
Max Data Period	90 Days	Temp. range	(-2.0) C – (8.0) C
Start Delay	30m		

Statistics (excludes Start Delay) (2)

Duration Time	8d 20h 40m	Total Data Number	1276
Start time	2017/12/12 15:10:59	Finish Time	2017/12/21 11:40:59
Total time within	40m	Total time above	3d 4h 20m – 5d 15h 40m
Highest Temperature	33.4 C	Average Temperature	-0.7 C
Lowest Temperature	-17.9 C	MKT	14.7 C

Alarm Information (3)

Alarm set	Alarm Type	Allow time	Time of violations	status
> 8.0 C	Single	15m	3d 4h 20m	Alarm
< 2.0 C	Single	15m	5d 15h 40m	Alarm



When the temperature falls out of the standard range

Transport operator should find the cause of the time window, in which data logger displays the value higher than specified. This may be because the door is left open for too long, or the refrigeration unit has malfunctioned. This information will help develop guideline to prevent repeating such the incident.

1.Characteristics

- Max Data Period. Continuous data logging window
- Start Delay. Time before data logging
- Temp range. Temperature range to notify for abnormality
- Sampling Rate. Data logging frequency

2.Statistic data

- Duration Time: Logging time (from start to finish logging)
- Start time: Starting date and time of logging
- Finish time: Finishing date and time of logging
- Total time above: Time when the temperature falls into a notifying range.
- MKT (Mean kinetic temperature): Values used to display the fluctuating temperature during transport

3. Warning

- Alarm Set: Temperature that needs to be notified
- Allow Time: Time before notifying the abnormal temperature
- Time of violations: Time of temperature violation since logging

Figure 4.23 Data graphing and analysis from a data logger

4.3.2 Plan and report for maintenance of a refrigeration unit and temperature measuring and logging devices for appropriate temperature control

Transport operator should have a plan for maintaining the refrigeration unit, and the temperature data measuring and logging devices to ensure that they are always ready to use.

The maintenance plan can prolong the life of the refrigeration unit and equipments. It also reduces the management cost, and risks of any errors during transportation. It will facilitate the operator in planning for effective truck dissemination. The transport operator can study the example of the maintenance plan for the refrigeration unit and equipments from the sample document 6.

Sample document 6 Refrigeration unit check plan chart

items \ time	6 mths	1 yr	1.5 yrs	2 yrs	2.5 yrs	3 yrs	3.5 yrs	4 yrs	4.5 yrs	5 yrs	5.5 yrs	6 yrs	6.5 yrs	7 yrs
Refrigerant	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Compressor conveyor belt	☐X	☐X	☐X	☐X	☐X	☐X	☐X	☐X	☐X	☐X	☐X	☐X	☐X	☐X
Condenser moter (hot coil)	X	X	X	X	X	X	X	X	X	C	X	X	X	C
Cooling unit moter (cold coil)	X	X	X	X	X	X	X	X	X	C	X	X	X	C
Condenser (hot coil)	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Cooling unit (cold coil)	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Receiver dryer	-	-	-	-	-	C	-	-	C	-	-	C	-	C
Compressor bracket	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Overhaul compressor	-	-	-	-	-	C	-	-	C	-	-	C	-	C
Magnetic clutch	X	X	X	X	X	X	X	X	X	C	X	X	X	C
High-Low Pressure switch	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Connectors drainage	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cables	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Systemp control electronics	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Note: C = Change X = Check o =Clean ☐ = Calibrate

Calibration and verification of temperature data loggers

Transport operator should verify or calibrate the temperature data loggers to ensure its effectiveness and ready-to-use. The details are as follows: (Figure 4.24)

- For calibration, transport operator can send all temperature data loggers to an accredited labolatory once a year.
- For verification, transport operator can send the master temperature data logger to an accredited lab for verification with the company's other data loggers. The master one must only be used for verification. The verification is required at least twice a year.

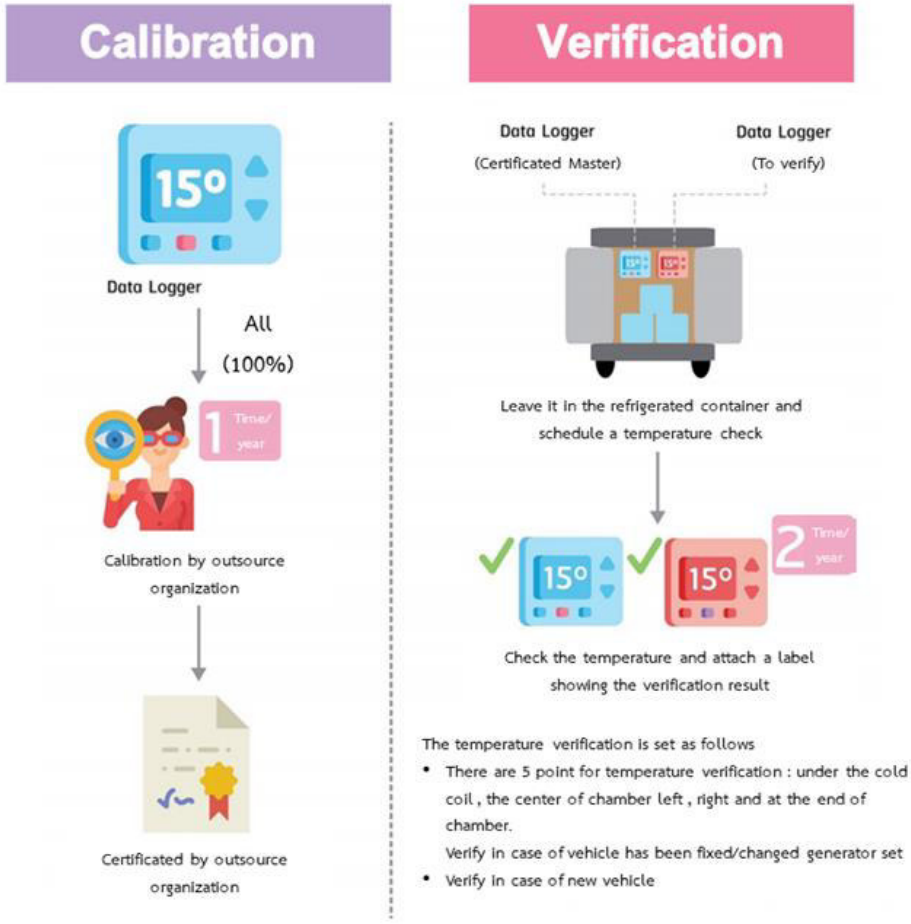


Figure 4.24 Calibration and verification of temperature data loggers

All in all, transport operator should set the acceptable variation of the values from the calibration/verification. For example, the different temperature between the master data logger and the others verified must not be more than 1 ℃.

In case that the result from calibration and verification of data loggers falls outside the acceptable variation range, the operator must adjust or change the loggers accordingly. The calibration report can be found from sample document 7.

Sample document 7 Calibration report

Calibration Report

Cert No.: T-1806185

Page 1 of 2

Equipment: Temperature Recorder
Model: TRID30-7R
Serial No.: 1050021990
ID No.: -
Manufacturer: LogTag
Customer:
Address:

1. General info
i.e. data logger, series, number, data, customers, address.

The temperature inside the room during the test.

The relative humidity inside the room during the test.

Ambient Temperature: 23 °c ± 3 °c
Relative Humidity: 55 % RH ± 15 % RH

Calibrated by: _____
Engineer

Approved By: _____
(**)**
Approved Signatory

Received Date: 25-Jun-18
Calibration Date: 25-Jun-18
Date of Issue: 26-Jun-18
Calibration Laboratory

Page 2 of 2

Job No.: 1815-184738

Calibration Procedure: WI-DC01

Calibration Method:

2. Calibration method

This instrument was calibrated by comparison with standard thermometer in liquid bath at temperature calibration point

Condition of this result of calibration:

3. Condition of the calibration
i.e. instruments used for the calibration

1. Reference Standard Instruments Used:

Instrument	Model	Serial No.	Cal. Report No.	Due date	Ref.STD Lab.	Traceability
Platinum Resistance Thermometer	5627	717101	18I363	28-Mar-19	TPA	NIMT
Thermometer, Chub-E4	1529	A12037	ER-00181-17	0-Oct-18	NIMT	NIMT

2. This result of calibration was found accurate as shown on date and place of calibration only.
3. This result of calibration was found accurate for this equipment only.
4. This calibration report document the traceability to nation standards, with realize units of measurement according to the international System of Units (SI).

Result of Calibration: Without adjustment

STD Value (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (±) (°C)
2.00	1.9	-0.10	0.15
8.00	7.9	-0.10	0.15
15.00	14.8	-0.20	0.15
20.00	19.8	-0.20	0.15
25.00	24.8	-0.20	0.15

4. Calibration result
consists of 4 main issues
1. STD Value: Standard temperature value
2. UUC Reading: The value from the calibrated loggers
3. Error
4. Uncertainty (+/-) of the loggers.

UUC = Unit Under Calibration

The reported expanded uncertainty is based on a uncertainty multiple by a coverage factor k = 2, providing a level of confidence of approximately 95%

End of Calibration Report

Note:

1. Transport operator must set an acceptable error value. When the report shows an inacceptable error value, the data logger must be adjusted or changed accordingly.

2. If the error value of the calibrated loggers is near or close to 0°C, the loggers are accurate in reading the actual temperature.

Transport operator can search for more information about the laboratories that provide a calibration service from the websit of Thai Industry Standards Institute (TISI) as in Figure 4.25.

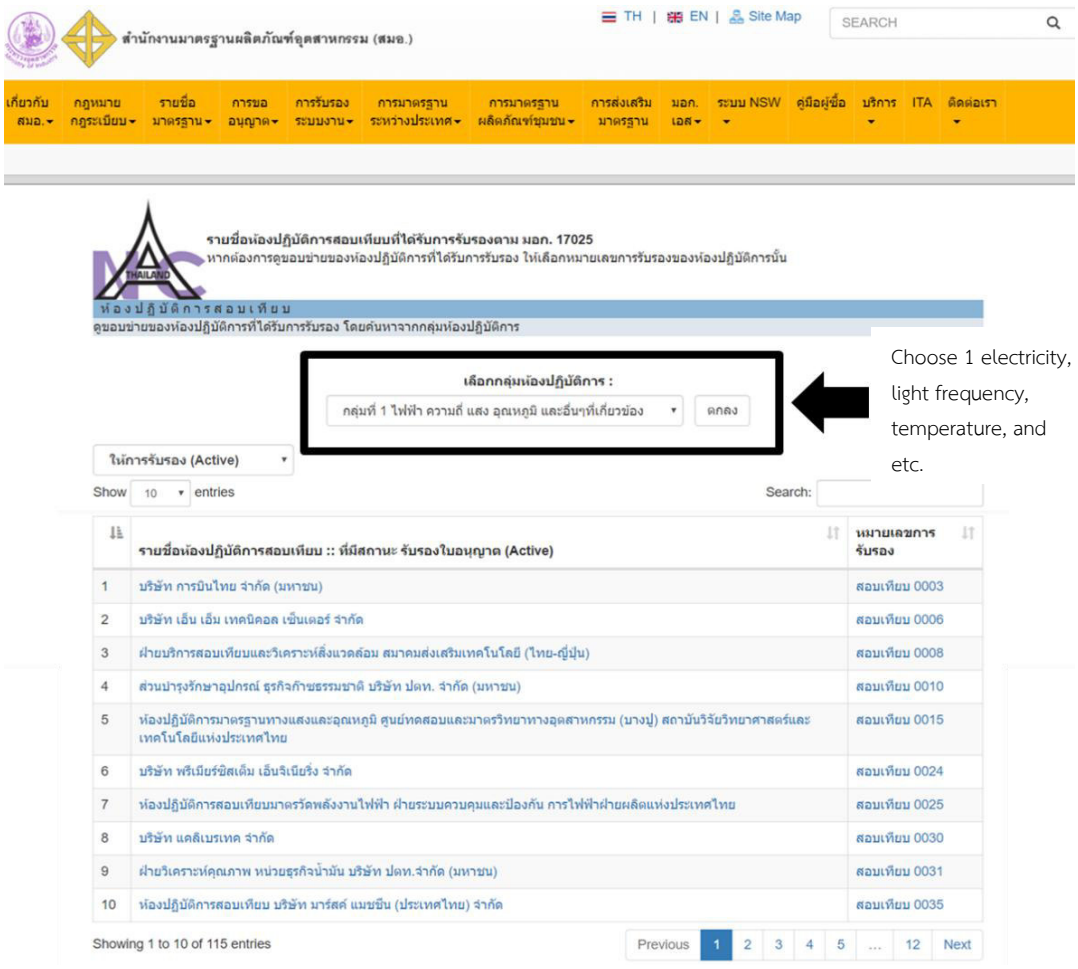


Figure 4.25 Search for data calibration laboratory

Source: *https://www.tisi.go.th/website/accreditation/labgroup*

Verification for cold air distribution inside a refrigerated chamber (additional information)

Verification for cold air distribution inside a refrigerated chamber is to verify the functionability of the refrigeration unit. It is to test for its capability in distributing cold air throughout the chamber (figure 4.26). The verification test includes the following stages:

- Install 9 temperature data loggers inside the chamber – one in the middle, 4 at the front corner, and 4 at the back corner.
- Cooling the chamber up to the temperature appropriate for the transport.
- Measure and record the temperature from each data logger
- The variation of the temperature from each logger should not be more than 3 °C or as specified by the transport operator.

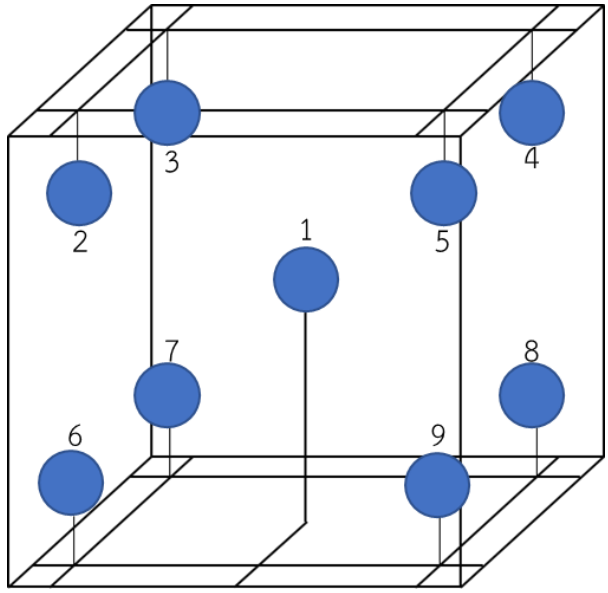


Figure 4.26 Location for installing a data logger to verify cold air distribution
***Source**: http://www.mastercalibration.com/*

Transport operator should continuously plan for calibration and verification of data loggers. If data loggers are found faulty or the calibration result is not within an acceptable range, the operator must adjust or change the loggers appropriately. The example of the verification and calibration of temperature data loggers plan is as sample document 8.

Sample Document 8 Verification and calibration of temperature data loggers plan

List / Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Note
Car registration	Number of data loggers													
	1.						✓						✓ O	
	2.						✓						✓ O	
	3.						✓						✓ O	
	4.						✓						✓ O	
	5.						✓						✓ O	
	1.						✓						✓ O	
	2.						✓						✓ O	
	3.						✓						✓ O	
	4.						✓						✓ O	
	5.						✓						✓ O	
	1.						✓						✓ O	
	2.						✓						✓ O	
	3.						✓						✓ O	
	4.						✓						✓ O	
	5.						✓						✓ O	

Note: ✓ = verification O = calibration

Verification may change accordingly if the particular data logger is faulty.

4.4 Human Resource Development

Human resources are central to temperature-controlled transport. Transport operator must have a continuous human resource development to prepare staff for the transport operation, in line with the 3 requirements of Q Cold Chian standards as follows:

- Educate the truck driver and relevant staff about temperature-controlled transport
- Provide an annual health check for the driver and relevant staff who may be in contact with goods, which is in addition to Q Mark on serious contagious diseases or nasty infectious diseases or carriers of contagiours diseases according to the announcement of Ministry of Public Health.
- Have a guideline for managing the incidents when the driver or relevant staff who may have contact with goods are diagnosed of digestive diseases or respiratory diseases. They should be refrained from the role that involves goods contact.

4.4.1 Educating the driver and relevant staff temperature-controlled transport

Transport operator should educate truck drivers and relevant staff on temperature-controlled transport transport once or twice a year. The operator may have different training programs such as

- In-house Training
- Outsourced training
- Online training

This will ensure that drivers and relevant staff have knowledge and understanding to operate up to standards in accordance to requirement 4.1 of Q Cold Chain Standards. (Figure 4.27)

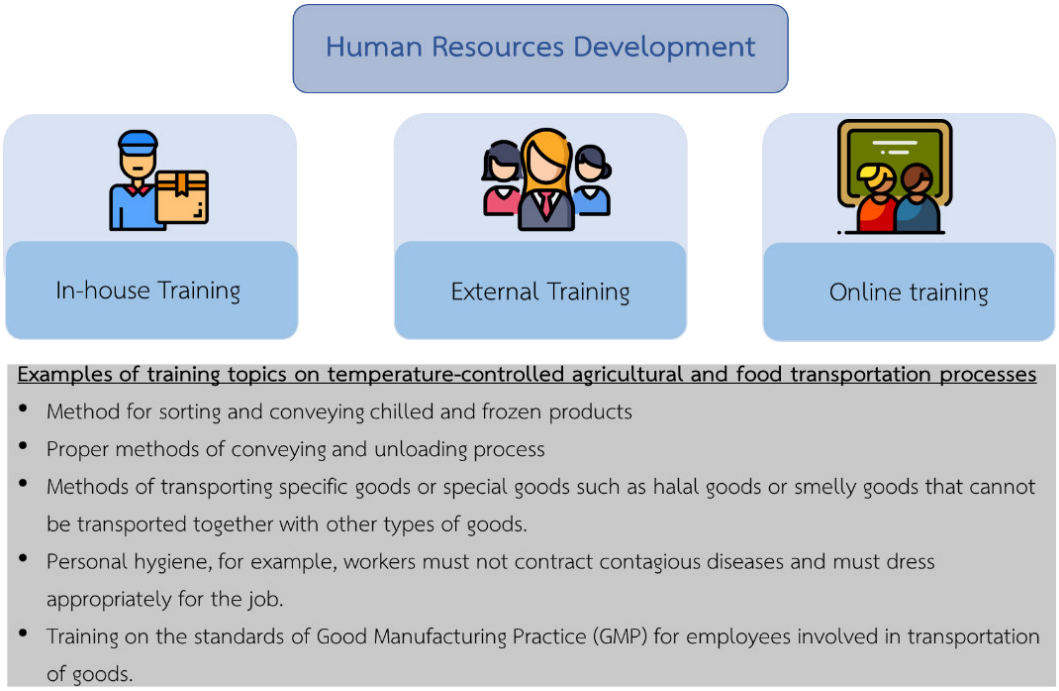


Figure 4.27 Human Resources Development

Transport operator should keep evidence of all training programs or plans for relevant staff to use as evidence for accreditation application.

Good Manufacturing Practice: GMP

Good manufacturing practice (GMP) is fundamental regulations or standards necessary for manufacturing and controlling to ensure that a manufacturer follows accordingly to safely produce food. GMP focuses on preventing and reducing any risks for contaminated food that will harm consumers. It covers all relevant aspects, from building structures, manufacturing process. This will ensure that the products are well received by consumers.

Benefits from operating in accordance to GMP

- Products are in good quality and safe for consumption
- Safe environment for staff
- Keep and control standards for a factory's hygiene
- Convenient for information tracking
- Reduce defects due to errors during operation.

Training centers for temperature-controlled transport

Transport operator can search for more information about training and educating staff from relevant organizations such as Department of Skill Development from website: http://www.dsd.go.th/ (Figure 4.28 and 4.29)

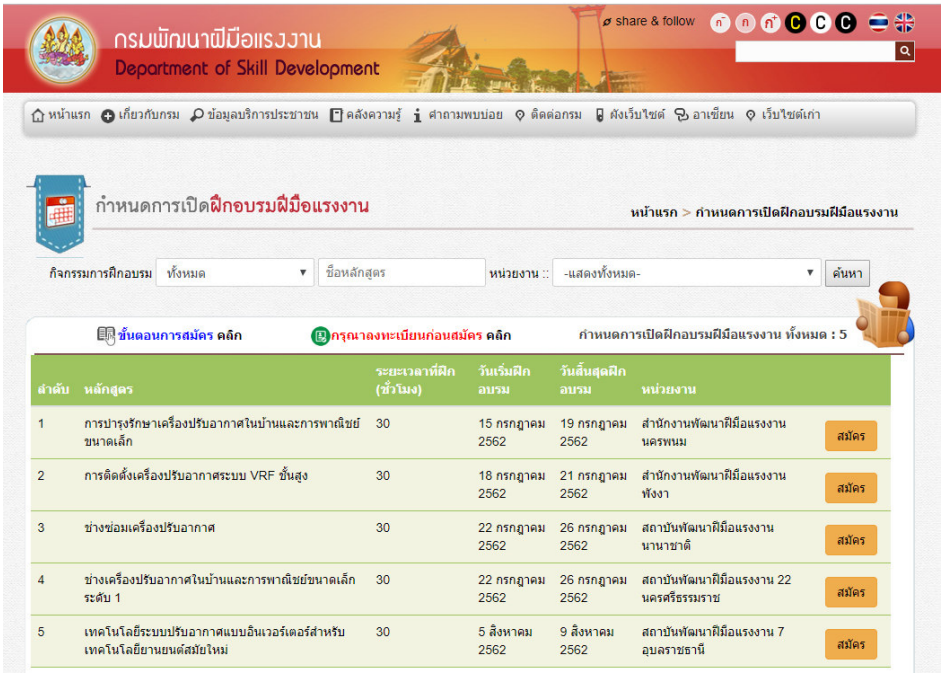


Figure 4.28 Searching for training programs

Figure 4.29 Training programs

4.4.2 Provide an annual health check for the driver and relevant staff who may be in contact with goods, which is in addition to Q Mark on serious contagious diseases or nasty infectious diseases or carriers of contagious diseases according to the announcement of Ministry of Public Health

Transport operator should provide truck drivers and relevant staff with an annual health check to reduce risks and prevent any contamination of germs from staff to goods. This is in accordance with Q Cold Chain standards. Thus, truck drivers and relevant staff who may be in contact with goods must have a health check on serious contagious diseases or nasty infectious diseases or being a carrier of contagious diseases, as specified by the Ministry of Public Health. For example;

- Leprosy
- Serious stage of Tuberculosis
- Elephantiasis
- Nasty skin diseases

Transport operator should ensure that the aforementioned diseases are included in the annual health check. This is to prevent contamination of such diseases from staff to consumers via goods, as well as protecting the organization image.

4.4.3 Have a guideline for managing the incidents when the driver or relevant staff who may have contact with goods are diagnosed of digestive or respiratory diseases. They should be refrained from the role that involves goods contact

Transport operator should have a guideline in managing truck drivers or relevant staff that may have goods contact, who are diagnosed with digestive or respiratory diseases. They should be refrained from the roles that may be in contact with goods. This is in line with requirement 4.3 of Q Cold Chain standards.

Transport operator should have a guideline for managing staff who are sick and have to work in goods transportation. The operator should have a clear announcement or a clear practice, and inform the drivers and relevant staff accordingly. When truck drivers or staff who are in contact with goods are diagnosed with digestive diseases such as diarrhea and repiratory diseases, they must be refrained from the role that is related to goods contact. Sample Document 9

Sample Document 9 Example of hygiene regulation

Operating hygiene regulations

Day/Month/Year

Recently, The company has a policy to accept temperature-controlled products. Most of these products are consumer food. In the delivery, the company has specified that the products are packed according to the specified system and standards to prevent contamination and direct contact with the product. In order to create a good standard of delivery, regulations have been established regarding hygiene in the workplace as follows:

1. All employees involved in the delivery service such as

- Product inspection staff
- Product loading staff
- Driver
- Joint venture employees

Should maintain their own hygiene such as hair, beard, nails, cleanliness of uniform to be in a clean and tidy condition, and is in the regulations set by the company

2. Employees according to item 1, if found to have symptoms or sick with a skin contagious disease or respiratory and/or other digestive system, do not working in contact with the product immediately and inform the head of the department or safety agency to send treatment and/or switch operations until there is evidence confirming from the doctor that the treatment has been cured

3. In case that the employee under item 1 has flu symptoms, cough, runny nose, they are required to wear a mask every time they work.

4.After eating and/or using bathroom, employees should wash their hands with soap or hand sanitizer every time before returning to work

Announced for cooperation to strictly follow

Signature

(.....)

Quality control manager

5

Accreditation application

5.1 Accreditation applicant

As Cold Chain Quality Standard for Truck Operation (Q Cold Chain) is developed further from Quality Service Standard for Truck Operation (Q Mark), transport operators who want to be accredited can be classified into two groups as follows:

1) The operator seeking for the Q Cold Chain accreditation must be Q Mark accredited or in the process of Q Mark accreditation application.
2) In case that the applicant has not yet been Q Mark accredited, the person can apply for Q Mark and Q Cold Chain accreditation at the same time.

5.2 Application documents

1) Transport operator who has been Q Mark accredited should have the following documents for the application:
    - Q Cold Chain accreditation application form
    - Q Cold Chain self-assessment form
    - Non-fixed route transport and private transport license in accordance with Land Transport Act, BE 2522 (1979).
2) Transport operator who has not been Q Mark accredited must prepare the following documents:
    - Q Mark accreditation application form
    - Q Mark self-assessment form
    - Q Cold Chain accreditation application form
    - Q Cold Chain self-assessment form
      Non-fixed route transport and private transport license in accordance with Land Transport Act, BE 2522 (1979).

5.3 Accreditation application process

The accreditation process is comprised of the following stages (Figure 5.1):

1) The applicant completes the application and the self-assessment forms
2) Apply at Freight Transport Bureau, or Provincial Land Transport office, Department of Land Transport or via the website: http://www.thaitruckcenter.com/tdsc
3) Freight Transport Bureau, Department of Land Transport will do the preliminary qualification check
4) Department of Land Transport forwards the application to the Inspection Body (IB) to evaluate the applicant.
5) IB contacts the applicant.
6) IB informs the applicant about the audit panel members and the date for audit with audit fees.
7) The auditors carry out the audit on site and report the result to the applicant.
8) IB reports the results to Department of Land Transport.
9) Freight Transport Bureau, Department of Land Transport reports the results to the Q Mark committee for consideration.
10) Q Mark committee approves the audit result

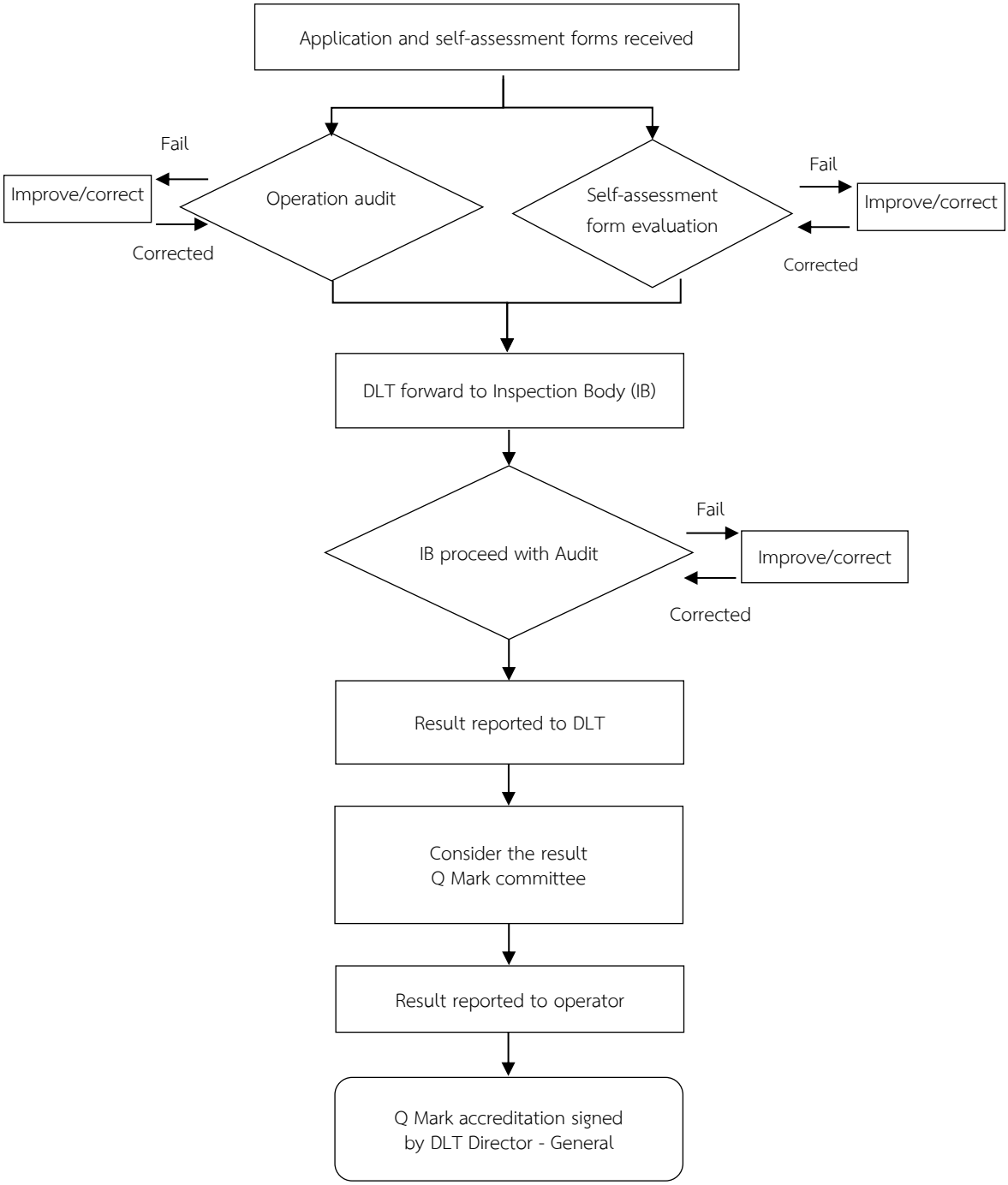


Figure 5.1 Accreditation application procedures for Q Cold Chain Standard

5.4 Audit

When auditing, Department of Land Transport will choose Inspection Body (IB) to proceed with the audit. The exception is when DLT believes that the audit of a particular applicant is complicated or has some issues, it may carry out the audit by itself. When the IB is assigned the audit task from DLT, it should coordinate with the applicant about the audit document preparation, date of audit, audit team, and audit fees.

Inspection Body (IB) refers to the legal entity enlisted by DLT to carry out Q Cold Chain evaluation**.**

Auditor is the person with appropriate qualifications, enlisted by DLT as an auditor to carry out the Q Cold Chain audit.

The IB audits the transport opetator who applies for the accreditation and reports the result to DLT. Then, Q Mark committee will consider approving the audit result. The auditor must maintain the confidentiality of each applicant.

The IB reports the result to the applicant with utmost fairness and just. The report must be reported to DLT and the transport operator so that the operator can use the result as a guideline for further improvement.

During auditing, the auditor must check for relevant evidence such as operation plan and implementation plan to ensure that the applicant has a good plan that is constantly implemented. This will ensure that the applicant can follow and maintain their operations in accordance with the Q Cold Chain standards.

5.5 Logos

When accredited for Q Cold Chain, the transport operator has the rights to use Q Cold Chain logos as specified by Department of Land Transport on its trucks and/or to promote its company. The logos are as Figure 5.2.

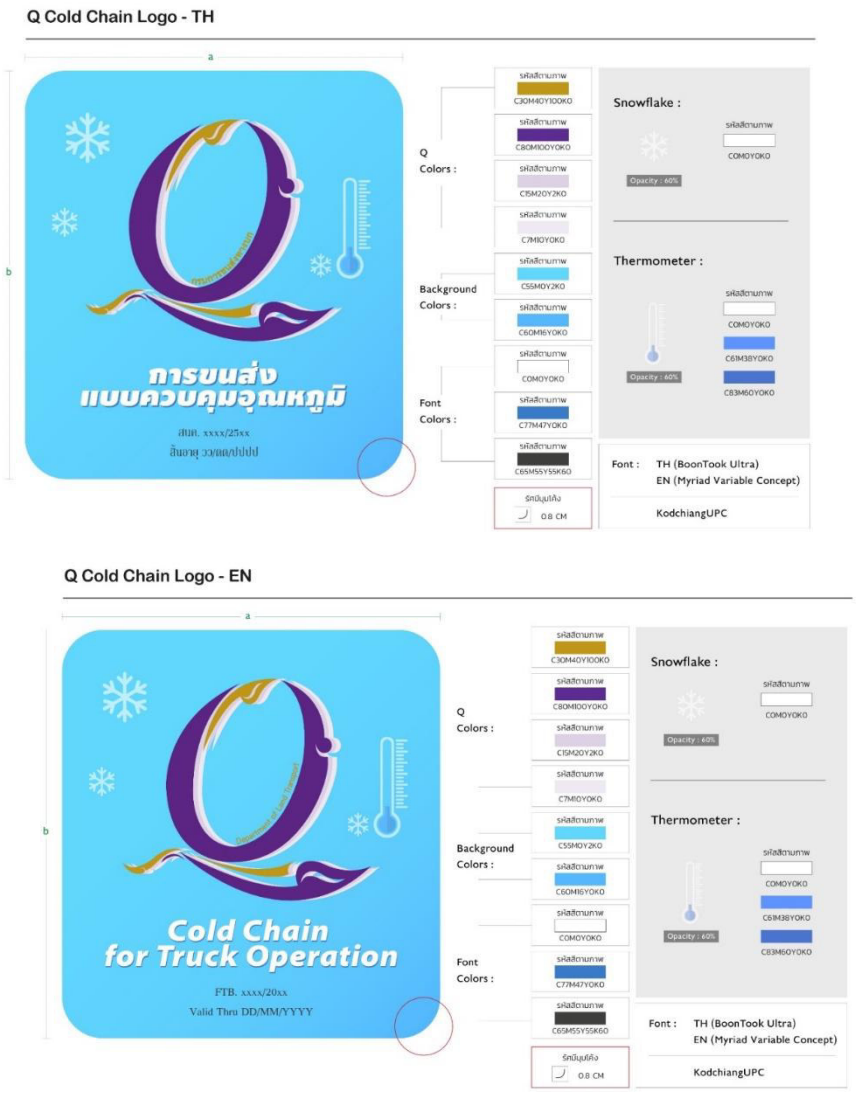


Figure 5.2 Q Cold Chain Standards Logo

5.6 Accreditation certificate

The example of the Q Cold Chain accreditation certificate is as Figure 5.3.

Figure 5.3 Q Cold Chain Standard Accreditation Certificate

5.7 Accreditation duration

Q Cold Chain accreditation lasts 3 years from the issue date of the ceritifcate. The accreditation will terminate when:

- Q Mark accreditation certificate is expired and not extended.
- Q Cold Chain accreditation certificate is expired and not extended.
- Q Mark accredited operator does not get an accreditation extension approval.
- Q Cold Chain accredited operator does not get an accreditation extension approval.
- Q Mark accreditation certificate is revoked.
- Q Cold Chain accreditation certificate is revoked.
- The accreditee has their transport operation license revoked or fails to get the transport license extended. Also, the accreditee has their transport license expired or fails to extend their license.

Appendix

Q Cold Chain Application and Self-Assessment Forms

Staff Only

Reference number .....

Application
for Cold Chain Quality Standard
for Truck Operation (Q Cold Chain)
Department of Land Transport

Documents required

☐ Copy of non-fixed route transport license

☐ Copy of private transport license

☐ Self-Assessment Form for Cold Chain Quality Standard for Truck Operation

1. Company's name (Thai) .....

(English) .....

Address .....

Tel. ..... Fax ..... E-mail .....

Web address .....

2. Location for audit .....

.....

3. Chief executive officer Name (Mr. /Mrs./Ms.) .....

.....

Tel. ..... Fax ..... E-mail .....

4. Coordinator Name (Mr. /Mrs./Ms.)

Position .....

Tel. ..... Fax ..... E-mail .....

5. Details of the business

Legal establishment date .....

Registered capital ..... Million Baht Number of employees .....

6. Quality assurance (Q Mark, ISO, GMP, HACCP etc.)

☐ No ☐ Yes *(Please specify)* .....

7. Refrigerated vehicle type and quantity

	Diesel vehicle	CNG vehicle
☐ Heavy truck (more than 10-wheeled)	.....	.....
☐ Light truck (6-wheeled)	.....	.....
☐ Small truck (4-wheeled)	.....	.....
☐ Semi trailer truck	.....	.....
☐ Trailer	.....	.....
☐ Other *(Please specify)*.....	.....	.....
☐ Other *(Please specify)*.....	.....	.....

8. Product type for refrigerated transport (*can choose more than 1*)

☐ Vegetable and fruit
☐ Processed food products
☐ Ice-cream
☐ Meat
☐ Bakery
☐ Aquatic animal
☐ Cut flowers or foliage
☐ Halal food product
☐ Ready-to-cook or ready-to-eat food
☐ Product
☐ Processed seafood products
☐ Other *(Please specify)*.....

9. Other services besides transportation services

☐ Warehouse
☐ Customs service
☐ Sorting
☐ Other (Please specify).....

I hereby certify that the information provided in the application for certification is correct. And I understand that if during the process of considering the Cold Chain Quality Standard for Truck Operation, there is any information that is deviated from what I have provided. My organization will not be considered for quality assurance.

Signature .....
(.....)
Position .....
.....

** For more information, contact Department of land transport*
Tel. 02-271-8888 ext. 4706 Tel (Direct) 02-271-8490
www.thaitruckcenter.com

Department of Land Transport
Self-Assessment
Cold Chain Quality Standard for Truck Operation (Q Cold Chain)

Part 1 General information

Company's name (Thai).....
(English).....
Address.....
Tel.....Fax.....E-mail.....
Web address.....
Coorperator Name-Surname (Mr./Mrs./Ms.) .....
Position.....
Tel.....Fax.....E-mail.....

Part 2 Self-assessment of the Cold Chain Quality Standard for Truck Operation (Q Cold Chain). By checking your organization whether it has complied with the requirements of the standard or not.

1. Transport Operation			
		Yes	No
1.1	Transport operators evaluate their competence and readiness prior to employment.	☐	☐
1.2	Transport operators have an operation manual, which specifies the overview and relations of key processes related to goods transport from order taking to delivery.	☐	☐
1.3	There is a plan for any emmergency incident.	☐	☐
	There are procedures for managing operations in case of temperature-controlled trucks or cooling unit failure during transporting.	☐	☐
	Every emergency incident is recorded and reported to the relevant parties to prevent any recurrence.	☐	☐

		Yes	No
2. Cleanliness			
2.1	Cleaning inside thr refrigerated chamber and its components appropriately and regularly	☐	☐
2.2	Disinfectants used inside a cooling unit must be hygienic and safe for goods and customers.	☐	☐
3. Refrigerated truck standard and maintenance			
3.1	The installed temperature measuring and recording devices are suitable for maintaining the temperature inside the chamber.	☐	☐
	The condotion of chamber and measuring equipment is checked.	☐	☐
3.2	There is a preventive and maintenance plan of cooling unit and temperature measuring devices and its result must be recorded	☐	☐
	The temperature is recorded throughout the transportation period.	☐	☐
4. Human Resources Development			
4.1	There is training to educate drivers and related staff on the topic of the process of transporting agricultural and food with refrigerated truck.	☐	☐
4.2	Annual health checks for drivers and employees involved in operations that may be in contact with goods are carried out in addition to the Q Mark for serious contagious or disgusting diseases or being a carrier of a communicable disease according to the notification of the Ministry of Public Health, Thailand	☐	☐
4.3	There are guidelines for handling in case that the driver or employees involved in operations that may have touched the product have symptoms of a gastrointestinal disease or diseases related to the respiratory system to refrain from performing duties related to touching the product.	☐	☐

I hereby certify that the self-assessment results are consistent with the truth in all respects.

Signature .....

(.....)

Date.....

Acknowledgments

Department of Land Transport and The College of Management, Mahidol University give an acknowledgments to

1. Merlex Transport Co., Ltd.
2. Rujoran Transport Co., Ltd
3. J M K Autopoint Limited Partnership
4. Nim See Seng Transport (1988) Co., Ltd
5. V-Serve Transport Co., Ltd
6. Inter Express Logistics Co., Ltd
7. Heritage Trans International Co., Ltd.
8. Mobile Logistics Co., Ltd. (Surapon Foods)
9. Thaisaeng Chanthaburi Logistics Co., Ltd.
10. CTI Distribution Co., Ltd.
11. Siam Aiyara Service Co., Ltd.
12. Smart Line Logistics Co., Ltd.
13. Reefer Express Co., Ltd.
14. Dynamic Logistics Co., Ltd.
15. Catering Lines Co., Ltd.

For participating as a pilot company for the Q Cold Chain inspection according to the pilot project of Cold Chain Quality standards for truck operation (Q Cold Chain) and provided useful information so that the implementation of this project was successfully accomplished.

Project Consultant

1.	Dr. Suthep Nimsai College of Management, Mahidol University	Project Leader
2.	Dr. Puwanart Fuggate Naresuan University	Agricultural technology and agricultural logistics Researcher
3.	Assoc. Prof. Dr. Chalermchai Wongs-aree King Mongkut's University of Technology Thonburi	Postharvest Technology Researcher
4.	Asst. Prof. Dr. Duangporn Arbhasil College of Management, Mahidol University	Investment Analysis Researcher
5.	Asst. Prof. Dr. Tuangyot Supeekit Faculty of Engineering, Mahidol University	Manufacturing and Systems Engineering Researcher
6.	Asst. Prof. Dr. Chanin Yoopetch College of Management, Mahidol University	Research and Analysis Researcher
7.	Asst. Prof. Dr. Phallapa Petison College of Management, Mahidol University	Marketing Researcher
8.	Assoc. Prof. Dr. Parisa Rungruang College of Management, Mahidol University	Management Researcher
9.	Dr. Narumon Seeponkai Naresuan University	Materials Engineering Researcher
10.	Mr. Saharat Arreeras Mae Fah Luang University	Logistics Management Potential Analysis Researcher
11.	Mr. Nattaphon Rangsaritvorakarn Mae Fah Luang University	Logistics and Supply Chain Management of Agricultural Products Researcher
12.	Dr. Kittichai Rajchamaha College of Management, Mahidol University	Financial and Accounting Analysis Researcher

13.	Assoc. Prof. Dr. Roengchai Tansuchat	Researcher
14.	Mr. Winit Yamlamai	Research Assistant
15.	Ms. Syamol Lumlongrut	Research Assistant
16.	Ms. Benjamas Kasemsupachote	Research Assistant
17.	Ms. Narathip Keiwkalong	Research Assistant
18.	Mr. Lertrit Wanichpongpichet	Research Assistant
19.	Mr. Piyawat Prateeprat	Research Assistant
20.	Mrs. Panida Orencia	Research Assistant

Department of Land Transport
Ministry of Transport

1032 Phaholyothin Road., Chom Phon,
Chatuchak, Bangkok 10900

Freight Transport Bureau, Department of Land Transport

Tel. +66 (0) 271 8490
email: develop_dlt@hotmail.com
www.thaitruckcenter.com/tdsc