



# Indonesia: Cold Chain Study

Operational Research in Indonesia for More Effective Control of Highly Pathogenic Avian Influenza



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Operational Research in Indonesia for More Effective  
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## **USAID | DELIVER PROJECT, Task Order 2**

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### **Abstract**

As part of the effort to control avian influenza, the Operational Research in Indonesia for More Effective Control of Highly Pathogenic Avian Influenza (OR) was designed and implemented in 16 districts in the West Java, Central Java, and Yogyakarta provinces. The OR started in mid-2008 and lasted for one year. Cold chain equipment—refrigerators, vaccine carriers, and temperature monitoring indicators—was provided to ensure proper maintenance of the cold chain and vaccine usability to the point of use. To improve vaccine and cold chain management practices at all levels of the OR vaccine distribution system, routine monitoring was also put in place. Below the district level, some identified areas of concern required further improvement and closer monitoring. It was, therefore, necessary to conduct a short study to assess the actual field practice, determine any problems along the distribution system, and recommend remedial actions that can be used as lessons learned for future vaccination program.

Cover photo: Worker administers a vaccination in the Kasihan sub-district. PATH/Jakarta contributed the photograph.

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# Acronyms

AI	avian influenza
API	Avian and Pandemic Influenza Unit
CCM	Cold Chain Monitor
FAO	Food and Agriculture Organization
HPAI	highly pathogenic avian influenza
ILRI	International Livestock Research Institute
JSI	John Snow, Inc.
KVM	Community Vaccinator Coordinator-district level
MOA-CMU	Ministry of Agriculture Campaign Management Unit
ND	Newcastle disease
NSP	National Strategic Plan
OR	Operational Research in Indonesia for More Effective Control of Highly Pathogenic Avian Influenza
ORI	Operational Research in Indonesia
PATH	[organization uses acronym only]
PT	Limited Liability Company
SOP	standard operation procedure
USAID	U.S. Agency for International Development
VM	Community Vaccinator-village level
VMC	Community Vaccinator Coordinator-sub-district level
WHO	World Health Organization



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The project staff would also like to thank Dr. Muhammad Azhar and his staff at the Ministry of Agriculture, Campaign Management Unit, as well as local personnel in the study's participating districts and the staff at PT Medion for providing access to valuable information that enabled us to conduct the study.

Our special thanks go to the project's technical staff, particularly Dr. Anton Widjaya and Vanda Moniaga, for their technical leadership and dedicated work on the study. The study was also supported by the project's management staff, including Jim Eberle, Russ Vogel, Margo Nowakowski, Diding Caturherdinwati, and Rio Chandra. We appreciate the close collaboration with our colleagues from the Food and Agriculture Organization (FAO) in Indonesia, especially Mary Young and Johan Purnama.

We are hopeful that the recommendations of this study will help the Ministry of Agriculture in Indonesia improve their cold chain management capacity and, subsequently, ensure effective and efficient vaccination campaigns to control highly pathogenic avian influenza (HPAI) outbreaks in animals.



# Executive Summary

As part of the effort to control avian influenza, the Operational Research in Indonesia for More Effectively Control of Highly Pathogenic Avian Influenza (OR) was designed and implemented in the 16 districts in the West Java, Central Java, and Yogyakarta provinces. The OR started in mid-2008 and was to last for one year. Cold chain equipment—refrigerators, vaccine carriers, and temperature monitoring indicators—was provided to ensure the cold chain and vaccine usability were properly maintained to the point of use. Routine monitoring, also put in place, improved vaccine and cold chain management practices, primarily at the district level. Below the district level, some areas of concern were identified that required further improvement and closer monitoring. It was, therefore, necessary to conduct a short study to assess the actual field practice, determine any problems in the distribution system, and recommend remedial actions that can be used as lessons learned for future vaccination program. The U.S. Agency for International Development (USAID), through the USAID | DELIVER PROJECT, provided the funding; and the OR team coordinated the implementation with the Food and Agriculture Organization (FAO), Ministry of Agriculture Campaign Management Unit (MOA-CMU), and the USAID | DELIVER PROJECT.

The cold chain study was implemented in the Gunungkidul and Bantul districts of Yogyakarta in July 2009 during the last/fourth booster campaign of the OR. The study used electronic data loggers inserted into avian influenza (AI) and Newcastle disease (ND) vaccine boxes to follow the course of vaccines from the time they left PT Medion, through the district refrigerators, through the sub-district storage, to the point of administration by vaccinators. Each data logger was programmed to record the temperature every 15 minutes; included with each logger was a recording-reporting form that study coordinators filled in with the time the vaccine arrived and left each distribution stage (district, sub-district, vaccinator). Two districts, four sub-district coordinators, and four vaccinators participated in the study, for an overall field implementation time of two weeks.

Temperature readings from the data loggers demonstrated good maintenance of 2–8°C during the three-day vaccine transport from PT Medion to the district and during storage in district refrigerators, which typically lasts from two to five days. Below the district level, the cold chain condition is more variable, with the weakest stage being storage in a domestic refrigerator at the sub-district and/or in the vaccinator's home. At this stage, five of the seven vaccine vials monitored were exposed to temperature above 8°C. Temperature monitoring and the use of monitoring indicators are almost non-existent at the sub-district and vaccinator level; this limits the ability to assess vaccine quality. Transport from the district to the sub-district, which takes one to one and a half hours, and another half hour to the vaccinator, largely depends on the quantity and quality of the cool packs inside the shipment boxes. Cool packs may have frequently been stored at above 2–8°C for 24 hours prior to use; this results in an elevated temperature beginning at the start of the shipment.

Overall, it is recommended that the cold chain management continue to be monitored at the district level, while the cold chain practices at the sub-district and vaccinator levels are monitored more closely. Vaccine transport should use cool packs that have been stored at 2–8°C for 24 hours, with an appropriate number of cool packs for the available space inside the shipment boxes. Storage in a

domestic refrigerator should be discouraged if it is functioning poorly, is not WHO-modified, or is not dedicated solely for vaccination materials; using monitoring indicators, such as Stop!Watch, and implementing a routine temperature recording system at all levels should be enforced.

# Background

Since first detected in Indonesia in mid-2004, highly pathogenic avian influenza (HPAI) has been a major focus of activity by national and international institutions. Under the government's National Strategic Plan (NSP) for Avian Influenza and Pandemic Influenza Preparedness, various interventions have been implemented to control the disease, all of which need to be evaluated to determine the most effective control measures. To do that, an Operational Research in Indonesia for More Effective Control of Highly Pathogenic Avian Influenza (OR) was designed and implemented in 16 districts in the West Java, Central Java, and Yogyakarta provinces.

Recognizing that vaccines are delicate biological substances that are sensitive to heat and freezing temperatures, a significant effort was made to maintain the correct temperature during vaccine storage and transport to the end user. A set of cold chain equipment—top-opening refrigerators, digital thermometers, and Stop!Watch monitoring indicators—was provided to each district, in addition to a vaccine carrier and a Stop!Watch for each vaccinator. Training and refresher trainings on proper cold chain and vaccine management were also provided for all district coordinators and vaccinators. All were part of the effort to ensure viability of the vaccine down to the point where it was administered.

Despite the extensive effort, field monitoring on cold chain and vaccine management at various levels of distribution and storage showed a wide variation in compliance with the vaccine management standard operating procedures (SOPs), including the type of equipment used for vaccine storage and transport below the district level. This resulted in some vaccines being discarded because of temperature violations. Intensive monitoring improved the situation, primarily at the district level, but to minimize and eliminate the risk of vaccine deterioration due to improper management, more is needed to improve monitoring and to ensure improvements of vaccine management at the sub-district vaccinator coordinator (VMC) and vaccinator (VM) levels.

A field study on cold chain and vaccine management from the manufacturer site to the end user was, therefore, necessary to assess the actual field practice, determine any problematic steps along the distribution system, and recommend remedial actions. This study was performed during the last/fourth booster campaign for OR; hopefully, the results will be used as lessons learned and recommendations for future vaccination planning.

## General Objective

To assess the current vaccine cold chain distribution system in one AI OR province.

## **Specific Objectives**

For the assessment, the following objectives were—

- to evaluate the current cold chain practice at different levels of the distribution system, from manufacturer to the end user
- to determine the weakest link/problematic steps in the vaccine cold chain distribution system
- to recommend actions that address any weaknesses identified as lessons learned for future vaccination program.

# Implementation

## Personnel

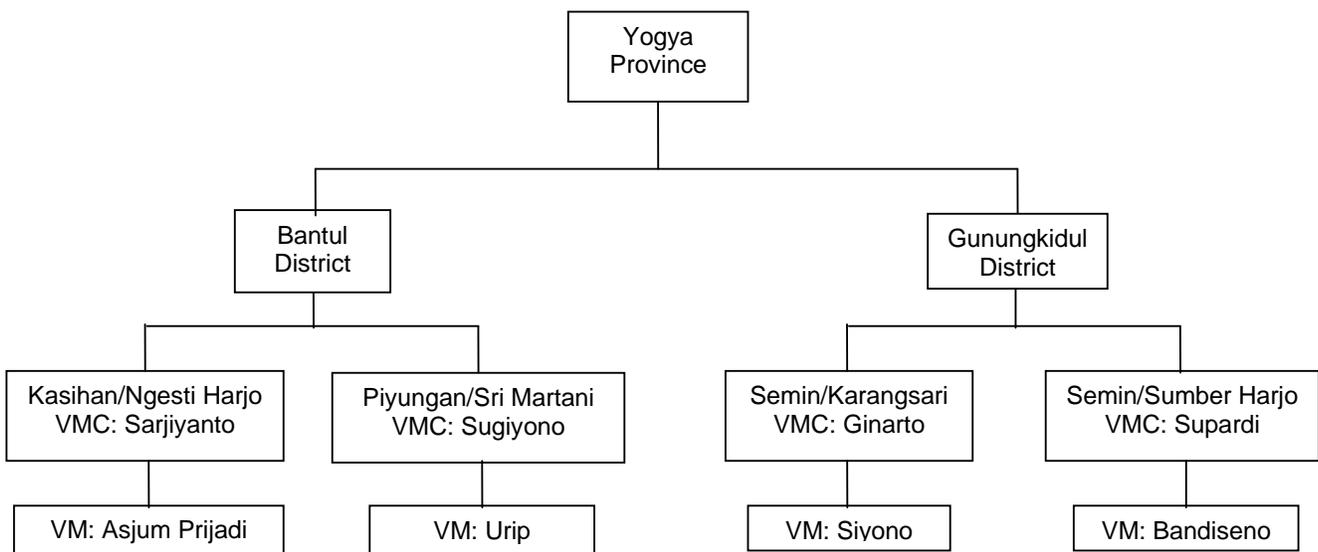
The study was done by a team whose members represent the various institutions involved in the operational research: Campaign Management Unit-Ministry of Agriculture (MOA-CMU) Republic of Indonesia, USAID | DELIVER PROJECT, FAO, and the vaccine manufacturer, PT Medion. Roles and responsibilities of each institution are outlined in the concept paper for this study.

## Study Sites

The study was performed in Yogyakarta province in two districts: Bantul and Gunungkidul. The two districts were selected based on their cold chain management—Gunungkidul implements proper cold chain management procedures, while Bantul needs to improve its cold chain management. Many vaccination sessions in Bantul occur during the day, while almost all vaccination sessions in Gunungkidul occur at night.

Within each district, two VMCs representing sub-districts that conduct AI and ND or AI vaccinations were selected; under each VMC, one VM was asked to participate in the study. Based on discussions with each related district, the sub-districts selected were Semin sub-district (implement AI and ND vaccination) in Gunungkidul, and Kasihan (implement AI and ND vaccination), and Piyungan (implement AI vaccination) sub-districts in Bantul. Figure 1 lists the study sites and participants:

Figure 1. Study Sites and Participants



## Timeline

The study was performed during the booster session of the fourth (last) campaign. Field activities started with the shipment of the vaccine to the district and ended with the vaccine use during the vaccination session, which lasted for approximately two weeks. The entire study—from proposal preparation, field coordination, and pre-conditioning, to results analysis and reporting—took three months. Table 1 lists the activities and timeline:

**Table 1. Timeline of Activities**

Activity	2009																	
	Apr	May Week				June Date											July Wk	
		1	2	3	4	8	9	10	11	12	13	14	15	16	17	18	19	1
<b>1. Preparation</b>																		
• preliminary discussion	■																	
• study protocol finalization	■																	
• approvals and coordination		■																
<b>2. Pre-conditioning meeting</b>																		
• meeting w/ Medion			■															
• meeting w/ KVM, VMC, VM				■														
<b>3. Implementation</b>																		
• shipment from Medion						■	■											
• district storage										■								
• district to sub-district (VMC) transport											■		■					
• VMC storage (monitoring by study team)											■	■	■					
• VMC to VM transport												■	■					
• VM storage and use													■	■				
• monitoring										■	■		■	■				
• collection of data logger														■	■			
<b>4. Data analysis and reporting</b>																		■

# Materials and Methods

## Methods

During the study, electronic data loggers were used to record the temperature that the vaccines were exposed to from the time they were packed into shipment boxes at the vaccine manufacturer until they were used in the vaccination session. Cold chain studies that use data loggers have been used extensively in the health field and this was the main reason for initiating improvements in the ministry of health immunization cold chain system (Nelson et al. 2004).

A data logger, programmed to record temperature every 15 minutes, was taped to the study vaccine vial, which was subsequently placed in the vaccine boxes, then transported and stored following the standard procedure used in the operational research.

The data logger followed the study vaccine through the following stages:



Each data logger was accompanied by a recording-reporting form that was completed by Medion, KVM, VMC, and VM at the Medion facility, the district, sub-district, and village levels, respectively. The form recorded the following information:

- date and time of vaccine dispatch
- date and time of vaccine receipt
- electrical power cuts (if any)
- other unusual events
- type of cool box and cooling agent used during vaccine transport, storage, and vaccination session (i.e., Coleman cooler, styrofoam box, RCW-2 vaccine carrier, Marina Cooler, other thermos and chilled water in plastic bags, Coleman cool packs, frozen ice cubes, etc.).

The information linked each stage to the temperature data to construct a complete picture of the cold chain situation throughout the vaccine distribution system.

A study team member was present at the district, sub-district, and VM level to ensure proper completion of recording-reporting forms and to participate in vaccine transport and vaccination session. After the vaccination session was complete, data loggers and forms were collected, and data were downloaded and analyzed.

## **Materials**

### **Cold chain equipment and devices**

The refrigerator (Vestfrost MK304 or MK204 or MK144), Coleman cooler/Medion styrofoam box, and vaccine carrier (Electrolux RCW2) were used to store and transport vaccine during the OR. No new storage or transport equipment was introduced.

### **Vaccine**

Monitoring was done on AI and ND vaccines manufactured by PT Medion, which were used in the OR. The study monitored one vial of AI and one vial of ND at each of the participating VMs. A total of four vials of AI and three vials of ND were monitored.

### **Data Logger**

An electronic data logger, Tiny TTM™<sup>1</sup>, was used to monitor the temperature the vaccine was exposed to during the study. A Tiny TTM temperature data logger is a single sensor logger small enough to fit inside a 35-mm film case. It can store 1,800 readings during lengthy time intervals, supplied in multiples of one second, up to a maximum of four and a half hours. It uses a thermistor to accurately record temperatures over  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

A total of seven Tiny TTM data loggers were used to monitor four vials of AI vaccine and three vials of ND vaccine at the four participating VMs. The serial number for each data logger is listed in table 2.

### **Stop!Watch<sup>2</sup>**

Stop!Watch is a temperature indicator for heat and cold exposure. It has two monitoring features, i.e., MonitorMark, a cumulative heat exposure monitor, and Freeze-tag, a freeze indicator. MonitorMark displays five different white-colored windows that change to blue when exposed to temperatures above the threshold. Freeze-Tag shows a cross (X) sign if it is exposed to subzero temperature for one hour.

### **Recording and reporting form**

A copy of recording and reporting form is provided in annex 2.

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<sup>1</sup> TinyTTM™ is a trademark of Remonsys, Ltd., United Kingdom.

<sup>2</sup> Stop!Watch is a trademark of Berlinger & Co. AG, Switzerland.

# Results and Discussion

Table 2 shows a summary of the temperature at each stage of distribution:

**Table 2. Temperature Summary Result**

TTM serial #	Vaccine	District/ Sub-District/ Village	Results	Transport from Medion to District*	Storage at District*	Transport from District to VMC	Storage at VMC*	Transport from VMC to VM	Storage at VM*	Vacc. Session	Note	
257009	AI	Gnkidul/Semin/ Karangsari	Temp. range (°C)	4.3–6.2	4.3–8.0	4.6–10.2	6.9–7.7	5.0–7.7		19.1–27.0	VMC: Coleman cooler VM: RCW2	
			Time period (hrs)	47.5	118.5	1	5	2		1.25		
237299		Gnkidul/Semin/ Sumber Harjo	Temp. range (°C)	3.9–6.5	4.3–8.4	7.3–9.1	9.1–9.9	1.1–6.9		18.8–23.7	VMC: Coleman cooler VM: RCW2	
			Time period (hrs)	48	118.5	1.5	5	3.5		0.5		
257180		Bantul/ Piyungan/Sri Martani	Temp. range (°C)	4.6–6.9	4.3–7.3	9.9–13.8	6.2–12.0	no VM storage.		25.9–34.9	VMC: modified domestic refrig. at puskesmas. VM picked up vaccine and used immediately	
			Time period (hrs)	71	48	1	48	0		1		
t220946		Bantul/Kasihah/ Ngesti Harjo	Temp. range (°C)	4.3–6.2	3.9–6.2	11.0–13.5	10.6–14.9	13.5 - 17.7	16.0–17.7	24.8–30.3	VMC: vacc.stayed in shipm.box VM: domestic refrigerator	
			Time period (hrs)	71	95	0.5	3	0.5	20	0.5		
257012		ND	Gnkidul/Semin/ Karangsari	Temp. range (°C)	1.9–5.8	2.3–3.9	3.5–8.0	neg 11.8 - neg 4.9	neg 4.9–pos 8.8		20.6–23.7	VMC: freezer VM: RCW2
				Time period (hrs)	47.5	118.5	1	5	2		0.75	
237663			Gnkidul/Semin/	Temp. range (°C)	1.9–5.4	1.9–4.3	8.8–10.6	8.8–11.7	1.9–6.2		19.8–23.4	VMC:

	Sumber Harjo	Time period (hrs)	47.5	118.5	1.5	5.25	3.5		0.5	Coleman cooler VM: RCW2
257175	Bantul/Kasihah/ Ngesti Harjo	Temp. range (°C)	2.7–7.3	3.1–3.9	12.0–15.3	8.4–16.0	17.0–17.4	14.5–17.4	14.9–24.8	VMC: vacc.stayed in shipm.box
		Time period (hrs)	71	95	0.5	3	0.5	20	0.5	VM: domestic refrigerator

\*Note: The temperature range for the vaccine excludes a one-hour stabilization period immediately following placement into a refrigerator/Coleman cooler.

## **Vaccine transport from PT Medion to the district**

Vaccine transport from PT Medion in Bandung, West Java, to the two study districts in Yogyakarta was by road in a refrigerated truck that took two days for Gunungkidul and three days for Bantul. The temperature was carefully maintained in the refrigerated truck; the resulting temperature was 1.9–7.3°C. The Q-tag monitoring indicator showed good maintenance of the cold chain, as well.

## **Vaccine storage at the district**

At the district, the vaccine was stored in a top-opening refrigerator that had been regularly maintained and monitored. The digital thermometer and Stop!Watch showed good functioning of the refrigerator, which is supported by the data logger record of temperature ranging between 1.9–8.4°C. A temperature of 8.4°C was recorded only once and that was 75 minutes after the vaccine was loaded into the district refrigerator. An analysis of the temperature data had actually excluded one hour after the vaccine was loaded into the refrigerator so the analysis was done on temperature that was already stable. A recording of one temperature above 8°C illustrates the importance of minimizing frequent or prolonged door opening because it takes at least one hour for temperature to return to 2–8°C.

On average, vaccine was stored at the district for 2–5 days. This was reported by the district coordinator as the typical length of storage period at the district level during this research.

## **Vaccine transport from district to sub-district (VMC level)**

Vaccine transport used the same styrofoam box and the same chilled water in plastic bags that PT Medion used to transport vaccine to the districts. Transport was by car or motorcycle and travel time was 1–1.5 hours, which is similar throughout all 16 OR districts. The temperature maintained in the shipment boxes largely depends on the quantity and quality of the cool packs inside. In this study, six to eight cool packs resulted in a temperature of 10–15°C; 12 cool packs barely maintained the 2–8°C in shipment boxes. This is contradictory to the temperature maintained during shipment from PT Medion to the district with only eight cool packs; this raises a question as to whether the cool packs used for shipment to the VMCs were chilled at 2–8°C for 24 hours per SOP. It is clear that the more cool packs in the shipment boxes, the better, but the quantity will need to be balanced with the amount of space available. Using Stop!Watch during shipment will also assist in monitoring the cold chain condition. It needs to be emphasized that using cool packs from a previous transport leg cannot be allowed because the cool packs, despite feeling cold to the touch, will not be at the right temperature.

## **Vaccine storage at the sub-district (VMC level)**

A variety of methods were used for storage at the sub-district level, including a modified domestic refrigerator that is specifically dedicated for vaccine, housed in an animal health center, freezer (for ND vaccine), Coleman cooler, or styrofoam box. All these are acceptable if certain requirements are met: for a domestic refrigerator, it must maintain a temperature of 2–8°C, be modified per WHO's recommendation, and be dedicated for vaccine use to minimize frequent door opening. The freezer should only be used to store ND vaccine; Coleman coolers and styrofoam boxes should be equipped with a sufficient quality of cool packs, replaced daily, and in a quantity that is appropriate for the available space in a Coleman cooler/styrofoam box.

In this study, 2–8°C was not achieved in the domestic refrigerator at Piyungan animal health center, or in the Coleman cooler/styrofoam box used for sub-district VMC storage. Stop!Watch as a temperature indicator was used inconsistently at the VMC level.

It is also observed that Coleman cool packs provide longer cold life than chilled water in plastic bags. The quantity of Coleman cool packs that was provided, therefore, needs to be uniformly distributed as a set with the Coleman cooler.

The storage period at the VMC level varies from three hours to two days. This great variation represents the condition throughout the 16 districts in the OR, from as little as zero to a few hours in some parts of Central Java to as long as two to three weeks in Indramayu district, West Java.

### **Vaccine transport from VMC to VM, and storage at VM level**

Below the sub-district level, there is a measurable variability. Distance from the sub-district, and the availability of a refrigerator at the vaccinator's home are some issues that determine the vaccine transport and storage arrangement at the VM level. In Gunungkidul, each vaccinator picks up the vaccine in their RCW2 vaccine carrier, then stores it for a few hours in the same vaccine carrier before using it for vaccinations the same evening. This practice provides optimum cold chain performance with a maximum temperature of 8.8°C, only slightly above 8.0°C. It is assumed that the RCW2 cool packs had been chilled to the right temperature to maintain the expected cold life.

In Bantul district, one vaccinator in Kasihan sub-district stores the vaccine for up to 20 hours in his domestic refrigerator at home, mixed with his household goods. Another vaccinator in Piyungan sub-district does not store vaccine but uses the Medion styrofoam box to transport the vaccine from the VMC, transfers it to his RCW2 vaccine carrier, and uses it immediately. In this study, in Piyungan sub-district, the temperature in the styrofoam box was 13.5–17.7°C, which may be due to the insufficient quantity of cool packs and/or temperature of cool packs that may not have been stored at 2–8°C for 24 hours. It also needs to be emphasized that cool packs from previous transport legs should not be used again because the cool packs will no longer be at the correct temperature.

In this study, the unmodified domestic refrigerator that was not dedicated for vaccine in one vaccinator's home in the Kasihan sub-district was unable to maintain the expected temperature of 2–8°C. Instead, the data logger recorded a temperature of 14.5–17.7°C throughout the 20-hour storage.

The vaccinator also did not use Stop!Watch as an indicator so the quality of vaccine stored there is in question. It is important that any domestic refrigerator that is used for vaccine storage be modified and dedicated for vaccine storage. Another option would be to use Coleman cooler or styrofoam box with a daily exchange of sufficient quantity and quality of cool packs. Stop!Watch as a monitoring indicator should also be included.

### **Vaccination session**

In this study, all seven vaccinators carried their vaccine in RCW2 vaccine carrier; they finished using one vial in approximately two hours. During the vaccination session, the vial in use is kept outside the vaccine carrier (14.9–34.9°C), while the other vials stay inside the vaccine carrier.

# Conclusion and Recommendation

- The required temperature of 2–8°C can be maintained during vaccine transport from PT Medion to the district and during vaccine storage at the district.
- The weakest stage is during vaccine transport from the district down and during storage at the VMC and VM levels. Temperature can be maintained during vaccine transport to the VMC level using cool packs that have been stored at 2–8°C for 24 hours, or by including more cool packs in the shipment box, always balancing the quantity of cool packs and the available space in the shipment box.
- Using a domestic refrigerator for vaccine storage at the VMC and VM level is acceptable if the refrigerator is able to maintain 2–8°C, is modified per WHO recommendations, and dedicated for vaccine use.
- Use of Coleman cooler/styrofoam box for vaccine storage at the VMC and VM level is acceptable if the cooler/styrofoam box is filled with a sufficient quantity of cool packs that have been cooled at 2–8°C for 24 hours and are exchanged daily. Theoretically, the quantity of cool packs as recommended in the training for operational research is adequate, if they are at 2–8°C.
- Monitoring indicators, such as Stop!Watch, are necessary for all stages of transport and storage. Recognizing that the cold chain monitor (CCM) part of Stop!Watch measures cumulative heat exposure, this means that the Stop!Watch must be kept constantly at 2–8°C, or the CCM part will no longer be relevant. The Stop!Watch also needs to be replaced regularly if the CCM part is to be relevant.



# References

Nelson, Carib M., Hariadi Wibisono, Hary Purwanto, Isa Mansyur, Vanda Moniaga, and Anton Widjaya. February 2004. "Hepatitis B vaccine freezing in the Indonesian cold chain: evidence and solutions." *Bulletin of the World Health Organization* (2004) 82:99–105. Geneva: World Health Organization.

World Health Organization. 2001. "Study Protocol for Temperature Monitoring in the Vaccine Cold Chain." *WHO/IVB/05.01*. Geneva: World Health Organization.



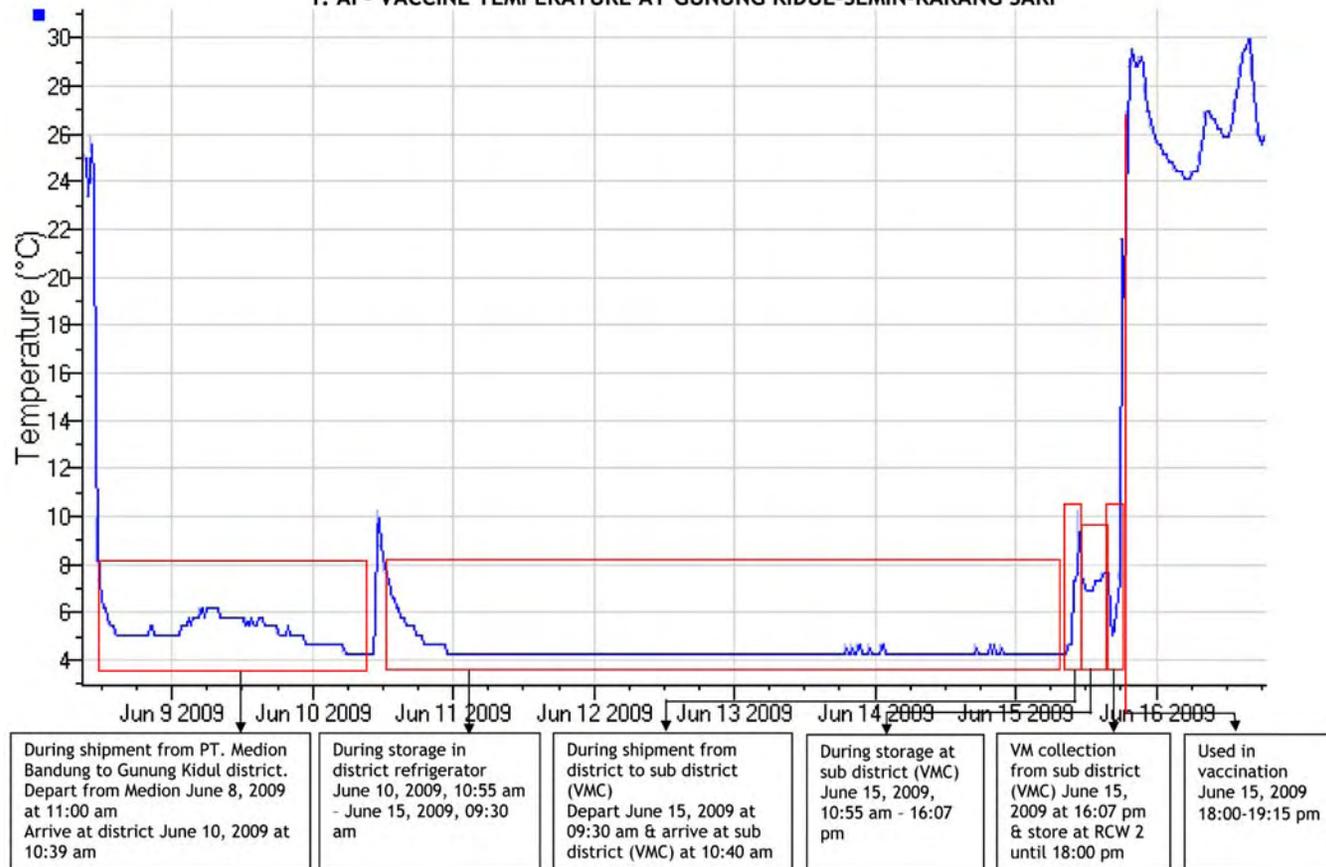
# Annex I

## TTM output graphs

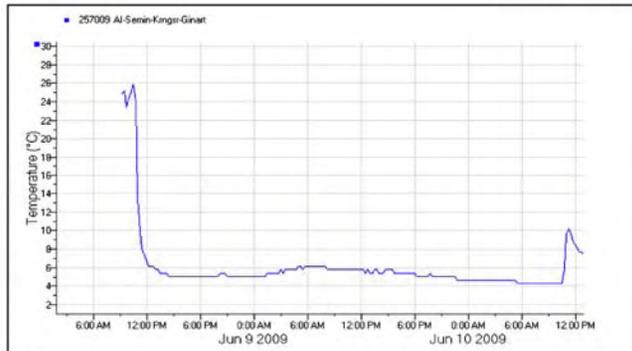
1. AI vaccine temperature at Karang Sari subdistrict, Gunung Kidul district
2. AI vaccine temperature at Karang Sari subdistrict, Gunung Kidul district according to distribution stages
3. ND vaccine temperature at Karang Sari subdistrict, Gunung Kidul district
4. ND vaccine temperature at Karang Sari subdistrict, Gunung Kidul district according to distribution stages
5. AI vaccine temperature at Sumber Harjo subdistrict, Gunung Kidul district
6. AI vaccine temperature at Sumber Harjo subdistrict, Gunung Kidul district according to distribution stages
7. ND vaccine temperature at Sumber Harjo subdistrict, Gunung Kidul district
8. ND vaccine temperature at Sumber Harjo subdistrict, Gunung Kidul district according to distribution stages
9. AI vaccine temperature at Piyungan subdistrict, Bantul district
10. AI vaccine temperature at Piyungan subdistrict, Bantul district according to distribution stages
11. AI vaccine temperature at Kasihan subdistrict, Bantul district
12. AI vaccine temperature at Kasihan subdistrict, Bantul district according to distribution stages
13. ND vaccine temperature at Kasihan subdistrict, Bantul district
14. ND vaccine temperature at Kasihan subdistrict, Bantul district according to distribution stages

■ 257009 Al-Semin-Krngsr-Ginat

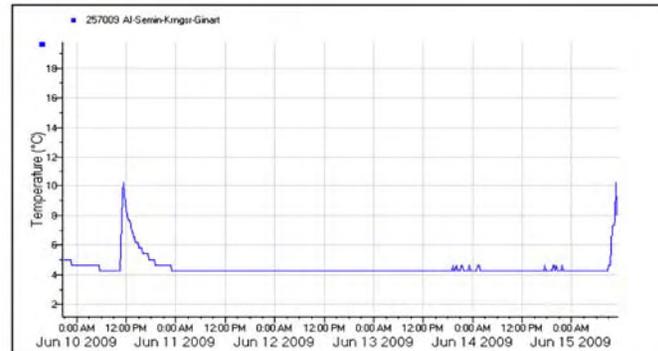
1. AI - VACCINE TEMPERATURE AT GUNUNG KIDUL-SEMIN-KARANG SARI



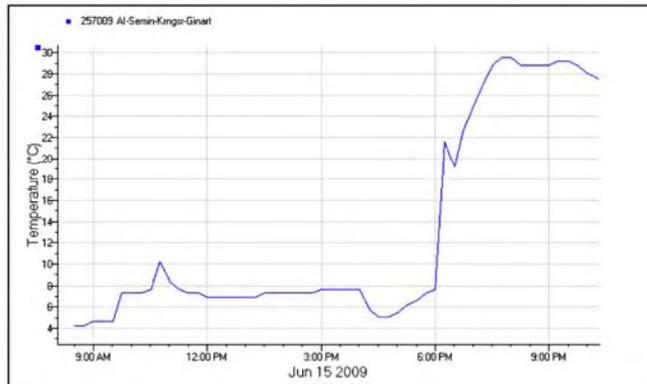
## 2. AI-VACCINE TEMPERATURE AT GUNUNG KIDUL-SEMIN-KARANGSARI ACCORDING TO DISTRIBUTION STAGES



During shipment from PT. Medion Bandung to Gunung Kidul district.  
Depart from Medion June 8, 2009 at 11:00 am.  
Arrive at district June 10 2009 at 10:39 am.



During storage in district refrigerator  
June 10, 2009 10:55 am - June 15, 2009 09:30 am.



During shipment from district to sub district (VMC)  
Depart June 15 2009 at 09:30 am & arrive at sub district (VMC) at 10:40 am.

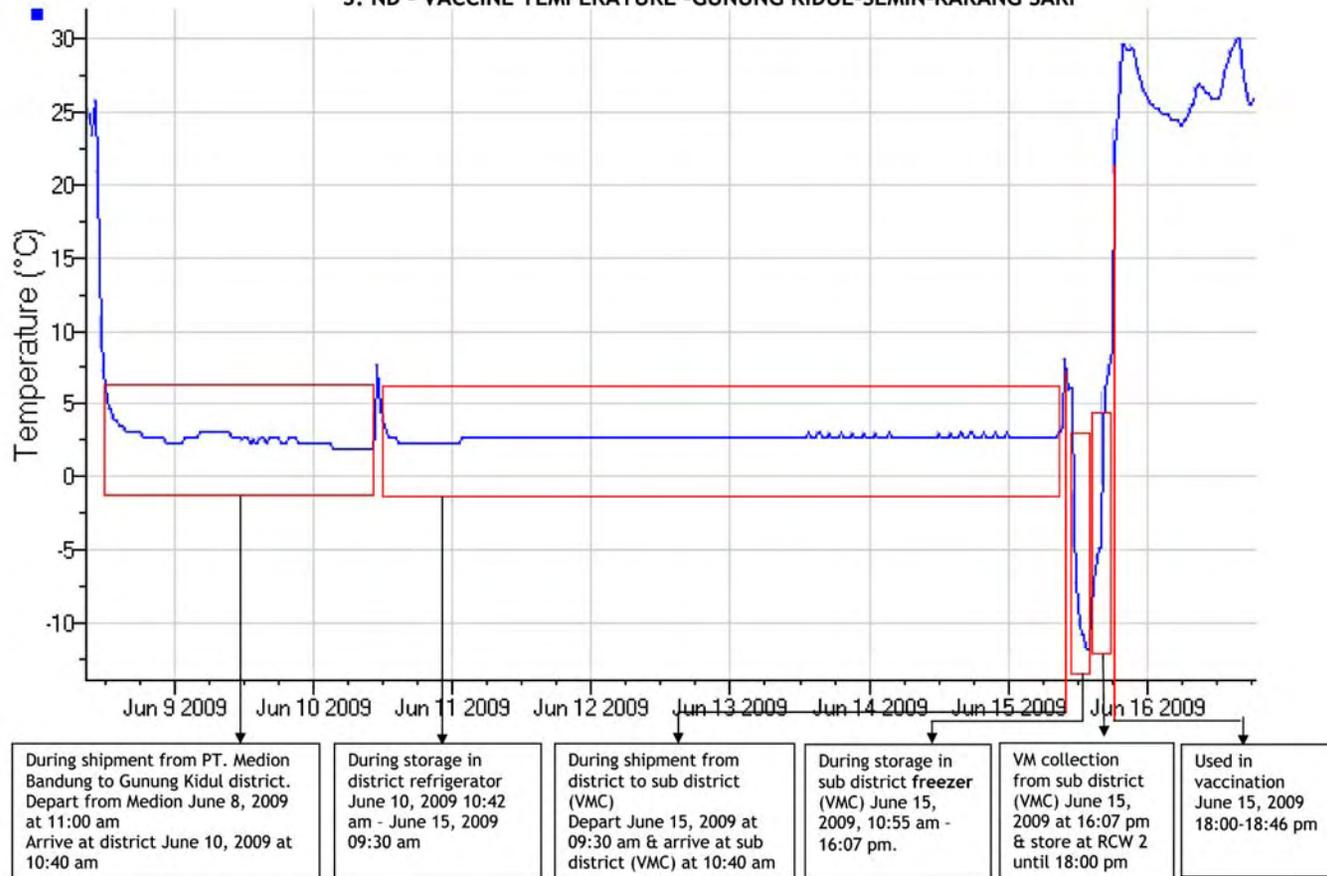
During storage at sub district (VMC) June 15, 2009, 10:55 am - 16:07 pm.

VM collection from sub district (VMC) June 15, 2009 at 16:07 pm & store at RCW 2 until 18:00 pm.

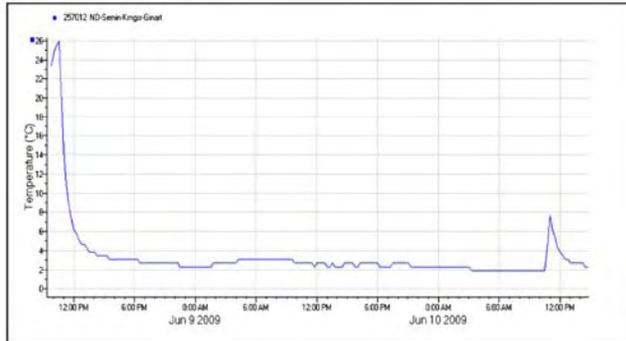
Used in vaccination June 15, 2009 18:00-19:15 pm.

■ 257012 ND-Semin-Krngrsr-Ginart

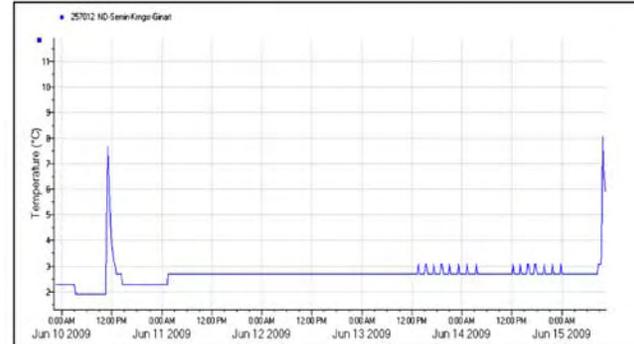
### 3. ND - VACCINE TEMPERATURE -GUNUNG KIDUL-SEMIN-KARANG SARI



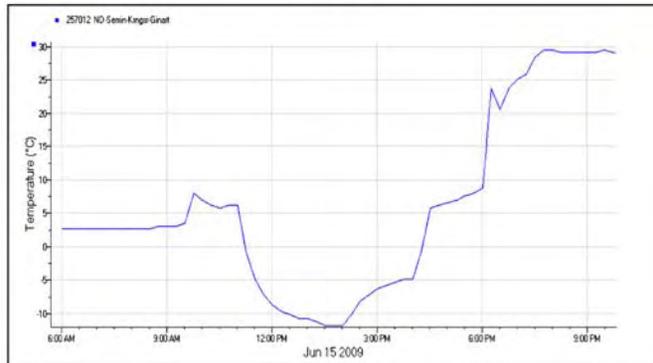
#### 4. ND-VACCINE TEMPERATURE AT GUNUNG KIDUL-SEMIN-KARANGSARI ACCORDING TO DISTRIBUTION STAGES



**During shipment from PT. Medion Bandung to Gunung Kidul district.**  
Depart from Medion June 8, 2009 at 11:00 am.  
Arrive at district June 10, 2009 at 10:40 am.



**During storage in district refrigerator**  
June 10, 2009, 10:42 am - June 15, 2009, 09:30 am



**During shipment from district to sub district (VMC)**  
Depart June 15, 2009 at 09:30 am & arrive at sub district (VMC) at 10:40 am.

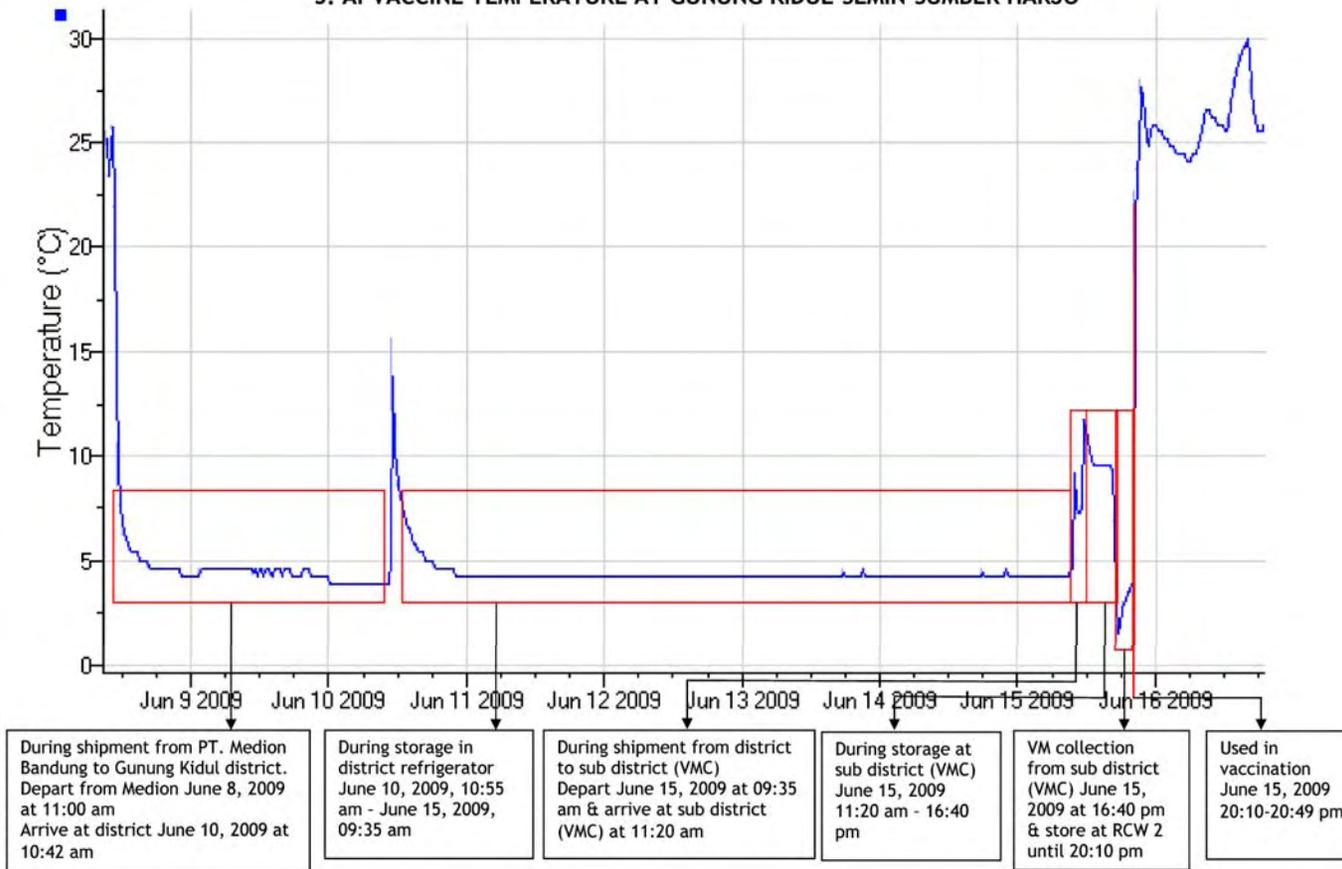
**During storage in sub district FREEZER (VMC)** June 15, 2009, 10:55 am - 16:07 pm.

**VM collection from sub district (VMC)** June 15, 2009 at 16:07 pm & store at RCW 2 until 18:00 pm.

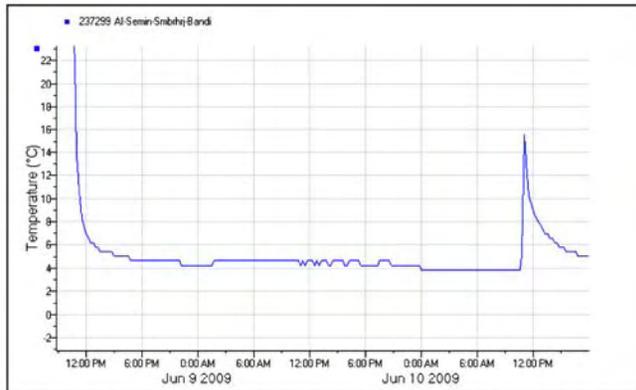
**Used in vaccination** June 15, 2009 18:00-18:46 pm.

■ 237299 AI-Semin-Smbrhrj-Bandi

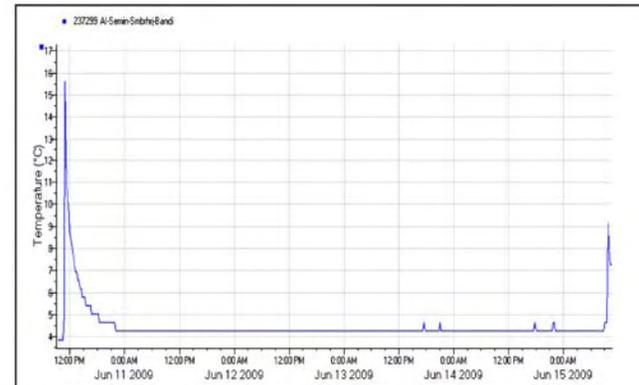
### 5. AI-VACCINE TEMPERATURE AT GUNUNG KIDUL-SEMIN-SUMBER HARJO



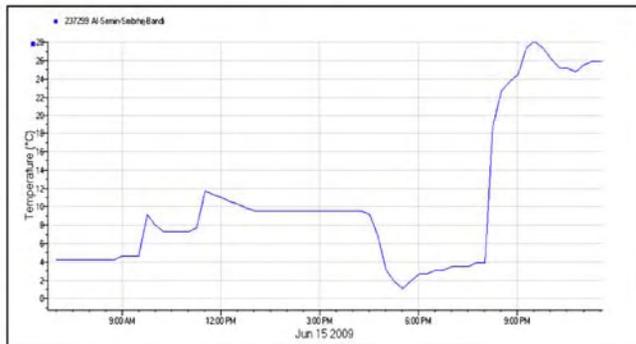
## 6. AI-VACCINE TEMPERATURE AT GUNUNG KIDUL-SEMIN-SUMBER HARJO ACCORDING TO DISTRIBUTION STAGES



**During shipment from PT. Medion Bandung to Gunung Kidul district.**  
 Depart from Medion June 8, 2009 at 11:00 am.  
 Arrive at district June 10, 2009 at 10:42 am.



**During storage in district refrigerator**  
 June 10, 2009, 10:55 am - June 15, 2009, 09:35 am.



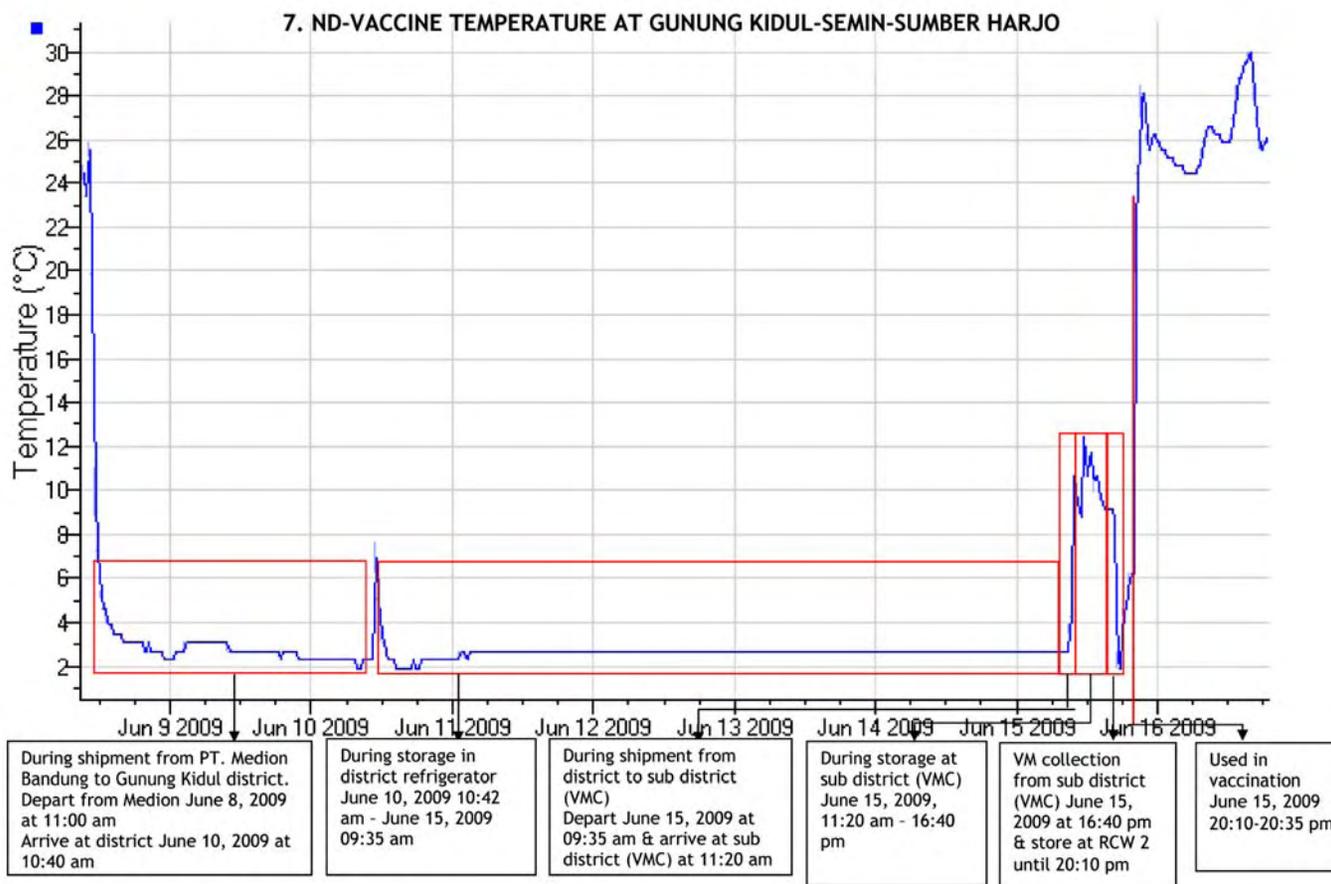
**During shipment from district to sub district (VMC)**  
 Depart June 15, 2009 at 09:35 am & arrive at sub district (VMC) at 11:20 am.

**During storage at sub district (VMC)**  
 June 15, 2009, 11:20 am - 16:40 pm.

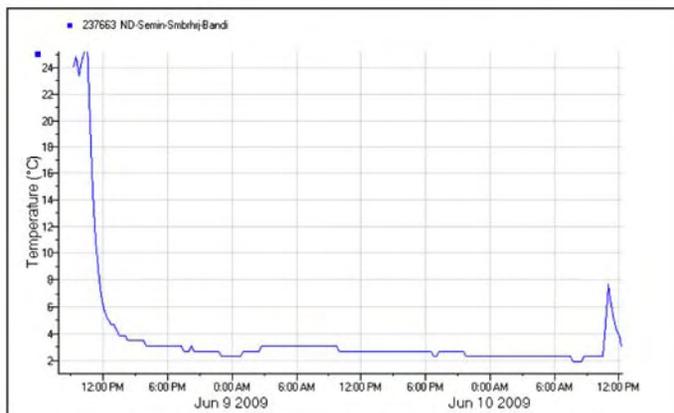
**VM collection from sub district (VMC)**  
 June 15, 2009 at 16:40 pm & store at RCW 2 until 20:10 pm

**Used in vaccination June 15, 2009 20:10-20:49 pm.**

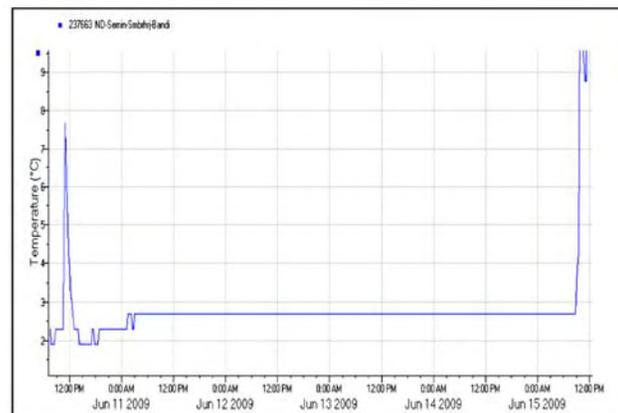
■ 237663 ND-Semin-Smbrhrj-Bandi



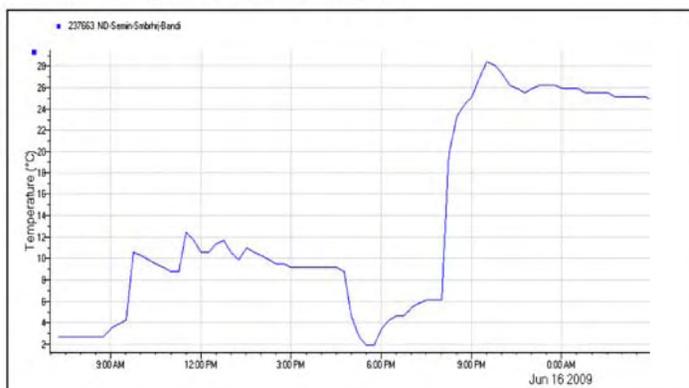
## 8. ND-VACCINE TEMPERATURE AT GUNUNG KIDUL-SEMIN-SUMBER HARJO ACCORDING TO DISTRIBUTION STAGES



**During shipment from PT. Medion Bandung to Gunung Kidul district.**  
Depart from Medion June 8, 2009 at 11:00 am.  
Arrive at district June 10, 2009 at 10:40 am.



**During storage in district refrigerator**  
June 10, 2009 10:42 am - June 15, 2009 09:35 am.



**During shipment from district to sub district (VMC)**  
Depart June 15, 2009 at 09:35 am & arrive at sub district (VMC) at 11:20 am.

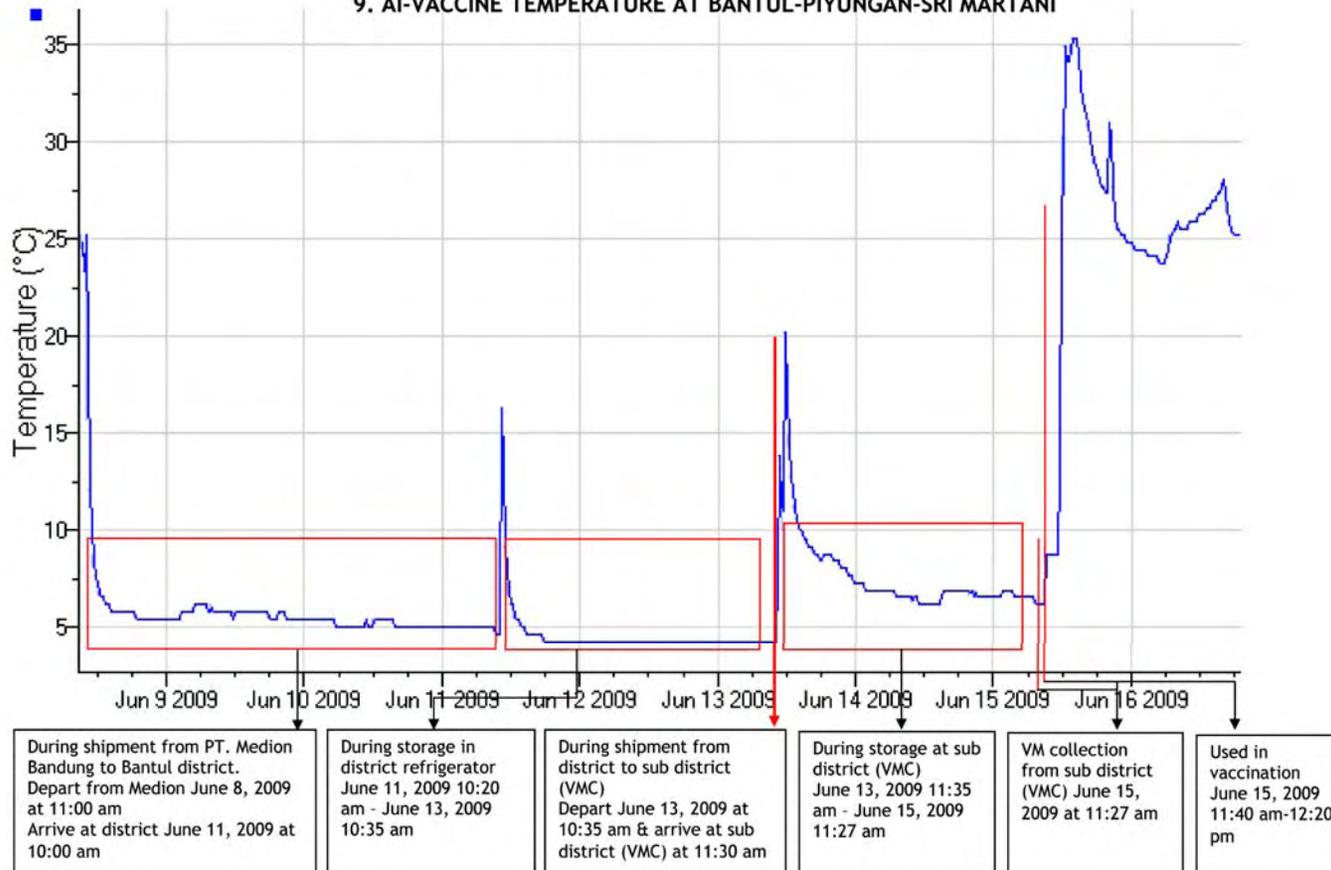
**During storage at sub district (VMC)**  
June 15, 2009, 11:20 am - 16:40 pm.

**VM collection from sub district (VMC)**  
June 15, 2009 at 16:40 pm & store at RCW 2 until 20:10 pm.

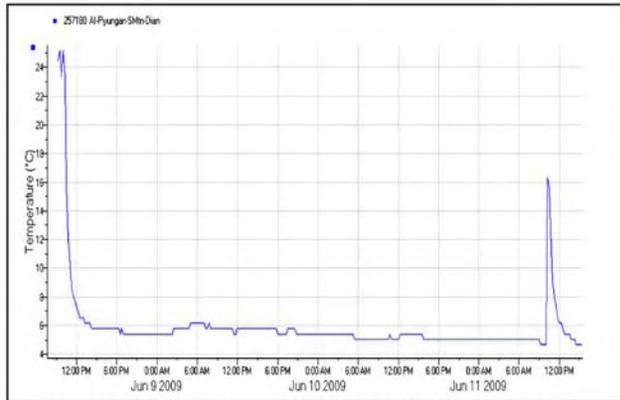
**Used in vaccination June 15, 2009 20:10-20:35 pm**

■ 257180 AI-Piyungan-SMtn-Dian

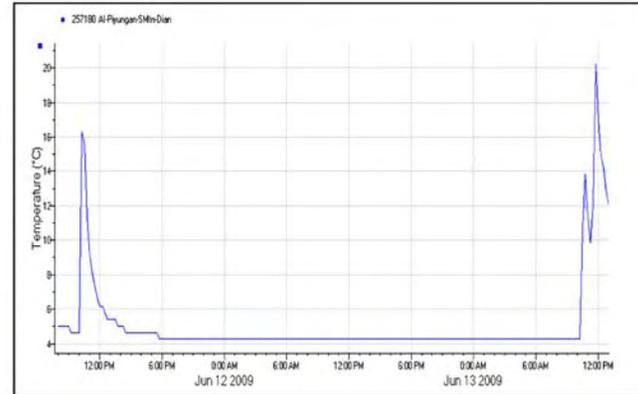
### 9. AI-VACCINE TEMPERATURE AT BANTUL-PIYUNGAN-SRI MARTANI



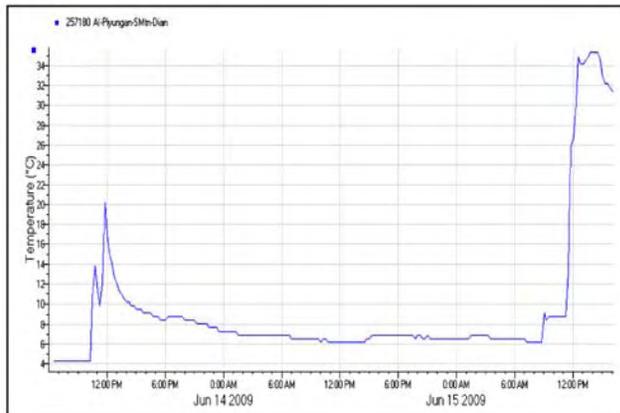
**10. AI-VACCINE TEMPERATURE AT BANTUL-PIYUNGAN-SRI MARTANI  
ACCORDING TO DISTRIBUTION STAGES**



**During shipment from PT. Medion Bandung to Bantul district.**  
Depart from Medion June 8, 2009 at 11:00 am.  
Arrive at district June 11, 2009 at 10:00 am.



**During storage in district refrigerator**  
June 11, 2009 10:20 am - June 13, 2009 10:35 am.



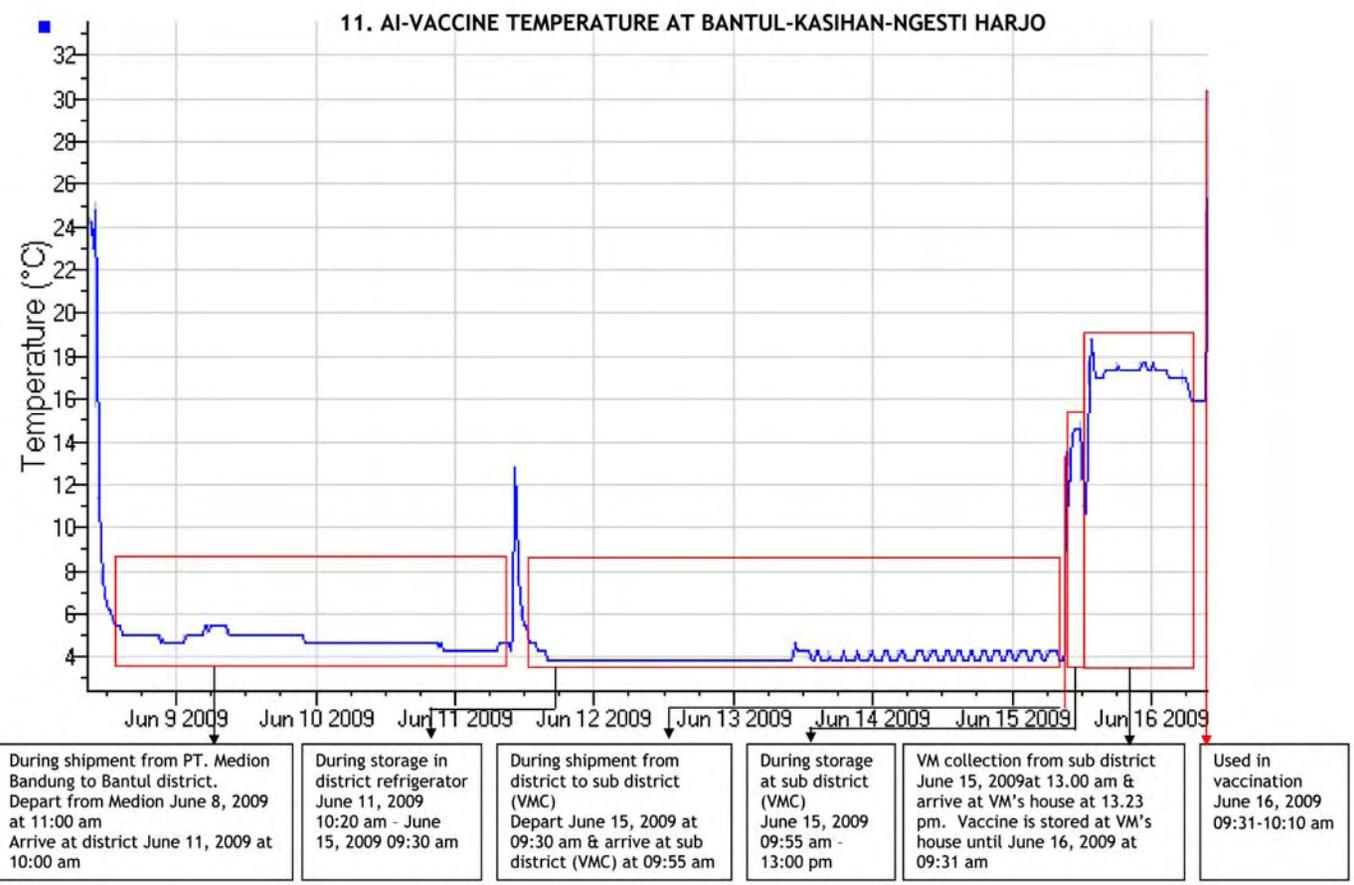
**During shipment from district to sub district (VMC)**  
Depart June 13, 2009 at 10:35 am & arrive at sub district (VMC) at 11:30 am.

**During storage at sub district (VMC)**  
June 13, 2009 11:35 am - June 15, 2009 11:27 am.

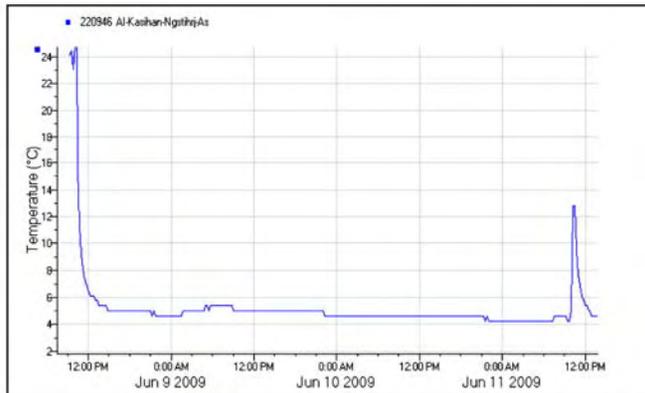
**VM collection from sub district (VMC)**  
June 15, 2009 at 11:27 am.

**Used in vaccination June 15, 2009 11:40 am-12:20 pm.**

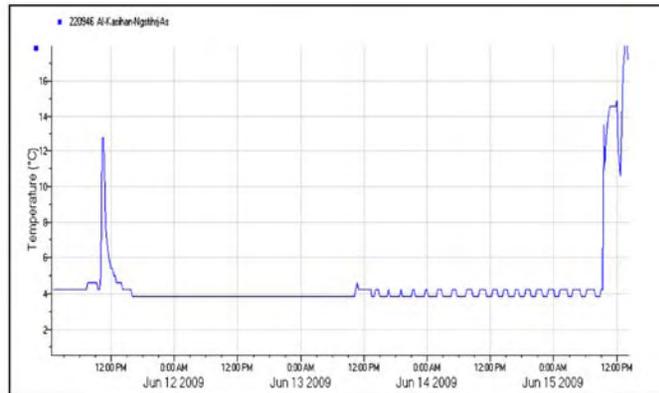
■ 220946 AI-Kasih-an-Ngstihri-As



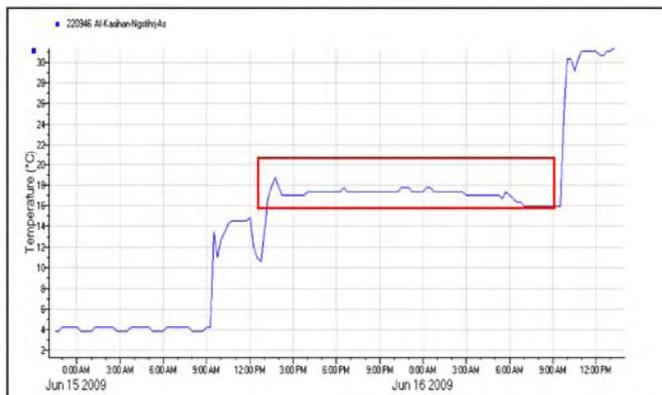
## 12. AI-VACCINE TEMPERATURE AT BANTUL-KASIHAN-NGESTI HARJO ACCORDING TO DISTRIBUTION STAGES



During shipment from PT. Medion Bandung to Bantul district.  
Depart from Medion June 8, 2009 at 11:00 am.  
Arrive at district June 11, 2009 at 10:00 am.



During storage in district refrigerator  
June 11, 2009 10:20 am - June 15, 2009 09:30 am



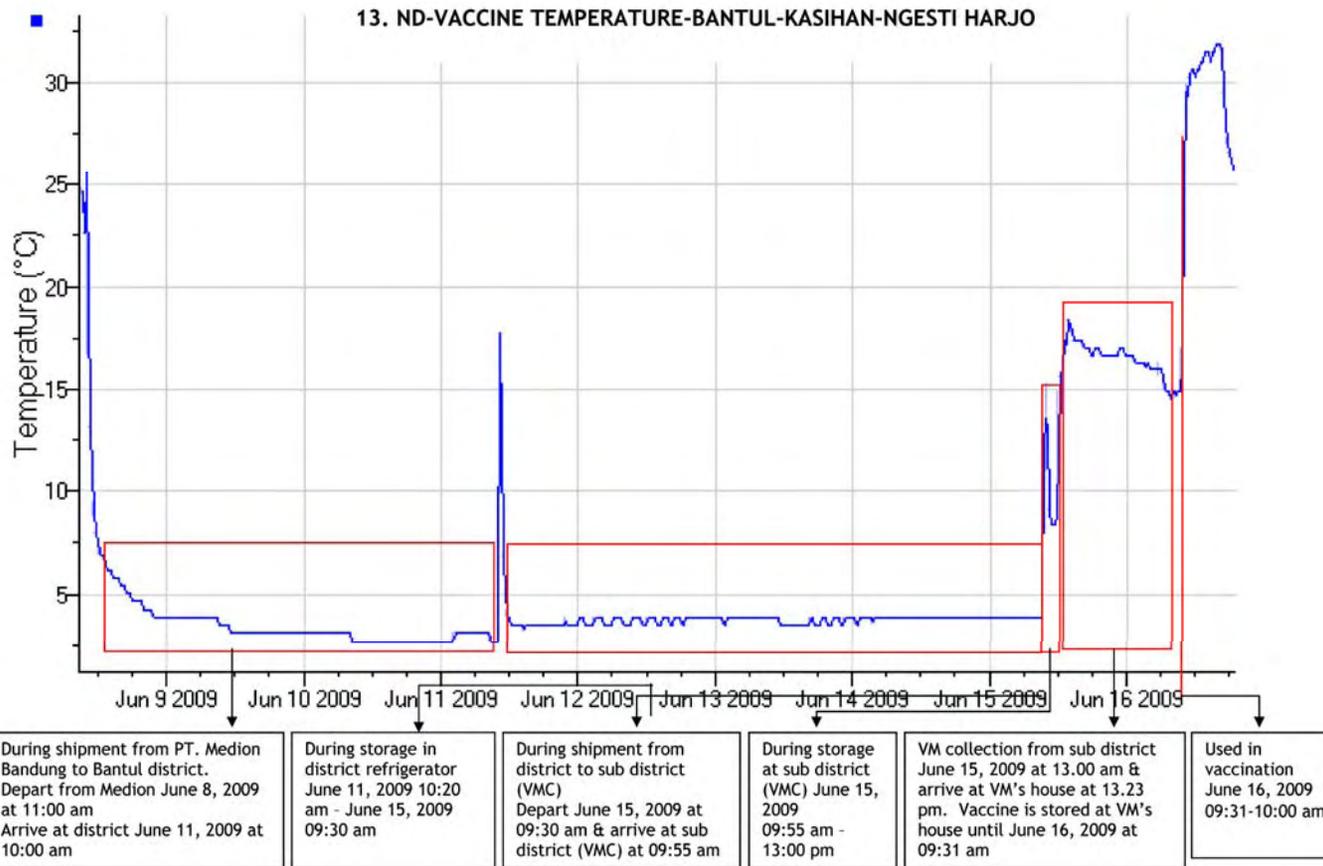
During shipment from district to sub district (VMC)  
Depart June 15, 2009 at 09:30 am & arrive at sub district (VMC) at  
09:55 am.

During storage at sub district (VMC)  
June 15, 2009 09:55 am - 13:00 pm.

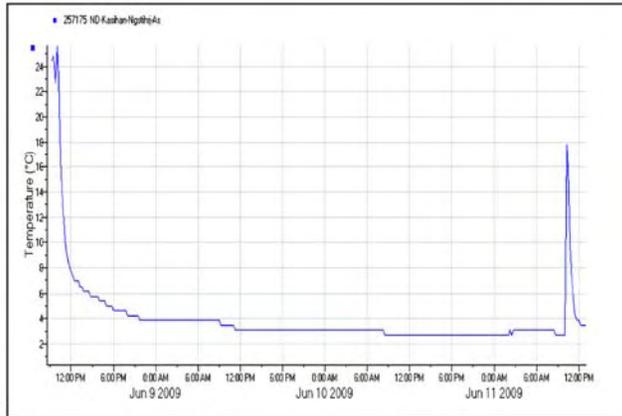
VM collection from sub district (VMC)  
June 15, 2009 at 13:00 am & arrive at VM's house at 13.23 pm.  
Vaccine is stored at VM's house until June 16, 2009 at 09:31 am.

Used in vaccination June 16, 2009 09:31-10:10 am

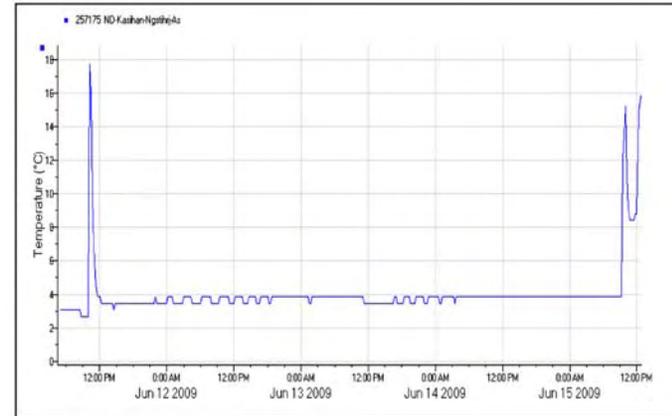
■ 257175 ND-Kasih-Ngstihj-As



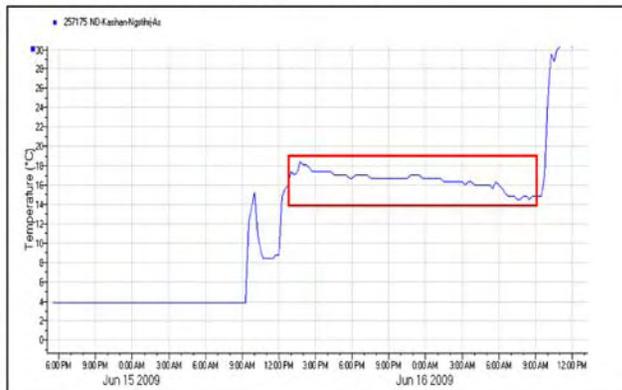
#### 14. ND-VACCINE TEMPERATURE AT BANTUL-KASIHAN-NGESTI HARJO ACCORDING TO DISTRIBUTION STAGES



During shipment from PT. Medion Bandung to Bantul district.  
 Depart from Medion June 8, 2009 at 11:00 am.  
 Arrive at district June 11, 2009 at 10:00 am.



During storage in district refrigerator  
 June 11, 2009 10:20 am - June 15, 2009 09:30 am.



During shipment from district to sub district (VMC)  
 Depart June 15, 2009 at 09:30 am & arrive at sub district (VMC) at 09:55 am.

During storage at sub district (VMC)  
 June 15, 2009 09:55 am - 13:00 pm.

VM collection from sub district (VMC)  
 June 15, 2009 at 13.00 am & arrive at VM's house at 13.23 pm.  
 Vaccine is stored at VM's house until June 16, 2009 at 09:31 am.

Used in vaccination June 16, 2009 09:31-10:00 am



# Annex 2

## Study monitoring form

1. Continues form (form lanjutan)
2. File form (form per tinggal)

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

<b>Vaksin ND</b> Kab. ....
-------------------------------

**FORM LANJUTAN**

<b>DIISI OLEH MEDION</b>	Pengiriman vaksin studi		Kotak pengirim	Cool pack	Catatan			
	Tgl	Jam						
TTM serial #  Batch #  Tgl kedaluwarsa					Truk plat nomor:			
<b>DIISI OLEH KVM</b>	Penerimaan vaksin studi		Jam masuk lemari es	Ada mati listrik?			Catatan	
	Tgl	Jam		Tdk ada	Ada: Tgl	berapa lama		
TTM serial #  Batch #  Tgl kedaluwarsa								
	Pengiriman vaksin studi		Kotak pengirim	Cool pack	Catatan			
	Tgl	Jam						
<b>DIISI OLEH VMC</b>	Penerimaan vaksin studi		Jam masuk lemari es / cooler / kotak styrofoam	Cool pack	Ada mati listrik?			Catatan
	Tgl	Jam			Tdk ada	Ada: Tgl	berapa lama	
TTM serial #  Batch #  Tgl kedaluwarsa								
	Pengiriman vaksin studi		Kotak pengirim	Cool pack	Catatan			
	Tgl	Jam						
<b>DIISI OLEH VM</b>	Penerimaan vaksin studi		Jam masuk lemari es / cooler / kotak styrofoam	Cool pack	Ada mati listrik?			Catatan
	Tgl	Jam			Tdk ada	Ada: Tgl	berapa lama	
TTM serial #  Batch #  Tgl kedaluwarsa								
	Penerimaan vaksin studi			Kotak pembawa vaksin	Cool pack	Catatan		
	Tgl	Jam mulai	Jam selesai					

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

**Vaksin AI  
Kab.....**

**FORM PER TINGGAL MEDION**

<b>DIISI OLEH MEDION</b>	<b>Pengiriman vaksin studi</b>		<b>Kotak pengirim</b>	<b>Cool pack</b>	<b>Catatan</b>
	<b>Tgl</b>	<b>Jam</b>			
<b>TTM serial #</b>					Truk plat nomor:
<b>Batch #</b>					
<b>Tgl kedaluwarsa</b> _____					

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

**Vaksin ND  
Kab.....**

**FORM PER TINGGAL MEDION**

<b>DIISI OLEH MEDION</b>	<b>Pengiriman vaksin studi</b>		<b>Kotak pengirim</b>	<b>Cool pack</b>	<b>Catatan</b>
	<b>Tgl</b>	<b>Jam</b>			
<b>TTM serial #</b>					Truk plat nomor:
<b>Batch #</b>					
<b>Tgl kedaluwarsa</b> _____					

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

Vaksin AI  
Kab.....

**FORM PER TINGGAL KVM**

DIISI OLEH KVM	Penerimaan vaksin studi		Jam masuk lemari es	Ada mati listrik?			Catatan
	Tgl	Jam		Tdk ada	Ada: Tgl	berapa lama	
TTM serial #							
Batch #	Pengiriman vaksin studi		Kotak pengirim	Cool pack	Catatan		
	Tgl	Jam					
Tgl kedaluwarsa							

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

Vaksin ND  
Kab.....

**FORM PER TINGGAL KVM**

DIISI OLEH KVM	Penerimaan vaksin studi		Jam masuk lemari es	Ada mati listrik?			Catatan
	Tgl	Jam		Tdk ada	Ada: Tgl	berapa lama	
TTM serial #							
Batch #	Pengiriman vaksin studi		Kotak pengirim	Cool pack	Catatan		
	Tgl	Jam					
Tgl kedaluwarsa							

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

Vaksin AI  
Kab.....

**FORM PER TINGGAL VM**

DIISI OLEH VM	Penerimaan vaksin studi		Jam masuk lemari es / cooler / kotak styrofoam	Cool pack	Ada mati listrik?			Catatan
	Tgl	Jam			Tdk ada	Ada: Tgl	berapa lama	
TTM serial # _____								
Batch # _____	Penggunaan vaksin studi			Kotak pembawa vaksin	Cool pack	Catatan		
	Tgl	Jam mulai	Jam selesai					
Tgl kedaluwarsa _____								

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

Vaksin ND  
Kab.....

**FORM PER TINGGAL VMC**

DIISI OLEH VMC	Penerimaan vaksin studi		Jam masuk lemari es / cooler / kotak styrofoam	Cool pack	Ada mati listrik?			Catatan
	Tgl	Jam			Tdk ada	Ada: Tgl	berapa lama	
TTM serial # _____								
Batch # _____	Pengiriman vaksin studi		Kotak pengiriman		Cool pack	Catatan		
	Tgl	Jam						
Tgl kedaluwarsa _____								

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

Vaksin AI  
Kab.....

**FORM PER TINGGAL VM**

<b>DIISI OLEH VM</b>	Penerimaan vaksin studi		Jam masuk lemari es / cooler / kotak styrofoam	Cool pack	Ada mati listrik?			Catatan
	Tgl	Jam			Tdk ada	Ada: Tgl	berapa lama	
TTM serial #								
Batch #	Penggunaan vaksin studi			Kotak pembawa vaksin	Cool pack	Catatan		
	Tgl	Jam mulai	Jam selesai					
Tgl kedaluwarsa								

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

Vaksin ND  
Kab.....

**FORM PER TINGGAL VM**

<b>DIISI OLEH VM</b>	Penerimaan vaksin studi		Jam masuk lemari es / cooler / kotak styrofoam	Cool pack	Ada mati listrik?			Catatan
	Tgl	Jam			Tdk ada	Ada: Tgl	berapa lama	
TTM serial #								
Batch #	Penggunaan vaksin studi			Kotak pembawa vaksin	Cool pack	Catatan		
	Tgl	Jam mulai	Jam selesai					
Tgl kedaluwarsa								

**FORMULIR STUDI RANTAI DINGIN VAKSIN AI DAN ND  
KAJIAN OPERASIONAL PENGENDALIAN HPAI 2009**

**Vaksin AI  
Kab. ....**

**FORM LANJUTAN**

<b>DIISI OLEH MEDION</b>	<b>Pengiriman vaksin studi</b>		<b>Kotak pengirim</b>	<b>Cool pack</b>	<b>Catatan</b>			
	<b>Tgl</b>	<b>Jam</b>						
<b>TTM serial #</b>  <b>Batch #</b>  <b>Tgl kedaluwarsa</b>					Truk plat nomor:			
<b>DIISI OLEH KVM</b>	<b>Penerimaan vaksin studi</b>		<b>Jam masuk lemari es</b>	<b>Ada mati listrik?</b>			<b>Catatan</b>	
<b>TTM serial #</b>  <b>Batch #</b>  <b>Tgl kedaluwarsa</b>	<b>Tgl</b>	<b>Jam</b>		<b>Tdk ada</b>	<b>Ada: Tgl</b>	<b>berapa lama</b>		
	<b>Pengiriman vaksin studi</b>		<b>Kotak pengirim</b>	<b>Cool pack</b>	<b>Catatan</b>			
	<b>Tgl</b>	<b>Jam</b>						
<b>DIISI OLEH VMC</b>	<b>Penerimaan vaksin studi</b>		<b>Jam masuk lemari es / cooler / kotak styrofoam</b>	<b>Cool pack</b>	<b>Ada mati listrik?</b>			<b>Catatan</b>
<b>TTM serial #</b>  <b>Batch #</b>  <b>Tgl kedaluwarsa</b>	<b>Tgl</b>	<b>Jam</b>			<b>Tdk ada</b>	<b>Ada: Tgl</b>	<b>berapa lama</b>	
	<b>Pengiriman vaksin studi</b>		<b>Kotak pengirim</b>	<b>Cool pack</b>	<b>Catatan</b>			
	<b>Tgl</b>	<b>Jam</b>						
<b>DIISI OLEH VM</b>	<b>Penerimaan vaksin studi</b>		<b>Jam masuk lemari es / cooler / kotak styrofoam</b>	<b>Cool pack</b>	<b>Ada mati listrik?</b>			<b>Catatan</b>
<b>TTM serial #</b>  <b>Batch #</b>  <b>Tgl kedaluwarsa</b>	<b>Tgl</b>	<b>Jam</b>			<b>Tdk ada</b>	<b>Ada: Tgl</b>	<b>berapa lama</b>	
	<b>Penggunaan vaksin studi</b>		<b>Kotak pembawa vaksin</b>	<b>Cool pack</b>	<b>Catatan</b>			
	<b>Tgl</b>	<b>Jam mulai</b>						<b>Jam selesai</b>



# Annex 3

Pictures during vaccine packaging, transport, and vaccination session

## Cold Study Monitoring, Bantul District on June 15-16, 2009



Vaccines packaging in district store and will distribute to Kasihan sub district office.



Vaccines arrived at the Kasihan Sub district at 09:55 am. KVM and VMC are opening the box to take out the form and then fill it. VM will collect the vaccine at 1 pm.



VM collected 3000 doses of AI and ND vaccines in Styrofoam box at the Kasihan sub district.



They are using motorcycle to bring vaccines.



VM is doing vaccination in Piyungan sub district. He modified the socorex syringe.



Vaccine is stored in the Sharp domestic refrigerator at the VM's house in Kasihan sub district.



VM is preparing the vaccines.



VM is doing vaccination in Kasihan sub-district



For more information, please visit [deliver.jsi.com](http://deliver.jsi.com).

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