

Reime NiS PCM GUIDE (status 04/2007)

# **PASSIVE COOLING MATERIALS PRINCIPAL GUIDE**

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## **1.0 INTRODUCTION AND FEATURES**

### **1.1 WHAT IS PCM?**

PCM stands for Passive cooling solution and is a proprietary solution developed by ACME providing back up for 4-6 hours in case of power failure.

The process of changing from solid to liquid or liquid to solid is known as changing phase, therefore these materials are generically known as Phase Change Materials, or PCM.

ACME PCM are in the form of an inorganic hydrated salt solution plus ACME chemical additives so that the changing phase can be repeated over thousands of cycles with no change to their physical or chemical properties for long term use.

PCM can be used in enclosure-based systems as a supplementary assistant to traditional proprietary cooling, typically from air conditioning units, heat exchangers, or fan trays. The PCM has the capability to absorb and release heat energy due to its ability to provide latent heat.

The easiest way to explain the PCM is to compare it to water. Water has 3 types of phases: ice, liquid and steam. Acme's PCM which is normally in GEL state (Liquid state) also works and behaves in the same way. Its working range keeps desired shelter temperature between 26<sup>0</sup>C to 35<sup>0</sup>C and the back up period varies between 4 to 6 hours depending on power situation

For example, PCM 29<sup>0</sup>C has the following characteristics:

Below 26 degrees (Air conditioner's tripping temp) it turns to solid. Whenever there is a power failure temperature starts rising and PCM absorbs the heat, starts melting there by releasing the cooling effect which is circulated inside the shelter with the help of DC Fans so as to maintain a uniform temperature throughout for 4-6 hours. In case power cut is extended beyond 4-6 hours DG Management circuitry which is provided with battery voltage and temperature sensors would switch on the Generators and Air conditioners would become operational which again would charge the PCM to normal conditions in 6 hours time.

The speed depends on heat load. When a substance is changing phase, a lot of energy is needed and that is the force of nature PCM is using. This is how we stabilize cool & heat.

## 1.2 FEATURES:

**i). Quiet:** This system is non mechanical in nature and thus has an added advantage of being quiet (both acoustically and electrically).

**ii). Safe:** This system is totally safe and can be used in any indoor environment.

**iii). Advantage PCM:** In case of mains failure, the system maintains the temperature within operating limits for long time and thus reducing or totally avoiding the Diesel Generator running requirement which results high savings in the site operational costs.

**iv). Safety Features:** ACME PCM is equipped with facility of monitoring inside shelter temperature and site battery voltage. Temperature sensor continuously detects shelter temperature as well as the Site battery voltage. In case the temperature goes above the set limit or the battery voltage is below the set limit, the DG saver/ PIU starts the DG set. In case DG remains ON continuously for 5 hours DG Saver / PIU stops the DG for giving the rest.

**2.0 TECHNICAL SPECIFICATIONS:**

**2.1 SPECIFICATIONS OF ACME PCM 29**

S.NO	Description	Specification
1	Panel Length	850mm
2	Panel width	210mm
3	Panel thickness	20mm
4	Weight of PCM material in panel	4.0 Kg
5	Panel weight	4.5Kg
6	Nos. of thermal cycle for PCM material life	4000 tested
7	PCM Panel / Material corrosion property	HDPE
8	Type of PCM	Hydrated salt
9	Melting temperature	29° C
10	Appearance	White deliquescent Crystals
11	Latent heat	79 Wh/L
12	Solid sensible heat	0.67 Wh/L °C
13	Liquid sensible heat	0.99 Wh/L °C
14	Flammability	Non- flammable
15	Vapour pressure	Non applicable
16	Flash point	Non applicable
17	Useful temperature range	26°C to 35°C
18	Minimum temperature needed inside the shelter to freeze the PCM	24 - 25° C

## 2.2 CONDITIONS FOR PROPER FUNCTIONING OF PCM

### i). Heat load should include total heat radiated by all equipments.

#### Calculation of PCM requirement for 1KW load

The calculation of PCM is done with its latent heat storage capacity as per the chemical properties of the material.

Energy storage	79Wh/ltr
Density of the material	1.5KG/ltr
Per KG energy storage capacity	$79/1.5 = 52\text{Wh/Kg}$
Material needed for 1KWH	$1000/52 = 19.23 \text{ KG}$

Considering the production variation of  $\pm 5\%$  we recommend 21KG per KW with other various factors also like air pressure, surface area, thermal conductivity etc.

For example if the total heat load comes to 2 KW then for 4 Hours back-up, 8Kwh of PCM capacity is required

### ii). The Air cons should work in the following manner:

The temperature inside the shelter should be maintained at  $25^{\circ}\text{C}$ .

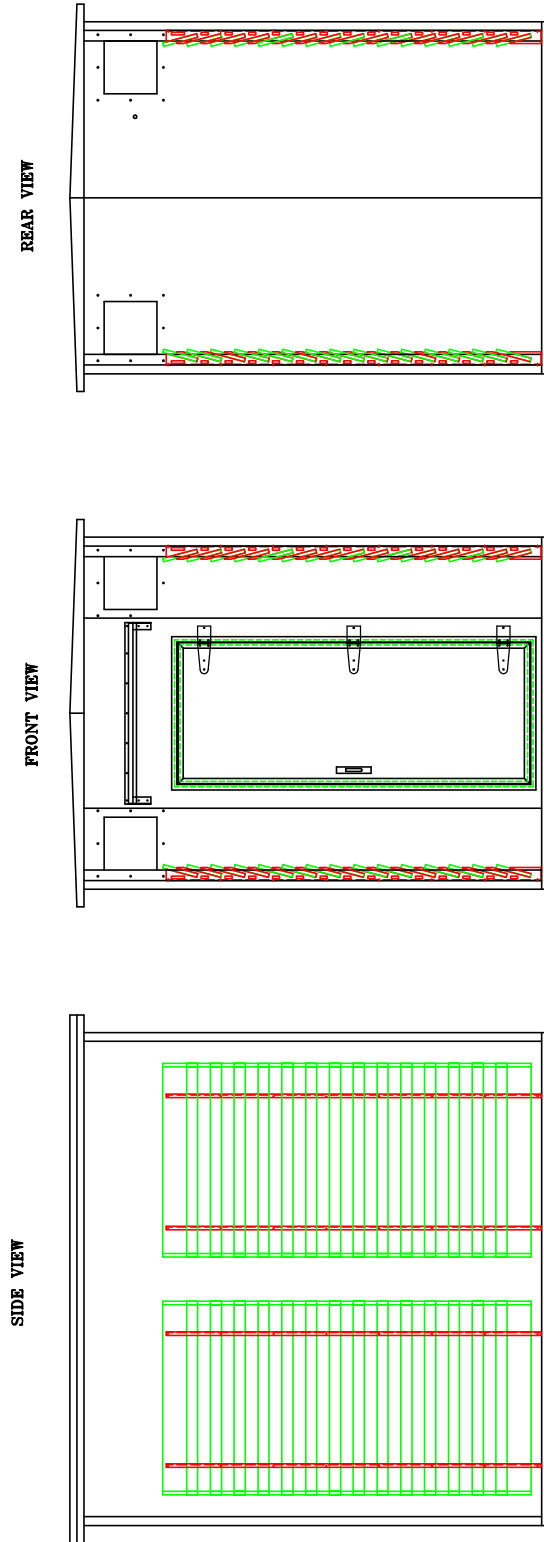
Below  $22^{\circ}\text{C}$  both AC's can be switched OFF only the blower of one AC will be ON for Air circulation.

### iii). Battery Back-up requirement:

Taking a DOD of 40%. For example for 4 hours back-up the battery set should be able to run the telecom equipment (in case of power failure) for 4 hrs.

The rectifier should be of proper rating to charge the batteries as well as to take care of the load of telecom equipment

### 3.2: INSIDE VIEW OF ACME GREEN SHELTER WITH PCM





## **5.0 INSTALLATION AND COMMISSIONING:**

### **INSTALLATION & COMMISSIONING PROCEDURE FOR PCM**

- i) Minimum required space 1000mm (L) x 500 mm (W) for installation of 850 mm size panels in three rows or the PCM Trolley.
- ii) PCM panels should be placed in such away so that the cooling from AC's is available effectively. There should not be any obstruction in air flow.
- iii) PCM brackets should be mounted on side walls, PCM trolley can be fixed in the desired location.
- iv) Air circulating fans should be securely mounted on top of PCM panels.
- v) Temperature sensor to be mounted in such away that it senses the shelter temperature correctly.
- vi) DG saver / PIU is placed properly at suitable place.

### **Customer shall confirm that existing equipment in the selected test sites will facilitate the following requirement:**

- i) Air circulating fans to be connected at fan relay terminals.
- ii) Site battery connections to be made at site battery terminals of DG saver card / PIU.
- iii) Mains to be connected at stabilized voltage terminals.
- iv) DG voltage to be connected at DG terminal at DG saver / PIU.
- v) DG start terminal of ACME DG saver / PIU to be connected at START pulse of AMF.
- vi) DG stop terminal of ACME DG saver / PIU to be connected to STOP pulse of AMF.
- vii) Temperature sensor to be connected with temperature terminals of ACME DG saver / PIU.

### **Customer shall ensure that the following conditions obtain for the proper functioning of PCM**

- i) Quantities of PCM material of required to be installed are calculated from figures derived from **EW** which should stipulate the total heat load inside the shelter. The heat load should include total heat radiated by all equipment inside the shelter plus the solar heat gain of the shelter. For example if the total heat load comes to 2 KW then for 4 Hours back-up 8KW of PCM material is required.
- ii) The Aircons to have additional cooling capacity (apart from the present heat load) for cooling the PCM material. The additional capacity should be 25% of the total PCM capacity installed.

- iii) The Aircons fitted to the selected shelters shall operate to the following criteria; Above 26 °C both Aircons will be ON. Once the temperature is below 24 °C second AC can be switch OFF. Below 22 °C both AC's can be switched OFF only the Fan of one AC will be ON for Air circulation.
- iv) The battery set should be in healthy condition to support the satisfactory working of the telecom equipment for the desired duration (back-up time) taking a DOD of 40%. For example for 4 hours back-up the battery set should be able to run the telecom equipment (in case of power failure) for 4 hours.
- v) The rectifier should be of proper rating to charge the batteries as well as to take the load of telecom equipment.

**5.1: INSTALLATION TEST:**

**Objective:**

Install the PCM system properly in the shelter and verify that the product and documentation is suitable for installation in the target applications.

**Test Setup:**

Installation site shall be selected to meet the requirements of the ACME PCM Installation, Operation & Maintenance Manual.

**Procedure:**

- i). Prepare site and install PCM system in accordance with the ACME PCM Installation Instructions.
- ii). Record any problems in the comments section.

<b>Installation Criteria</b>	<b>Results</b>
Location meets code and service access requirements.	
PCM mounting brackets /Trolley installed & leveled properly	
Air circulating fans installed properly and connected with suitable DC power 24V/ 48V	
PCM Panels placed properly	
PIU/ DG Saver cabinet installed and connected	
Temperature sensor installed at proper place and connection done at DG saver /PIU	
Voltage connection terminated at site Batt. Terminals of DG saver cabinet/ PIU	
AC mains to be connected at prescribed terminals	
DG connections to be done at DG terminals at DG saver / PIU	
DG Start terminal of DG saver/PIU to be connected to DG start pulse of AMF panel	
DG Stop terminal of DG saver /PIU to be connected to DG stop pulse of AMF panel	

**Comments:**

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**Installation Test:** Pass      Fail      Date: \_\_\_\_\_ Sign: \_\_\_\_\_

**5.2: COMMISSIONING TEST:**

**Objective:**

Verify PCM systems’ automatic start, stop function corresponding to site battery voltage and shelter temperature set limits. Check if the system performs to defined parameter.

**Test Setup:**

- i). Energy meters, Hour meters and temperature sensor are installed to check the PCM system performance.
- ii). Hour meters connected across The DG, MAINS, AC separately.
- iii). Energy meter is connected along with AC input.

**Procedure:**

- i). Configure PCM system as per ACME PCM Installation, Operation & Maintenance instructions.
- ii). Perform commissioning test per ACME PCM Installation, Operation & Maintenance instructions.

**Success Criteria:**

<b>Commissioning Test</b>	<b>Pass</b>	<b>Fail</b>
AC Settings configured		
Site battery voltage configured		
Temperature settings configured		
DG ON and OFF functions activated as configured		
Take the readings of Energy meter, DG and Mains hour meters at regular intervals		
Workout the backup provided by the PCM system		

**Comments:**

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**Commissioning Test:** Pass                      Fail                      Date: \_\_\_\_\_  
 Sign: \_\_\_\_\_

**5.3: MANUAL PERATION TEST:**

**Objective:**

Verify that the PCM system performs to specification.

**Test Setup:**

PCM system installed and connected in the shelter with DG automation circuitry. The PCM material should be fully charged and is in crystalline state.

**Procedure:**

- i). Take the initial reading of the all the meters installed at site and the shelter temperature.
- ii). Switch OFF the Mains Input form the MCB.
- iii). Site battery will support the equipment connected in the shelter.
- iv). DC Fans will switch ON to circulate the air inside the shelter.
- v). Record the shelter temperature at every 15 minutes.
- vi). Record the PCM back up time duration.

**Success Criteria:**

PCM system maintains the temperature inside the shelter with in specified limits up to installed capacity.

Site Load	Output Power	Output Voltage	Pass	Fail
Watts DC Load				

**Comments:**

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**Manual Operation Test:** Pass                      Fail                      Date: \_\_\_\_\_  
 Sign: \_\_\_\_\_

**5.4: AUTOMATIC START TEST:**

**Objective:**

Verify that the PCM system performs automatic DG start & Stop function as per the specification.

**Test Setup:**

- i) Site battery voltage connection terminated at site Batt. Terminals of DG saver / PIU.
- ii) Mains Voltage to be connected at AMF stabilization terminal of DG saver / PIU.
- iii) DG voltage to be connected at DG Terminal at DG saver / PIU.
- iv) DG start terminal of ACME DG saver / PIU to be connected to start pulse of DG AMF.
- v) DG stop Terminal of ACME DG saver / PIU to be connected to stop pulse of DG AMF.
- vi) Temperature sensor to be connected with temp terminals of ACME DG saver / PIU.

**Procedure:**

- i) Make sure the settings in the DG saver / PIU are as per Acme’s manual.
- ii) Turn off the Mains MCB to simulate grid power outage.
- iii) Repeat steps 1 – 2, for as many times as you want to test it.
- iv) Record any faults or failures in the comment section.

**Success Criteria:**

- i) DG ON will be delayed after the mains outage for particular backup period.
- ii) DG starts after the Temperature or Battery voltage is out of range.
- iii) DG stops after Mains restore or after 5 hours of operation.

<b>Auto Start Site Load</b>	<b>Pass</b>	<b>Fail</b>
DG ON delay after mains failure		
DG STARTS after crossing of set limit		
DG STOPS Mains restore or 5 hours of stretch run		

**Comments:**

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**Automatic Start Test:** Pass      Fail      Date: \_\_\_\_\_ Sign: \_\_\_\_\_

**5.5: VALIDITY TEST:**

**Objective:**

Verify the PCM system operational reliability.

**Test Setup:**

- i) Temperature sensor installed at proper place and it is connected to be at DG saver / PIU Temperature terminal.
- ii) Site battery connection voltage connection terminated at site Batt. Terminals of DG saver / PIU.
- iii) Mains Voltage to be connected at AMF stabilization terminal of DG saver / PIU.
- iv) DG voltage to be connected at DG Terminal at DG saver / PIU.
- v) DG start terminal of ACME DG saver / PIU to be connected to start pulse of DG AMF.
- vi) DG stop Terminal of ACME DG saver / PIU to be connected to stop pulse of DG AMF.
- vii) Temperature sensor to be connected with temp terminals of ACME DG saver / PIU.

**Procedure:**

- 1. Make sure the settings in the DG saver card / PIU are as per Acme’s manual.
- 2. Turn off the Mains MCB to simulate grid power outage.
- 3. Repeat steps 1 – 2, for required test cycles.
- 4. Record any faults or failures in the comment section.

**Success Criteria:**

- i) Room Temperature maintains within the limit for particular back up period when power outages.
- ii) DG starts & stops automatically when ever it requires.

**Comments:**

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**Validity Test:** Pass      Fail      Date: \_\_\_\_\_ Sign: \_\_\_\_\_