

Guideline

Loss of power and gas usage in neonatal transport

1 Scope

For use within the Acute Neonatal Transfer Service (ANTS) for the East of England.

2 Purpose

To provide efficient and practical guidance on battery life of equipment, what steps can be taken if there is a loss of power and management of gas usage when a baby is on respiratory support.


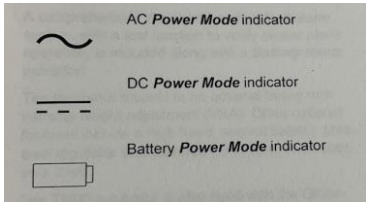

3 Definitions and abbreviations

AC	Alternating current
ccm	Cubic centimetres per minute – a measurement
CE	Clinical engineering
DC	Direct current
L	Litres – a measurement
l/min	Litres per minute – a measurement
MRI	Magnetic resonance imaging
SpO ₂	Peripheral capillary oxygen saturation


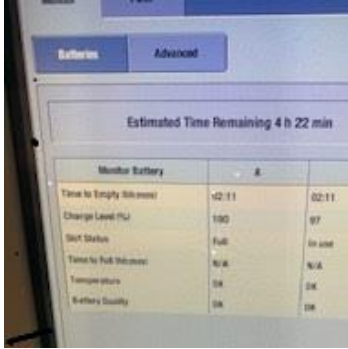


4 Loss of power


In the event of power loss, staff need to be aware of what pieces of equipment can function on battery power, how long the battery will last for and what other things can be done.

EQUIPMENT	BATTERY LIFE	WHAT CAN BE DONE WHEN MAINS POWER IS LOST?
<p>Transport Incubator Dräger TI500</p>	<p>2 batteries each one lasting 60 minutes. Total time 2 hours before the low DC alarm activates</p>  <p>4 LED indication of battery charge 25% - 100%</p>   <p>DC power socket as shown in above picture</p>	<ul style="list-style-type: none"> • Is the incubator main lead the problem? Can it be changed? • If in the ambulance connect the DC lead • If in the ambulance can the heating be turned up to maximum • Keep the incubator doors closed as much as possible. Consider hat and blankets for the baby • Keep incubator covered as much as possible to keep drafts out – use the space blankets in the ambulance • If batteries run


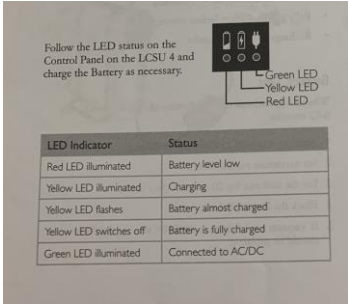


		<p>out consider using a transwarmer (only to be used with no other additional heat source)</p>
<p>GE Carescape Monitor B450</p>	<p>Contains 2 batteries A and B. Typically, each battery will last for 2 hours. To check use in each battery, turn off mains power and press green battery symbol in top right-hand side of screen.</p> <div style="text-align: center;">   </div>	<ul style="list-style-type: none"> • Click on the green battery symbol top right-hand corner of the screen to determine how long both batteries will last for • There is a spare mains lead in the ambulance that could be connected from the monitor directly into the mains • Consider what is running on the monitor for example do you need non-invasive blood pressure set to every 15 minutes as this will use up battery • Remember that the Nellcor portable SpO2 can also give saturations and heart rate

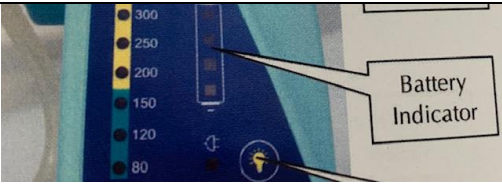

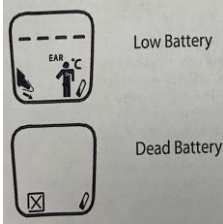



<p>Alaris syringe pump</p>	<p>Battery lasts 4 hours from fully charged at 5ml/hr at 20°C under normal conditions. Charging takes 2.5 hours from discharge to 90% charged.</p>  <p>Illuminated in picture above is battery symbol meaning pump is running on the internal battery. When this flashes the battery power is low with less than 30 mins remaining. BATTERY LOW will also appear in the display</p> <p>When BATTERY EMPTY appears in the display it means internal battery is exhausted</p>	<ul style="list-style-type: none"> • Consider moving to another pump as battery gets low • Remember there is a spare pump in the ambulance • There is a spare mains lead kept in the ambulance that could be plugged from the pump to the mains if on a unit and there is a fault with the incubator lead • If on a unit ask to borrow a spare pump or lead
<p>NOxBOX</p>	<p>Battery lasts 4-6 hours (when operational)</p> <p>Symbol BATlow flashes and sounds when the battery is low</p> <p>Blue LED light on front of the NOxBOX will be illuminated when plugged into the mains</p>	<ul style="list-style-type: none"> • If there is a fault with the incubator lead consider using spare mains lead in the ambulance to plug directly from the NOxBOX to the mains
<p>Laerdal Compact Suction Unit 4 (suction on incubator)</p>	<p>Battery run time approximately 45 minutes of continuous operation at zero vacuum level (free flow) from fully charged. An empty battery must charge up to 5 hours to reach full capacity</p>	<ul style="list-style-type: none"> • If on a unit use the unit suction • If in ambulance







	  <table border="1"> <thead> <tr> <th>LED Indicator</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>Red LED illuminated</td> <td>Battery level low</td> </tr> <tr> <td>Yellow LED illuminated</td> <td>Charging</td> </tr> <tr> <td>Yellow LED flashes</td> <td>Battery almost charged</td> </tr> <tr> <td>Yellow LED switches off</td> <td>Battery is fully charged</td> </tr> <tr> <td>Green LED illuminated</td> <td>Connected to AC/DC</td> </tr> </tbody> </table>	LED Indicator	Status	Red LED illuminated	Battery level low	Yellow LED illuminated	Charging	Yellow LED flashes	Battery almost charged	Yellow LED switches off	Battery is fully charged	Green LED illuminated	Connected to AC/DC	<p>use SAM eps (ambulance suction)</p> <ul style="list-style-type: none"> Ambulance suction can be removed and taken out of the ambulance with the incubator If baby has an atrium drain on suction and suction fails, as long as tick remains in suction indicator window, continue using drain. If suspected re-accumulation occurs, aspirate via three-way tap If baby has a replogle tube insitu and there is complete loss of suction aspirate the replogle tube frequently from where the suction would connect
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<p>SAM eps (ambulance suction)</p>	<p>Battery lasts 2 hours at maximum suction (550+ mmHg. Free flow). Approximate battery operation for 80mmhg is 12 hours and 50 mins. From flat, charge time is 2.5 hours</p>	<ul style="list-style-type: none"> Consider using incubator suction if needed As above with 												



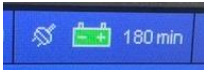


		chest drain and repleg tube
Welch Allyn Thermometer	Requires 3 x AA batteries  <p>As battery life decreases the number of segments decreases. When a single segment appears, battery is low and needs replacing. Normal operation is not affected. No segments = dead battery, means device will not operate</p>	<ul style="list-style-type: none"> • Spare AA batteries in the ambulance if needed • If on a unit could use the unit’s thermometer
Genius Tympanic Thermometer	Requires 3 x AAA batteries Minimum of 15000 readings when batteries are brand new Will display the following when battery is low and battery is dead 	<ul style="list-style-type: none"> • Spare AAA batteries in ambulance if needed
Nellcor Portable SpO2	Requires 4 x AA batteries Battery power level is top right side of the screen when monitor is on. Fewer bars indicate less power  <ul style="list-style-type: none"> • Green – battery power is good. 4 green bars appear when battery is fully charged. The number of green bars decreases as battery power is used 	<ul style="list-style-type: none"> • Spare AA batteries in the ambulance if needed


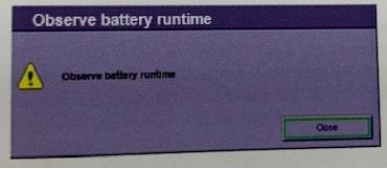
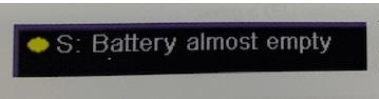
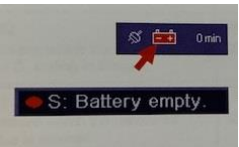


	 <ul style="list-style-type: none"> • Low battery symbol – yellow with 1 bar. There is only enough power left for 15 minutes of continuous operation.  <ul style="list-style-type: none"> • Critically low battery – red symbol with no bars. Battery must be replaced 	
<p>MX300 Portable Oxygen monitor/analyser</p>	<p>3 x AA alkaline batteries and is designed to operate for 2000 hours on a single set of batteries in a non-alarm state. Check batteries by pressing BAT TEST key, 5 segments are illuminated when batteries are full and it will then count down.</p> 	<ul style="list-style-type: none"> • Spare AA batteries in ambulance if needed
<p>babyPAC ventilator</p>	<p>The ventilator is gas driven so does not plug in</p>  <p>Has MRI safe battery that powers the alarm functions. This battery is only to be changed by CE (normally changed at service and is dated)</p>	<ul style="list-style-type: none"> • Gas driven



	 <p>Low battery alarm (above) flashes yellow to indicate that the internal battery power is giving reduced voltage. The flashing rate increases to twice every second, accompanied by a medium priority audible alarm (one burst of three pulses of sound repeated at the rate of 6 times per minute for 60 seconds then the next 60 seconds 12 times per minute for the final few minutes of the battery life)</p> <p>NOTE: if battery fails the ventilator will still work, it will only be the alarms that stop working</p>	
<p>Leoniplus transport ventilator</p>	<p>For normal ventilation the battery will run for 60-200 minutes or longer</p> <p>Depending on the setting, the battery will run between 15 and 120 minutes in the case of HFO</p> <p>Beware that changing modes of ventilation can significantly reduce the battery life</p>  <p>On mains operation the plug symbol is green and percentage the battery is charged is shown</p>  <p>On battery operation the battery symbol is green and the operating time on battery is shown</p>	<ul style="list-style-type: none"> • There is a spare mains lead in the ambulance that could connect the ventilator to a separate mains supply on a unit • Look at battery symbol to determine how many minutes the battery will last in that ventilation mode. • Hand ventilation by neopuff or bag, valve



	<p></p> <p>An information message is displayed when mains power is disconnected</p> <p></p> <p>When the remaining operating time on battery is 20, 10 and 5 minutes a dialog is shown which prompts operator to pay attention to the time the battery will continue to run</p> <p></p> <p>When the residual battery operating time is only 10 more minutes, the battery symbol turns yellow</p> <p>Below a residual battery operating time of 5 minutes the residual operating time is shown as <5 min</p> <p></p> <p>The alarm battery is almost empty is shown and an audible alarm sounds informing user that the device is about to shut – connect to the mains power source immediately</p> <p></p> <p>If the remaining run time of the battery falls below 0 minutes, the battery symbol turns red</p> <p>The battery empty alarm is shown and</p>	<p>mask that's kept in incubator drawer if ventilator battery runs out</p>
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	audible alarm sounds. The device stops all ventilation actions and switches to a passive, safe status that will not influence the patient during autonomous breathing	
Tecotherm	Does not have a battery so must run off mains power. Must be powered down before unplugging the incubator	<ul style="list-style-type: none"> • If on a unit or there is a fault with the incubator lead then spare mains lead can be used from ambulance to plug into the mains • If tecotherm cannot be powered, move to passive cooling
SenTec Digital Monitoring System (SDMS)	<p>A new fully charged battery provides at least 6 hours of operating/monitoring time depending on the display type being used.</p> <p>It cannot operate with a fully discharged battery. Recharging the battery from fully discharged takes approximately 7 hours, 80% of battery capacity is available after 5 hours.</p> <p>If not connected to mains supply and battery is <10% the battery icon is highlighted yellow and the message ‘battery low’ is displayed in the status bar and a low priority alarm signal begins to sound.</p> <p>When the battery level is critical, the battery icon is highlighted red and the message ‘battery critical’ is displayed – a medium priority alarm signal sounds and the monitor shuts down in a few minutes.</p>	<ul style="list-style-type: none"> • If there is a fault with the incubator lead then the spare mains lead can be used from the ambulance to plug the monitor directly into the mains power in unit or ambulance • Look at battery life. Will the battery last the duration of the journey? • More regular blood gases may need to



		be taken if monitor fails															
	<table border="1" style="width: 100%;"> <tr> <td style="width: 30%;">ON/OFF Indicator</td> <td style="width: 30%;">green: LED off:</td> <td style="width: 40%;">SDM turned ON SDM turned OFF</td> </tr> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td>AC Power/Battery Indicator</td> <td>green: yellow: LED off:</td> <td>Connected to AC power, battery fully charged Connected to AC power, battery charging Not connected to AC power (i.e. powered by internal battery)</td> </tr> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="3">Note: The AC Power/Battery Indicator functions irrespective of the SDM being switched ON or OFF.</td> </tr> </table>	ON/OFF Indicator	green: LED off:	SDM turned ON SDM turned OFF				AC Power/Battery Indicator	green: yellow: LED off:	Connected to AC power, battery fully charged Connected to AC power, battery charging Not connected to AC power (i.e. powered by internal battery)				Note: The AC Power/Battery Indicator functions irrespective of the SDM being switched ON or OFF.			
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5 Gas usage for babies on respiratory support

The transport incubator carries 2 x oxygen size E cylinders that have a 680L capacity each and 2 x air size E cylinders that have a 640L capacity each. The ambulance 1 x oxygen size ZX cylinder that has a 3040L capacity and 3 x air size F cylinders that have a 1280L capacity each.

Duration time
 of cylinder = volume (L) ÷ flow (l/min)
 (minutes)

5a Incubator cylinders

Gas consumption at 4 l/min on incubator cylinders

Percentage of oxygen (%)	Air consumption 640L capacity	Oxygen consumption 680L capacity
21	2hrs 40mins	---
25	3hrs 33mins	11hrs 20mins
30	3hrs 48mins	9hrs 26mins
40	4hrs 26mins	7hrs 5mins
50	5hrs 20mins	5hrs 40mins
60	6hrs 40mins	4hrs 43mins
70	8hrs 53mins	4hrs 2mins
80	13hrs 20mins	3hrs 32mins
90	26hrs 40mins	3hrs 8mins
100	---	2hrs 50mins



Gas consumption at 6 l/min on incubator cylinders

Percentage of oxygen (%)	Air consumption 640L capacity	Oxygen consumption 680L capacity
21	1hr 46mins	---
25	2hrs 22mins	7hrs 33mins
30	2hrs 32mins	6hrs 17mins
40	2hrs 57mins	4hrs 43mins
50	3hrs 33mins	3hrs 46mins
60	4hrs 26mins	3hrs 8mins
70	5hrs 55mins	2hrs 41mins
80	8hrs 53mins	2hrs 21mins
90	17hrs 46mins	2hrs 5mins
100	---	1hr 53mins

Gas consumption at 8 l/min on incubator cylinders

Percentage of oxygen (%)	Air consumption 640L capacity	Oxygen consumption 680L capacity
21	1hr 20mins	---
25	1hr 46mins	5hrs 40mins
30	1hr 54mins	4hrs 43mins
40	2hrs 13mins	3hrs 32mins
50	2hrs 40mins	2hrs 50mins
60	3hrs 20mins	2hrs 21mins
70	4hrs 26mins	2hrs 1 min
80	6hrs 40mins	1hr 46mins
90	13hrs 20mins	1hr 34mins
100	---	1hr 25mins

Gas consumption at 11 l/min on incubator cylinders

Percentage of oxygen (%)	Air consumption 640L capacity	Oxygen consumption 680L capacity
21	58 mins	---
25	1hr 17mins	4hrs 7 mins
30	1hr 23mins	3hrs 26mins
40	1hr 36mins	2hrs 34mins
50	1hr 56mins	2hrs 3mins
60	2hrs 25mins	1hr 43mins
70	3hrs 13mins	1hr 28mins
80	4hrs 50mins	1hr 17mins
90	9hrs 41mins	1hr 8mins
100	---	1hr

5b Ambulance cylinders

Gas consumption at 4 l/min on ambulance cylinders

Percentage of oxygen (%)	Air consumption 1280L capacity	Oxygen consumption 3040L capacity
21	5hrs 20mins	---
25	7hrs 6mins	50hrs 40mins
30	7hrs 37mins	42hrs 13mins
40	8hrs 53mins	31hrs 40mins
50	10hrs 40mins	25hrs 20mins
60	13hrs 20mins	21hrs 6mins
70	17hrs 46mins	18hrs 5mins
80	26hrs 40mins	15hrs 50mins
90	53hrs 20mins	14hrs 4mins
100	---	12hrs 40mins



Gas consumption at 6 l/min on ambulance cylinders

Percentage of oxygen (%)	Air consumption 1280L capacity	Oxygen consumption 3040L capacity
21	3hrs 33mins	---
25	4hrs 44mins	33hrs 46mins
30	5hrs 4mins	28hrs 8mins
40	5hrs 55mins	21hrs 6mins
50	7hrs 6mins	16hrs 53mins
60	8hrs 53mins	14hrs 4mins
70	11hrs 51mins	12hrs 3mins
80	17hrs 46mins	10hrs 33mins
90	35hrs 33mins	9hrs 22mins
100	---	8hrs 26mins

Gas consumption at 8 l/min on ambulance cylinders

Percentage of oxygen (%)	Air consumption 1280L capacity	Oxygen consumption 3040L capacity
21	2hrs 40mins	---
25	3hrs 33mins	25hrs 20mins
30	3hrs 48mins	21hrs 6mins
40	4hrs 26mins	15hrs 50mins
50	5hrs 20mins	12hrs 40mins
60	6hrs 40mins	10hrs 33mins
70	8hrs 53mins	9hrs 2mins
80	13hrs 20mins	7hrs 55mins
90	26hrs 40mins	7hrs 2mins
100	---	6hrs 20mins

Gas consumption at 11 l/min on ambulance cylinders

Percentage of oxygen (%)	Air consumption 1280L capacity	Oxygen consumption 3040L capacity
21	1hr 56mins	---
25	2hrs 35mins	18hrs 25mins
30	2hrs 46mins	15hrs 21mins
40	3hrs 13mins	11hrs 30mins
50	3hrs 52mins	9hrs 12mins
60	4hrs 50mins	7hrs 40mins
70	6hrs 27mins	6hrs 34mins
80	9hrs 41mins	5hrs 45mins
90	19hrs 23mins	5hrs 7mins
100	---	4hrs 36mins

Note: The babyPAC consumption is different depending on what mode of ventilation it is using. Maximum consumption is 11 l/min

5c Nitric cylinders

- Each nitric cylinder has a 307L capacity when full
- Digital flow meter measures in ccm = cubic cm/min
- 1cm³ = 1ml = 0.001L

ccm on digital flow meter	L/min	Hourly Usage	Cylinder life of a full cylinder
50	0.05	3L	102 hours
100	0.1	6L	51 hours
150	0.15	9L	34 hours
200	0.2	12L	25 hours
250	0.25	15L	20 hours
300	0.3	18L	17 hours

6 Monitoring compliance with and the effectiveness of this document

The effectiveness of the document will be monitored by review of any reported incidents via the lead nurse for risk. These incidents will be shared with the team and consideration given to adjusting the guideline if concerns are identified.

New pieces of equipment to be added to the document.

7 References

- Asena cc syringe pump directions for use (Sept 2002) Issue 2.0. Alaris Medical Systems
- BabyPAC 100 Ventilator User’s Manual (2007) Smiths Medical
- Drager TI500 Neonatal transport incubator instructions for use (2016) Edition 13

- GE Carescape Monitor B450 Technical Manual (2016) GE Healthcare
- Genius Tympanic Thermometer Operating Manual (2011) Covidien
- Inspiration Tecotherm Neo Instructions for use manual (2019) Version 21.1. Inspiration Healthcare
- Laerdal Compact Suction Unit 4 - Directions for use (2012) Laerdal
- Leoniplus Transport User Manual (2018) Lowenstein Medical
- MX300 Portable oxygen monitor operating and service instructions (2009) Teledyne Analytical Instruments
- Nellcor portable SpO2 Instructions for use (2014) Covidien
- NOxBOX O2 Operating Manual (2016) NOxBOX Ltd
- SAM e.p.s portable suction operating and maintenance instructions (2015) Issue 05. SP Services
- SenTec Digital Monitoring Instruction Manual. (June 2020) SenTec
- Sure Temp Plus Instruction Manual (2003) WelchAllyn

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