

UN38.3 Test Report

Sample Name &
Model

LiFePO₄ Battery Model:
YS-12.8-18-17B
(SLAUMXLI18-12)

Applicant

Ultramax Batteries Limited

Manufacturer

Ultramax Batteries
Limited

I、Sample Description

| | | | |
|---------------------------|-----------------------------|---|---------------|
| Sample name | LiFePO ₄ Battery | Sample model | SLAUMXLI18-12 |
| Applicant | Ultramax Batteries limited | | |
| Manufacturer | Name | Ultramax Batteries limited | |
| | Address | Watkins House Pegamoid Road, London N18 2NG | |
| | Tel. | +44-(0)2088038899 | |
| | E-mail | sales@ultramax.co.uk | |
| | Website | www.ultramax.co.uk | |
| Nominal voltage | 12.8V | Rated capacity | 18Ah |
| Charge current | 10A | Maximum continuous charge current | 20A |
| Limited charge voltage | 14.6V | End charge current | 0.36A |
| Discharge Cut-off voltage | 8V | Maximum discharge current | 20A |
| Discharge current | 10A | Mass | 2220.8g |
| Manufacturer of cell | Ultramax Batteries limited | | |
| Cell model | 32700 3.2V 6AH | Cell number | 12PCS |
| Cell nominal voltage | 3.2V | Cell rated capacity | 6Ah |
| Entrust date | 2020-11-09 | Finished date | 2020-12-07 |

II、Test Standard

Manual of Tests and Criteria (ST/SG/AC.10/11/Rev.7 Part III sub-section 38.3)

III、 Test Item & Conclusion

| Item | Sample Number | Conclusion |
|--|-----------------|------------|
| T.1 Altitude simulation | N1~N4 C1~C4 | PASS |
| T.2 Thermal test | | PASS |
| T.3 Vibration | | PASS |
| T.4 Shock | | PASS |
| T.5 External short circuit | | PASS |
| T.6 Impact | N5~N9 C5~C9 | PASS |
| T.7 Overcharge | N1~N4 C1~C4 | PASS |
| T.8 Forced discharge | N10~N19 C10~C19 | PASS |
| The Samples has passed the test items of Manual of Tests and Criteria (ST/SG/AC.10/11/Rev.7), Part III sub-section 38.3. | | |

Notes

N1~N4 Batteries at first cycle in fully charged states

N5~N9 Cells at first cycle at 50% of the design rated capacity

N10~N19 Cells at first cycle in fully discharged states

C1~C4 Batteries after 25 cycles ending in fully charged states

C5~C9 Cells after 25 cycles at 50% of the design rated capacity

C10~C19 Cells after 25 cycles ending in fully discharged states

Tested by:

Checker by:

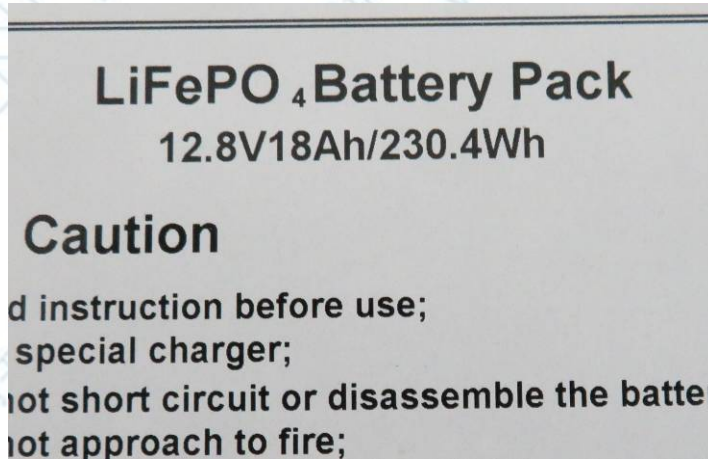
Approver by:

Technical Manager

Issue date 2020-12-07

IV、Photo of The Sample

Sample No.: J09147721



Authenticate the photo on original report only

V、Test Method

Tests T.1 to T.5 shall be conducted in sequence on the same cell or battery. Tests T.6 and T.8 shall be conducted using not otherwise tested cells or batteries. Test T.7 may be conducted using undamaged batteries previously used in tests T.1 to T.5 for purposes of testing on cycled batteries.

In order to quantify the mass loss, the following procedure is provided:

$$\text{Mass loss (\%)} = (M_1 - M) / M_1 \times 100$$

Where M_1 is the mass before the test and M_2 is the mass after the test. When mass loss does not exceed the values in Table below, it shall be considered as “no mass loss”.

| Mass M of cell or battery | Mass loss limit |
|------------------------------------|-----------------|
| $M < 1\text{g}$ | 0.5% |
| $1\text{g} \leq M \leq 75\text{g}$ | 0.2% |
| $M > 75\text{g}$ | 0.1% |

T.1 Altitude simulation

Test cells and batteries shall be stored at a pressure of 11.6kPa or less for at least six hours at ambient temperature ($20^\circ\text{C} \pm 5^\circ\text{C}$).

Cells and batteries meet this requirement if there is no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.

T.2 Thermal test

Test cells and batteries are to be stored for at least six hours at a test temperature equal to $72^{\circ}\text{C} \pm 2^{\circ}\text{C}$, followed by storage for at least six hours at a test temperature equal to $-40^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The maximum time interval between test temperature extremes is 30 minutes. This procedure is to be repeated until 10 total cycles are complete, after which all test cells and batteries are to be stored for 24 hours at ambient temperature ($20^{\circ}\text{C} \pm 5^{\circ}\text{C}$). For large cells and batteries the duration of exposure to the test temperature extremes should be at least 12 hours.

Cells and batteries meet this requirement if there is no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.

T.3 Vibration

Cells and batteries are firmly secured to the platform of the vibration machine without distorting the cells in such a manner as to faithfully transmit the vibration. The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7Hz and 200Hz and back to 7Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting positions of the cell. One of the directions of vibration must be perpendicular to the terminal face.

The logarithmic frequency sweep shall differ for cells and batteries with a gross mass of not more than 12kg (cells and small batteries), and for batteries with a gross mass of more than 12kg (large batteries).

For cells and small batteries: from 7Hz a peak acceleration of $1g_n$ is maintained until 18Hz is reached. The amplitude is then maintained at 0.8mm (1.6mm total excursion) and the frequency increased until a peak acceleration of $8g_n$ occurs (approximately 50Hz). A peak acceleration of $8g_n$ is then maintained until the frequency is increased to 200Hz.

For large batteries: from 7Hz to a peak acceleration of $1g_n$ is maintained until 18Hz is reached. The amplitude is then maintained at 0.8mm (1.6mm total excursion) and the frequency increased until a peak acceleration of $2g_n$ occurs (approximately 25Hz). A peak acceleration of $2g_n$ is then maintained until the frequency is increased to 200Hz.

Cells and batteries meet this requirement if there is no leakage, no venting, no disassembly, no rupture and no fire during the test and after the test and if the open circuit voltage of each test cell or battery after testing in its perpendicular mounting position is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.

T.4 Shock

Test cells and batteries shall be secured to the testing machine by means of a rigid mount which will support all mounting surfaces of each test battery.

Each cell shall be subjected to a half-sine shock of peak acceleration of 150g_n and pulse duration of 6 milliseconds. Alternatively, large cells may be subjected to a half-sine shock of peak acceleration of 50g_n and pulse duration of 11 milliseconds.

Each battery shall be subjected to a half-sine shock of peak acceleration depending on the mass of the battery. The pulse duration shall be 6 milliseconds for small batteries and 11 milliseconds for large batteries. The formulas below are provided to calculate the appropriate minimum peak accelerations.

| Battery | Minimum peak acceleration | Pulse duration |
|-----------------|---|----------------|
| Small batteries | <p>150g_n or result of formula</p> <p>Acceleration (g_n)= $\sqrt{\left(\frac{100850}{\text{mass}^*}\right)}$</p> <p>Whichever is smaller</p> | 6ms |
| Large batteries | <p>150g_n or result of formula</p> <p>Acceleration (g_n)= $\sqrt{\left(\frac{30000}{\text{mass}^*}\right)}$</p> <p>Whichever is smaller</p> | 11ms |

* Mass is expressed in kilograms

Each cell or battery shall be subjected to three shocks in the positive direction and to three shocks in the negative direction in each of three mutually perpendicular mounting positions of the cell or battery for a total of 18 shocks.

Cells and batteries meet this requirement if there is no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.

T.5 External short circuit

The cell or battery to be tested shall be heated for a period of time necessary to reach a homogeneous stabilized temperature of 57°C ± 4°C, measured on the external case. This period of time depends on the size and design of the cell or battery and should be assessed and documented. If this assessment is not feasible, the exposure time shall be at least 6 hours for small cells and small batteries, and 12 hours for large cells and large batteries. Then the cell or battery at 57°C ± 4°C shall be subjected to one short circuit condition with a total

external resistance of less than 0.1 ohm. This short circuit condition is continued for at least one hour after the cell or battery external case temperature has returned to $57^{\circ}\text{C} \pm 4^{\circ}\text{C}$, or in the case of the large batteries, has decreased by half of the maximum temperature increase observed during the test and remains below that value. The short circuit and cooling down phases shall be conducted at least at ambient temperature.

Cells and batteries meet this requirement if their external temperature does not exceed 170°C and there is no disassembly, no rupture and no fire during the test and within six hours after the test.

T.6 Impact

Impact (applicable to cylindrical cells not less than 18 mm in diameter)

The test sample cell or component cell is to be placed on a flat smooth surface. A $15.8 \pm 0.1\text{mm}$ diameter, at least 6 cm long, or the longest dimension of the cell, whichever is greater, Type 316 stainless steel bar is to be placed across the centre of the sample. A $9.1\text{kg} \pm 0.1\text{kg}$ mass is to be dropped from a height of $61 \pm 2.5\text{cm}$ at the intersection of the bar and sample in a controlled manner using a near frictionless, vertical sliding track or channel with minimal drag on the falling mass. The vertical track or channel used to guide the falling mass shall be oriented 90 degrees from the horizontal supporting surface.

The test sample is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the $15.8 \text{ mm} \pm 0.1\text{mm}$ diameter curved surface lying across the centre of the test sample. Each sample is to be subjected to only a single impact.

T.7 Overcharge

The charge current shall be twice the manufacturer's recommended maximum continuous charge current. The minimum voltage of the test shall be as follows:

(a) When the manufacturer's recommended charge voltage is not more than 18V, the minimum voltage of the test shall be the lesser of two times the maximum charge voltage of the battery or 22V.

(b) When the manufacturer's recommended charge voltage is more than 18V, the minimum voltage of the test shall be 1.2 times the maximum charge voltage.

Tests are to be conducted at ambient temperature; the duration of the test shall be 24 hours.

Rechargeable batteries meet this requirement if there is no disassembly and no fire during the test and within seven days after the test.

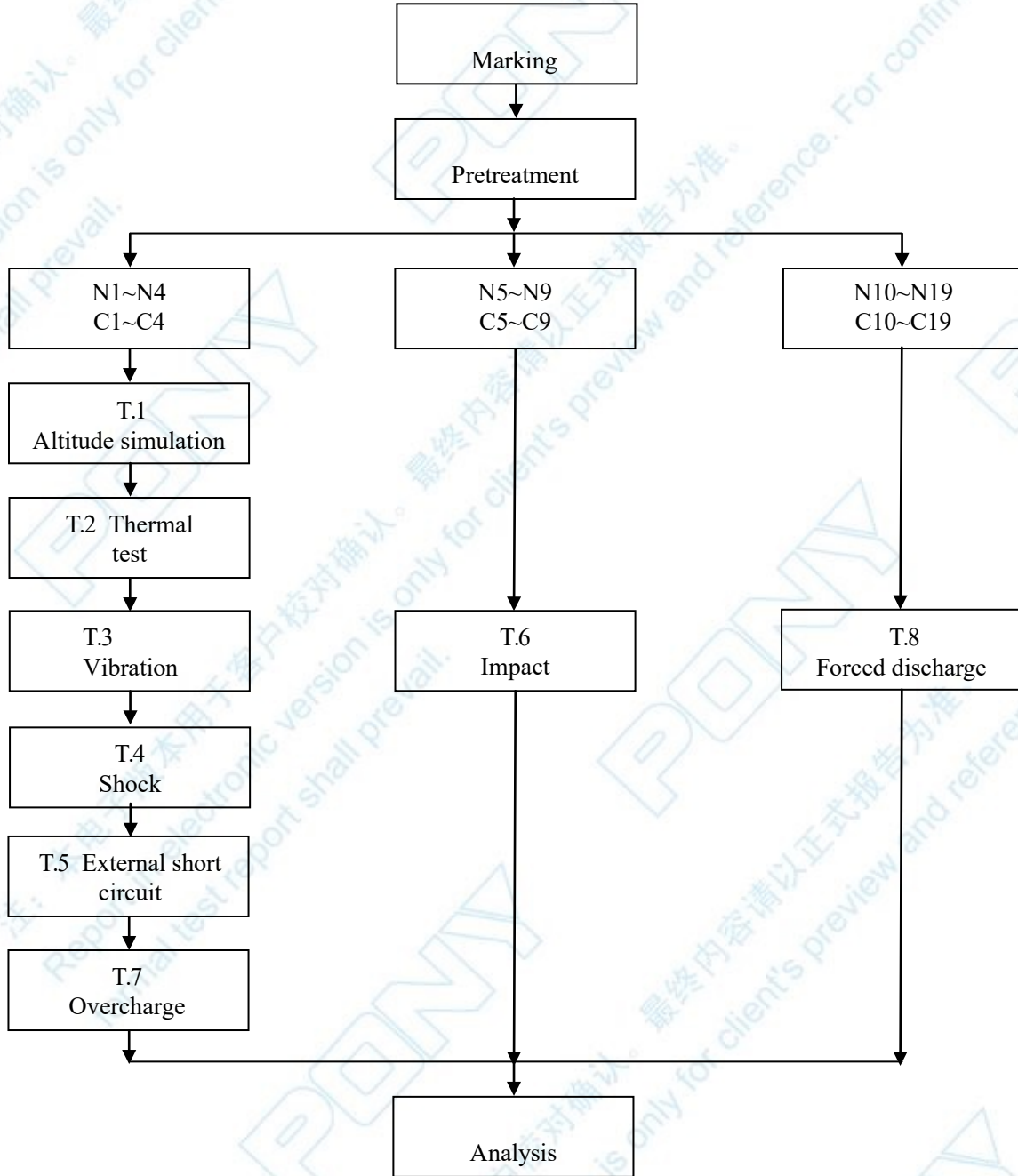
T.8 Forced discharge

Each cell shall be forced discharged at ambient temperature by connecting it in series with a 12V D.C. power supply at an initial current equal to the maximum discharge current specified by the manufacturer.

The specified discharge current is to be obtained by connecting a resistive load of the appropriate size and rating in series with the test cell. Each cell shall be forced discharged for a time interval (in hours) equal to its rated capacity divided by the initial test current (in ampere).

Primary or rechargeable cells meet this requirement if there is no disassembly and no fire during the test and within seven days after the test.

VI、 Test Procedure



VII、Test Apparatus

| | |
|---------|--|
| IE-0121 | High precision battery test system |
| IE-0513 | High precision battery test instrument |
| IE-0568 | Multi-function digital milliohmmeter |
| IE-0434 | Vacuum drying oven |
| IE-0090 | Multimeter |
| IE-0824 | Tableland air pressure gauge |
| IE-0178 | CNS·TC series electronic counting scales |
| IE-0219 | Rapid temperature change test chamber |
| IE-0503 | Electric vibration test system |
| IE-0128 | Electric vibration test system |
| IE-0287 | Vertical impact crash test platform |
| IE-0281 | Temperature controlled short circuit testing machine |
| IE-0185 | The digital thermometer (TC) |
| IE-0833 | Battery heavy shock testing machine |
| IE-0511 | Programmable DC power source |
| IE-0294 | Programmable DC power source |

VIII、 Test Data

T.1 Altitude simulation

| No. | Pre-test | | After test | | Mass loss (%) | Voltage loss (%) | Whether leakage, venting, disassembly, rupture, fire (Yes/No) |
|-----|----------|-------------|------------|-------------|---------------|------------------|---|
| | Mass (g) | Voltage (V) | Mass (g) | Voltage (V) | | | |
| N1 | 2220.8 | 13.33 | 2220.8 | 13.33 | 0.000 | 0.000 | (No) |
| N2 | 2221.9 | 13.39 | 2221.8 | 13.38 | 0.005 | 0.075 | (No) |
| N3 | 2215.6 | 13.39 | 2215.5 | 13.39 | 0.005 | 0.000 | (No) |
| N4 | 2223.7 | 13.36 | 2223.6 | 13.35 | 0.004 | 0.075 | (No) |
| C1 | 2222.5 | 13.39 | 2222.4 | 13.39 | 0.004 | 0.000 | (No) |
| C2 | 2222.9 | 13.41 | 2222.7 | 13.39 | 0.009 | 0.149 | (No) |
| C3 | 2214.4 | 13.34 | 2214.4 | 13.33 | 0.000 | 0.075 | (No) |
| C4 | 2215.9 | 13.40 | 2215.9 | 13.39 | 0.000 | 0.075 | (No) |

T.2 Thermal test

| No. | Pre-test | | After test | | Mass loss (%) | Voltage loss (%) | Whether leakage, venting, disassembly, rupture, fire (Yes/No) |
|-----|----------|-------------|------------|-------------|---------------|------------------|---|
| | Mass (g) | Voltage (V) | Mass (g) | Voltage (V) | | | |
| N1 | 2220.8 | 13.33 | 2220.0 | 13.30 | 0.036 | 0.225 | (No) |
| N2 | 2221.8 | 13.38 | 2221.3 | 13.32 | 0.023 | 0.448 | (No) |
| N3 | 2215.5 | 13.39 | 2215.1 | 13.31 | 0.018 | 0.597 | (No) |
| N4 | 2223.6 | 13.35 | 2223.2 | 13.30 | 0.018 | 0.375 | (No) |
| C1 | 2222.4 | 13.39 | 2222.0 | 13.31 | 0.018 | 0.597 | (No) |
| C2 | 2222.7 | 13.39 | 2222.1 | 13.31 | 0.027 | 0.597 | (No) |
| C3 | 2214.4 | 13.33 | 2213.9 | 13.30 | 0.023 | 0.225 | (No) |
| C4 | 2215.9 | 13.39 | 2215.5 | 13.31 | 0.018 | 0.597 | (No) |

T.3 Vibration

| No. | Pre-test | | After test | | Mass loss (%) | Voltage loss (%) | Whether leakage, venting, disassembly, rupture, fire (Yes/No) |
|-----|----------|-------------|------------|-------------|---------------|------------------|---|
| | Mass (g) | Voltage (V) | Mass (g) | Voltage (V) | | | |
| N1 | 2220.0 | 13.30 | 2220.0 | 13.30 | 0.000 | 0.000 | (No) |
| N2 | 2221.3 | 13.32 | 2221.2 | 13.31 | 0.005 | 0.075 | (No) |
| N3 | 2215.1 | 13.31 | 2215.1 | 13.31 | 0.000 | 0.000 | (No) |
| N4 | 2223.2 | 13.30 | 2223.2 | 13.30 | 0.000 | 0.000 | (No) |
| C1 | 2222.0 | 13.31 | 2221.9 | 13.31 | 0.005 | 0.000 | (No) |
| C2 | 2222.1 | 13.31 | 2222.1 | 13.30 | 0.000 | 0.075 | (No) |
| C3 | 2213.9 | 13.30 | 2213.7 | 13.30 | 0.009 | 0.000 | (No) |
| C4 | 2215.5 | 13.31 | 2215.5 | 13.30 | 0.000 | 0.075 | (No) |

T.4 Shock

| No. | Pre-test | | After test | | Mass loss (%) | Voltage loss (%) | Whether leakage, venting, disassembly, rupture, fire (Yes/No) |
|-----|----------|-------------|------------|-------------|---------------|------------------|---|
| | Mass (g) | Voltage (V) | Mass (g) | Voltage (V) | | | |
| N1 | 2220.0 | 13.30 | 2220.0 | 13.30 | 0.000 | 0.000 | (No) |
| N2 | 2221.2 | 13.31 | 2221.2 | 13.31 | 0.000 | 0.000 | (No) |
| N3 | 2215.1 | 13.31 | 2215.0 | 13.30 | 0.005 | 0.075 | (No) |
| N4 | 2223.2 | 13.30 | 2223.2 | 13.30 | 0.000 | 0.000 | (No) |
| C1 | 2221.9 | 13.31 | 2221.9 | 13.31 | 0.000 | 0.000 | (No) |
| C2 | 2222.1 | 13.30 | 2222.1 | 13.30 | 0.000 | 0.000 | (No) |
| C3 | 2213.7 | 13.30 | 2213.7 | 13.29 | 0.000 | 0.075 | (No) |
| C4 | 2215.5 | 13.30 | 2215.4 | 13.30 | 0.005 | 0.000 | (No) |

T.5 External short circuit

| No. | Peak temperature (°C) | Whether disassembly, rupture, fire (Yes/No) |
|-----|-----------------------|---|
| N1 | 57.4 | (No) |
| N2 | 57.3 | (No) |
| N3 | 57.3 | (No) |
| N4 | 57.4 | (No) |
| C1 | 57.5 | (No) |
| C2 | 57.3 | (No) |
| C3 | 57.3 | (No) |
| C4 | 57.4 | (No) |

T.6 Impact

| No. | Pre-test Voltage (V) | Peak temperature (°C) | Whether disassembly, fire (Yes/No) |
|-----|----------------------|-----------------------|------------------------------------|
| N5 | 3.284 | 24.2 | (No) |
| N6 | 3.286 | 24.1 | (No) |
| N7 | 3.287 | 24.2 | (No) |
| N8 | 3.284 | 24.0 | (No) |
| N9 | 3.283 | 24.1 | (No) |
| C5 | 3.285 | 24.1 | (No) |
| C6 | 3.286 | 24.1 | (No) |
| C7 | 3.285 | 24.1 | (No) |
| C8 | 3.287 | 24.0 | (No) |
| C9 | 3.286 | 24.1 | (No) |

T.7 Overcharge

| No. | Pre-test Voltage (V) | Whether disassembly, fire (Yes/No) |
|-----|----------------------|------------------------------------|
| N1 | 13.33 | (No) |
| N2 | 13.39 | (No) |
| N3 | 13.39 | (No) |
| N4 | 13.36 | (No) |
| C1 | 13.39 | (No) |
| C2 | 13.41 | (No) |
| C3 | 13.34 | (No) |
| C4 | 13.40 | (No) |

T.8 Forced discharge

| No. | Pre-test Voltage (V) | Whether disassembly, fire (Yes/No) |
|-----|----------------------|------------------------------------|
| N10 | 2.861 | (No) |
| N11 | 2.865 | (No) |
| N12 | 2.861 | (No) |
| N13 | 2.861 | (No) |
| N14 | 2.865 | (No) |
| N15 | 2.860 | (No) |
| N16 | 2.869 | (No) |
| N17 | 2.862 | (No) |
| N18 | 2.865 | (No) |
| N19 | 2.866 | (No) |
| C10 | 2.869 | (No) |
| C11 | 2.864 | (No) |
| C12 | 2.867 | (No) |
| C13 | 2.860 | (No) |
| C14 | 2.862 | (No) |
| C15 | 2.860 | (No) |
| C16 | 2.868 | (No) |
| C17 | 2.869 | (No) |
| C18 | 2.868 | (No) |
| C19 | 2.867 | (No) |

*** End of report***