LINCAD
POWER MANAGEMENT SYSTEMS

SUMMER NEWS 2018

Lincad, a leader in the design and manufacture of bespoke batteries, chargers and power management systems.

www.lincad.co.uk

WELCOME

Janet Rowe

Peter Slade

Welcome to the Summer issue of the Lincad newspaper. Our aim is to keep you in contact with what is going on in our world as we continue to innovate at the leading edge of battery technology.

In this issue, we are covering recent contract wins and exhibitions we've attended; welcoming our new Sales & Marketing Assistant, Rebecca Rossiter; talking to our Research & Quality Manager, Gavin Durham, about battery chemistry, transportation and storage; and finally, taking a look back at the role that the Clansman radio played in the birth of the company.

We hope you enjoy the read!

Janet Rowe and Peter Slade
Joint Managing Directors

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EXHIBITING AT EUROSATORY

From June 11th to June 15th, Lincad will be in Paris exhibiting at Eurosatory. You can meet the team in Hall 5a on Stand 719.

Held every two years, Eurosatory is the world's largest international Land and Airland Defence and Security tradeshow and brings together the entire supply chain from subcontractors to major industrial primes. In 2016, the event attracted over 57,000 visitors, including more than 8200 representatives from the armed and security forces of 103 different countries.

With our full range of products on display, we will be demonstrating the full extent of our capabilities in the design, development and manufacture of batteries, chargers and power management systems to both UK Defence Standards and US Military Standards.

We will also be taking the excellent opportunity that Eurosatory offers to launch the latest addition to our ever expanding portfolio of batteries.

2018
EUROSATORY
11 - 15 JUNE 2018 / PARIS

LINCAD TO SUPPLY BATTERIES FOR JAPANESE HALO SYSTEM

Sojitz Aerospace Corporation

We were delighted to win an important new contract from the Japanese Sojitz Aerospace Corporation to supply batteries for the HALO (Hostile Artillery Locator) used by the Japanese Ministry of Defence. The HALO system employs passive acoustic location techniques to detect the source of artillery fire at ranges of up to 30km. Virtually immune to countermeasures, it can provide almost instant data on hostile firing positions.

The HALO battery is a 24V, 80Ah battery, based on Lincad's LIPS 6, and is engineered to the highest mechanical and environmental specifications to provide a robust and reliable power source.

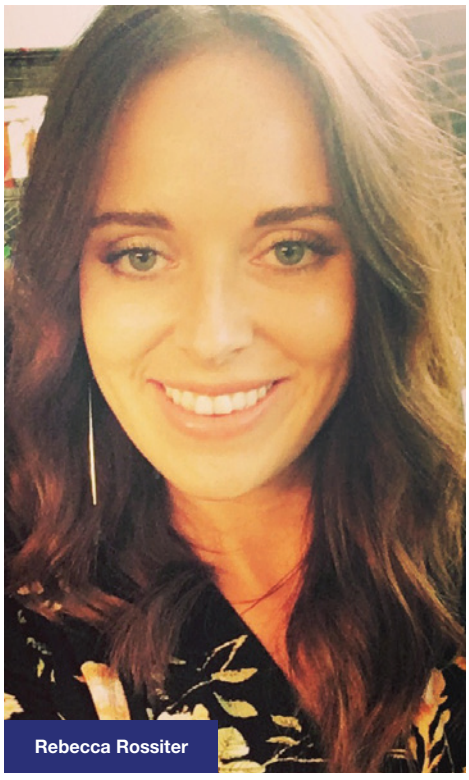
In the words of Peter Slade: **"Lincad has a long and successful record of providing specialist batteries for military applications. We're delighted to receive further orders from Sojitz in Japan, demonstrating the quality and value that we can offer to international customers."** ●

THALES ORDERS FURTHER LINCAD BATTERIES AND CHARGERS FOR ECM SYSTEM

Earlier this year, we received an order from Thales to supply additional batteries for the Storm-H, an ultra-compact, lightweight Electronic Countermeasures (ECM) system designed to protect individuals against Radio Controlled Improvised Explosive Devices (RCIED).

In addition to protecting specialist military personnel such as observers, mentors, dog handlers and engineers who operate in small, detached teams, Storm-H can also be used for domestic emergencies that require a response from combined civilian and military services. Providing first responders with a lightweight, unobtrusive, 'turn on and forget' capability that operates in conjunction with other systems, Storm-H can also be easily installed on unmanned search vehicles.

We were obviously delighted that Thales decided on Lincad to continue providing the power for the Storm-H. ●



Rebecca Rossiter

REBECCA ROSSITER JOINS LINCAD AS SALES & MARKETING ASSISTANT

It was a great pleasure to welcome Rebecca (Becky) Rossiter to the Lincad team when she joined us recently as our new Sales & Marketing Assistant. Coming from a marketing background, she quickly found herself in the middle of getting us ready for what has been a very busy exhibition season. From the shipping of all the products, the literature and the furniture required for the stands to the booking of flights and accommodation to managing the social media coverage, Becky well and truly hit the ground running! ●

Come and visit us at Eurosatory, Paris - Hall 5a, Stand 719

A VERY BUSY EXHIBITION SEASON

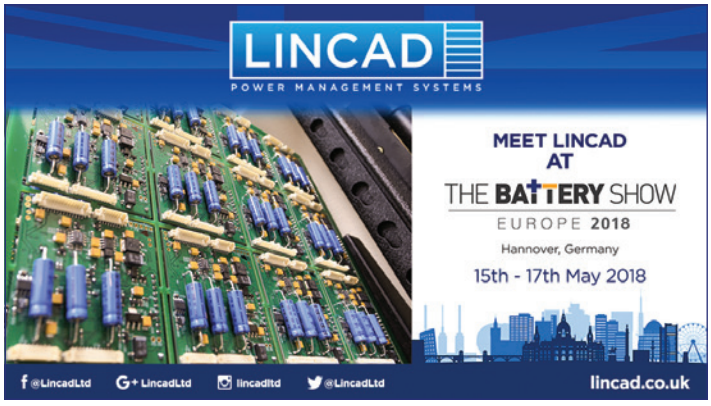
As we mentioned above, it has been a very busy exhibition season for us – apart from Eurosatory in June, we attended The Battery Show Europe and China International Battery Fair in May and exhibited at DPRTE 2018 and Battery Tech Expo in March.

The Battery Show Europe

Taking place this year from 15th to 17th May at the Deutsche Messe in Hannover, Germany, The Battery Show is Europe's largest trade fair for advanced battery technology and attracted more than 300 manufacturers and service providers from across the supply chain. Attending the show, at which thousands of design, production and manufacturing solutions were showcased, we had an excellent opportunity to assess new technological developments and establish new relationships with important players in the industry.

China International Battery Fair

Organised by CIAPS (China Industrial Association of Power Sources), the China International Battery Fair is the world's largest trade fair devoted to batteries and has become a major platform for battery manufacturers and users to exchange ideas on new technologies, expand their markets and promote their products and services to customers. Attending the show which was held at the Shenzhen Convention and Exhibition Center from the 22nd to 24th May, we were once again able to assess the new technologies on offer and gain a valuable insight into a worldwide marketplace. ●



DPRTE 2018

This year's DPRTE (Defence Procurement, Research, Technology & Exportability) was held on 27th March at the Motorpoint Arena, Cardiff. Firmly established as the UK's leading defence procurement event, DPRTE 2018 brought together over 1500 key decision makers from across the defence sector with a collective responsibility for an annual budget of more than £19 billion. For us, it proved to be an excellent platform for promoting the full extent of our capability in the design and manufacture of bespoke batteries, chargers and power management systems for military applications.

BATTERY TECH EXPO

Two weeks before DPRTE, we were exhibiting at Battery Tech Expo which was held at the International Centre, Telford. The battery industry is on the cusp of a power revolution with major technology companies investing heavily in the next generation of battery development and energy storage. Bringing together professionals from across the industry, this event enabled us to demonstrate our position at the forefront of lithium-ion battery technology.

BATTERY TECH EXPO

LINCAD
POWER MANAGEMENT SYSTEMS

2018 EUROSATORY

A LINCAD INVITATION

We would like to invite you to join us for drinks at Eurosatory 2018

When: Wednesday 13th June 2018 **Time:** 3pm - 5pm
Where: Eurosatory UK Pavilion Hall 5a Stand 719

RSVP: Lincad press office
abigail@singletonpr.com

www.lincad.co.uk

Come and visit us at Eurosatory, Paris - Hall 5a, Stand 719

TECHNICAL TALK WITH GAVIN DURHAM

In a series of interviews, our Research & Quality Manager, Gavin Durham, talked about three key technical issues for Lincad - Battery Chemistry, Battery Transportation and Battery Storage.

Gavin Durham

BATTERY CHEMISTRY

Q. Lithium-ion seems to be the dominant battery chemistry at the moment. Is that a fair assessment?

A. Yes, it is. There is a massive amount of research and development into lithium-ion, pushing it further ahead of alternative chemistries. It has been estimated that the manufacture of lithium-ion batteries is set to increase at least five-fold in the next three years. In part, that's because lithium is a relatively abundant element with significant deposits found mainly in Argentina, Chile, China, Australia and Mexico although other components of lithium-ion batteries, such as cobalt, are rarer.

Q. So, is lithium-ion the only story now?

A. Not entirely. Sodium is the next element down from lithium in the Periodic Table and sodium ions are similar to lithium ions. But there are issues with sodium-ion batteries, largely from the chemistry point of view. Sodium ions are bigger and heavier than lithium ions. In a lithium-ion battery, the reaction taking place is basically an intercalation reaction where the lithium ions are transferred from the anode to the cathode and inserted into the structure of graphite in the anode. Because sodium ions are larger, that process doesn't occur so readily.

Due to the fact that sodium ions are heavier, you cannot get such a high energy density in a sodium-ion battery compared to a lithium-ion battery. So, you're unlikely to see sodium-ion laptop or mobile phone batteries because they'd be a lot heavier and bulkier. They're also lower voltage. However, what you might see is sodium-ion batteries being used in domestic and large scale energy storage systems where size and weight don't matter so much. The major advantage for sodium is that it is more abundant than lithium and therefore offers potential cost savings.

Q. Is it an area that Lincad will be looking at?

A. Lincad is always open to new developments in cell technology. However, our current focus is on high energy density, high power, and weight reduction – imperative characteristics for the soldier in the field – and sodium-ion batteries can't compete with lithium-ion at all in that area.

Q. What about aluminium-ion batteries?

A. It's a similar picture with aluminium. Aluminium ions have the advantage that for every ion that crosses the membrane from anode to cathode, you get three electrons. But there are a lot of technical issues with aluminium, particularly because, when you look at the Periodic Table, you can see that it's much heavier.

In my opinion, lithium is going to be the leader in the field for many years to come. There's nothing to touch it really whether it's for non-rechargeable primary or rechargeable secondary batteries.

BATTERY TRANSPORTATION

Q. I understand there have been a number of changes regarding the transport of batteries by air. Can you start by expanding on that?

A. Yes, basically there has been a strict tightening of the regulations for air transport, especially for lithium batteries, over recent years. Until just a few years ago, you could transport lithium primary cells and lithium-ion rechargeable batteries by either passenger or cargo aircraft. The International Air Transport Association (IATA) then prohibited the transport of lithium primary cells by passenger aircraft because there had been a few incidents, particularly in America. In the last couple of years, they've extended that ban to cover lithium-ion rechargeable batteries as well.

In addition, they introduced a state-of-charge rule on lithium-ion rechargeable batteries being transported by cargo aircraft. They must now be in a state-of-charge of 30% or less. Effectively, in that condition, they contain less energy and are therefore far less likely to have a problem if they get crushed, punctured or something else happens to them.

Other types of battery, like nickel-metal hydride, nickel cadmium and lead acid, are not regulated to anything like the same extent as lithium batteries.

Q. Are other forms of transport similarly regulated?

A. Certainly the strictest rules are on air transport. If you're shipping batteries by multi-modal transport (a combination of two or more of road, sea and air), normally if they're packed suitably for air freight, they should be OK for the other two modes of transport.

Basically, if there's a major incident in the air, the implications are much more serious than if it happens on the ground. With road transport, small lithium batteries can still be shipped as non-dangerous goods, exempt from road transport regulations. By air, all lithium batteries are now classified as Class 9 dangerous goods and have to be shipped under a UN number with specific packaging and labelling requirements.

The situation for transport by sea is similar to road transport, although in certain circumstances an extra packing certificate is required.

Q. How do all of these regulations affect Lincad?

A. By far the majority of our lithium batteries are transported by road but many of our contracts will state that the batteries have to be suitable for shipping by all modes of transport. So, even though we're only shipping them by road, we still have to pack them as if they were going by air.

For example, a customer may ask us to send the batteries by road to a depot in the UK but they will then ship them by air to a final destination. In order that they don't have to repack them, with all the added costs that might entail, we provide the correct packaging and labelling to make their job more straightforward.

Come and visit us at Eurosatory, Paris - Hall 5a, Stand 719

BATTERY STORAGE

Q. What are the big issues when it comes to battery storage?

A. There are two fundamental issues – temperature and state of charge. In general, batteries prefer to be stored at relatively low temperatures and the reason for that is because reaction rates slow down at lower temperatures. For every ten degrees drop in temperature, the reaction rate halves. You see, the main problems with storing batteries are firstly that they self-discharge losing capacity (which can be recovered after re-charge) and secondly, when stored at higher temperatures they can permanently lose capacity which is not recoverable by re-charging.

Depending on the chemistry, most batteries like to be stored at a temperature of about 5 to 15 degrees centigrade. If you go to much lower temperatures, say, -10 or -20, like a freezer, you run into issues of condensation. As you bring the battery out of the very cold conditions and it starts to warm up, condensation forms on the battery which can be very damaging to it.

Q. And the state of charge?

A. With primary batteries, you obviously have no choice; they have to be stored in a fully charged state. But rechargeable batteries, depending on their chemistry, like to be stored in different states of charge. Lead acid batteries, for example, need to be stored fully charged. Storing them in a discharged state causes a process called sulphation and other problems that affect the capacity. But with nickel cadmium batteries, it doesn't really matter what state of charge they're stored at; they tend to store pretty well whether they're fully charged or fully discharged.

Lithium-ion batteries, on the other hand, should be stored in a 40 to 50% state of charge. If you store them at 100%, they tend to lose capacity, especially if stored at higher temperatures. But if they're stored at a very low state of charge then there's a risk of them dropping below 2 volts and once that happens, there can be issues regarding their serviceability.

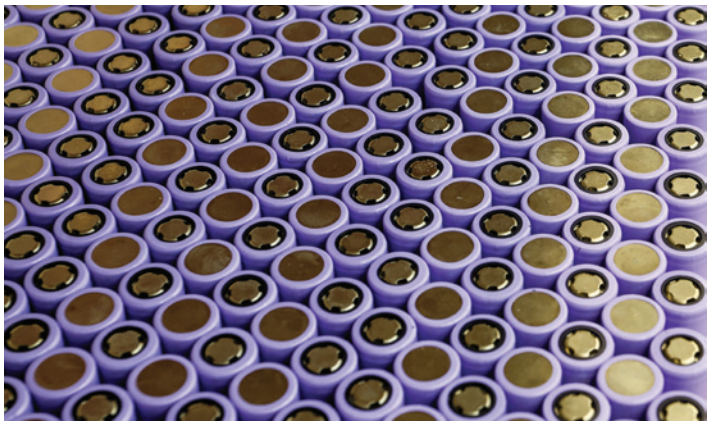
Q. All of this must make it difficult for organisations which have a lot of batteries to store, the MOD for example?

A. Well, there's certainly a lot of important information you need to understand when it comes to storage. Customers may not have

this information, so they have to come back to battery experts for guidance. If it was straightforward, if the same rules applied to all chemistries, then it would be easy. But unfortunately, that's not the case.

Q. Finally, does Lincad offer its customers any kind of battery storage service?

A. We do offer battery storage and maintenance services for some customers. We also provide battery handling notes for most of the batteries that we design and manufacture. These give the recommended storage conditions, so the customer can maximise the battery's shelf life. ●



THE ROLE OF THE CLANSMAN RADIO IN THE FOUNDING OF LINCAD

Brian Soden

The very origins of Lincad as a company are inextricably linked to the Clansman radio that was in use with the British armed forces for more than 30 years, from 1976 to 2010.

It was in 1986 when Brian Soden, now Lincad's Chairman, founded the company. Having previously worked as a Divisional Director for Saft, a major international battery manufacturer, he believed he could offer the UK Ministry of Defence both a high quality battery service and better value for money. When he approached the MOD with a proposal to provide an inspection and maintenance service, he was initially offered 1,000 batteries to check and he set up a testing facility in Sandhurst. Before long, the newly formed Lincad was receiving Clansman batteries in the tens of thousands which, having been inspected, were either made good for service use or scrapped.

Having successfully demonstrated its capabilities in this way, Lincad was then awarded the production contract for the battery in 1995, establishing the company as a manufacturing business for the first time.

The Clansman was an integrated radio system, sometimes called a Combat Net Radio (CNR), developed by the Signals Research and Development Establishment (SRDE) in response to a General Staff Requirement first laid down by the MOD in 1965. As a replacement for the ageing Larkspur system, the Clansman was not only much lighter than its predecessor, it also proved to be more flexible and more reliable. Originally manufactured by Racal BCC, Mullard Equipment Ltd (MEL) and Plessey, the Clansman introduced the army to several new technological features, including SSB (single-sideband) operation and NBFM (narrow-band frequency modulation).

The name 'Clansman' actually referred to a family of nine main radio units, operating in the high frequency (HF), very high frequency (VHF) and ultra high frequency (UHF) bands and individual models were designated UK/PRC or UK/VRC for portable radio communications and vehicle radio communications respectively. The main advantage was that they were all frequency synthesised, using switched channels as opposed to a variable tuning scale which provided frequency stability and removed the need for frequent tweaking to maintain a signal.

In active use during the Falklands War of 1982 and the First Gulf War in 1991, the Clansman was progressively phased out from the mid-2000s onwards, being replaced by the new digital Bowman communication system. Whilst much of the equipment is still available to collectors on the surplus market, technical details of some of the parts remain classified to this day.

"The MOD originally planned to deploy the Clansman with primary non-rechargeable batteries but just as it was coming into service in the early 1970s, while I was still working for Saft, we persuaded them to go for a secondary rechargeable battery," remembers Brian Soden. **"The Ministry of Defence gave both Saft and Chloride a contract to produce 1,000 rechargeable batteries which were trialled and, lo and behold, the rechargeable batteries that we supplied worked. The design of the battery went on from there."**

A variety of rechargeable nickel-cadmium batteries were used in the early days of the Clansman, including a small 12V 0.5Ah , a 14.4V 1.8Ah as well as a 24V 3.3Ah battery which was later upgraded to 4Ah. To support this 4Ah version, an alternating current charging unit (ACCU) was provided for use in barracks, where up to sixteen batteries could be charged simultaneously or singly, whilst a direct current charging unit (DCCU) was used to recharge the battery when it was mounted in a vehicle. Both chargers worked in a similar way, providing an appropriate charging current while sensing the battery temperature to detect when charging was complete. Later, an intelligent battery management system (IBMS) was provided which could automatically condition one or more batteries, ensuring that only a complete charge cycle was ever applied.

By this stage, the days of the Clansman being used on active service were numbered. Time was moving on for the army and for Lincad which is now operating at the forefront of lithium-ion technology. However, it all began with the servicing of the nickel cadmium batteries for the Clansman radio.