# HOW THE LEAD MARKET OPERATES

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## INTRODUCTION

To begin with, this is not a technical paper. It is a presentation on how the lead market operates (what causes the fluctuations in the LME), how battery manufacturers procure lead and hedge on pricing, and how all of this affects the price of the end product. The paper was written as a result of a request by the technical committee.

## HOW THE LEAD MARKET OPERATES

### The Lead Market – What is it?

For the context of this paper, the lead market is defined as the London Metals Exchange (LME). It is important to note that lead contracts are traded on the LME and spot prices can be obtained via the Shanghai Nonferrous Metals Exchange as well as via an exchange in New Delhi. There may be other exchanges trading lead; however, the LME is regarded as the benchmark exchange and its settlement prices are the recognized market prices on a global basis, outside of China.

The LME provides a transparent forum for all trading activity and as a result helps to 'discover' what the price of material will be months and years ahead. This helps the physical industry to plan forward in a world subject to often severe and rapid price movements. Such is the liquidity at the Exchange that the prices 'discovered' at the LME are recognized and relied upon by industry throughout the world[1]. This 'discovered' price has to correlate directly to an actual physical purchase price and this is achieved by the LME acting as a delivery point of last resort, i.e., all of the underlying contracts are covered by an aspect of physical delivery, such that if one party wants to take delivery of the lead at the settlement price they can.

In this capacity, the LME is known as a 'market of last resort'; the physical non-ferrous metals and plastics industries can use the Exchange's delivery option to sell excess stock in times of over supply and as a source of material in times of extreme shortage. The market does not replace the normal channels for the buying and selling of material and only a very small proportion of contracts actually result in delivery. The presence, or 'threat', of physical delivery plays a vital role in creating price convergence between the futures and the physical market[1].

### Background on the LME

The LME itself can trace its origins back to 1571, although it was formally established in 1877 as the London Metal Market and Exchange Company. It is the second oldest futures exchange in the world and is by far the world's largest non-ferrous metals exchange. It offers futures and options contracts for aluminum, copper, nickel, tin, zinc and lead plus two regional aluminum alloy contracts. In 2005 the Exchange launched the world's first futures contracts for plastics; for polypropylene and linear low density polyethylene, with the introduction of regional plastics contracts in 2007. In addition, it offers LME minis, which are smaller-sized contracts for copper, aluminum and zinc plus an index contract (LMEX). The LME is a highly liquid market and in 2006 achieved volumes of 87 million lots, equivalent to $8,100 billion annually and between $35-45 billion on an average business day. Despite its London location the LME is a global market with an international membership and with more than 95% of its business coming from overseas.[1]

**Definition of LME contracts – What is traded on the LME**

There are three categories of lead contracts – Lead Futures, Lead Options and Lead Traded Average Price Options (TAPO's). The settlement prices for the Lead Futures contracts are what most people know as the price of lead. The "cash price" is derived from the official settlement price for that given trading day. The "three month" prices is the official price for a futures contract with a settlement date three months forward and the "15 month" price is the official price for a futures contract with a settlement date 15 months forward. The 15 month futures contract is the longest duration futures contract traded for lead. Contract settlement dates are as follows: daily for 3 months forward and then every Wednesday for the next 3 months and then every third Wednesday of the month for the next 9 months out to 15 months forward.

Table 1 lists the key specifications for the various Lead Contracts:

| **Table 1 – Key Specifications for Lead Contracts traded on the LME**[1] | |
|---|---|
| LME Lead Futures Contract Specification | |
| Contract | Lead of 99.970% minimum purity. Lead placed on warrant after 08/05/2001 must conform with graded lead chemical composition of BS EN 12659:1999 Standard entitled "Lead and Lead Alloys - Lead". |
| Lot size | 25 tonnes (with a tolerance of +/- 2%) |
| Form | Ingots (pigs will be referred to as ingots) |
| Weight | Up to 55 kg each.<br>Each parcel (bundles) placed on warrant shall not exceed 1.2 tonnes (01/06/1985-05/05/1992) or 1.5 tonnes after 06/05/1992. |
| Delivery dates | Daily for 3 months forward and then every Wednesday for the next 3 months and then every third Wednesday of the month for the next 9 months out to 15 months forward. |
| Quotation | US dollars per tonne |
| Minimum Price Movement | **Ring** - Outright $0.50, Carries $0.01<br>**LME Select** - Outright $0.25, Carries $0.01<br>**Inter-office** - Outright/Carries $0.01 |
| Clearable currencies | US dollar; Japanese yen; sterling; euro |
| LME Lead Options Contract Specification | |
| Delivery dates | Monthly from the first month out to 15 months |
| Value date | The third Wednesday of the prompt month |
| Exercise date | The first Wednesday of the prompt month |
| Premium quotation | US dollars per tonne |
| *Strike price | $25 gradations for strikes from US$25 to US$3975<br>$50 gradations for strikes form US$4000 to US$7950<br>$100 gradations for all strikes over $US8000 |
| *Strike price gradations and tick size for premiums available in all clearable currencies. | |
| LME Lead TAPOS Contract Specification | |
| Contract date | The business day on which the contract is traded |
| Contract period | Calendar months up to 15, 27 or 63 months forward (in line with the underlying futures contracts). The inclusive period between the first business day and the last business day of the traded month. |
| Option type | Calls & puts base don the monthly average settlement price (MASP) |
| Currency & strike price | US dollars :$1 gradations |
| Premium tick size | 0.01 USD (one cent) |
| Premium payment | Next business day after contract is traded |
| Settlement date | Settlement is two business days after exercise<br>The futures trades settle as per LME rules & regulations |

**How the LME price is set**[1,2]

The LME is a principal-to-principal market and as such, the only organizations able to trade are its member firms, of which there are various categories. LME members provide the physical industry with access to the market, to the risk management tools and to the delivery mechanism. Trading takes place across three trading platforms: through open-outcry trading in the 'Ring', through an inter-office telephone market and through LME Select, the Exchange's electronic trading platform[1].

There are only 12 ring dealing members authorized to trade in the open outcry ring of the LME. Trading in the London market starts about 7.00 a.m. with the 'premarket' session, where members make markets in the various metals from their offices. The trading floor of the LME, called the Ring, opens at 11.45 and each contract trades in turn for a five-minute period. At 12.20, when all contracts have traded once, there is a ten-minute break before, starting at 12.30, each contract trades for an additional five minutes. It is during this second morning ring session that the 'settlement' and 'official' prices are determined. At around 13.15, once the official pricing is complete, a period of trading known as the 'kerb' begins. This less formal trading session takes place in the Ring and lasts until 13.30, during which time all contracts trade simultaneously.

The afternoon ring trading session begins at 15.10 and follows the structure of the morning session, ending with a kerb trading period of 25 minutes from 16.35 until 17.00. From 17.00, the market reverts to inter-office trading until at least 18.00.

Each day the LME announces a set of official prices, which are determined from the open-outcry trading. This trading is highly liquid and trade and industry has confidence that they properly reflect the current supply/demand situation. These prices are used by industry worldwide as the basis for contracts for the movement of physical material throughout the production cycle.

Price discovery is one of the most important functions of the Exchange. The most reliable prices in any market are derived from those where the greatest concentration of trading takes place. While trade can take place at any time on the LME because of its flexibility, the greatest concentration for each contract occurs during the five minute ring sessions, especially the second ring session. At the end of each five minute ring (in the second ring session) the LME market operations staff, who monitor ring trading from the ring itself, determine the official prices from the last bid and offer for cash, three months and fifteen months before the bell is sounded to end the ring. These prices become the settlement prices (that is, the cash seller's price) so long as they result from trading in the ring which meets all the LME standards. The ring prices are highly transparent, and are sent around the world almost instantaneously. Market participants are able to judge immediately that the prices properly reflect supply and demand at that time, and have great confidence in the result.

Other prices in the forward curve are determined using trades as well as established formulae - this is important as not every date available might be traded on each business day. The Exchange also determines "unofficial" prices from the fourth ring in a similar way to the official prices. They are used as a further benchmark and are helpful where there have been significant price movements between the second ring and close of floor trading. One further set of prices is important to note. These are the closing prices, derived from the final kerb session of the day. These are important for market participants, such as London Clearing House Clearnet, who uses them when it determines margin requirements at the close of business.

**Market factors influencing prices**

Lead is a commodity; as such, supply and demand are the underlying factors driving the price of lead. As is the case with most commodities, both real and potential supply and demand drive the perceived value of a commodity. There are numerous economic and financial books written that can provide insight into factors affecting commodity prices[3]. I wish to only comment on a couple of relevant factors. If demand stays steady and supply diminishes (smelter fire, mine closing, commodity tax increase), the price should increase accordingly. Likewise, if demand diminishes (China's car and electric bike markets growing slower than expected) and supply is steady, then the price should decline accordingly. A third factor is the amount of capital invested in metals via hedge funds or commodity funds.

Over the last several years, there has been a steady growth in the amount of money invested in the metals markets. This is a combination of increased investing and hedging activity. The increased investing is either speculating in the price of metal, or allocating a percentage of a portfolio to metals versus other financial investments. The increased hedging is a desire by users and producers to reduce volatility in the prices they incur. The result has been more money in the market and a price increase in the long run and a price decrease when the money has to exit quicker than planned. The latter most recently observed when the 'sub prime credit crunch' hit the markets and caused an immediate outflow of cash from the metals market.

Together, these three factors --- demand, supply, and capital invested --- drive the price. More importantly, however, is that real or perceived changes in any of these factors can and does change the price, sometimes dramatically overnight. When the ring traders know information regarding lead supply or demand changes, that information will drive the price. As more information becomes known, and the accuracy of that information becomes confirmed, the price will follow the impact. During the spring, summer and fall of 2007, several factors converged to drive the price to historical highs – all of these were supply disruption issues – all real, but at least one supply disruption's impact was significantly overstated and within days the price went down when the impact of the disruption was clear.

**User factors influencing prices**

Most battery manufacturers buy their lead from either lead suppliers or metals traders through an agreed to physical contract. The price paid for lead is based on the LME price. The major element of the price is the underlying market price for lead, typically based on either the cash price, the average of the cash price for a period of time, or the settlement price for a specific futures contract. When lead is purchased via a LME contract other fees applies. In addition to the LME price, futures or options contracts contain the following fees: commissions, options premiums (a % of the value and can be very expensive depending on settlement time, strike price and market volatility), fees for odd-lots and atypical settlements (ex. Fixed price for 23 tons per month for a three month period). Brokers will put together a contract that meets the need of their client and this flexibility comes at a lead price slightly higher than the corresponding market price. Since these contracts are for lead that meets the LME specification only, any significant alloying costs that are indexed based may need to be offset via a separate arrangement – for example, an alloy with significant silver content may require a separate hedge if the duration of the contract is lengthy.

## HOW BATTERY MANUFACTURERS PROCURE LEAD AND HEDGE ON PRICING

**Production of Lead**

Lead is either mined or recycled. Lead mines are located throughout the world with total production in 2006 at 3,540,000 tonnes, as shown in Figure 1. Africa mined 3%, Europe mined 7%, Oceania mined 18%, Americas mined 29% and Asia mined 43% of the total production. Lead has been mined for several hundred years. Most low cost lead mines have been exhausted and today's mines require significant capital investment, both in infrastructure as well as environmental compliance. Due to the hazardous nature of lead, environmental legislation is often a driving factor to new mines being opened. Exploration continues at a breakneck pace compared to historic lead mining exploration. However, with that said, 2007's mine output was expected to be only about 2.8% more than 2006, according to the International Lead and Zinc Study Group.

Lead can be recycled indefinitely and as expected, recycled production has grown accordingly, as depicted in Figure 1; from 3,643,000 tonnes in 2003 to 4,408,000 tonnes in 2006. The growth in recycled lead is expected to outpace the growth in mined lead for some time, as more recycling takes place in Asia and growth in mines slows down as reserves are exhausted.

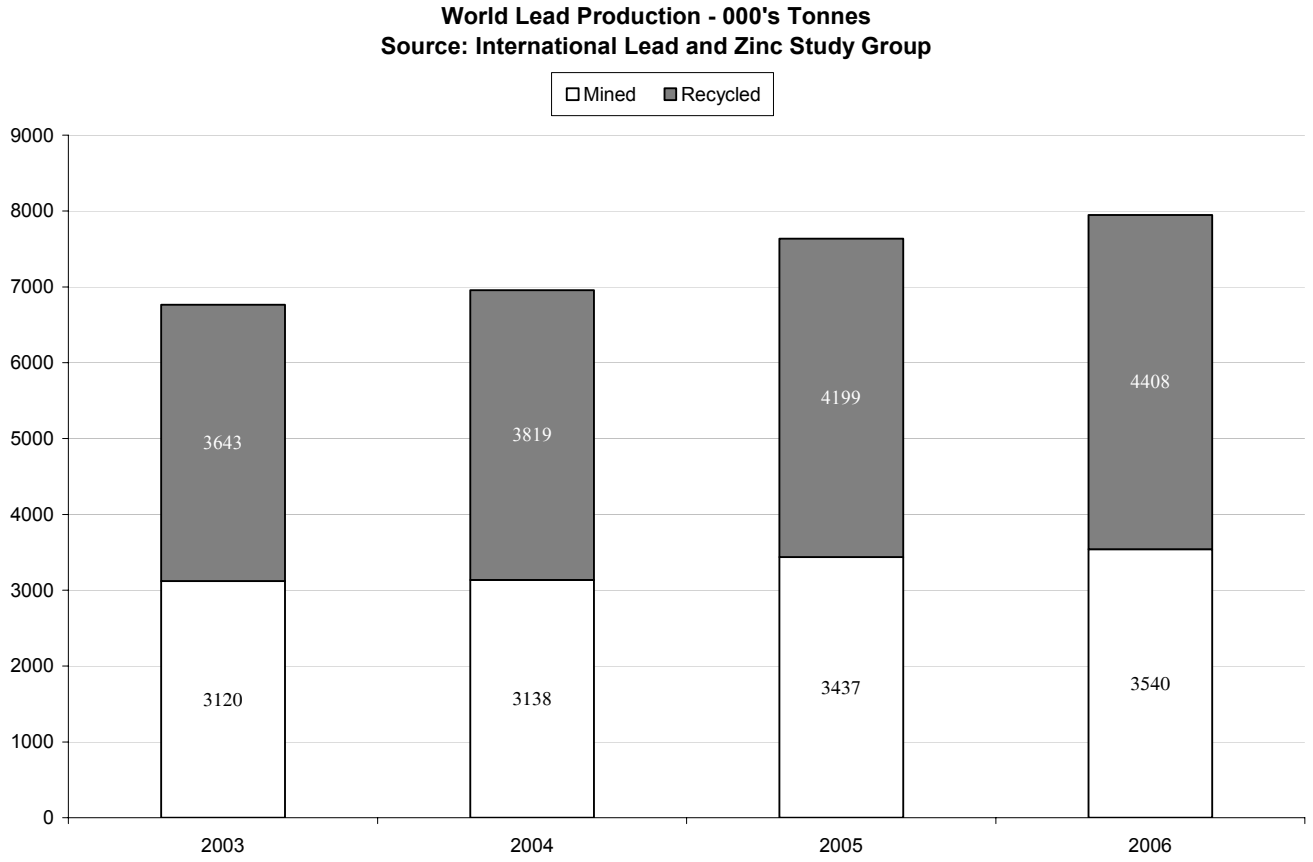


**Figure 1 – World Lead Production 2003 – 2006, Mined and Recycled**

Smelters extract the lead (via either metallurgical extraction or electroextraction) from its ore and supply lead to a refinery for refining into pure lead. Some refineries are set up to produce lead alloys from the pure lead. The purity of the lead is a function of the raw material at the front end of the process and the processing done by the smelter and refinery. Not all lead produced is equal in purity nor are all smelters or refiners equal in capability. Generally, lead from China is produced via electroextraction and is of a higher purity level than most other leads in the world. Additionally, certain lead ores in the US are of higher purity and have a corresponding premium price to them.

Lead used in batteries is generally pure lead for oxide and a lead alloy for grids. The specifications vary by manufacturer, but suffice it to say that pure lead is available from many producers and alloys are available from only a select few. The cost associated with pure lead is almost always less than the cost of lead alloys. The purer the lead or lead alloy, generally the more expensive the lead.

Many of the lead alloys used for battery grids require a level of purity above that of the LME specification and as such have a higher cost associated with them as well as limited supply. Certain elemental impurities are expensive to extract (bismuth is one) and can result in ‘pure lead’ with high levels of these impurities that cannot be used in all applications. Additionally, certain alloy additives (cadmium is one) can cause the cost of recycling these alloys to be almost prohibitively expensive, rendering the used batteries near worthless. However, most batteries can be recycled easily, allowing for a closed loop process that influences grid alloy specifications based on available recycled lead impurities.

**Procurement of lead**

In order to insure an adequate supply of lead for manufacturing batteries, most lead is contracted for delivery for a period of time mutually agreeable to the buyer and seller. This duration can vary, but is typically at least one year in duration. As such, the future market price of lead is not known with certainty to either party when signing the contract and therefore the price is determined based on the LME prices. As stated earlier, the major element of the price is the underlying market price for lead, typically based on either the cash price, the average of the cash price for a period of time, or the settlement price for a specific futures contract. The volume and delivery date (usually tons/month) and price terms are clear in the contract, as well as the additional fees for alloying, additives, treatment charges, and freight and producer premium. Energy adjustments can be plus or minus to the total cost. There maybe opportunity for setting the price in advance, i.e. hedging the price, but this fixed price reflects the forward price curve at the instant in time when the agreement is made. The risk is on the buyer at this point, as the seller will always counter the sales price with a corresponding market contract. This option is generally available from the metals traders with a mark to market valuation of the contract. As such, the ability to lock in prices for physical delivery are limited to what types of metal are available, credit limits and risk tolerances of the buyer. Therefore, a fixed price physical contract maybe available, but at significant risk if the duration is lengthy and there is volatility in the price. The only counter for a buyer is a fixed price, fixed tonnage, fixed delivery, higher margin sales order to a battery customer.

There are several North American lead alloy manufacturers, most notably, the Doe Run Company, RSR, Gopher Resources, Exide, Tech Cominco and Xstrata. Capabilities vary by manufacturer.

**Hedging options available to battery manufacturers**

According to the LME, hedging is the process of offsetting the risk of price movements in the physical market by locking-in a price for the same commodity in the futures market. The reasons for doing this are clear: for a converter, for example, it allows for better control of their raw material costs and for a producer, better management of product pricing.

There are predominantly two motivations for a company to hedge: to lock-in a future price which is attractive, relative to an organization's costs and to secure a commodity price fixed against an external contract. When hedging, an organization starts with price risk exposure from its physical operations, and will buy or sell a futures contract to offset that price exposure in the futures market. The ability to hedge means that an organization can decide on the amount of risk it is prepared to accept. It may wish to eliminate price risk entirely and it can generally do so quickly and easily on the LME.

Hedging by trade and industry is the opposite of speculation as its primary purpose is to offset risk. Speculators, however, come to the futures market with no initial risk; they assume risk by taking futures positions. Hedgers reduce or eliminate the chance of future losses or profits, while speculators risk losses in order to make profits.

To be successful, a hedging program must be devised in conjunction with a sale or purchase plan, and all pricing must be basis the LME settlement price in order to achieve the most effective hedge and to meet the requirements for international accounting standards. The program can be as simple or as complex as a company wants to make it, but it will be unique depending on that company's appetite for risk, internal practices, pricing policies and hedging motives[1].

Battery manufacturers have the option, at their own expense, to hedge physical contracts with LME futures contracts. By doing this, the battery manufacturer can lock in a fixed price by entering into a LME futures contract with financial settlement and taking physical delivery via a floating LME basis priced physical purchase contract. The major cost involved in this is the credit limit costs. The futures contract is marked to market daily. For most large manufacturers, the credit limit required to cover one year's worth of lead, would be unavailable from most brokers or banks. Regardless of credit limitations, if there is a margin call when the market price falls below the contract price and exceeds the credit limit, the battery manufacturer must cover the margin call at their own expense, either via additional credit limit or cash.

Rather than a futures contract, the battery manufacturer can buy an option to buy or sell a fixed amount at a fixed price at a predetermined time. These options (calls or puts) are very expensive and rarely justifiable in ROI terms to the customer, but can be a valuable tool if the costs can be covered. With these options, a battery manufacturer can acquire a floor or ceiling price for a fixed volume and time. This can be useful when selling to OEM's to help them maintain competitive pricing in the market place, while having a fixed battery price.

As part of a typical hedging strategy, a battery manufacturer may consider future contracts when they feel the price of lead is attractive to their organization and they want to control their raw material costs. The risk is that the price will decline and relative to the competition, their purchased price will be higher and as such, they will be less competitive. By using an option instead of a futures contract, the battery manufacturer may obtain the attractive price, but still participate in any declining price. However, the difference in cost is significant, often several thousand times more expensive to enter an option contract compared to a futures contract for the same volume, price and settlement. That is why it is rarely justifiable to take out any options. A more typical hedging strategy for battery manufacturers is to sell at LME based prices, often some averaging the LME price for some prior period. As long as the customers continue to buy over the length of the contract, the purchased price of lead should be reflected in the sales price of lead fairly for both parties.

## HOW ALL OF THIS AFFECTS THE PRICE OF THE END PRODUCT

**Lead's effect on the battery price is a function of:**

The effect of lead on battery prices is a function of the amount of lead in the battery, the type of lead alloy used and the sales agreement for pricing. The amount of lead and the market price at the time of sales agreement are the driving factors for lead's impact on battery pricing. The battery price is also significantly affected by the specific alloy used. Some alloys require the purest lead or alloys with expensive additives (high silver alloys) and will cost anywhere from 10 to 25 cents/lb more in the form of additional premiums and alloy costs and perhaps, freight costs, due to limited suppliers.

Most sales contracts are based on a trailing average of the monthly LME cash price of lead, and if not, the manufacturer usually sets the price based on the current market price of lead. A sales contract can be structured to provide a fixed lead price when both sides can agree on volume and delivery. In order to do this, the customer should commit to a fixed volume and fixed delivery date. If volume and delivery cannot be agreed upon, the risks (margin calls & real losses) are the responsibility of the seller. However, this is generally not practical for the battery customers, as their demand is not generally known with enough certainty to make this commitment. When the demand and delivery are known, a contract can be arranged that fixes the lead price at measured risks to both parties and can generally be agreed upon.

## SUMMARY

Market forces drive the LME price of lead, particularly demand, supply and investment capital. Real or perceived changes in any of these market forces will result in changes in the price of lead traded on the LME. Since the price of lead on the LME is factored into the purchase price contracts for lead, the battery price will reflect the actual procured lead price. In addition to the market price, there are additional cost drivers, such as alloy fees, additive fees, treatment charges, premiums, freight costs and energy surcharges that contribute to the actual procured cost of lead versus the LME price for lead. These costs significantly add to the price per lb for lead, as much as 25 cents per lb or more.

Most battery sales contracts determine the price based on the market price for lead. If a customer can commit to a fixed volume with fixed delivery, then a fixed price can be derived at with little risk for both sides. However, most battery customers do not enter into fixed priced, fixed volume, fixed delivery contracts and most manufacturers cannot fix their price of lead without knowing the price, volume and delivery commitments from a customer. As a result, the price of batteries is often based on an average price of lead on the LME over a period of time.

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