

## **TESLA TECHNOLOGIES PTY LTD**

### **R&D START APPLICATION**

#### **Supporting Material**

- [1] Simple English explanation of process, background to technology & plant process chart
- [2] MIM supportive letter
- [3] University of Wollongong letter re intellectual property
- [4] Organisational chart
- [5] Project plan – Gantt chart
- [6] Cash flow chart
- [7] Construction Engineers- Thomas & Coffey
- [8] Line Drawings-Test Rig
- [9] Restec- company details and financial projections
- [10] Tesla experimental program - 1/2 tonne per hour test rig.
- [11] CSIRO work program

**Abbreviations:**

AIME	American Institute of Mining and Petroleum Engineers.
A-NZ	Australia New Zealand Standards on various items of note.
AUSMELT	AUSMELT smelting technology, variant of CSIRO SIRO Process.
CFB	Circulating Fluidised Bed-technology.
EAF	Electric Arc Furnace.
EM Group	EM Group.
HRD	Horsehead Resource Development.
IMM	Institution of Mining and Metallurgy, UK.
MW	Micro Wave.
TMS	The Minerals, Metals and Materials Society of AIME.
TESLA	TESLA Group Holdings Pty Ltd..
TGH	TESLA Group Holdings.

**Other items:**

No items of note at pm, 15:02:01.

## BACKGROUND TO MICROWAVE-STIMULATED REDUCTION/FUMING.

As a spin-off of earlier experimental work into the microwave-stimulated reduction of laboratory and ore minerals, and metallurgical and industrial by-product or waste materials, Tanner-Jones observed and recorded the capability of such means of zinc removal from such generic "waste" materials as slags and baghouse dusts. The basic removal and recovery of zinc is by Zn-phase reduction (typically carbothermic) to yield zinc vapour which can be either plated-out or collected as finely-divided zinc particles, each option yielding zinc of high purity (because of the selectivity imbued by mineral susceptibility to microwave energy). Alternatively, the reduced zinc vapour can be "fumed" by re-oxidation to equivalently pure zinc oxide, ZnO, or otherwise "re-oxidised" to form other desired compounds of value (such as nitride, or any of the possible halide family of compounds).

In late 1999, Tanner-Jones was approached by acquaintances and asked whether he could remove zinc from a slag (then identified as a "slag from copper production"). Having indicated positively, Tanner-Jones was supplied with a slag sample (with no accompanying analysis, but now identified as an MIM waste) and challenged to provide evidence/proof of the claimed capability. The slag was appropriately sampled and divided, one specimen set aside for analysis whilst another microwave treated to fume end-point leaving spent slag material and yielding a clean white fume product which also was collected for analysis.

The as-received slag was a stockpile-sampled granulated material, blue-grey in colour showing signs of some weathering. Its X-ray fluorescence (XRF) and neutron activation analysis (NAA) analyses are given below [with original reports as **Appendix 8.1 and 8.2**]. An X-ray diffraction analysis (by BHP Laboratory Services) of the MIM slag is attached as **Appendix 8.3**.

XRF analysis (mean) from BHP Laboratory Services [**Appendix 8.1**].

Species	Pb	Zn	Fe	S	CaO	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	MgO	K <sub>2</sub> O	TiO <sub>2</sub>	Cu	Mn	P
wt%	5.4	13.5	25.3	0.6	21.4	20.2	4.2	2.6	1.5	0.21	0.25	0.21	0.15

Neutron activation analysis from Becquerel Laboratories [**Appendix 8.2**].

Species	Pb	Zn	Fe	S	Ca	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	MgO	K	Sb	Cu	Mn	P
wt%	ND	13.4	20.4	NA	15.6	NA	NA	NA	2.0	0.13	ND	NA	NA

ND: not determined by this technique. NA: not determined in this test.  
[NAA technique largely for trace element determination.]

White zinc oxide (ZnO phase zincite) was sent for NAA and the "high purity" determination is given below [**Appendix 8.4**]. An X-ray diffraction spectra and peak search analysis is provided as **Appendix 8.5**.

Neutron activation analysis from Becquerel Laboratories [Appendix 8.4].

Species	Pb	Zn	[ZnO]	Fe	S	Ca	Sb	As	Cd	K	Na
wt%	ND	71.8	>98	BDL	NA	BDL	tr	tr	0.095	BDL	0.034

BDL: below detection limit. tr: trace

Being satisfied with the microwave technique's capability to remove *and* recover virtually all zinc plus the possibility of recovering other metals, the acquaintances disclosed their connection with EM Mactec Pty. Ltd. Somewhat later, MIM allowed the disclosure of the true identity of the slag as lead blast furnace slag, however, for commercial and legal reasons, they remain to this day reticent to the point of refusal in releasing any chemical or comparable assay results. Although published in 1979, a litigationally safer era, the following comprehensively compiled (mean) chemical analysis of granulated slag from the same lead blast furnace remains realistically comparable to the current slag output. [From J.F. Riley; *Phase relations and lead losses in Mount Isa blast-furnace slags*. – J. Inst. Mining and Metallurgy, London, March, 1979.]

	Pb	Zn	Ag	Fe	CaO	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	MgO	Sb	S	Cu
Min. (wt%)	1.04	7.16	0.0007	21.7	17.6	15.9	3.2	0.1	0.032	0.3	0.057
Max (wt%)	7.20	14.4	0.0123	28.8	26.3	23.2	4.8	2.03	0.280	1.94	0.36
Yearly ave. (wt%)	2.8	11.5	0.0008	23.4	22.9	18.5	4.5	1.5	-	0.9	0.15

#### EXTENSION OF RESEARCH AND ANALYTICAL AND PHYSICAL TESTING DURING EVOLUTION OF COMMERCIAL RELATIONSHIP.

During the period up to the present, environmental and waste remediation company EM Mactec Pty. Ltd. became The EM Group Pty. Ltd. and from this new company the metals recovery company ResTec Pty. Ltd. was formed to operate interactively with Tesla on proposed projects – centrally, the recovery of metals from slags, and principally, recovery of zinc from MIM lead slag. Towards a commercially successful outcome, Restec provided more MIM lead blast furnace slag, now freshly granulated slag from the production stream.

Slag from this second delivery was analysed and the chemical analysis found to be similar to the initial stockpile sampled slag with the significant variation of lower lead percentage (<3% rather than >5%). This variation is well within the ranges typically reported in the literature and within the range of 1.04wt% to 7.20wt% Pb reported by Riley (above) and close to his reported "yearly average" of 2.8wt% Pb.

Experimental zinc reduction/fuming was stepped-up in Tanner-Jones' restricted independent premises utilising all available privately acquired equipment and consumables and consistently good results were obtained from a limited experimental programme on the second slag bulk sample. The initial strand of experimentation was intended to reproduce the success

of the earlier work on the stockpile slag. To this end, reproducibility was established when zinc oxide fume products were found to lie in the "high purity" oxide range and superior to the oxide products of the stockpile slag derived fume (Appendix 8.4). Studies using scanning electron microscopy with energy dispersive spectroscopy (SEM/EDS) revealed all (8) zinc oxide fumes produced (in the presence of oxygen) provided closely comparable analyses. Subsequently, equal quantities of each oxide were blended and the blend sent for NAA at Becquerel Laboratories. The result [included as Appendix 8.6] reveals the possible presence of a minor proportion of metallic powder in the generally white fume blend.

A second strand of experimentation was designed to reduce the zinc to metallic vapour in a controlled, non-oxidising atmosphere of carbon monoxide (CO) in nitrogen (N<sub>2</sub>) to produce a finely divided zinc (metal) powder. The system generally worked well (given the system limitations imposed by limited facilities), and of the four successful experimental runs, all produced a variable mixture of white zinc oxide fume in metallic zinc powder. SEM/EDS analyses revealed no significant non-zinc components in the mixtures which, again, were blended equally and sent for NAA and XRD analyses at Becquerel and BHP respectively. The results of these tests [Appendices 8.7 and 8.8] confirm the encouraging purity of zinc products derived from the process.

A third strand of physical testing was undertaken to establish such properties as slag friability, softening ("stickiness") temperature range, melting point, specific gravity, bulk density, size range, *et cetera*, in preparation to prepare a small fluidised bed reactor to test the feasibility of such a system. A small fluidised bed reactor was constructed and shown to remain fluidised across a range of operating temperatures up to 1000°C and for campaigns (operating times) up to 40 minutes. This reactor was run utilising microwave energy as the only externally applied power and runs were terminated once the controlling, sensed "bulk" temperature exceeded the pre-determined maximum temperature. Consistent results (of product fume) were attained at the upper-limiting temperature of 900 °C for a campaign of 20 minutes at low input microwave energy into a bed load of 200g sized slag fluidised in reactant 20% CO/air mix at minimum fluidizing flow rate (pressure), however, similar campaigns at 950 °C and 1000 °C yielded very good fume products. The three product ZnO fumes are shown as smp1(7) [950 °C], smp2(7) [1000 °C] and smp3(7) [900 °C] on SEM/EDS summary provided as Appendix 8.9. Notably, the lowest operating temperature yielded the highest Zn (99.3%) and the lowest Pb (0.34%), whilst the highest operating temperature yielded the lowest Zn (94.1%) and the highest Pb (1.30%) – not an unexpected result – [and 97.1% Zn and 0.53% Pb for the mid 950°C campaign].

The resultant "spent" slag, in a slightly sintered and agglomerated-particle form, was crushed and SEM/EDS analysed. The 950 °C run yielded the analysis presented in Appendix 8.9 as smp6(7) [in which 0.44% Zn was detected] and the 1000 °C run yielded the result smp7(7) [in which nil Zn was reported]. The apparent concentration of some prominent element components may be due to partial metallisation of iron and some tramp elements which were taken into solid solution. Also, the degree of accuracy of SEM/EDS results on such complex ceramic materials is open to some healthy scepticism".

Significantly, when (at their request) MIM were sent a sample of the 950 °C treated, slightly agglomerated granulated slag for their inspection and analysis, they verbally reported "no Zn detected" in their in-house chemical laboratory analyses [no other components were reported to Tanner-Jones] and they were greatly encouraged by the form and physical properties of the fluidised-bed-treated slag.

SEM/EDS analyses for the original as-received stockpile slag (for "degree of accuracy" reference) is shown in smp4(7) of Appendix 8.9 whilst similar SEM/EDS analysis of the third delivered MIM granulated slag sample (also 30 kg), similarly sampled fresh at granulation as

second delivery, is shown as smp5(7). These results are indicative only. The third delivered slag quantity was sent to CSIRO Minerals, Clayton, Victoria to enable their fluidised bed team to begin stage 1 of a mini-pilot study to complement Tanner-Jones' Tesla bench-scale work in Wollongong and to guide design of the 1/2 tonne per hour Tesla test rig. A preliminary, partial ICP-OES analysis of the third MIM slag material has determined the slag to contain 11.4wt% Zn, 1.96wt% Pb, 23.2wt% Fe, 9.64wt% Si and 0.10wt% Cu. Initial experimental programme results are encouraging. Zinc metallic product produced in an early experimental run was analysed, found to be >95wt% Zn metal, and shown as smp8(6) in **Appendix 8.9**. SEM micrographs and some SEM/EDS analyses are shown in **Appendix 8.10**. [The CSIRO has reported (verbally) that they have found the same metal product to be >95wt% zinc.]

Tanner-Jones has microwave-fumed the third slag to verify its reactivity and collect the total fume from fume-start to fume-end. SEM/EDS analysis of the zinc oxide fume produced is presented as smp9(4) in **Appendix 8.9**. Some SEM/EDS spectra and analyses form **Appendix 8.11**. Significantly, the 97% Zn is accompanied by 2%Pb – a result likely to result from process temperature dependency. Such process foibles are currently being addressed – particularly in the CSIRO studies – and we are confident that remaining process “unknowns” will have been addressed by the start of the test rig operation.

For many industrial processes, “microwave” processing is less expensive than other, “conventional” processing routes. If this was not so then over fifty years of medium to heavy industrial applications in America would be an illusion in such central industries as rubber, ceramics, timber, food preparation and cooking, medical and pharmaceutical operations, coal drying and mineral preparation, plus many more. To provide an example, the electrical power cost of producing high purity zinc oxide by boiling and combusting pure zinc metal is about \$100 per tonne. By comparison, the cost of electrical power (as conservatively calculated) used in producing one tonne of zinc oxide of comparable purity from MIM slag in the proposed Tesla test rig will be about \$20. At “bench scale”, the costs of the two systems are much closer.

The Tesla process does not simply harness the solid state “microwave effect” to achieve its process benefit as do the very efficient “first generation” microwave technologies, the Tesla process utilises the benefits of the non-equilibrium thermochemistry of microwave plasma(s) generated from a far wider range of stimulating electromagnetic frequencies than standard microwave frequencies. The Tesla process is a true “second generation” microwave processing technology and is well suited to plasma chemistry applications – not just the simple “heating” applications of earlier microwave applicators.

**The Tesla Process as applied to the recovery of zinc from metallurgical slag by fuming. The implications of cost efficient, electromagnetically-stimulated metal recovery upon metallurgical waste remediation, fixation of biological toxins in such wastes, impact upon leaching and further pollution, and the increased scope of uses or other disposal of treated slag materials.**

As it applies to the present proposed project, the recovery of saleable metals from zinc-bearing slag from MIM's Mount Isa lead blast furnace, the Tesla Process will be configured to recover zinc by microwave-stimulated fuming of zinc as its oxide, ZnO (in the zincite phase), with the gravimetric, mineral processing separation of most of the 5% lead as metal prills. Preliminary experimental work has provided microwave-processed slag material whose analyses have yielded results of nil Zn in the treated slag remnant – concurrently, analyses of the fume recovered yielded results of high purity zinc oxide (>99.7% ZnO). The recovery of Pb could have been approached in several ways (including fuming), however, as 5% Pb can economically be chemically “fixated” in the worst case scenario, and as only a minor portion of Pb was present as either un-reduced or reversion product sulphide or oxide, it was decided that Pb as metal prills – present as un-settled liquid metal droplets in the prior-cast slag – should be recovered (in as much as possible) by a mechanical, specific gravity separation technique during pre-fuming mineral dressing operations. It is reckoned from mineralogical evaluations that such an operation is likely to retrieve 4 of the 5% Pb (ie. 80%) present.

Microwave-stimulated reactions – particularly as they manifest in the non-equilibrium plasma environment of the Tesla Process – are acknowledged for their “catalytic” ability to enable reactions to proceed which might otherwise not proceed, and which do not proceed under energetically comparable “conventional” thermal stimulation. Experimental results over a wide suite of resource, industrial and laboratory minerals indicate that the Tesla Process is highly appropriate for configuration into a range of reduction applications for extractive and process metallurgy. Years of experimental/development work by various microwave research groups using earlier generation microwave technology have established the efficacy of microwave driven zinc fuming from a range of industrial and metallurgical wastes. The new generation Tesla Process confirms earlier results and lifts process efficiency well into the realm commercial reality.

Recovery of saleable metal commodities from otherwise intractable waste material products of industrial and metallurgical operations provides benefits on several fronts. Most obvious is the recoverable value of the recovered metal or other commodity. Such removal of metallic elements may render the treated material fit for safe disposal – even as exposed landfill, or it may have removed the leachable element (as with Zn in the MIM slag), it may remove an element or phase which prevents chemical fixation – or economically viable fixation – prior to safe disposal (as is Zn for Pb fixation in the MIM slag). Metal recovery processes, such as the Tesla Process, are not only ideal prior-treatments for waste remediation operations, but they can return “waste” as “commodity” and re-define the economics of waste treatment/waste remediation operations.

Tesla's intention (and expectation) with the zinc fuming project is to cost efficiently remove and recover the zinc and lead fractions in the MIM Zn-bearing lead slag as high value commodities (zinc oxide and lead metal of commercial purities) leaving a granular treated slag product which may have further processing value (as a cement component) or which may be utilised as a clean loose fill or a clean fine aggregate in concrete. From indications in the work of earlier groups, and following promising results from the initial experimental work programme by the Tesla group, this intention is likely to become reality.

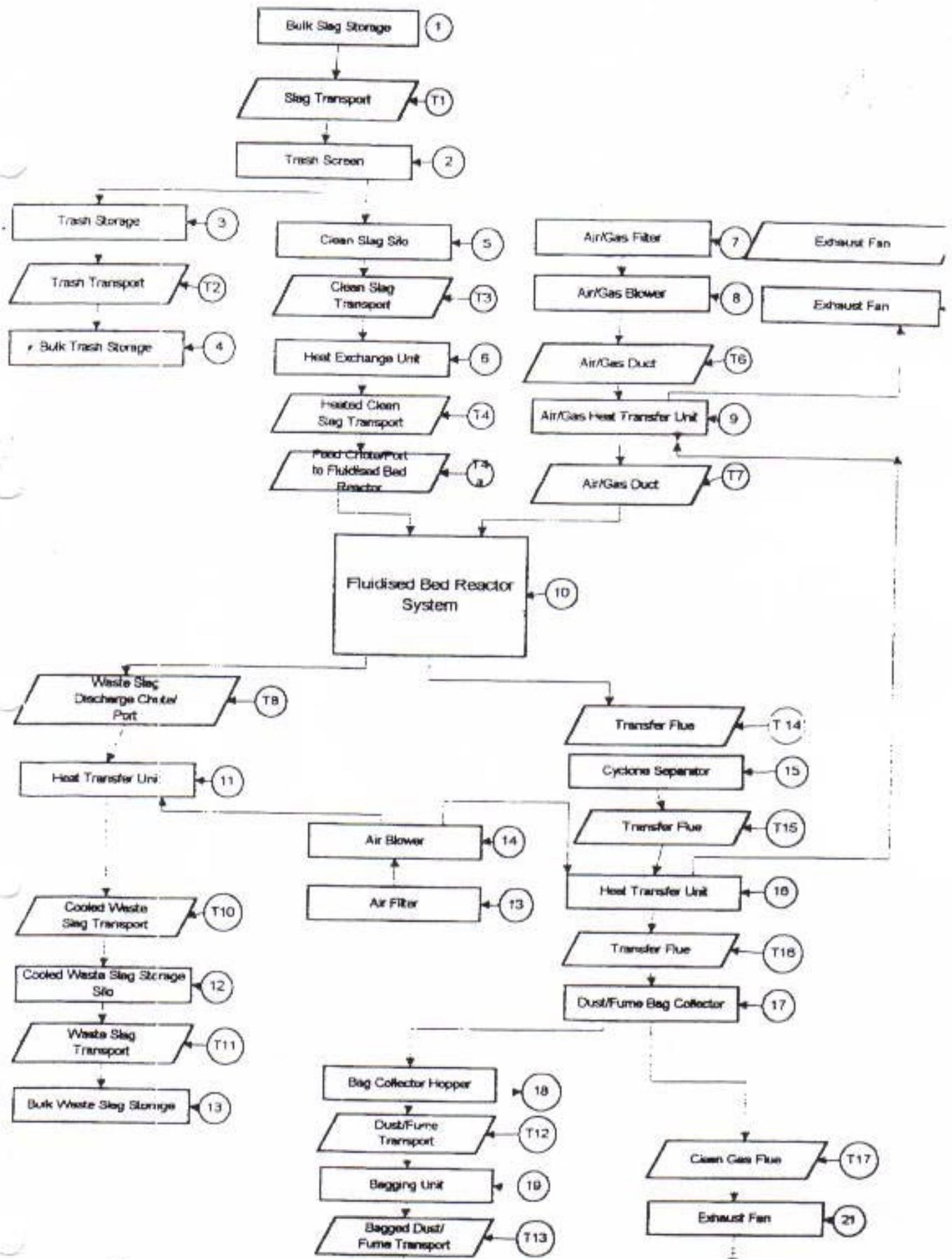
**Plain English explanation of "the technology", .... in as much as this is possible.**

The following briefly outlines the plasma-based process as it applies to the range of processing applications – not specifically to zinc fuming.

Plasma has been called the fourth state of matter (beyond gas, liquid and solid) with over 90% of matter in the universe existing as plasma – either fully or partially ionized. Whilst all flames are combustion events and include ionised matter which qualifies them as plasmas, most plasmas are not combustion events. That is to intimate that for combustion reaction systems of our usual experience – ovens, furnaces, fires, et cetera – combustion products are produced. However, whilst utilising the same applied energy form, plasmas do not necessarily produce combustion products; therefore, they may remain pollution-output neutral. So, systems which utilise plasma chemistry rather than combustion chemistry in which to conduct processes have the enviable opportunity of producing no or negligible flue output – hence, no flue pollutants.

The technology utilises the benefits of plasma chemistry in which to perform chemical transformations on matter - typically, this "matter" is a chemical or mineral commodity which is to undergo a transformation to material having higher extrinsic or intrinsic economic value. Processes which fit this outline, and are ideal applications to complement the technology, are the reduction of ore-derived and residue-derived minerals, synthesis of fertilizer from metallurgical waste gases, combustion synthesis of intermetallic materials and hard materials, dissociation of compounds into their elements, and the synthesis of gaseous, liquid or solid matter from component elements. The technology can be adapted to well accepted, familiar processing units and reactor types such as rotary kilns, fluid bed reactors, shaft furnaces, cyclones, conveyor strands and ovens in batch or continuous modes, and co-current or counter-current flow regimes.

Specifically, the Tesla technology utilises in its processes the benefits of non-equilibrium plasma chemistry at real processing pressures. Such *high pressure* non-equilibrium plasma systems exhibit the dual processing benefits of high particle energy and a wide range of highly reactive species. Electromagnetic energy of frequency (chosen for its particular susceptibility by the irradiation target reactant) between radio frequency, through microwave and into the "millimeter wavelength" frequencies allow the maintenance of thermal non-equilibrium up into a pressure range above atmospheric thus allowing mass transfer at kinetics which confer commercial viability upon the process.





## Mount Isa Business Unit

OUR VISION OUR PEOPLE OUR FUTURE

18 January 2001

ResTec Pty Limited  
Level 2, 1 Rosebery Avenue  
ROSEBERY NSW 2018

Dear Sir,

### Letter of Intent – Metal Recovery from Lead Smelter Slag

ResTec has approached Mount Isa Mines Limited (MIM) with interest in extraction of zinc metal from substantial stockpiles of slag produced from the Mount Isa Lead Smelting process. ResTec are currently developing a process for the recovery of zinc from the lead smelter slag, and have also expressed interest in recovery of copper from coppery settlement ponds on the Mount Isa Lease. The recovery of metals from these sources could provide substantial environmental and financial benefits to both companies.

This letter confirms that, should the technology and extraction processes prove commercially viable, MIM intends to proceed with negotiations with ResTec regarding the application of the recovery processes for extraction of metals from the waste process sources.

Yours Faithfully

A handwritten signature in black ink, appearing to read 'Chris Faulkner'. The signature is fluid and cursive.

Chris Faulkner  
Business Support Manager

### Mount Isa Mines Limited

A.B.N. 87 009 661 447  
A Member of the MIM Group of Companies

Private Mail Bag Mount Isa Queensland Australia 4825  
Telephone (07) 47 44 2011 Facsimile (07) 47 44 3731 Website [www.mimholdings.com.au](http://www.mimholdings.com.au)



# University of Wollongong

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12 February 2001

Mr. J Tanner-Jones  
Research Director  
Tesla Group Holdings Pty Limited  
"Fern Court" Dale Street  
BURRAWANG NSW 2577

Dear Mr. Tanner Jones,

In reply to your letter of 9 February 2001 concerning possible University involvement in your START grant application to AusIndustry it is my understanding that:

- Tesla has expressed interest in the University of Wollongong being involved as a sub-contractor in certain of the R&D activities encompassed by the START grant. While details have yet to be negotiated, this is in-principle acceptable to the University.
- The research activities proposed within the START grant application do not require access to background intellectual property held by the University.
- As a contractor for R&D under the START grant the University would have no ownership interest, other than that derived from possible use of University background IP, in the intellectual property but would negotiate for beneficial usage in further research areas.
- There have been preliminary discussions on the location of a pilot facility at the Engineering Faculty's Coniston site, subject to space availability, infrastructure service requirements and EPA requirements.

The position will be more definitive once we have discussed the details of the START grant application and University of Wollongong's possible involvement.

Best regards,

P.M. Robinson  
Deputy Vice-Chancellor

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TESLA TECHNOLOGIES PTY LTD  
PROJECT STRUCTURE

Chairman of Directors

Elton Stone

Project Director

Steve Ribich

Project Officer

Chris Clare

Technical Supervisor

Stan Morrow

Plant Development  
Co-ordinator

Des White

Graham Smith

Tech Assistants  
[2]

Design & Constructn  
Engineers

Thomas & Coffey

Onsite Office  
Manager

Glenys Ribich

Consultant

Hugo Huey

Task Number	Description	Responsibility	Implementation Date
1	Thomas & Coffey Quote for Cost Estimates	JJT	3-1-2001
2	Line Drawing of Test Plant by Thomas & Coffey	JJT	14-1-2001
3	Cost Estimate from Thomas & Coffey	JJT	31-1-2001
4	CSIRO Contract Executed	JJT	10-1-2001
5	Lodgement of Draft R & D Application	CC	15-1-2001
6	Lodgement of Final R&D Application	CC	15-2-2001
7	Result of R&D Application	CC	31-3-2001
8	CSIRO Cost Estimate	JJT	10-1-2001
9	CSIRO Commence Contract Works	JJT	1-2-01 - 31-3-01
10	CSIRO test results to Hugo Huey	SRR	31-3-2001
11	Thomas & Coffey to Prepare Preliminary Test Plant Plans	SRR	15-1-01 - 15-4-01
12	Development Application To Local Council	T & C	15-2-01 - 15-4-01
13	Design of Application & Test Generator to Thomas & Coffey	SRR	1-5-01
14	Thomas & Coffey to Complete Final Test Plant Plans	SRR	1-5-2001
15	Construction Completion and Commissioning of Test Plant	T & C	1-5-01 - 1-9-01
16	Completion of all Experimental Work with Test Plant	JTT,HH,SM	1-9-01 -15-12-01
17	Sign off of Works by Des White	DW	15-12-2001
18	Verification & Proving Up of Test Results	JTT & SM	1-12-01 - 1-2-01

### The Implementation Schedule



Information Schedule  
(N/A 1 Commences 1/1/01)

W23 W24 W25 W26 W27 W28 W29 W30 W31 W32 W33 W34 W35 W36 W37 W38 W39 W40 W41 W42 W43 W44 W45 W46 W47 W48 W49 W50 W51 W52 W53 W54 W55 W56 W57

T & C

JTJ, JH, SM  
DW

JTJ, SM

TESLA TECHNOLOGIES

CASH FLOW 23/02/01 to 22/02/02

	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec	Jan
Opening Cash	1	-26,280	-78,008	-345,147	-532,153	-666,317	-779,431	-884,898	-1,007,261	-1,132,026	-1,208,326	-1,267,507
Receipts	26,281	52,566	266,211	187,006	134,165	112,115	105,464	122,364	124,764	76,269	59,162	54,785
Sub Total	26,282	26,379	187,275	-158,141	-387,988	-554,202	-671,967	-762,532	-882,497	-1,055,727	-1,149,144	-1,212,721
Payments												
Outside testing												
Oak Ridge USA		20,000	20,000	20,000	20,000	10,000						
CSIRO		10,000	10,000	10,000	10,000	10,000	10,000		10,000	5,000	5,000	5,000
Unit of Wgong	10,000											
Consulting fees												
Micramics		10,000	10,000	20,000	20,000	20,000						
Consulting Engineers		12,000	8,000	12,000	8,000	8,000	8,000		25,000	25,000	25,000	25,000
Contract Engineer due diligence etc												
Supply & disposal		3,000	3,000	3,000	3,000	3,000	3,000	2,000	2,000	2,000	2,000	2,000
Raw material for Testing												
Hire of small plant			1,000		1,000	1,000	1,000		1,000			1,000
Materials & Supplies	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Laboratory												
ASSAYS & MINERALOGICAL SURVEYS	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000		
Repairs & maintenance			500	500	500	500	500	1,000	1,000	500	500	500
Motor vehicle expenses	500	500	500	500	500	500	500	500	500	500	500	500
Subcontracting		1,000	1,000	2,000	2,000	2,000	2,000	2,000	1,000	1,000	1,000	1,000



## TESLA GROUP HOLDINGS PTY, LTD.

### PROPOSAL FOR ENGINEERING ASSISTANCE

1

#### INTRODUCTION

Tesla Group Holdings Pty Ltd represented by Mr. Des White of White Resources Pty Ltd have requested Thomas and Coffey for a proposal for engineering assistance relating to Tesla's electromagnetically stimulated thermochemical process sequence.

Specifically this proposal relates to the compilation of a preliminary capital cost estimate of a pilot/demonstration plant based on Tesla's process which will be designed to recover zinc oxide from the 500 kg/h of lead blast furnace slag. The accuracy of this capital cost estimate is to be 25-30%.

The engineering and estimating exercise is to be undertaken on the basis that the plant would be built in an existing building in Wollongong.

It is understood that Tesla is organising to have testwork conducted at the CSIRO in Clayton Vic. And that the engineering and estimation exercise would proceed using the results of this testwork.



- Generate electrical cost based on historical costs per drive according to power rating, and calculated costs for panels and switchgear.
- Generate instrumentation costs based on historical costs per loop according to type.
- Generate installation costs according to estimated man-hours.
- Piping costs would be factored.
- Indirect costs (Engineering, Procurement, Construction Management, and suggested contingencies) would be factored.

#### Reporting

The documents listed above would be presented in the form of a report which would also include descriptions of design features as appropriate, and discussions of design issues where relevant.

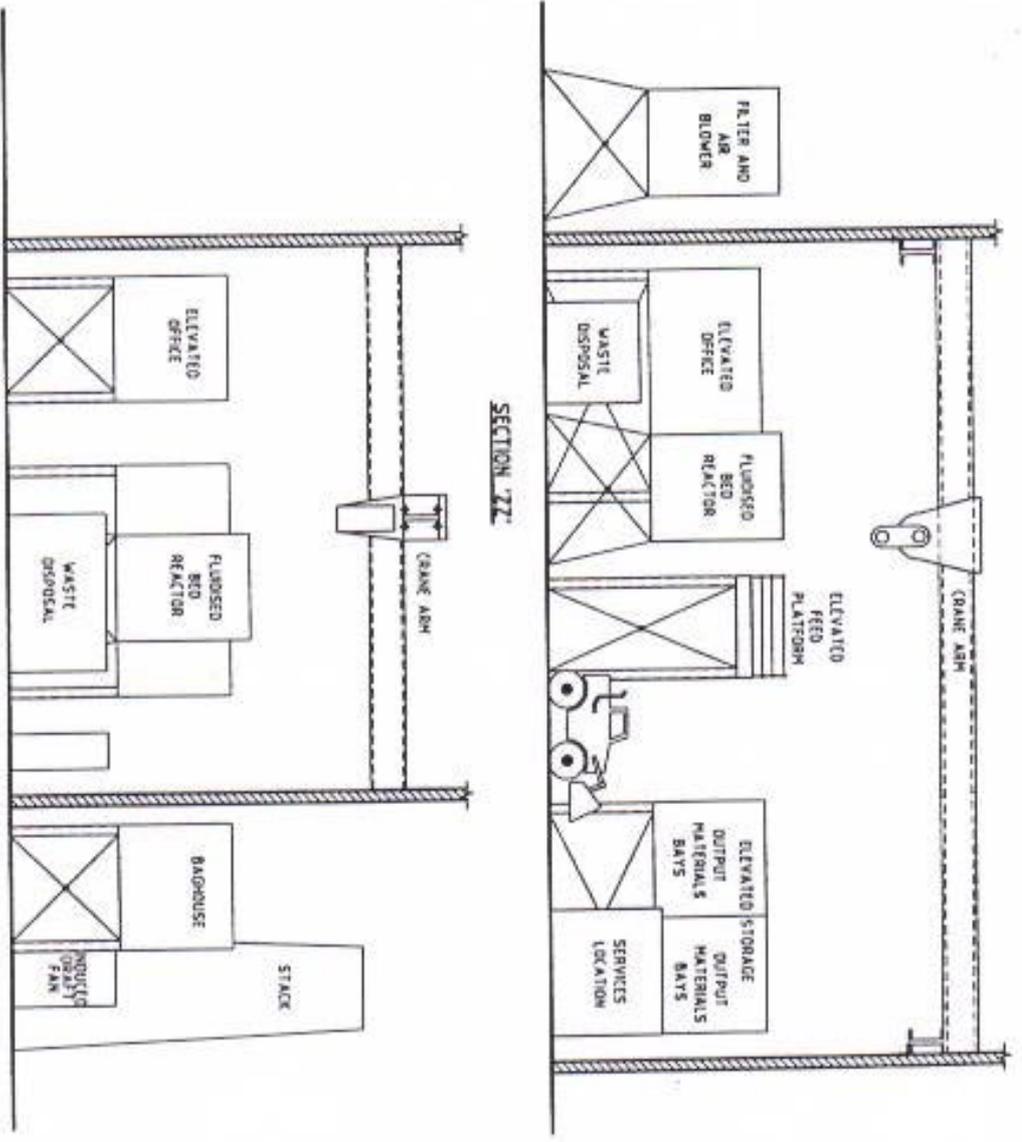
The report would also present an approximate schedule for construction of the project.

It is suggested that the report be issued first as a draft for comment, and then as a final report once Principal's comments have been received.









SECTION ZZ

**GENERAL NOTE:-**  
 - ALL ITEMS TO CONFORM TO FEDERAL-STATE & LOCAL GOVERNMENT STANDARDS

**BASIS FOR CONSTRUCTION**

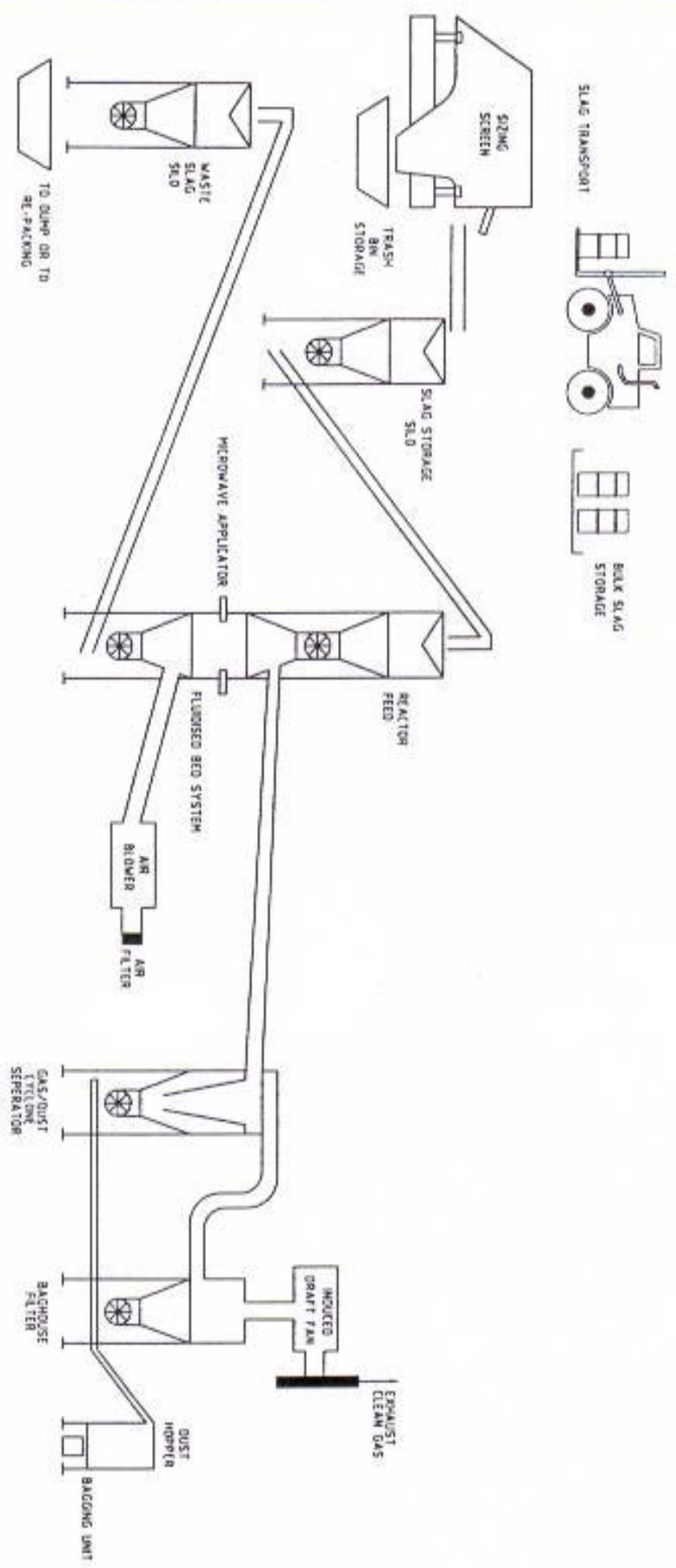
- LEASE AREA WITHIN UNIT, OF WOLONGONG CENTRE
- AS MUCH AS PRACTICABLE, RELIABLE SECOND HAND PURCHASES OF ITEMS
- PORTABLE UNITS ON SKID MOUNTED FEET
- EXTERNALLY LOCATED AIR BLOWER OAS/DOUST SYSTEMS
- BLDGHOUSE: SINGLE UNIT FOR BOTH PROCESS AND FIGHTIVE STREAMS
- ELEVATED ITEMS TO ALLOW SERVICES PIPING, DUCTS, POWER CONDUITS ABOVE GROUND AND FROM CEILING DOWN
- (CHANGING BY EITHER FORK-LIFT, BOBCAT, RUBBER CONVEYORS OR VIBRATING CHUTES)
- OFFICE/CONTROL ROOM UNIT CAN BE SECOND HAND COMPACTABLE OR CONVERTED CONTAINER UNIT

*TO BE READ IN CONJUNCTION W/ - 668-002*

GARDNER ASSOCIATES PTY. LTD. CONSULTING ENGINEERS 11-13 EAST PEPPER STREET MELBOURNE, VIC 3042 TEL: 03 9412 1111 FAX: 03 9412 1111		THOMAS COFFEY 11-13 EAST PEPPER STREET MELBOURNE, VIC 3042 TEL: 03 9412 1111 FAX: 03 9412 1111		DATE: 10/31/91 BY: T/W/668 CHECKED: T/W/668 SCALE: 1:50	SHEET NO: A3 TOTAL SHEETS: 115 PROJECT NO: 668-003
<b>TESLA</b> TECHNOLOGIES PTY. LTD. "HANGOVER" BALE STREET MELBOURNE, VIC 3042 AUSTRALIA		ZINC OXIDE EXTRACTION 1/2 TONNE PER HOUR TEST RIG ELEVATION		SHEET NO: A	

REFERENCE DRAWINGS

REVISIONS



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**GENERAL NOTE:-**  
 - ALL ITEMS TO CONFORM TO FEDERAL-STATE & LOCAL GOVERNMENT STANDARDS

<b>THOMAS COFFEY</b> CONSULTING ENGINEER 15/1600 MOUNTAIN VIEW DRIVE MOUNTAIN VIEW VIC 3089 TEL: 03 9497 1111 FAX: 03 9497 1111		<b>TESLA TECHNOLOGIES PTY LTD</b> ZINC OXIDE EXTRACTION PLANT 1/2 TONNES PER HOUR TEST RIG		<b>MC MATERIAL CONVERTOR</b> TERNBOROUGH DALE STREET ROBINSON RD N.S.W. 7207 AUSTRALIA	
<b>THOMAS COFFEY</b> CONSULTING ENGINEER 15/1600 MOUNTAIN VIEW DRIVE MOUNTAIN VIEW VIC 3089 TEL: 03 9497 1111 FAX: 03 9497 1111		<b>THOMAS COFFEY</b> CONSULTING ENGINEER 15/1600 MOUNTAIN VIEW DRIVE MOUNTAIN VIEW VIC 3089 TEL: 03 9497 1111 FAX: 03 9497 1111		<b>THOMAS COFFEY</b> CONSULTING ENGINEER 15/1600 MOUNTAIN VIEW DRIVE MOUNTAIN VIEW VIC 3089 TEL: 03 9497 1111 FAX: 03 9497 1111	
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DRAWING NO: 668-004					
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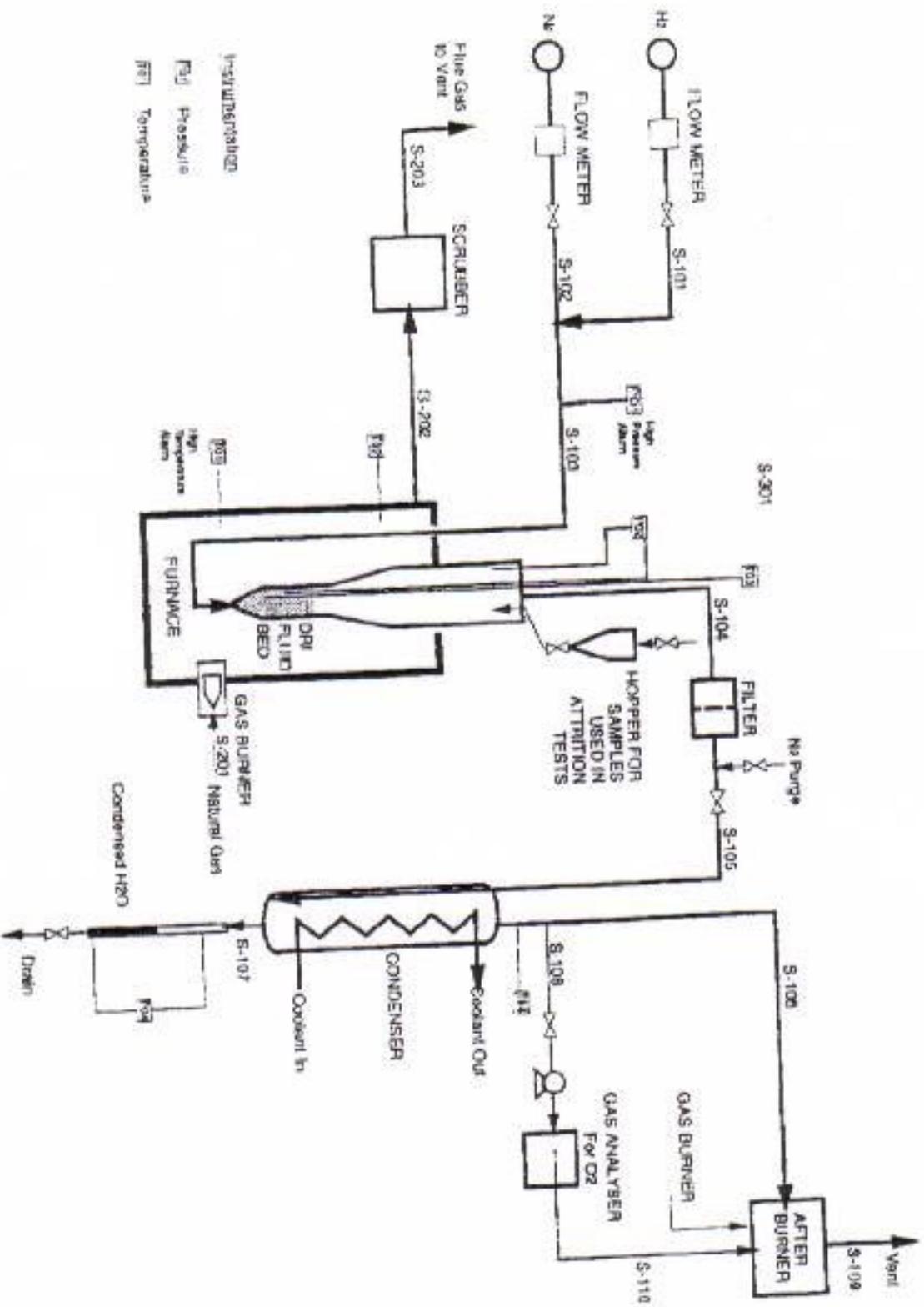


Figure 1. Fluidized bed reactor for direct reduction of iron ore

4



# ResTec Pty Limited

Creating The Balance Between Environment And Mining

16 February 2001

Elton Stone  
24 Shelly Beach Road  
Shelly Beach NSW 2478

Dear Sir,

## FINANCIAL COMMITMENT TO TESLA PROJECT

We refer to the above project for the design and construction of a demonstration and development plant for the extraction of metals from solid waste residues owned by Mount Isa Mines Limited.

As you are aware, ResTec is committed to the provision of funds required under the Development Agreement which we have entered into with Tesla Technologies Pty Limited in an amount of approximately \$1.5M. The full commercialisation of the technology upon proven success will require funds in the order of \$15M.

To this end, ResTec has located investors to provide this funding.

Significant due diligence has been undertaken and is in the process of completion and we expect documentation to be completed and available within the next 14 days.

We will keep you informed of developments and the completion of funding as it arises

As you are aware, ResTec has at this stage no assets or liabilities of substance but we are happy to provide financial accounts for the company if you so require

We trust this is of assistance and if you require any further information please do not hesitate to call and discuss.

Yours truly

Beven Schwaiger  
Director

**DRAFT  
INFORMATION BRIEFING  
RESTEC PTY LIMITED**

CONTENTS

1. INTRODUCTION
2. PRODUCTS & SERVICES
3. CURRENT TARGET PROJECTS
4. BUSINESS PLAN

## 1. INTRODUCTION

This Information Briefing sets out details of the proposed business of ResTec Pty Limited (ResTec).

Restec has been established for the commercialisation of specific technologies in the extraction and recovery of metals from industrial and mining wastes and by-products.

Over many years mining and manufacturing companies have employed traditional methods to mine and process metal ores and concentrates. Smelting and leaching processes have been used to extract metals such as zinc, lead, nickel, and copper from ore bodies and concentrates. Traditionally these processes are relatively inefficient, leaving residual stockpiles of by-products and wastes with significant concentrations of metals.

Until now, technologies and processes have not been available to economically extract the residual metals from these large stockpiles or waste streams. The result is millions of tonnes of stockpiled materials and continuous waste streams with high levels of metals including zinc, lead, copper and other base and precious metals and rare earths. Additionally these large stockpiled resources present environmental challenges for their owners to ensure the metals present do not leach into the environment, either in their current stockpiles or if disposed underground or in landfills.

ResTec has the exclusive commercial rights to new leading edge proven at bench scale and treatability stages to economically extract metals from such waste streams providing significant returns on investment.

ResTec has letters of intent from mining companies which own large stockpiles of material with extractable concentrations of zinc and lead, (over 7 million tonnes) and a continuing production stream in excess of 250,000 tonnes of material per year.

Treatability studies to date have proven the economic and efficient extraction of high grade zinc and zinc oxide, with the resultant treated residual material suitable for re-use as in-fill, or subgrade material.

ResTec has also entered into a Heads of Agreement with a leading global glass manufacturing company to treat a difficult waste stream and recover tin and ammonium chloride for value.

ResTec's technologies have significant worldwide application.

## **2. PRODUCTS & SERVICES**

ResTec has a number of technologies available for the extraction of and processing of metals from mining and industrial residues.

### **Microwave Extraction Technology (Tesla Technologies Pty Limited)**

ResTec has the exclusive worldwide rights to commercialise this new patented technology. The technology uses the application of microwaves to effectively extract metals from material. This has significant benefits and advantages over traditional methods:

- a. energy efficient
- b. mobile, modular in design and scalability
- c. environmental best practice, with no emissions/discharges
- d. relatively low capital requirement

ResTec's licence rights include the worldwide application of the technology to industrial and mining residues, wastes, ore-derived zinc and zinc concentrate.

ResTec's obligations include the funding of fifty percent of the Demonstration plant project (budget is \$1.45M), with government funding to Tesla Technologies providing the other 50% funding.

Success of the Demonstration plant is to be determined by an independent auditor that the plant is capable to be scaled up to 5 tonnes/hour. Given the modular nature of the plant and short resonance time (time taken for metal to fume to gas phase) the units are likely to achieve greater production rates to the required productivity for full scale treatment.

Tesla Technologies has compiled for the Demonstration project a significant team of leading experts in the fields of microwave applications and metal extraction. The team includes CSIRO who are undertaking trials on zinc fume collection, and Lockheed Martin (USA) for the provision of industrial microwave applicators.

ResTec is currently looking to apply this technology to a number of significant stockpiles and continuous waste streams. While the current application of this technology is directed to zinc and zinc oxide, it is also applicable to lead, nickel, mercury, and other metals and rare earths.

In addition, through its affiliation with The EM Group Pty Limited, ResTec has capability to add chemical fixation processes to the "back end" of the metal extraction, providing fixation of the residual materials for environmental regulations, for landfilling and end use of the material. This value adds to the revenues for projects.

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The commercial viability of the metal extraction, (whereby the revenue from the extracted metal exceeds the capital and operating costs) allows ResTec to offer “no risk” contracts to owners and generators of such waste streams. Thus, stockpiles of waste can now be viewed as valuable resource bodies and commercial arrangements for “mining” can be made. This will usually involve the payment of a royalty per tonne of processed “waste to be paid to the owner/generator.

#### **Electrowinning Extraction (Zeftec Pty Limited)**

ResTec has licence rights to commercially promote and deliver certain metal extraction technologies owned by Zeftec.

These technologies use electrowinning processes for the extraction of metals from solids and liquids. This is applicable where there are low metal concentrations, yet it is commercially viable to extract these materials,

Accordingly the application of the suite of technologies at ResTec’s disposal allows the extraction of a wide range of metals from different medium and has worldwide application.

### 3. CURRENT TARGET PROJECTS

ResTec has three current target projects:

#### **Mount Isa Mines Limited, Queensland**

MIM currently has stockpiled in excess of 5 million tonnes of zinc/lead slag waste. This material has an average zinc concentration of 13.8%.

MIM continues to produce this waste stream at a rate of 170,000 tonnes per year. Of this, approximately 110,000 tonnes is currently used as backfill within the mine and the balance added to the stockpile.

ResTec treatability and pilot scale trials have proven the removal of high grade zinc (99.8%) using the Tesla microwave process. This has been achieved at estimated operational costs to provide a significant return on investment.

Under the Licence and Development Agreements with Tesla, ResTec and Tesla have agreed to proceed to design and construction of a Demonstration Plant capable of processing 500kg per hour of waste slag. The Demonstration stage is estimated to take 6-12 months to complete.

Upon completion of the successful demonstration plant, the following stage is the full scale commercialisation of the technology applied to the identified stockpiles.

The next stage proposes to construct 3 full scale plants each capable of processing 5 tonnes/hour. Significant infrastructure will also be required as part of the operations on the MIM site. It is estimated this stage will take 18 months to complete.

The Demonstration Plant stage will cost ResTec \$1.45M (with an equivalent amount being provided by government R&D grant through Tesla Technologies).

The next stage (3 plants) will cost approximately \$14M, and will produce 13,815 tonnes per annum of high grade zinc oxide. The current price per tonne of high grade zinc oxide is A\$1800. At current prices this equates to revenue of \$14M per annum.

The estimated operational costs (including royalties and licence fees) will result in a before tax profit (EBIT) of \$7.6M per annum, with production from the 3 metal extraction plants.

A Letter of Intent has been issued by MIM dated 29 January 2001.

#### **Pasminco Cockle Creek, New South Wales**

Similar to the MIM project, Pasminco has a slag stockpile of 2million tonnes with zinc concentration ranging between 6 and 9.5%. The slag also contains significant concentrations of lead. Pasminco continues to produce 70,000 tonnes a year of this material.

**RESTEC PTY LIMITED***Level 2**1 Rosebery Avenue**ROSEBERY NSW 2018***Profit & Loss Statement**

1/09/00 through 31/01/01

4-0000	Income	
4-1000	Sales	
	<b>Total Income</b>	\$0.00
5-0000	Cost of Sales	
	<b>Total Cost of Sales</b>	\$0.00
	<b>Gross Profit</b>	\$0.00
6-0000	Expenses	
6-1000	Administration Expenses	
6-1050	Rent	\$1,000.00
6-1060	Sales and marketing	\$22,000.00
6-1070	Management & legal	\$5,000.00
6-1080	Office Expenses	\$2,000.00
	<b>Total Administration Expenses</b>	\$30,000.00
	<b>Total Expenses</b>	\$30,000.00
	<b>Operating Profit</b>	(\$30,000.00)
8-0000	Other Income	
9-0000	Other Expenses	
	<b>Net Profit / (Loss)</b>	(\$30,000.00)

**RESTEC PTY LIMITED***Level 2**1 Rosebery Avenue**ROSEBERY NSW 2018**AUSTRALIA***Balance Sheet**

January 2001

<b>1-0000</b>	<b>Assets</b>	
1-1000	Current Assets	
1-1100	Cash On Hand	
1-1110	Cheque Account	\$0.00
	Total Cash On Hand	\$0.00
	<b>Total Assets</b>	<b>\$0.00</b>
<b>2-0000</b>	<b>Liabilities</b>	
2-1000	Current Liabilities	
2-1100	Loans	\$0.00
2-1200	Schwaiger Holdings	\$0.00
	Total Loans	\$30,000.00
2-1310	GST Collected	\$0.00
2-1330	GST Paid	\$0.00
	Total GST Liabilities	\$0.00
<b>2-1400</b>	<b>Payroll Liabilities</b>	
2-1410	Superannuation Payable	\$0.00
2-1420	PAYG Withholding Payable	\$0.00
	Total Payroll Liabilities	\$0.00
	Total Current Liabilities	\$0.00
	<b>Total Liabilities</b>	<b>\$30,000.00</b>
	<b>Net Assets</b>	<b>\$0.00</b>
3-0000	Equity	
3-1000	Owner's Equity	\$120,000.00
3-1100	Owner's Capital	
	Total Owner's Equity	
3-8000	Retained Earnings	
3-9000	Current Year Earnings	
	<b>Total Equity</b>	<b>\$90,000.00</b>

It is proposed to proceed with the construction of 3 metal extraction plants immediately after the commissioning of the MIM MEPs. Returns similar to the MIM project can be achieved due to the lower operating costs associated with lower energy costs.

#### **ACI Packaging, Australia wide**

ACI produces approximately 120 tonnes per annum of tin waste residue. This material is currently shipped overseas for treatment.

ACI and ResTec have entered into a Heads of Agreement for ResTec to take this material and treat at a centralised location in Australia.

ResTec's treatment process (using the Zeftec electrowinning technology) provides for the 100% recovery of 2 products, namely tin and ammonium chloride (both valuable resources for resale).

The capital outlay for the MEP is \$175,000 which includes a pilot plant (4 weeks duration) and full scale plant (8 weeks duration for construction). The plant will be capable of treating 240 tonnes per annum. ResTec proposes to establish the facility at Bulla, Victoria through a licence arrangement with The EM Group which holds the exclusive licence rights to operate a solid waste treatment facility.

Based on the 120 tonnes of feed material sourced from ACI in Australia, this equates to \$302,000 revenue per year with an EBIT of \$100,000. This project is scheduled to commence in March 2001.

ACI (and its parent, Dow Corning), have many similar plants worldwide including China and India. ResTec proposes to procure contracts for shipment of this material to our Australian treatment facility. ResTec estimates to double the quantity of feed material each year by accessing these waste streams from other countries. It is a condition of the HOA that ACI introduces ResTec to its affiliated international plants.

A Heads of Agreement has been executed between ResTec and ACI Packaging.

## **SHAREHOLDER STRUCTURE**

### **RESTEC PTY LIMITED**

ResTec Pty Limited has three shareholders, namely

Schwaiger Holdings Pty Limited	80%
Norton Holdings Pty Limited	10%
Stangroom Holdings Pty Limited	10%

Each shareholder is incorporated in Australia

Schwaiger Holdings Pty Limited also wholly owns The EM Group Pty Limited

The EM Group Pty Limited is an environmental remediation technologies company trading in Australia since June 2000. It has revenue of \$1.4M for year to date 31 January 2001 and projects revenue of \$4M to 30 June 2001.

#### **4. BUSINESS PLAN**

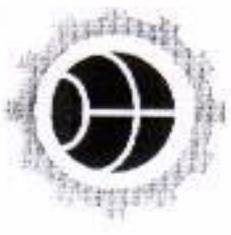
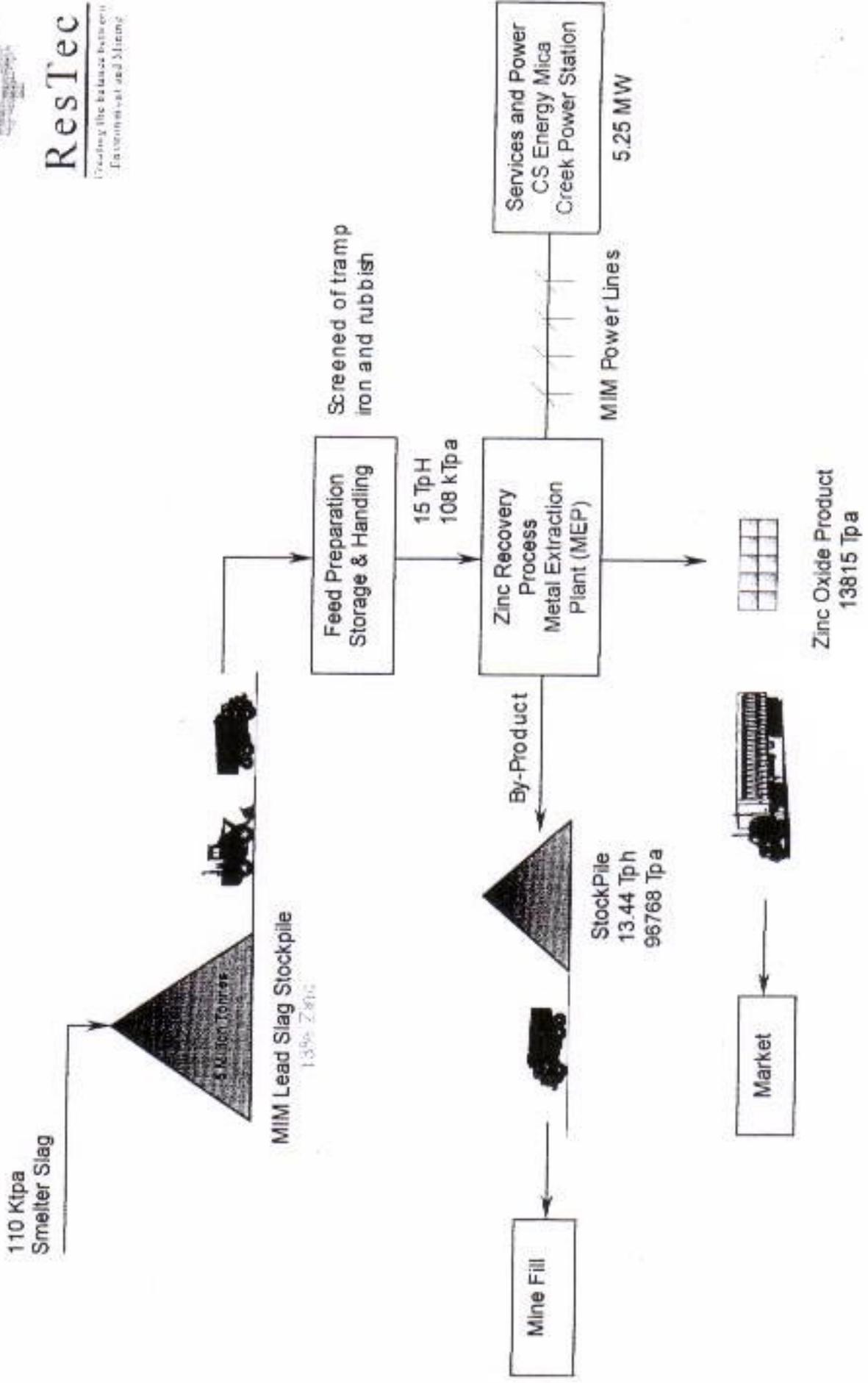
ResTec has developed a business plan to capitalise on the leading edge technologies and the current projects.

The plan involves the acquisition of the rights to numerous waste streams based on undertaking pilot programs and thereafter full scale metal extraction. Each project will have its own variables and factors for success.

The preferred approach is to negotiate with owners/generators of waste streams to acquire a Put Option on current stockpiles whereby providing a period of time to prove up the application of technology on that waste stream. ResTec can exercise its Put Option to proceed to extract metals from the waste streams and pay a royalty to the owner/generator on an agreed basis.

ResTec's primary focus is to succeed on the Demonstration project for the MIM and Pasminco stockpiles, and thereafter proceed to a further capital raising to fund the full scale production.

# Zinc Recovery Flowsheet - Mt Isa Mines Lead Slag



**ResTec**  
*Leading the balance between  
 Environment and Mining*







The preceding programme of "mini pilot" scale experimentation at CSIRO Minerals, Clayton, Victoria is a **provisional** programme. That is, that whilst the (initially) three stage programme proposed is accurate in its intended schedule, it is *indicative only* in that the precise schedule of experimentation will be open to amendment upon review of the progress and success of results at each stage, and with respect to redundancy of discrete values (or ranges of values) of variables as experimentation progresses.

Stages 1 and 2 establish the degree of comparison which can be inferred between "conventional" and "microwave" processes and will be less open to reviewed amendment. Stage 3 experimentation – the stage pertinent to the testing and establishment of system parameters – will be subject to schedule review and more open to amendment, and may lead to a fourth stage of experimentation if such is required to clarify or develop the system inter-relationships (re: fuming of discrete metallic fractions, fuming versus MW power (temp.), reductant options, flow rate and fluidisation mode, *et cetera*).

### **EXPERIMENTAL PROGRAMME: HALF TONNE PER HOUR TEST RIG.**

Once the CSIRO programme has been completed, enough will be known of the system parameters and controlling variables to design an informed programme of pilot programme studies for the ½ tonne per hour test rig. For complete zinc recovery, it is expected that the CSIRO tests will identify both a tight temperature range and an (associated) optimal residence time (processing time) [with respect to feed slag size range and fluidisation dynamics] upon which the pilot programme studies can be initiated. The CSIRO "mini-pilot" findings and results will be (subjectively) verified in initial test rig work.

Of course, required residence time will fundamentally dictate the chamber size of the fluidised bed reactor section of the rig (with respect to the ½ tonne per hour requirement). Reactor chamber volume will dictate the applied microwave power input and some flexibility will be designed into the microwave generator and delivery systems.

Consequently, test rig experimental campaigns will be designed to accommodate all pertinent system parameters and variables such that the information gained from testing is maximised and leads logically to the next stage. To this end, it is expected that test rig campaigns will be operated over a relatively narrow temperature range (directly represented by applied microwave power), over a relatively narrow residence time range and within a relatively well-defined range of reductant/fluidizing gas regimes (which can only be identified after the completion of the CSIRO studies).

Fluidisation dynamics, bed diagnostics and product material analyses will be continuously monitored. Fume composition, reduction completeness (of fumed metals) and the composition and state of spent solid slag will be key determinants guiding the actively reviewed test parameters and schedule. Overall test rig "well-being" will be assessed and monitored.

Once preferred operational conditions are established, the test rig will be operated over extended campaigns – increasing to the limitations of staffing availability and safety considerations (staff and system fatigue), material availability and project life (funding). Results from the test rig campaigns will be utilised to design full-scale pilot plant leading to commercial production.

CSIRO Visit, 23/10/2000.

Outline of Proposed Experimental Programme (Preliminary).

All experimental FB runs to be in same 75 mm ID bed with a standard charge of zinc-bearing slag (from same sampled material) and having the same particle size and distribution. The charge mass - perhaps 1 kg, to be agreed after considering bed height, and bed and particle density.

**Programme Stage 1. Non-microwave.**

This stage to be heated by a conventional, non-electromagnetic means - possibly by heat transfer from fluidising gas at temperature.

The dynamics of the fluid bed - gas velocities, pressure drop through bed, required minimum fluidising pressure (for "standard" experimental charge) to keep top (stockline) pressure at a minimum (~1atm). Against these (CSIRO) established diagnostics, further microwave-stimulated systems will be monitored, determined or compared.

	900°C	950°C	1000°C
1.	Slag, in N <sub>2</sub>	Slag, in N <sub>2</sub>	Slag, in N <sub>2</sub>
2.	Slag + C, in N <sub>2</sub>	Slag + C, in N <sub>2</sub>	Slag + C, in N <sub>2</sub>
3.	Slag + C, in 20% CO/N <sub>2</sub>	Slag + C, in 20% CO/N <sub>2</sub>	Slag + C, in 20% CO/N <sub>2</sub>

**Programme Stage 2. Microwave-stimulated at 2450 MHz.**

This stage to be heated by 2450 MHz microwave irradiation on top of heat transfer from fluidising gas at temperature and "temperature" regulated by microwave power input with respect to temperatures measured during conventional processing of Stage 1. This temperature correlation to be in conjunction with verification of fluidising pressures between comparable cases of microwave and non-microwave experimental runs.

	900°C	950°C	1000°C
4.	Slag, in N <sub>2</sub>	Slag, in N <sub>2</sub>	Slag, in N <sub>2</sub>
5.	Slag + C, in N <sub>2</sub>	Slag + C, in N <sub>2</sub>	Slag + C, in N <sub>2</sub>
6.	Slag + C, in 20% CO/N <sub>2</sub>	Slag + C, in 20% CO/N <sub>2</sub>	Slag + C, in 20% CO/N <sub>2</sub>

Note that "temperature" is equivalent to "temperature as measured" [by probes (thermocouple or other) at CSIRO] and will be correlated with "input microwave power". Verify that fluidising pressures are the same or comparable to those of Stage 1

**Programme Stage 3.** Microwave-stimulated at 2450 MHz. Use standard fluidising pressures and microwave power to "temperature" relationships.

	Time (min)	850°C	900°C	950°C	1000°C
7.	x	A	B	C	D
8.	x + $\delta x$	E	F	G	H
9.	x + 2 $\delta x$	I	J	K	L
10.	x + 3 $\delta x$	M	N	O	P

Where A to P: (i) Slag + C, in N<sub>2</sub>  
(ii) Slag + C, in 20% CO/N<sub>2</sub>  
(iii) Slag, in 20% CO/N<sub>2</sub>

Note that "fume end point" should lie between 9 and 10 .

Options D, H, L and P (at 1000°C) may not be needed. Also, other options may be cancelled.

Possible experimental runs at temperatures below 850°C should institute a Stage 4 programme and are not proposed here.

## Work Program

The work program of this contract refers to the first stage of a three-stage program discussed at a meeting between CSIRO and Tesla on 23<sup>rd</sup> October 2000. The objective of the overall program is the recovery of zinc from a blast furnace slag.

This first stage is concerned with determining the fluidization characteristics of the slag particles over a range of possible operating temperatures, fluidizing gas compositions and addition of a solid reductant. Particularly it is important to determine whether any sticky phases develop in the bed which could result in operational problems.

The program is defined as follows:

1. Determine the particle size distribution of a representative sample of the slag material supplied by Tesla. (Tesla is to provide approximately 50 kg of slag material, screened to  $-800\ \mu\text{m}$ , and will be responsible for any costs associated with the return of samples, material accumulated during commissioning and any unused feed.)
2. Determine the apparent particle density and bulk density of the slag sample.
3. Determine the minimum fluidizing velocity of the slag sample in air at ambient conditions.
4. Conduct a Hazop/Hazid study of the proposed experimentation and complete a Health, Safety & Environment Assessment of the proposed work before any experimentation proceeds.
5. Modify and reconfigure an existing bubbling fluidized bed reactor rig to meet the requirements of this stage of the work program. The fluidized bed vessel is 50 mm ID expanding to 100 mm at the freeboard and is mounted in a gas-fired firebox.
6. CSIRO will provide brown coal char (Auschar) and determine by ambient condition fluidization tests the char particle size which mixes well with the much denser slag material. A bulk char sample will then be prepared by crushing and screening for use in the hot fluidization trials.
7. Select a superficial gas velocity, at operating conditions, which will be suitable for a mixed bed of slag and char particles (10 wt%).
8. Conduct twelve fluidization tests of up to 30 minutes duration each on approximately 0.35 kg portions of the slag sample as described in the following Table.

	Bed Material	Fluidizing Gas	Bed Temperature [ $^{\circ}\text{C}$ ]
Series 1	Slag	$\text{N}_2$	900°, 950° and 1000°
Series 2	Slag and crushed char	$\text{N}_2$	900°, 950° and 1000°
Series 3	Slag and crushed char	20 vol% CO in $\text{N}_2$	900°, 950° and 1000°
Series 4	Slag	20 vol% CO in $\text{N}_2$	900°, 950° and 1000°

During these parametric tests the fluidized bed temperature and differential pressure across the bed will be continuously monitored to try to identify any agglomeration and consequent defluidization of bed particles.

9. Samples of the final fluidized bed material of each of the 12 tests will be retained for analytical testing as required by Tesla. Note that any analytical charges will be additional item