DESKTOP STUDY ON AVAILABLE INCINERATION TECHNOLOGIES

Prepared for:
Livestock Waste Tissue Initiative,
BC Investment Agriculture Foundation
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Funding provided by:

Canada

Investment Agriculture Foundation of British Columbia

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Funding for this study was provided in part by the Investment Agriculture Foundation of British Columbia through programs funded by the Government of Canada and the Province of British Columbia.

The Investment Agriculture Foundation is a not-for-profit organization that manages and distributes federal and provincial funds in support of innovative projects to benefit the agriculture and agri-food industries in British Columbia.

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E/07/3566
August 23, 2007 07-1700-0035

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Attention: Mr. Rick Van Kleeck

RE: DESKTOP STUDY ON AVAILABLE INCINERATION TECHNOLOGIES

Dear Mr. Van Kleeck:

Golder Associates Innovative Applications (GAIA) Inc. is pleased to present our report on our review of the material received from suppliers concerning available incineration technologies for the purpose of dealing with Specified Risk Materials (SRMs).

1.0 BACKGROUND

The BC Ministry of Agriculture and Lands has provided assistance to the provincial cattle industry to aid in the disposal of SRMs through the Livestock Waste Tissue Initiative (LWTI). GAIA was requested by the LWTI to carry out a desktop study for the purpose of investigating possible incineration options for disposal of SRMs.

2.0 INFORMATION

2.1 Request for Information

The LWTI provided GAIA with a list of potential suppliers for incinerator technologies. GAIA expanded on this list and compiled the contacts into a master list which is included in Appendix I. A Request for Information (RFI) was sent to each potential supplier encouraging them to share as much information as possible and by presenting this report as an opportunity to display their technologies to the appropriate decision makers. An evaluation matrix was included with the RFI. A copy of the RFI documentation is included in Appendix I.

2.2 Comparison of Information

A variety of information was received from numerous suppliers and entered into a master comparison table. Not all potential suppliers responded. Due to the nature of the responses, not all of the technical information could be readily captured in the comparison table as it was not in keeping with the data requested or in a format that could be readily incorporated, however all response data has been included in the appendices.

Tables 1, 2 and 3 provide a comparison of the suppliers based on the information provided. Table 1 represents smaller incinerators from 1 kg/hr to 150 kg/hr. Table 2 represents medium incinerators from 150 kg/hr to 400 kg/hr, and Table 3 represents larger incinerators with feed rates 400 kg/hr and higher.

GAIA acknowledges that there are a number of assumptions made when comparing incinerators in the format below. The costs provided by the suppliers were budgetary costing. This analysis does not take into account detailed costing of the units. Often the higher cost is due to added features such as fuel alternatives or options. The feed rates provided are averages and do not take into account burn time or down time which can affect productivity.

This comparison serves only to summarize the information received and indicates the variances in the systems presented. From this table, and depending on the Ministry's procurement and detailed technical criteria, an approximate ranking of systems could be derived which could form the basis for selecting suppliers. It is anticipated that the next phase of this selection process would be for the Ministry to contact a number of the best ranked suppliers listed and enter into detailed discussions regarding specific implementations.

2.3 Analysis

GAIA believes that a determination should not be based on capital cost alone. Having looked at all of the information provided a higher value has been placed on suppliers who provided the most information since there are fewer unknowns.

GAIA compiled the information provided by suppliers and prepared the summary presented in Table 1 in order to assess the most appropriate model for a smaller incinerator rated from 1 kg/hr to 150 kg/hr. Based on this review GAIA is of the opinion that Westland Environmental Services provided a good deal of information concerning their product and good estimations on the implementation and operation and maintenance and are worthy of further detailed consideration. While the capital cost was not the lowest it was comparable to both the Infratech model and lower than the Trecan estimate.

GAIA examined the information provided by suppliers and prepared the summary in Table 2 in order to estimate the most appropriate model for a medium incinerator rated from 150 kg/hr to 400 kg/hr. The information provided by suppliers in this category was much more thorough and as such made comparing the models much more difficult. Of the eleven companies listed in Table 2, the following six are worthy of further consideration based on the information they provided. Trecan Combustion, ECO Waste Solutions, Westland Environmental Services, Infratech, Energy Sustaining Technologies and Advanced Combustion Systems. Of these six a comparison was made of capital cost vs burn rate to select Advanced Combustion Systems as likely the most economic solution and hence worthy of further detailed assessment.

GAIA completed a final comparison to estimate the most appropriate model for a large incinerator rated above 400 kg/hr using the information provided by suppliers and the comparison in Table 3. Both ECO Waste solutions and Energy Sustaining Technologies both appear to be excellent choices and warrant further assessment.

As can be seen in Tables 1, 2 and 3 there are a wide variety of incinerators available at a number of different prices. We recommend that in all cases additional research should be done to fit the specific application with the best available incinerator.

It should be noted that the information provided by the gasification suppliers was not as complete in comparison to the incinerator suppliers. Perhaps this is due to the fact that gasification technology is not as developed as incinerator technology. As a consequence, gasification suppliers could not be as highly ranked when a direct comparison was attempted, however, gasification should be explored further as a possibility for dealing with SRM waste.

TABLE 1: Smaller Incinerators 1 kg/hr to 150 kg/hr

Manufacturer	Capital Cost (CAN $)	Installation Cost (CAN $ unless otherwise noted)	Annual Operation Cost (CAN $ unless otherwise noted)	Burn Rate	SRM burn information	Options	Appendix
Trecan Combustion – Model T7, 20-r and T-11	$240,000 to $632,840	$20,000 for T7 Model $195,000 for 20-R Model $130,000 for T11 Model	Training $5,000 to $6,000 / year Repairs allow $10,000 to $12,000	90 to 91 kg/hr	Designed and tested on medical waste	Trailer option Equipped with ram feeder	Appendix XI
ECO Waste Solutions – Model CA50, CA100 and CA600	$115,000 to $170,000	Not estimated	Annual maintenance estimated at 5% of capital cost 5,000 to 7,500 gallons per year (assumed diesel)	36.5 to 113 kg/hr	Detailed report on Emissions from an Animal Crematorium.	Not Specified	Appendix IX
Imexco – Model 34,36,37-1,367 and 428 (Same as Energy Sustaining Technologies smaller incinerator)	$5,600 to $10,200 *	Not estimated	Not estimated	35 to 45 kg/hr various capacities	Not Supplied	Not Specified	Appendix VIII
Westland Environmental Services – Model CY50 and CY100 #	$155,000 to $245,000	10% of Capital Cost	Training $12,000 Labour $60,000 Repairs Allow $18,000 to $22,000 Fuel $18,000 to $36,000	50 to 100 kg/hr	Experience shows an Air Pollution Control Device is required to achieve 50 mg/m³	Feed Ram included with cost Scrubber (basic) Scrubber (Fine Polishing)	Appendix V
Infratech – Model 100MC and 200MC	$215,000 to $265,000	Estimated 3 to 5 days operator training at $1,000 per day	Model 100MC Diesel Max 125,000 litres per year Natural Gas Max 125,000 sm³/year Propane Max 49,250 sm³/year Model 200MC Diesel Max 184,000 litres per year Natural Gas Max 185,000 sm³/year Propane Max 72,750 sm³/year (2500 hours/year)	50 to 100 kg/hr	Results from Model 500 testing on unknown material.	Semi-Automatic Hydraulic Ram Feeder Servomex 2700 O2 Monitor Servomex 2700 O2/COe Monitor Continuous Emissions Monitoring System (CO/O2) LaserGas Continuous Emissions Monitoring System (CO/O2) Ash Removal Personal Protective Equipment Diesel Fuel Tank Automatic Fill Waste Oil Disposal System Siemens PLC and Touch Screen HMI Spare Parts Package	Appendix IV
Energy Sustaining Technologies – Model Burn Easy 367 – 1W and Burn Easy 428 – 1W (Same as Imexco incinerator) #	$16,000 to $19,000 *	Delivery included in Capital cost	$0.12 to $0.15 per lbs of SRM on diesel fuel	35 to 45 kg/hr at various capacities	Not on this model	Not Specified	Appendix III
Brookes Gasification Process – 50 kg/cycle unit	$35,000	Not estimated	Annual Maintenance cost of 10% Capital cost No Operational costs estimated	50 kg over 12 hours	Tested on U.K. bovine carcasses and SRM. Air emissions met EU standards	Not Specified	Appendix XII
B&L Cremation Services – Model BLI 200/50, 400/75, 800/150, 1500/150, 1500/300, 2500/250	$16,900 to $68,900 US$	Not estimated	Not estimated	23 to 136 kg/hr	Not Supplied	BL-100 Animal Processor One Single Pen Temperature Recorder Dual Pen Temperature Recorder Stainless Steel Exterior (Front) Environmental Approval and Stack Test BLP-20M Hydraulic Loading Table Small Animal Loader Large Animal Loader Ram-Feed Loader Roof Thimble Air Louver Outdoor Use Modification	Appendix XIII

 # See Section 2.4.1
*** Simplified System**

TABLE 2: Medium Size Incinerators 150 kg/hr to 400 kg/hr

Manufacturer	Capital Cost	Installation Cost (CAN $ unless otherwise noted)	Annual Operation Cost (CAN $ unless otherwise noted)	Burn Rate	SRM burn information	Options	Appendix
Trecan Combustion – Model 36-R	$840,000	$120,000 for 36-R Model	Training $6,000 / year Repairs allow $14,000	340 kg/hr	Designed and tested on medical waste	Trailer option Equipped with ram feeder	Appendix XI
Meshtech – Model Orverter A	$2,500,000	Assuming included in capital cost	Estimated at $100,000/year includes: - Labour $20,000 - Repair $50,000 - Emissions monitoring $20,000 - Electricity $10,000	225 kg/hr	Ash tested.	Gravity Fed included Ash Management included Feed weigh scale Mobilization upgrade	Appendix X
ECO Waste Solutions – Model ECO 2 TN	$430,000	Not estimated	Annual maintenance estimated at 5% of capital cost 37,500 gallons per year (assumed diesel)	250 kg/hr	Detailed report on Emissions from an Animal Crematorium.	Not Specified	Appendix IX
Westwood Energy Systems - Gasifier	$630,000	$60,000	$112,000	Varies dependent on feedstock	Specific testing performed on meat and bone meal material	Not Specified	Appendix VI
Westland Environmental Services – Model Pathological and CY150	$280,000 to $315,000	10% of Capital Cost	Training $12,000 Labour $60,000 Repair Contingency $30,000 Fuel $52,000	150 kg/hr	Experience shows an Air Pollution Control Device is required to achieve 50 mg/m³	Feed Ram included with CY150 Scrubber (basic) Scrubber (Fine Polishing)	Appendix V
Infratech – Model 500 MC #	$328,900	Estimated 3 to 5 days operator training at $1,000 per day	Model 500MC Diesel Max 297,000 litres per year Natural Gas Max 298,500 sm³/year Propane Max 72,750 sm³/year (2500 hours/year)	200 kg/hr	Results from Model 500 testing on unknown material	Semi-Automatic Hydraulic Ram Feeder Servomex 2700 O2 Monitor Servomex 2700 O2/COe Monitor Continuous Emissions Monitoring System (CO/O2) LaserGas Continuous Emissions Monitoring System (CO/O2) Ash Removal Personal Protective Equipment Diesel Fuel Tank Automatic Fill Waste Oil Disposal System Siemens PLC and Touch Screen HMI Spare Parts Package	Appendix IV
Energy Sustaining Technologies – 3TS Model PD35, CIM150 and CIM250	$220,000 to $405,000	Included in Capital cost	$0.12 to $0.15 per lbs of SRM on diesel fuel	150 to 350 kg/hr	Exhaust Gas Emission statement on PD35, PD72, PD144, PD288 and PD1000 models	- auto feed ram and waste bin tipper included in capital cost - auto ash available upgrade - PD35 and CIM150 can be put on a trailer	Appendix III
Thermogenics – Model 103-2X-6 Gasifier	$660,000	Not Estimated	Not Estimated	680 kg/hr with feedstock	No SRM burn information but 2 electrostatic precipitators included.	- Trailer configuration available	Appendix II

Manufacturer	Capital Cost	Installation Cost (CAN $ unless otherwise noted)	Annual Operation Cost (CAN $ unless otherwise noted)	Burn Rate	SRM burn information	Options	Appendix
Advanced Combustion Systems – Model CA1750M, CA1500 and CA1000M #	$170,000 to $300,000 US$	Estimated at 5% of Capital cost. $30, 000 to $60,000 US$	1 operator Over 400 cubic metres of propane per year (2500 hours per year) Over 20,000 kW per year (2500 hours per year)	227 to 397 kg/hr	Emission test data on Municipal and Hospital waste	Feed Ram Top Loader Cart Tipper Ash Removal Ash/Waste Carts Waste Oil Burner Load Scale Data Acquisition System Wet Scrubber Mobile Unit	Appendix XIV
Brookes Gasification Process – 4000 kg/cycle unit	$450,000	Not estimated	Maintenance of 10% capital cost	4000 kg over 10 hours	Tested on U.K. bovine carcasses and SRM. Air emissions met EU standards.	Not Specified	Appendix XII
B&L Cremation Services – Model BLI 2500/500 and 5000/550	$78,900 to $99,900 US$	Not estimated	Not estimated	227 to 250 kg/hr	Not Supplied	BL-100 Animal Processor One Single Pen Temperature Recorder Dual Pen Temperature Recorder Stainless Steel Exterior (Front) Environmental Approval and Stack Test BLP-20M Hydraulic Loading Table Small Animal Loader Large Animal Loader Ram-Feed Loader Roof Thimble Air Louver Outdoor Use Modification	Appendix XIII

**See Section 2.4.1**

TABLE 3: Larger Incinerators 400 kg/hr and higher

Manufacturer	Capital Cost	Installation Cost (CAN $ unless otherwise noted)	Annual Operation Cost (CAN $ unless otherwise noted)	Burn Rate	SRM burn information	Options	Appendix
Meshtech – Model Orverter B	$4,000,000	Assuming included in capital cost	Estimated at $100,000/year includes: - Labour $20,000 - Repair $50,000 - Emissions monitoring $20,000 - Electricity $10,000	450 kg/hr	Ash tested.	Gravity Fed included Ash Management included Feed weigh scale Mobilization upgrade	Appendix X
ECO Waste Solutions – Model ECO 4 TN and ECO 8 TN	$630,000 to $850,000	Not estimated	Annual maintenance estimated at 5% of capital cost 62,500 to 125,000 gallons per year (assumed diesel)	500 to 800 kg/hr	Detailed report on Emissions from an Animal Crematorium.	Not Specified	Appendix IX
Energy Sustaining Technologies – 3TS Model PD288 and PD1000	$580,000 to $750,000	Included in Capital cost	$0.12 to $0.15 per lbs of SRM on diesel fuel	500 to 1000 kg/hr	Exhaust Gas Emission statement on PD35, PD72, PD144, PD288 and PD1000 models.	-auto feed ram and waste bin tipper included in capital cost -auto ash available upgrade	Appendix III

2.4 Specific Supplier Information

The following is specific information regarding certain issues and supplier products which should be considered before exploring specific systems further.

2.4.1 Opacity Regulations

The British Columbia Ministry of Environment (MOE) has released a regulation which details slaughter and poultry waste disposal through incineration. (http://www.env.gov.bc.ca/epdiv/ema_codes_of_practice/slaughter/index.html) The incinerator chosen should be able to operate and be approved under these regulations, otherwise alternative permiting will be required. Some specific points to be aware of:

- This proposed code only applies to incinerators, either continuous or batch, with a feed rate of 400 kg per hour or less. Incinerators with a higher feed limit must address more stringent permitting and should not be chosen unless absolutely necessary.

- Air emissions must be measured for total particulate below 50 mg/m³ and opacity below 10% averaged over 6 consecutive minutes.

- The permitting for the incinerator is for animal by-product waste stream only.

- Waste loading into the incinerator must be weighed.

A number of potential suppliers informed GAIA that the opacity of regular incinerators could not be maintained at 50 mg/m³:

1. Advanced Combustion Systems (ACS) stated at the bottom of their quotation that Particulate emissions of 50 mg/m³ are not achievable with a stand-alone incinerator. ACS guarantees no more than 200 mg/ m³, with emissions test data on Municipal and Hospital waste ranging from 75 to 185 mg/m³. (Appendix I).

2. Energy Sustaining Technologies reported test results from some of their incinerators with opacity emissions of less than 120 mg/m³. (Appendix III).

3. Infratech reported emission testing from their model 500 with particulate results of 44.2 mg/m³. Infratech also detail that a scrubber upgrade would reduce particulate emissions from 40-250 mg/m³ down to less then 17 mg/m³. (Appendix IV).

4. Westland Environmental Services states: 'A maximum particulate emission of 50 mg/m³ is specified, yet the use of an air pollution control device (APCD) is not stipulated. Based on our experience and literature information, an APCD is needed to meet that standard. See for example the following statement, which refers to a crematorium:"*BACT for a new or modified incinerator is a maximum particulate emission rate of 0.12 gr/dscf corrected to 12% CO2."* [1] [BACT = Best Available Control Technology; 0.12 grains/dscf = 275 mg/m³]' (Appendix V).

In contradiction to this the following sources indicate that the standard can be met:

1. Thompson Rivers University of Kamloops, BC through A. Lanfranco and Associates conducted an emission survey on the exhaust of an animal waste combustor. They reported a particulate range of 38 to 48 mg/m³. (Appendix VII).

2. Eco Waste Solutions conducted a study on a CleanAire cremator system with a 250 kilogram capacity report 13 to 21 mg/m³ particulate for swine and poultry waste. (Appendix IX).

3. Trecan was confident in achieving the regulations, 'The last animal waste incinerator we had to test was a T-7 in Ontario, which is a batch load machine. This had very good results namely an average of 8.38 mg/DRm³. Thus for our batch load incinerators we feel confident of meeting 50mg/m³. The unit tested had no scrubber.' (Appendix XI).

4. BGP reported that the average emission particulate was below 25 mg/m³. (Appendix XII).

2.4.2 Leakage of liquid through incinerator joints

2.4.3 Manually Batch Loading Incinerator

GAIA spoke with Dr. Steve Looker of B&L Cremation Systems. Dr. Looker raised the issue of SRM liquid being pressurized through the joints of the incinerator to be a possible contamination to the area surrounding the incinerator. Dr. Looker was confident that their model of incinerators can deal with the problem, and stated that "B&L has devised a totally unique primary chamber hearth system that eliminates fluid leakage which is a common problem with many of our competitors designs." (Appendix XIII).

Richard Stoton of Energy Sustaining Technologies (EST) raised a valid concern with the Canadian Food Inspection Agency's (CFIA) regulations on incineration. Richard directly contacted the CFIA to object to manually loading a preheated incinerator. This will place the operator in a dangerous workplace condition as he attempts to load the 850°C preheated chamber. For more information please refer to his letter included in Appendix III. This is a valid concern which should be addressed before incinerators are installed on site. This issue warrants consideration during further detailed assessment.

3.0 LIMITATIONS

The scope of work reported above is restricted to a desk top examination of technical and cost considerations associated with incineration of livestock waste tissue.

GAIA has completed its work in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to the scope of work. No other warranty, expressed or implied, is made.

4.0 CLOSURE

Based on the research completed to date there are numerous waste management systems available. While certain suppliers have been identified as worthy of further, more detailed, assessment GAIA recommend that the interested purchaser rank the suppliers based on their procurement and detailed technical requirements and short list suppliers for further discussions in terms of specific applications. We trust that the above is satisfactory. Should you have any questions, please contact the undersigned.

Yours very truly,

GOLDER ASSOCIATES INNOVATIVE APPLICATIONS (GAIA) INC.

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