28 February 2019

Assol Kubeisinova
Technical Advisor
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU, X0B 1J0

RE: Mary River Project - Modification Request No. 11
Incineration Unit for Milne Port 380 Person Camp
Water Licence 2AM-MRY1325 - Amendment No. 1

1 – INTRODUCTION

Baffinland Iron Mines Corporation (Baffinland) is pleased to submit this request for approval for planned modifications to the Mary River Project (the Project), in accordance with Part G of Type A Water Licence 2AM-MRY1325 - Amendment No. 1 (Type A Water Licence). As part of this modification request, consistent with guidance from the Nunavut Impact Review Board (NIRB), Baffinland has completed a self-assessment to demonstrate that the changes proposed do not constitute significant modifications to the Project as originally approved under Project Certificate No. 005 (as Amended) and that the potential ecosystemic and socio-economic effects associated with the modifications are insignificant.

On January 18, 2019, Baffinland received approval from the Nunavut Water Board (NWB) for Modification No. 3b (Motion No. 2018-A1-024), for the construction of the 380 Person Camp and supporting infrastructure at Milne Port. This approval included the construction and occupation of the 380 Person camp, a potable water treatment plant, and a waste water treatment plant. When the camp was originally conceived in 2017, a solid waste incineration unit was considered at that time. Subsequent project planning determined that insufficient information and documentation was available for the incinerator to be included in the submission to the NWB, however it was included in the 2017 Addendum reclamation security estimate.

Since the approval of the 380 Person camp, the need for additional waste management at Milne Port has been identified, and the required documentation compiled for the submission of this modification request. Baffinland intends to operate a skid mounted Ketek CY-100-CA controlled air dual chamber combustion unit, with 2.74 m^3 primary combustion chamber and 2.87 m^3 secondary combustion chamber. The location of the incinerator is depicted on the attached Figure 1 General Layout of the 380 Person Camp, provided in Attachment 1.

2 – SELF-ASSESSMENT OF PROPOSED MODIFICATIONS

Baffinland has undertaken a self-assessment of the proposed modification in accordance with the *Process for Seeking Approval for Modifications to Previously-Approved Projects* (NIRB, 2018). This self-assessment consists of four main components:

- Comparison of the modifications with the scope of the Approved Project
- An assessment of significance applying the factors set out in Section 90 of the *Nunavut Project Planning and Assessment Act* (*NuPPAA*)

- Identification of other new or modified permits, licences or approvals necessary to complete the proposed modifications
- Determination as to whether or not reconsideration of the existing Project Certificate is appropriate, considering *Nunavut Agreement* Section 12.8.2 and *NuPPAA* Section 112.

2.1 COMPARISON OF MODIFICATIONS TO APPROVED PROJECT

Baffinland undertook a comparison of the proposed modification with the scope of the Approved Project, as described in the Final Environmental Impact Statement (FEIS) and the FEIS Addendum (Baffinland, 2012 and 2013) for the Early Revenue Phase (ERP) of the Project. In completing this review, Baffinland considered the following question:

Was the modification activity assessed previously, or does it represent a reasonably expected modification or optimization of that which was assessed in the FEIS or FEIS Addendum?

The activity identified in this modification request has been either assessed previously, or is an optimization consistent with previously assessed activities. The results of this review are presented in Table 1.

Table 1 Comparison of Proposed Modifications to the Scope of the Approved Project

Item No.	Activity/Infrastructure	Comparison to the Scope of the Approved Project	FEIS Reference
1	Incinerator for 380 Person Camp	The proposed incinerator at the 380 Person Camp in Milne Port is consistent with the scope of the approved project. The FEIS Addendum for the Early Revenue Phase considered two (2) incinerators at Milne Port, of which one (1) is currently operating.	FEIS Addendum Vol. 5, Table 5-2.16 FEIS Addendum Appendix 5C-4, Table 1

2.2 SIGNIFICANCE ASSESSMENT

A screening level assessment of potential changes to the assessment of the Approved Project effects was completed for each of the valued ecosystem components (VECs) and valued socio-economic components (VSECs) identified in the FEIS. This assessment is presented in Table 2.

Table 2 Comparison of Effects of Requested Modification to Approved Project

Theme	FEIS VEC	FEIS Key Indicator	Change in Effect and Significance	Description of Change in Potential Effects	Additional Mitigation Measures
Atmospheric Environment	Climate change	Greenhouse gases (GHGs)	No change	Second incinerator at Milne Port was considered in the FEIS Addendum effects assessment.	No additional mitigation required
		Climate change	No change	Second incinerator at Milne Port was considered in the FEIS Addendum effects assessment.	No additional mitigation required
	Air quality	Particulate matter, SO_2, NO_X	No change	Second incinerator at Milne Port was considered in the FEIS Addendum effects assessment. Estimated annual emissions were based on operation of two (2) incinerators.	No additional mitigation required; implement existing Air Quality and Noise Abatement Management Plan.
	Noise and vibration	Atmospheric noise levels, marine noise levels, vibration	No change	Second incinerator at Milne Port was considered in the FEIS Addendum effects assessment.	No additional mitigation required; implement existing Air Quality and Noise Abatement Management Plan.
Terrestrial Environment	Landforms, soil and permafrost	Sensitive landforms	No change	There are no sensitive landforms identified within the existing PDAs where the modification will be undertaken.	No additional mitigation required; implement existing Environmental Protection Plan (EPP).
	Vegetation	Plant abundance and diversity Plants important to Inuit Plant health	No change	Assessment of the Approved Project assumed complete loss of vegetation within the PDAs. Since all modifications will occur within the existing PDAs, no change to vegetation will occur relative to the Approved Project.	No additional mitigation required.
	Terrestrial wildlife and habitat	Caribou	No change	No change to terrestrial wildlife habitat will occur relative to the Approved Project.	No additional mitigation required.
	Migratory birds and habitat	Peregrine Falcon, Snow Goose, Eider, Red-throated Loon, shorebirds, songbirds, species at risk	No change	Any nests located within the footprints of the modifications will be surveyed for bird nests prior to work being undertaken during the nesting season, in accordance with the TEMMP and EPP.	No additional mitigation required; implement existing TEMMP and EPP.
Freshwater Aquatic Environment	Surface water include freshwater quality and quantity	Water quantity Water and sediment quality	No change	No additional earthworks required. No major diversions are proposed that will result in material impacts to water quantity.	No additional mitigation required.
	Freshwater fish, fish habitat and other aquatic organisms	Arctic char	No change	The proposed modification is not situated within or immediately upstream of fish habitat.	No additional mitigation required.
Marine Environment	Sea ice	Area of shore fast ice in Steensby Inlet	No change	Not applicable to the requested modification.	No additional mitigation required.

Theme	FEIS VEC	FEIS Key Indicator	Change in Effect and Significance	Description of Change in Potential Effects	Additional Mitigation Measures
	Water and sediment quality	Water and sediment quality parameters with established guidelines	No change	Not applicable to the requested modification.	No additional mitigation required.
Human Environment	Land and resources use	Wildlife harvesting by Inuit Travel and camps	No change	The scale of the modification is minor and entirely confined to the existing PDAs and Commercial Lease boundaries. Changes to how Baffinland manages visitors and hunters will not be necessary.	No additional mitigation required.
	Cultural resources	Archaeological sites	No change	Effects to archaeology are not expected, as all modifications are located in areas previously surveyed (and mitigated, if necessary).	No additional mitigation required; implement existing Cultural Heritage Protection Plan and EPP.
	Other Valued Socio-economic Components (VSECs): • Population demographics • Education and training • Human health and wellbeing • Community infrastructure and public services • Governance and leadership • Livelihood and employment • Economic development and self-reliance • Contracting and business opportunities • Benefits, taxes and royalties		No change	Any additional employment and contracting will be undertaken in accordance with the provisions of the Inuit Impact and Benefit Agreement (IIBA) with the Qikiqtani Inuit Association (QIA).	No additional mitigation required.

The modification request as a whole was evaluated against the significance criteria presented in Section 90 of the *Nunavut Project Planning and Assessment Act* (*NuPPAA*):

(a) The size of the geographic area, including the size of wildlife habitats, likely to be affected by the impacts

(b) The ecosystemic sensitivity of that area

(c) The historical, cultural and archaeological significance of that area

(d) The size of the human and animal populations likely to be affected by the impacts

(e) The nature, magnitude and complexity of the impacts

(f) The probability of the impacts occurring

(g) The frequency and duration of the impacts

(h) The reversibility or irreversibility of the impacts

An assessment of the requested modifications as a whole in relation to Section 90 of the *NuPPAA* is presented in Table 3.

Table 3 Significant Modification Self-Assessment Using *NuPPAA* S.90 Significance Criteria

NuPPAA Section 90 Significance Criteria	Evaluation of Modification Request No. 11
(a) the size of the geographic area, including the size of wildlife habitats, likely to be affected by the impacts	The proposed modification is located within the Commercial Lease Boundaries; the geographic extent of the Project remains unchanged.
(b) the ecosystemic sensitivity of that area	The proposed modification is confined to the existing project boundaries; no new environmental sensitivities have been identified.
(c) the historical, cultural and archaeological significance of that area	The proposed modification is confined to the existing project boundaries; no new features of historical, cultural or archaeological significance will be affected.
(d) the size of the human and the animal populations likely to be affected by the impacts	No change.
(e) the nature, magnitude and complexity of the impacts	The proposed modification has effects that are consistent with the Approved Project.
(f) the probability of the impacts occurring	The proposed modification has effects that are consistent with the Approved Project.
(g) the frequency and duration of the impacts	The proposed modification has effects that are similar in frequency and duration to effects assessed for the Approved Project.
(h) the reversibility or irreversibility of the impacts	The proposed modification has effects that range from fully reversible to irreversible, consistent with the Approved Project.
(i) the cumulative impacts that could result from the impacts of the project combined with those of any other project that has been carried out, is being carried out or is likely to be carried out	Marginal potential increases in the effects to air quality are confined to the local study areas, and do not overlap with other past, present or reasonably foreseeable activities that would constitute new cumulative effects.
(j) any other factor that the Board considers relevant to the assessment of the significance of impacts	This criterion is not applicable to a proponent self-assessment.

The activity is confined within the boundaries of Baffinland's Commercial Lease and therefore do not represent a change to the previously assessed geographic extent of the Project. The activity will not be located in an area of particular ecosystem sensitivity and the areas of disturbance do not impact areas of historical, cultural or archeological significance. Human and wildlife are not likely to be adversely affected. The activities will not significantly change air emissions above what was considered in the FEIS Addendum, impede water flow, impact any aquatic life, hinder wildlife access or increase noise levels, and the activities will not directly interact with fish or fish habitat. Most the effects are reversible as reclamation will be carried out once the activity is complete. Additional

cumulative effects are not expected given that there are no new residual effects predicted from the requested modifications.

2.3 OTHER REQUIRED APPROVALS

In addition to requiring NWB approval as modifications under the Type A Water Licence, the proposed modifications require approval from the QIA as land owner, as part of the annual work plan approval process. The incineration unit was included in the 2017 Work Plan Addendum and associated reclamation estimate, for which reclamation securities were posted with the QIA in July 2017. Therefore, no additional approvals are required at this time.

2.4 RECONSIDERATION OF THE PROJECT CERTIFICATE

Baffinland reviewed Section 12.8.2 of the Nunavut Agreement and Section 112 of the *NuPPAA* and has determined that reconsideration of the existing Project Certificate is not appropriate.

Section 112 of *NuPPAA* states the following:

> ***112 (1)*** *The Board may, on its own initiative or at the request of the Designated Inuit Organization, the proponent or any interested person, reconsider the terms and conditions set out in a project certificate that it has issued if*
>
> *(a) the terms and conditions are not achieving their intended purpose or are having effects that are significantly different from those anticipated at the time the certificate was issued;*
>
> *(b) the circumstances relating to the project are significantly different from those anticipated at the time the certificate was issued; or*
>
> *(c) technological developments or new information provides a more efficient method of achieving the intended purpose of the terms and conditions.*

Section 12.8.2 of the *Nunavut Agreement* presents nearly identical wording as *NuPPAA* Section 112.

The requested modification is consistent with the scope of the Approved Project, and hence Baffinland has concluded that the terms and conditions of the Project Certificate are achieving their purpose (Clause a); and that the circumstances related to the project and its effects remain unchanged from the Approved Project (Clause b). No technological developments or new information have been identified in relation to Clause c. The requested modifications do not warrant changes to existing conditions or new conditions within the Project Certificate. As such, reconsideration of the Project Certificate is not appropriate.

The requested modification is described in more detail in Section 3, in accordance with Part G, Item 3 of the Type A Water Licence.

2.5 SELF-ASSESSMENT CONCLUSION

Based on the self-assessment provided in Sections 2.1 through Section 2.4, Baffinland has concluded that:

- The proposed modification is an activity that was previously assessed by Baffinland.
- The effects of the proposed modification are not significant.
- Other permits, licences or approvals (or modifications of existing approvals) are required, but have already been addressed through the posting of adequate reclamation security in 2017 with the QIA.
- Reconsideration of the terms and conditions in Project Certificate No. 005 is not required.

3 – MODIFICATION REQUEST

In accordance with Part G of Baffinland's Type A Water Licence, the Licensee may carry out modifications after written notification has been provided to the Board, provided such modifications do not place the Licensee in contravention of the Licence or the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*, and such modifications are consistent with the NIRB Project Certificate.

In Section 2, Baffinland confirmed that the requested modifications are consistent with the scope of the Approved Project, and that a reconsideration of the Project Certificate is not appropriate.

Baffinland has also reviewed the proposed modifications to determine which modifications may potentially contravene the Water Licence, thereby requiring written approval from the NWB before proceeding. The construction and operation of an incinerator does not contravene the Licence. Baffinland will proceed with these works 60 days following submission of this modification request. Should the Board respond in writing before the 60 days that approval is not granted for specific works, Baffinland would not proceed with the works until written approval is granted.

3.1 INCINERATION UNIT FOR 380 PERSON CAMP

3.1.1 Description of Facilities and/or Works to be Constructed

One (1) new incinerator will be installed and operated to support the 380 Person Camp infrastructure at Milne Port. The incinerator is a controlled air dual chamber combustion unit manufactured by Ketek Group Inc. (Ketek). The unit, model number CY-100-CA, is manufactured to meet all Canadian Council of Ministers of the Environment (CCME) Operating and Emission Guidelines for Municipal Solid Waste Incinerators. Engineering drawings of the unit are provided in Attachment 2. A copy of the Operation & Maintenance manual is provided for reference as Attachment 3.

3.1.2 Proposed Location of the Structure

The location of the incinerator unit is shown in Figure 1. The incinerator will be placed on the existing 380 Person camp laydown area, adjacent to the 380 Person Camp.

3.1.3 Identification of any Potential Impacts to the Receiving Environment

The incinerator unit is consistent with previous activities at Milne Port. Potential impacts of the activity have been assessed in the FEIS (Table 1). The proposed incinerator will generate air emissions, which are regulated under the Government of Nunavut (GN) Environmental Guideline for the Burning and Incineration of Solid Waste. The following air emissions standards presented in Table 4, adopted from the CCME Canada Wide Standards for Dioxins and Furans and Mercury Emissions, will apply to the proposed incinerator.

Table 4 Air Emissions Standards for Solid Waste Incinerators

Parameter	Numeric Standard	Explanation
Dioxins and Furans	80 pg I-TEQ/cubic metre	Unit of measure is picograms of International Toxicity Equivalents per cubic metre of air
Mercury	20 µg/R cubic metre	Unit of measure is micrograms per Reference cubic metre (the volume of gas adjusted to 25°C and 101.3 kilopascals)

Note: Values taken from Table 1, *Environmental Guideline for the Burning and Incineration of Solid Waste (GN, 2012)*

The proposed incinerator will be subject to stack testing to confirm emissions standards are met immediately following the commissioning of the unit, consistent with Project Certificate Condition No. 12. Additionally, Ketek has provided emission test results from a CY-100-CA unit installed at a northern mine site, which confirm the standards outlined in Table 4 are achievable with the proposed unit. These emission results are provided for reference in Attachment 4.

In addition to emissions generation, the incinerator will also generate bottom ash which will require disposal. Consistent with the existing Waste Management Plan (BAF-PH1-830-P16-0028 r7), bottom ash will be tested using the Toxicity Characteristic Leachate Procedure (TCLP) analysis to determine if the ash is considered hazardous waste. The results of the TCLP analysis will be compared against the GN guidelines for solid waste residuals (ash) suitable for landfill disposal. Ash that meets the GN guidelines and is considered non-hazardous will be disposed of on-Site in the project landfill facilities. Ash that is considered hazardous will be re-processed on-Site or transported off-Site for disposal at a licenced waste disposal facility.

Updates to the Waste Management Plan will be required to include the addition of the incinerator unit at the 380 Person Camp, however no material changes to the monitoring, maintenance and management of wastes will be required in this update. The update to the Waste Management Plan will be limited to Section 3.5 (Incinerators), the block flow diagrams for solid waste, and the Site Layout for Milne Port. Updates to the waste management plan will be provided with the 2018 Annual Report submission on March 31, 2019.

3.1.4 Monitoring

Periodic environmental inspections will be conducted during assembly of the incinerator unit by Baffinland's Environmental personnel in conjunction with the Contractor's Health, Safety and Environment Lead. Inspections will ensure that Contractors are complying with the conditions of the Type A Water Licence (in particular Part D, Conditions Applying to Construction and Operation) and Baffinland's management plans and procedures. Inspections will be documented by taking photos and using Baffinland's environmental inspection forms. This includes inspections and photos before and after the work, and during the course of the work to document any deficiencies. Documented deficiencies will be forwarded to the responsible Contractor for corrective action.

Baffinland will prepare a Construction Summary Report for the modifications described in this request, in accordance with Part D, Item 17 of the Type A Water Licence. The Construction Summary Report will include the information specified in Schedule D of the Licence and the Commercial Lease Operations Guide. Included in the Construction Summary Report will be the results of the stack emissions testing to be completed immediately following commissioning.

3.1.5 Schedule for Construction

Construction is expected to begin 60 days following submission of this modification request in accordance with Part G Item 1 of the Type A Water Licence, or upon written approval from the Board in accordance with Part G Item 2. Assembly and commissioning of the incinerator will take approximately four (4) weeks.

3.1.6 Drawings of Engineered Structures

The following engineering documents provide details on the incineration unit:

- Attachment 2 – Ketek CY-100-CA Engineering Drawing (1A-3500)

3.1.7 Proposed Sediment and Erosion Control Measures

The incineration units will be placed on existing laydown as part of the 380 Person camp infrastructure. Where required, sediment and erosion control measures to address sedimentation concerns (check dams, rip-rap, silt fences, etc.) will be implemented during construction in accordance to Baffinland's Environmental Protection Plan (Baffinland, 2016a) and Surface Water and Aquatic Ecosystems Management Plan (Baffinland, 2016b). No sediment or erosion control measures are expected to be required once construction has been completed.

4 – CLOSURE

We trust that this information meets the requirements under Part G under Baffinland's Type A Water Licence and look forward to the NWB's response. Please do not hesitate to contact the undersigned should you have any questions or comments.

Regards,

Christopher Murray,
Environmental & Regulatory Compliance Manager

Cc:
Karén Kharatyan (Nunavut Water Board)
Fai Ndofor, Jared Ottenhof (Qikiqtani Inuit Association)
Bridget Campbell, Ian Parsons, Justin Hack (Crown Indigenous Relations and Northern Affairs Canada)
Solomon Amuno (Nunavut Impact Review Board)
Grant Goddard, Megan-Lord Hoyle, Timothy Ray Sewell (Baffinland)

ATTACHMENTS

1 380 Person Camp Layout
2 Engineering Drawings
3 Incinerator Operations & Maintenance Manual
4 Emission Testing Results

REFERENCES:

Baffinland, 2012. *Mary River Project - Final Environmental Impact Statement*. February.

Baffinland, 2013. *Mary River Project - Addendum to the Final Environmental Impact Statement for the Early Revenue Phase*. June.

Baffinland Iron Mines Corporation (Baffinland), 2016a. *Environmental Protection Plan*. Doc. No. BAF-PH1-830-P16-0008, Rev. 1, August 30, 2016.

Baffinland Iron Mines Corporation (Baffinland), 2016b. *Surface Water and Aquatic Ecosystems Management Plan*. Doc. No. BAF-PH1-830-P16-0026, Rev.4, March 17, 2016.

Baffinland Iron Mines Corporation (Baffinland), 2016c. *Roads Management Plan*. Doc. No. BAF-PH1-830-P16-0023, Rev. 5, March 16, 2016.

Baffinland Iron Mines Corporation (Baffinland), 2018. *Waste Management Plan*. Doc. No. BAF-PH1-830-P16-0028, Rev. 7, September 25, 2018.

Nunavut Impact Review Board (NIRB), 2018. *Process for Seeking Approval for Modifications to Previously-Approved Projects*. Memorandum dated February 14, 2018 issued to the Nunavut Wide Distribution List.

Attachment 1

380 Person Camp Layout

TRAIN
YDOWN
AREA

751'-5"
[229028mm]

196'-10"
[60000mm]

725'-5"
[221094mm]

38'-11"
[11863mm]

49'-3"
[15000mm]

T1

T2

T3

COLD STORAGE (x3)

STORAGE (x3)

40' x 60'
GARAGE

INCINERATOR

WS

WS

PWTP

WS

WWTP

TRANSFORMER ☒
FOR 5kV POWER

DIST.

BOOT ROOM

CHANGE ROOM

CHANGE ROOM

CHANGE ROOM

CHANGE ROOM

16 UNIT CAMP CORE

36 ROOM DORM

50 ROOM DORM

50 ROOM DORM

50 ROOM DORM

50 ROOM DORM

50 ROOM DORM

50 ROOM DORM

50 ROOM DORM

312'-5"
[95212mm]

327'-2"
[99716mm]

24'-10"
[7570mm]

TRAINING FACILITY

REC / FITNESS

WASHCAR

WASHCAR

WASHCAR

WASHCAR

WASHCAR

LAUNDRY

WASHCAR

WASHCAR

RESERVED FOR PARKING
(2540 SM)

ACCESS ROAD

DIMENSIONS ARE NOMINAL
SAMPLE DRAWING - TO BE USED AS A GUIDE ONLY

No.	Y	M	D	REVISION	BY	CHKD
6	17	05	02	UPDATED SITE PLAN	TS	RA
5	17	04	26	UPDATED SITE	TS	DG
4	17	04	25	UPDATED SITE	TS	DG
3	17	04	24	UPDATED SITE AND BED COUNT	TS	RS
2	17	02	14	ISSUED FOR BID	TS	CN
1	17	02	02	ISSUED FOR REVIEW	TS	CN

HORIZON NORTH

PROJ # : 24015
TN # :
SCALE : 1" = 70'-0"
DRAWN BY : TS
CHECKED : CN

BAFFINLAND IRON MINES

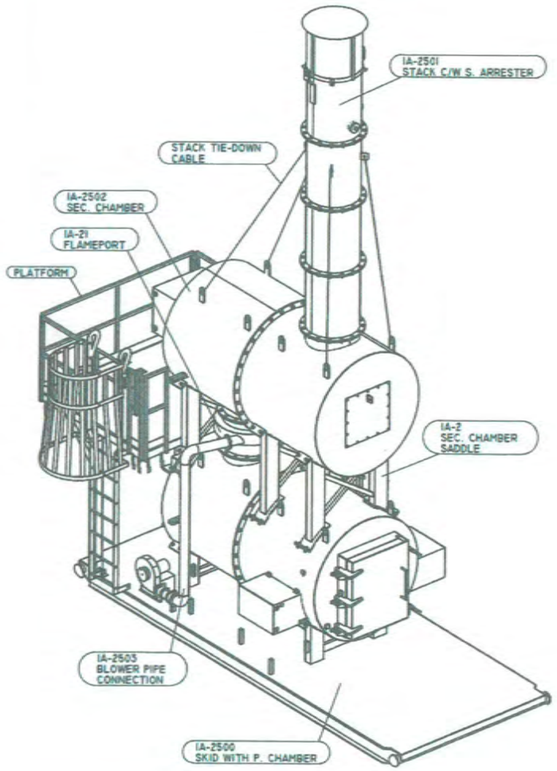
386 BED PORT SITE
BAFFINLAND
SITE PLAN

DWG No.:
AF-000-010

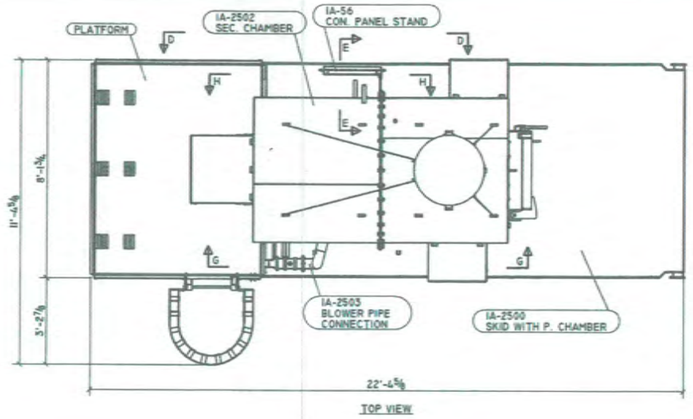
Last Plot: May 02, 2017 – 9:36am, Plot By: TSHRYAN Drawing Location: J:\PROJECTS\24000 SERIES PROJECTS\24015 (BAFFINLAND 120 P CAMP EXPANSION)\BAFFINLAND SITES.DWG

Attachment 2

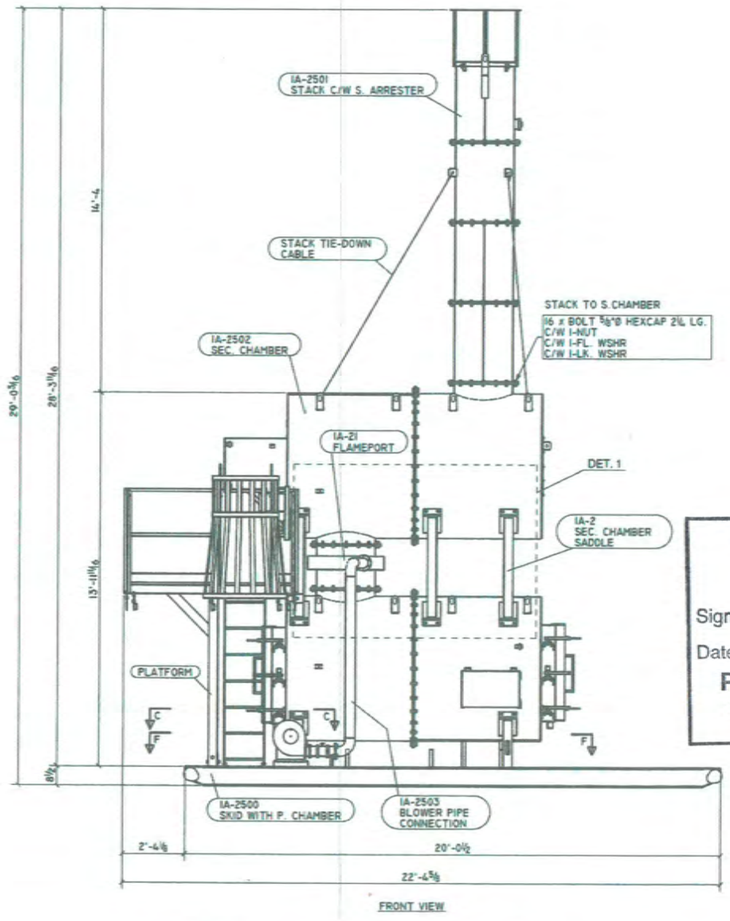
Engineering Drawings



3D



TOP VIEW



FRONT VIEW

ONE CY-100-CA WITH SEACAN - Mkd - 1A-3500

FOR DETAILS & SECTIONS
REFER TO DWG. IA-3500-1 & IA-3500-2

BILL OF MATERIAL

MARK	TOTAL QTY	UNIT QTY	DESCRIPTION	SUBASSEMBLY ASSEMBLY	WEIGHT lbs (per unit qty)	REMARKS
1A-3500	1	1	CY-100-CA WITH SEACAN			
1A-2	3	3	SEC. CHAMBER SADDLE	-	942.9	
1A-21	1	1	FLAMEPORT	YES	184.5	
1A-35	1	1	ASH SCRAPER	-	11.9	
1A-38	2	2	UNISTRUT	-	1.0	
1A-48	4	4	UNISTRUT	-	2.8	
1A-49	4	4	UNISTRUT	-	2.0	
1A-50	2	2	UNISTRUT	-	1.4	
1A-51	3	3	UNISTRUT	-	2.1	
1A-52	1	1	UNISTRUT	-	1.0	
1A-53	1	1	UNISTRUT	-	0.8	
1A-54	2	2	UNISTRUT	-	2.0	
1A-56	1	1	CON PANEL STAND	-	72.1	
1A-59	1	1	UNISTRUT	-	2.2	
1A-60	1	1	PANEL STAND SUPPORT	-	1.6	
1A-2500	1	1	SKID WITH P.CHMBR	-	8548.	
1A-2501	1	1	STACK C/W S.ARRESTER	-	853.6	
1A-2502	1	1	SEC. CHAMBER	-	3547.	GRADE : 44W
1A-2503	1	1	BLOWER PIPE CON.	-	190.9	
BOUGHT ITEMS						
BIA-100	4	4	TOGGLE CLAMP		0.0	
BIA-101	6	6	BEARING		0.0	
BIA-102	6	6	RBL SHAFT COLLAR		0.0	
BIA-103	1	1	DIRECT-DRIVE BLOWER		35.0	MODEL 4C150
BIA-104	8	8	DOOR CATCH		26.9	
BIA-105	8	8	STRIKER PLATE		9.6	
BIA-106	1	1	BUTTERFLY GAS VALVE		5.0	FOR 4"Ø PIPE
BIA-106	2	2	4"Ø HALF NIPPLE		0.0	(ONE END THREADED)
SHOP BOLTS, NUTS & WASHERS						
TOTAL QTY	UNIT QTY	DESCRIPTION	LENGTH	MAT.GRADE	REMARKS	
5	5	5/16"Ø HEXCAP BOLT	0'-1"	Grade 5		
48	48	5/8"Ø HEXCAP BOLT	0'-2 1/2"	Grade 5		
24	24	3/4"Ø HEXCAP BOLT	0'-2 1/2"	Grade 5		
1	1	5/16"Ø HEX NUT		Grade 5		
48	48	5/8"Ø HEX NUT		Grade 5		
2	2	3/4"Ø HEX NUT		Grade 5		
1	1	5/16"Ø FLAT WASHER		Grade 5		
48	48	5/8"Ø FLAT WASHER		Grade 5		
2	2	3/4"Ø FLAT WASHER		Grade 5		
1	1	5/16"Ø LOCK WASHER		Grade 5		
48	48	5/8"Ø LOCK WASHER		Grade 5		
2	2	3/4"Ø LOCK WASHER		Grade 5		
MISC. FASTENERS						
20	20	HOLD DOWN CLIPS W/T SCREW	1.5	B.S.	FISHER & LUDLOW	
17	17	3/8"Ø MANIFOLD STUD	N/A	Grade 5		
TOTAL WEIGHT THIS DRAWING :				14451.0		

Note: Structural components only.

PERMIT TO PRACTICE
EAGLE INSPECTIONS & ENGINEERING INC.
Signature G. Smordin
Date February 17, 2019
PERMIT NUMBER: P 1090
NT/NU Association of Professional Engineers and Geoscientists

REGISTERED PROFESSIONAL ENGINEER
G.M. SMORDIN
LICENSEE
NWT/NU
Feb 17, 2019

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
G.M. SMORDIN
25114
ENGINEER
April 10, 2014

PROFESSIONAL ENGINEER ALBERTA
SEBASTIAN MACOVEI BENCZUR
April 10th, 2014

Alberta Permit to Practice No. P 06501

GENERAL NOTES:	REV.#	DESCRIPTION	DATE
1.	A	ISSUED FOR FABRICATION	MAR-19-13
2.			
3.			
4.			
5.			

USER: yogi PLOT DATE: 04/09/2014 - 11:09:32

CLIENT:
PROJECT: INCINERATOR CY_100_CA_D
TITLE: CY-100-CA WITH SEACAN

KETEK MANUFACTURING
20204 - 110 AVENUE EDMONTON, AB T5S 1X8
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Attachment 3

Incinerator Operations & Maintenance Manual

KETEK GROUP
Results Driven.

MANUAL
OPERATION & MAINTENANCE

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KETEK GROUP
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1. Introduction

Thank you for selecting **KETEK GROUP INC.** to provide you with a reliable, proven and cost-effective system to manage your waste in an environmentally sound manner. This manual has been prepared to allow you to operate and maintain the system safely and efficiently, thereby ensuring its proper operation and continued use for a long period of time.

It also contains information on the combustion process. We think that a good understanding of the basic principles would make you knowledgeable, and hence a better operator.

Table 1 outlines the contents of this manual. We encourage you to read Chapter 2 although only Chapters 4 and 5 contain the most relevant information.

TABLE 1 ORGANIZATION OF MANUAL

Chapter	Title / Description
2	**Waste Incineration and General Guidelines for Waste Management**
3	**Roles and Responsibilities**
4	**Principles of waste incineration** What incineration is, how it is affected by waste properties, including incinerator capacity and the design and operational features of the system.
5	**System Description** List of photographs of the components of the system and their functions
6	**Operation and Maintenance** How to operate and maintain the system, including discussion on safety aspects

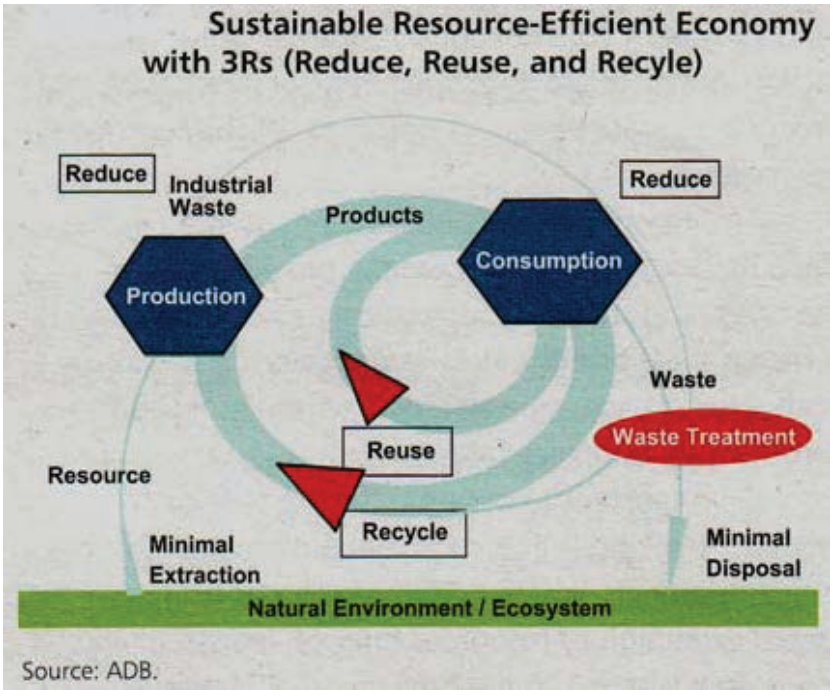
2. Waste Incineration and General Guidelines for Waste Management

Incineration of waste is recognized as an effective and environmentally sound disposal method for a wide range of wastes, provided the incinerator is properly operated and maintained. However, waste segregation, recycle and reuse shall be considered before the final waste is sent for waste incineration. Examine the waste to determine the opportunities that exist for:

- reducing the overall quantity of waste generated,
- reusing materials; and
- recycling as much as possible before disposal.

Incineration of wastes can lead to the emission of pollutants. Polychlorinated dihenzop-dioxins and polychlorinated dibenzofurans (PCDDF), commonly known as dioxins/furans can be generated from incomplete combustion resulting from the use of inefficient operation of incineration system. Dioxins and furans are toxic, persistent, and bio-accumulative and therefore must be controlled in the final emission from the incinerator. Mercury is another high priority potential contaminant released from incinerators. Mercury is toxic and bioaccumulates in the environment. Mercury is not emitted unless the waste items incinerated contain mercury. The best method to control mercury is therefore waste segregation to limit the amount of mercury in the waste fed into the incinerator.

Waste Management and segregation before incineration will help in providing cleaner emissions, and provide reduction of waste; maintaining an environmentally way of disposing waste products.



3. Roles and Responsibilities

3.1 Waste Management In charge / Site Services

- Ensure that relevant waste handling training is provided to all waste management personnel at site and only properly trained individuals (Qualified Incinerator Operators) operate the incinerator.

- Ensure that the Incinerator Operator follows the requirements of the Incinerator Operational Plan, Operation Manual and other relevant guidelines of the company.

- Ensure that all checklists and data logs are filled up, and the records required by this guidance document are collected and maintained.

- Ensure adequate re-training is provided to the operators are regular interval.

- Ensure the safety of all personnel and the site.

- Carryout periodic inspections and record observations in Supervision checklist appended in this document.

3.2 Incinerator Operator

- Ensure the safe operation of the incinerator and the associated work and storage area.

- Ensure the operation and maintenance of the incinerator is carried out in accordance with the Equipment Operation Manual.

- Ensure that only appropriate wastes are incinerated, and all other inappropriate wastes including plastics, aerosol cans, metallic containers or cans filled with waste oil are removed and handled accordingly.

- Document and maintain the required logs and records as appended in the document (pre operational checklist, operational checklist and waste incineration log).

- Notify the supervisor or waste management In charge of any incinerator upsets, malfunctions or required repairs.

- Wear proper Personal Protective Equipment at all times while working with the incinerator or waste.

3.3 Maintenance Personnel

- Carry out timely Inspections and maintain the records

- Carry out preventive maintenance at scheduled intervals; record and report any unusual observations on the equipment.

- Do not alter the electrical wiring and incinerator components.

- Consult **KETEK** for any clarifications or guidance related to maintenance of the equipment

- Fill and record the inspection and maintenance checklist and follow the checklist for weekly, monthly and annual inspection and maintenance

- Make sure to lock out/tag out the unit as per the company's existing procedures if there is a problem.

4. Principles of Waste Incineration

4.1 Combustion

Combustion, burning, incineration, and thermal oxidation all denote the same process, which is the reaction of a "combustible" matter with oxygen that occurs at temperatures higher than the ignition temperature[1] of that matter. The reaction is exothermic, meaning that it generates heat in the form of hot gas.

In the case of waste, it may also contain non-combustible matter which does not react with oxygen. In waste incineration, the non-combustible component ends up as ash and a small portion of it is also present in the hot gas in the form of particulate matter or dust.

Figure 1 shows schematically the process of waste incineration. The oxygen used comes from air, which contains 21% of oxygen by volume, and the hot gas is typically referred to as flue gas.

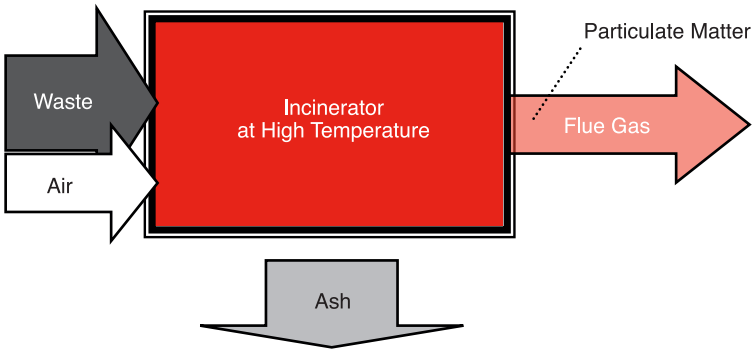


FIGURE 1 SCHEMATIC DIAGRAM OF INCINERATION PROCESS

4.2 Why incinerate waste?

The main purpose is to reduce the mass and volume for final disposal. Another important reason, since the waste may contain pathogenic, infectious or toxic materials, is to "detoxify" it. And in remote areas where wildlife is present, scavenging and spreading of diseases can be prevented by incineration.

In some cases, incineration is used to recover the energy contained in the waste in the form of electricity, steam, hot fluids or hot air. And in other cases, valuable materials can be recovered from the ash, or the ash as a whole can be used for soil amendment or as a construction material.

4.3 Waste components

There are different ways of characterizing waste, depending on the purpose for doing it. Here, it is sufficient to characterize the components as follows: [2]

A. WATER is an important component because in incineration it has to be evaporated, which requires a lot of energy, [3] which in turn, has the effect of lowering the temperature of the flue gas.

B. COMBUSTIBLE is the component that reacts with oxygen and releases heat in the process. [4] The higher the combustible content in the waste the more air per kg of waste is needed for incineration.

This component can be further classified as:

(i) Volatile, which is released to the gas phase when the combustible matter is heated without the presence of oxygen, and
(ii) Fixed carbon which remains in the solid waste after the volatile has been released. This is often referred to as charcoal.

C. NON-COMBUSTIBLE OR ASH is the component that does not react with oxygen. [5] As previously mentioned, this forms ash, and some of it is entrained in the flue gas in the form of particulate matter or dust. The higher the ash content in the waste, the less quantity of waste that can be incinerated without removing ash from the combustion chamber. Note also if the waste contains metals, such as lead and cadmium, these metals will be present in the ash as well as in the particulate matter.

4.4 Heating Value

Heating value, calorific value and heat of combustion are synonyms that quantify the heat released by the combustible component in the waste upon complete combustion. An understanding of the concept can be gained from the hypothetical processes shown in **Figure 2.**

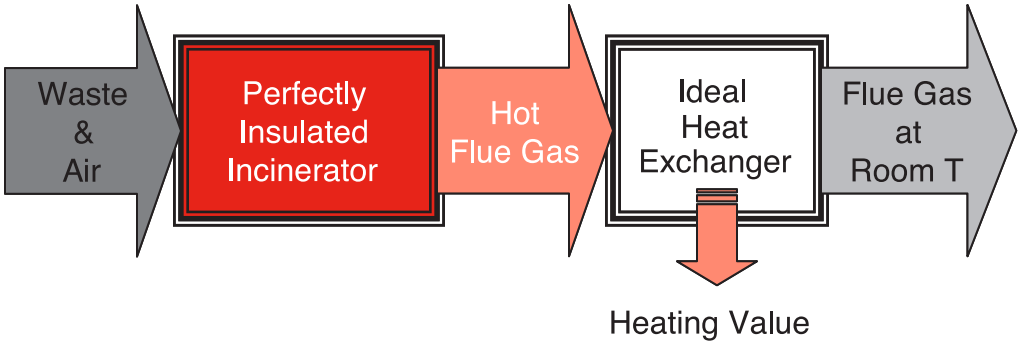


FIGURE 2 THE CONCEPT OF HEATING VALUE

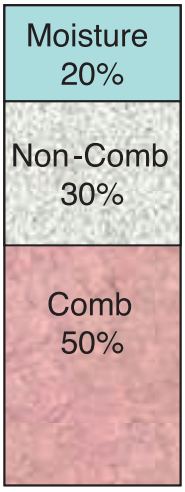
A measured mass of dry waste and a sufficient amount of oxygen , at room temperature, are ignited, and the resulting hot flue gas is passed through a heat exchanger, where heat is extracted until the flue gas is brought back to room temperature. Let M be the mass (kg) of the dry waste fed, and H (MJ) the heat extracted from the heat exchanger. The heating value of the dry waste is H/M (MJ/kg).

1 Below the ignition temperature combustion does not take place. Consider, for example, gasoline or wood: it has to be "ignited" for combustion to take place. That is, the temperature in some portion of the matter must be brought up to the ignition temperature for combustion to start..
2 This is referred to as proximate analysis. Another method is elemental analysis, which produces the elemental composition (C, H, O, N, S, Cl …) of the waste.
3 It takes ~ 2.3 MJ (2200 BTU or 90 cc of propane or 60 cc of diesel) to evaporate 1 L or 1 kg of water. This is referred to as the latent heat of evaporation.
4 The term "organic" is also used, which is strictly incorrect in that some "inorganic" elements or compounds are combustible, such as carbon, sulphur and carbon monoxide.
5 The terms "ash" and "inorganic" are also used. Note that the latter is inaccurate as explained previously.

4.5 Different Expressions for Heating Value

Two different values are reported in the literature (a) "high" or "gross", and (b) "low" or "net". The former corresponds to the case where the moisture in the flue gas is condensed, and hence the high or gross heating value includes the latent heat of evaporation of the water formed in combustion (see Footnote 3). The latter excludes the latent heat evaporation. The low or net heating value thus represents the maximum available energy that can be recovered from the flue gas without condensation.

To be noted also is the basis on which the heating value is expressed, which can be (a) as fired, (b) dry basis or (c) ash free. The distinction is illustrated in **Figure 3**. An understanding of the different bases can be gained by noting that heating value is a property of the combustible component in the waste. Water and the non-combustible component simply "dilute" the heating value. In terms of incinerator operation, the relevant basis is "as fired".



* HV as measured:
15 MJ/kg "Dry Basis "

* HV of whole waste:
= (30 + 50)/100 * 15 = 12 MJ/kg "As Fired"

* HV of combustible component:
= (30 + 50)/50 * 15 = 24 MJ/kg "Ash Free"

FIGURE 3 DIFFERENT BASES FOR EXPRESSING HEATING VALUE (HV)

4.6 Examples of waste characteristics

Proximate compositions and heating values of commonly found wastes are given in **Table 2.**

TABLE 2 CLASSIFICATION AND PROPERTIES OF COMMON WASTES

Type*	Description	Components	Weight %			MJ/kg
			Moist	Comb	Non-C	HHV (A/F)
0	Trash	Paper, cardboard, cartons wood boxes and combustible floor sweepings from commercia l and industrial activities. Up to 10% by weight of plastic bags, coated paper, laminated paper, treated corrugated cardboard, oily rags and plastic or rubber scraps.	10%	85%	5%	19.7
1	Rubbish	Trash + Type 3 (up to 20%)	25%	65%	10%	15
2	Refuse	Rubbish and Garbage	50%	43%	7%	10
3	Garbage	Animal and vegetable wastes, restaurants, hotels, markets, institutional, commercial and club sources	70%	25%	5%	5.8
4	Animal/ Pathological	Carcasses, organs, hospital and laboratory abbatoit, animal pound, veterinary s ources	85%	10%	5%	2.3

Notes:
Moist = moisture, Comb = Combustible, Non-C = Non-combustible, HHV = High Heating Value, A/F = As Fired
* In some cases Roman numerals are used. That is Types 0, I, II, III and IV

4.7 Incinerator Capacity and Load Size

Incinerator capacity is dependent on waste composition. In general, the higher the heating value, the lower is the capacity in terms of kg/h that can be incinerated. This can be explained by noting that a waste that has a higher heating value requires more air per unit mass than that required to incinerate a waste with a lower heating value. To put it another way, for the same amount of air, more mass of a waste with a lower heating value can be incinerated.

Another important consideration is the size of the batch loaded to the incinerator. The higher the heating value, the smaller (lighter) the load should be. Otherwise, insufficient amount of air would generate black smoke.

Unfortunately, waste composition is not always known. Nevertheless there may be indications of the components present. To assist in getting a qualitative estimate of the heating value of a batch of waste, the heating values of common "generic" waste components are shown in **Table 3.**

TABLE 3 HIGH HEATING VALUES (APPROXIMATE) OF COMMON WASTE COMPONENTS

Component	MJ/kg A/F *	Component	MJ/kg A/F *
Kerosene, Diesel …	44	Leather	16
Plastics	46	Wax paraffin	44
Rubber, Latex	23	Rags (linen, cotton)	17
Wood	18	Animal fats	39
Paper	17	Citrus rinds	4
Agricultural waste	17	Linoleum	25

* A/F: As Fired

Another important waste component is the volatile content in the waste. **Table 4** shows the proximate components of various materials and wastes.

In general, this component is responsible for smoke generation. Therefore, as in the case with heating value, the higher the volatile content, the smaller the load that should be charged to the incinerator.

4. Principles of Waste Incineration

TABLE 4 PROXIMATE COMPOSITION OF VARIOUS MATERIALS

Material	Volatile	Moisture	FC	Ash	FC/V
	%wt	%wt	%wt	%wt	-
Coal (bituminous)	30	5	45	20	1.5
Peat	65	7	20	8	0.3
Wood	85	6	8	1	0.1
Paper	75	4	11	10	0.15
Sewage sludge	30	5	20	45	0.66
MSW	33	40	7	20	0.21
RDF	60	20	8	12	0.13
PDF	73	1	3	13	0.04
TDF	65	2	30	3	0.46
PE,PP,PS	100	0	0	0	0
Plastics + Colour	98	0	0	2	0
PVC	93	0	7	0	0.08

Notes: FC = Fixed Carbon; FC/V = Ratio of Fixed Carbon to Volatile
RDF = Refuse Derived Fuel; PDF = Paper Derived Fuel;
TDF = Tire Derived Fuel; PE = Polyethylene; PP = Polypropylene;
PS = Polystyrene; PVC = Polyvinylchloride

5.1 Overview

Regardless of the model of your incinerator, the main components are similar. Figure 4 shows a schematic diagram of the incineration system. It consists of a Primary Chamber and a Secondary Chamber, which are connected by a “flame-port”. Combustion air to the secondary chamber is delivered via the flame-port by the flame-port blower. Auxiliary burners are provided for start-up and to maintain the minimum temperatures set in the primary and secondary chambers.

Thermocouples are used to measure the temperatures in the primary and secondary chambers, the outputs of which are used by on-off Omron controllers which regulate the operation of the auxiliary burners.

The secondary chamber combined with high temperatures maintained by the auxiliary burner, and the turbulence created from the delivery of air (oxygen) by the flame-port air blower, ensures that black smoke is not generated provided the size of the waste load is not too large.

Waste is charged manually and intermittently via the waste charging door (1), and ash is removed manually and batch-wise after previous operation. Waste charging door is also used to rake the waste in the primary chamber after several loads have been charged, which is necessary to expose the fixed carbon component in the waste to the oxygen.

5. System Description

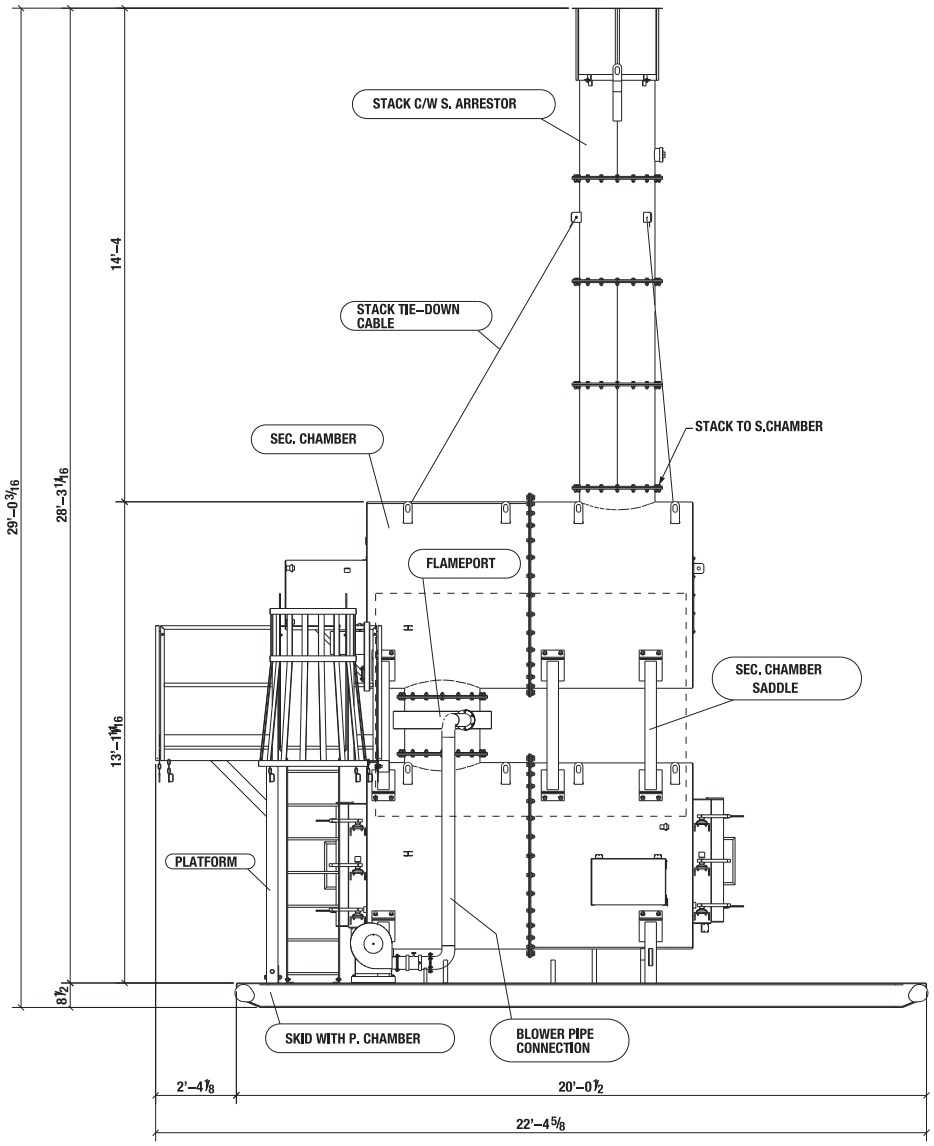


FIGURE 4 SCHEMATIC OF THE INCINERATION SYSTEM

5.2 Description of system components

For convenience, the system has been grouped into sections, as shown in Figure 5. In each section, the components are shown in subsequent photographs. Each component is designated with a code corresponding to the section to which it belongs. These codes are unique and will be used in later sections on operation, maintenance and trouble shooting. The following Tables contain all the components in the system, their codes and brief descriptions of their functions.

Information on components that are not manufactured in-house, such as blowers and burners, is given in the accompanying binder. Please consult the corresponding manuals for details of operation and maintenance.

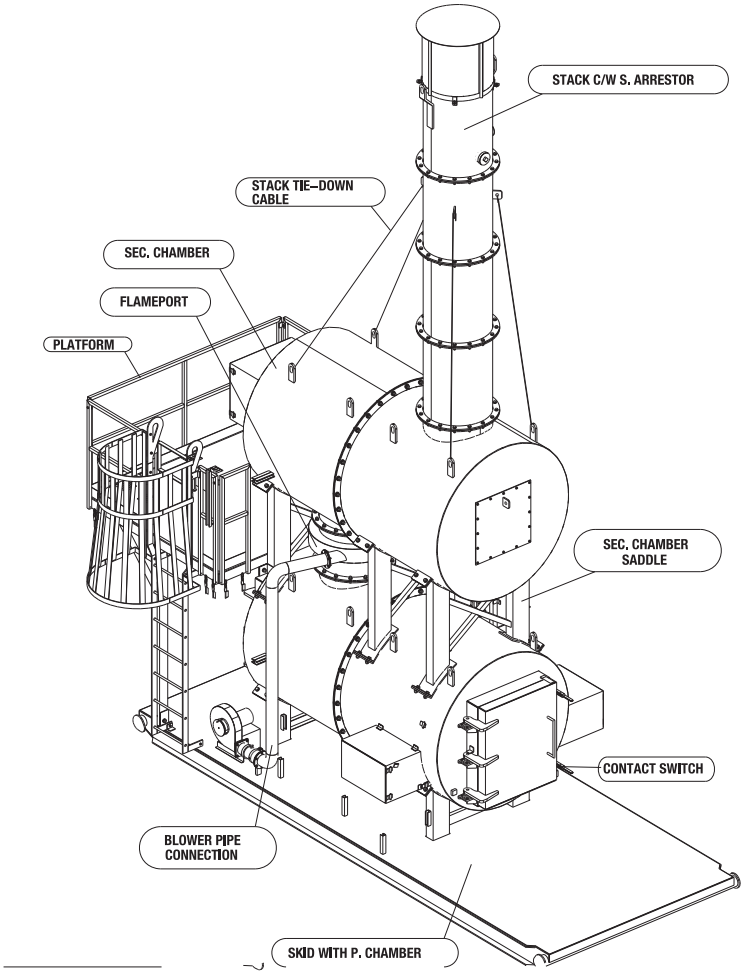


FIGURE 5 OVERALL VIEW SHOWING THE SECTIONS

5.3 Primary Chamber Section

Table 5 Components in the Primary Chamber Section (Figure 6 & Figure 7)

Code	Component	Description	Function
PC	Primary Chamber	Built i n-house. Inside Vol: 2.74m^3 Refractory + Insulation	Pyrolysis and gasification Combustion of fixed carbon
PC_B	Auxiliary Burner	Becket 2 x WIC-201; 770,000 BTU/h (Each); 5.5 USG/h (Each)	Start-up and maintains a minimum temperature
PC_T	Thermocouple	Stainless Steel	Used by PC Temp. Controller to regulate burner
PC_D	Charging Door & Ash Door	Built i n-house. Feed Door: 90 cm(Height) x 70 cm (Width) Ash Door : 86 cm(Height) x 70 cm (Width)	Load waste and ash removal
PC_S	Contact Switch	Square D ZCKJ1H7 (2)	Turn off PC burner when Feed door/Ash door is opened

5.4 Secondary Chamber Section

Table 6 Components in the Secondary Chamber Section (Figure 6 & Figure 7)

Code	Component	Description	Function
SC	Secondary Chamber	Built i n-house. Inside Vol: 2.87m^3 Refractory Insulation	Complete combustion of gases and soot generated in primary chamber
SC_B	Auxiliary Burner	Becket WIC-301; 1,600,000 BTU/h; 13.0 USG/h	Start-up and maintain minimum set temperature
SC_T	Thermocouple	Ceramic	Measure temperature in secondary chamber
FP_P	Flame-port Plenum	Turbulent vortex flow built In-house.	Mixing of combustible gases and flame-port air
FP_B	Flame-port Blower	4C 108 Dayton; 1 HP; 3600 rpm	Combustion air supply to flame-port plenum
FP_T	Flame-port Throttle	Butterfly valve	Controls flame-port airflow
ST	Stack	Refractory + Insulation, built in-house.	Dispersal of flue gas

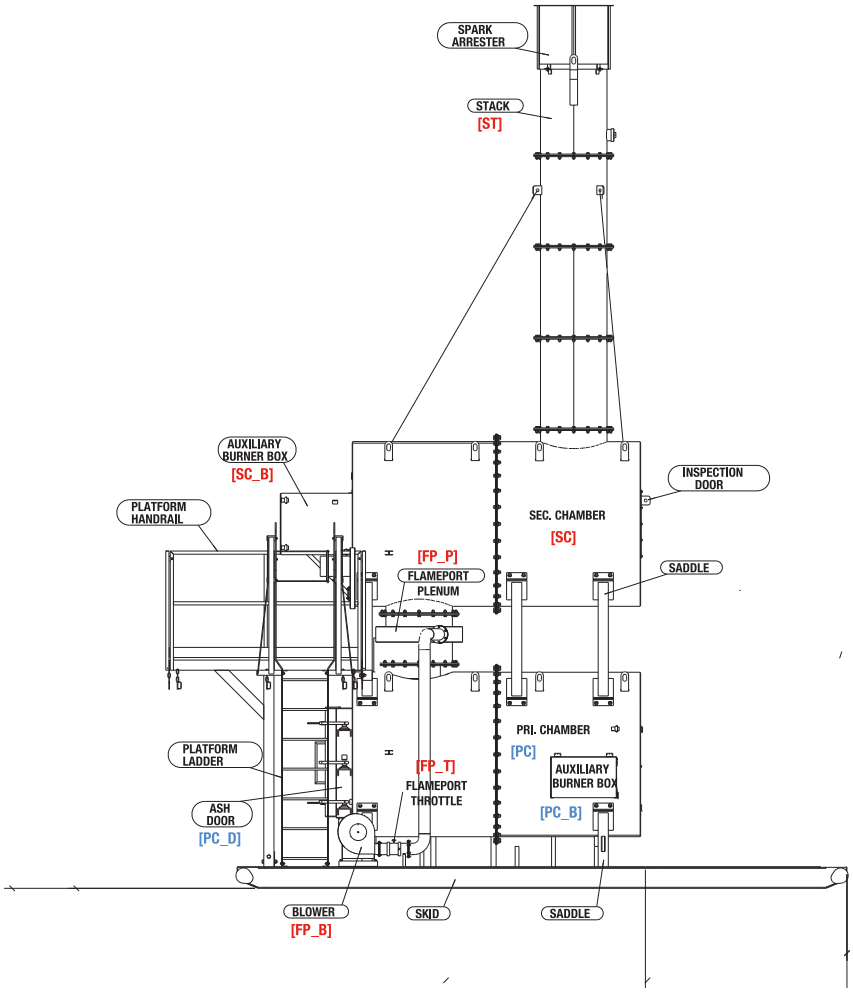


FIGURE 6 COMPONENTS IN THE PRIMARY AND SECONDARY CHAMBER SECTIONS (1)

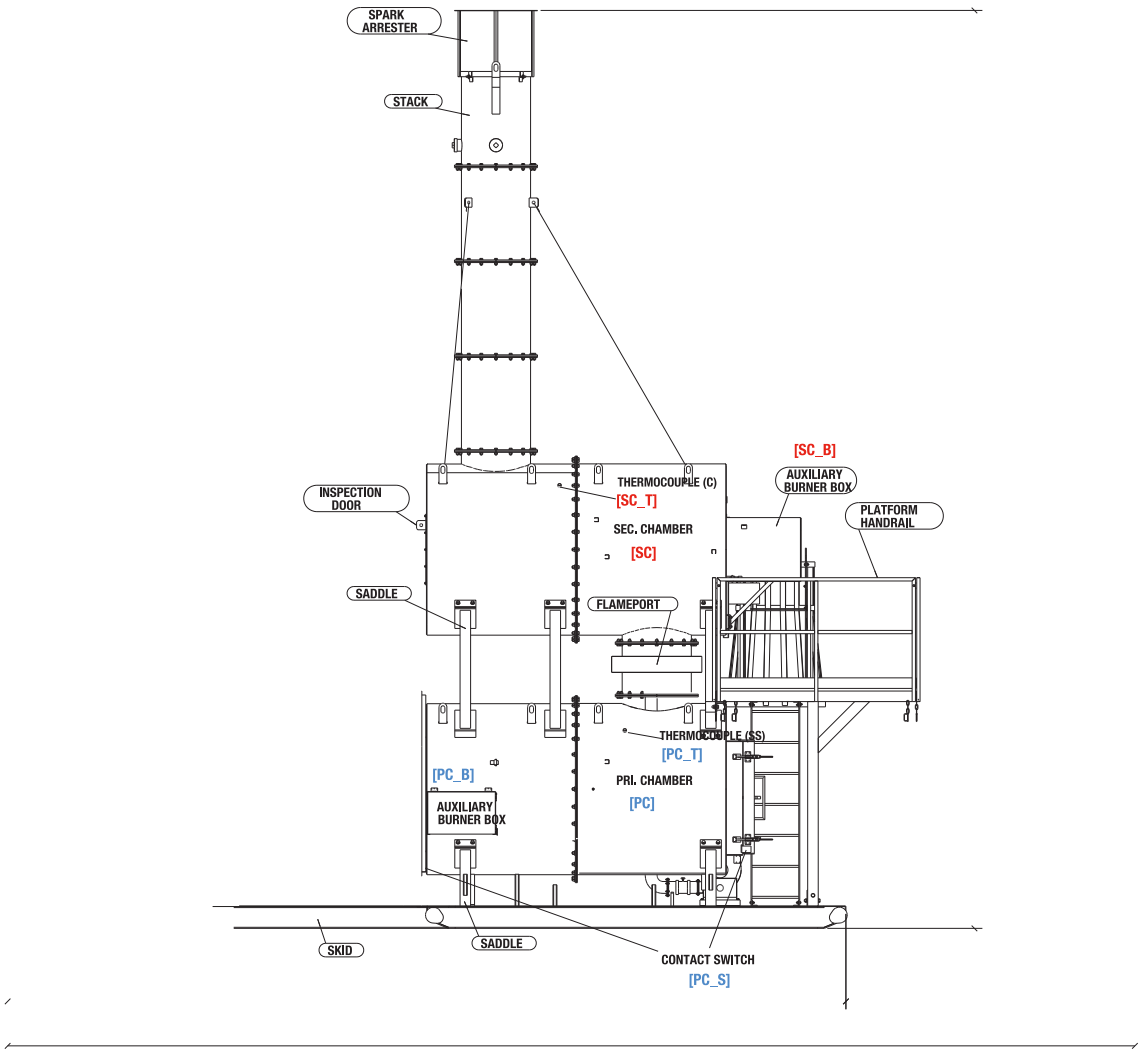


FIGURE 7 COMPONENTS IN THE PRIMARY AND SECONDARY CHAMBER SECTIONS (2)

5.5 Control Panel Section

The components are listed in Table 7.

Figure 8 Overview of Control Panel, Showing the Main Sections shows a photograph of the whole control panel, which has been divided into sub-sections marked A, B, C, and D.

TABLE 7 COMPONENTS IN THE CONTROL PANEL SECTION

Code	Label	Function
Sub-Section A: Indicator LEDs (ON-OFF)		
C3,C5 **C8**	Primary Blower Secondary Blower	GREEN PC_BL GREEN SC_BL
C6	Flameport Blower	GREEN FP_B
C2,C4 **C7**	Primary Burner Secondary Burner	RED PC_B RED SC_B
Sub-Section B: Burn Timer		
T1	Burn Timer	Set burn-cycle duration to the specified time. (Start switch restarts timer)
Sub-Section B and C: Main Controller and Controllers for Burners and Blower		
PB1 **PB2** **R1**	Start Switch Emergency Stop Contact Switch	Initiate Pre-Purge, Burn, Burn-Down, Cool-Down Automatic Cycles. Emergency Use Only. For Normal Stop, Set Burn Time to 0. Safety Apparatus, Will Turn ON/OFF Primary Chamber Burner When Feed Door is OPEN/CLOSED.
Sub-Section D: Omron Temperature Controllers and Indicators		
TC1 **TC2** **TC3**	Primary Chamber T.C. Secondary T.C. Secondary Trigger T.C.	Temperature Displays and Control of Minimum Temperatures in Primary and Secondary Chambers by Setting Adjustable Set Points (OMRON E5CN). Primary Burner Enabled When Secondary Trigger Reaches its Specified Temperature Set Point.
Sub-Section E: Primary Pressure		
	Magnehelic Gauge Box	Displays pressure of Primary Chamber Should be Negative Pressure between 0 and -0.5 inches

NOTE: This panel has been configured with Burner Protection which ensures that if the primary and/or secondary chamber is hot, the corresponding burner-blower will run even if the cool-down period has elapsed, or if there has been a power disruption.

5. System Description

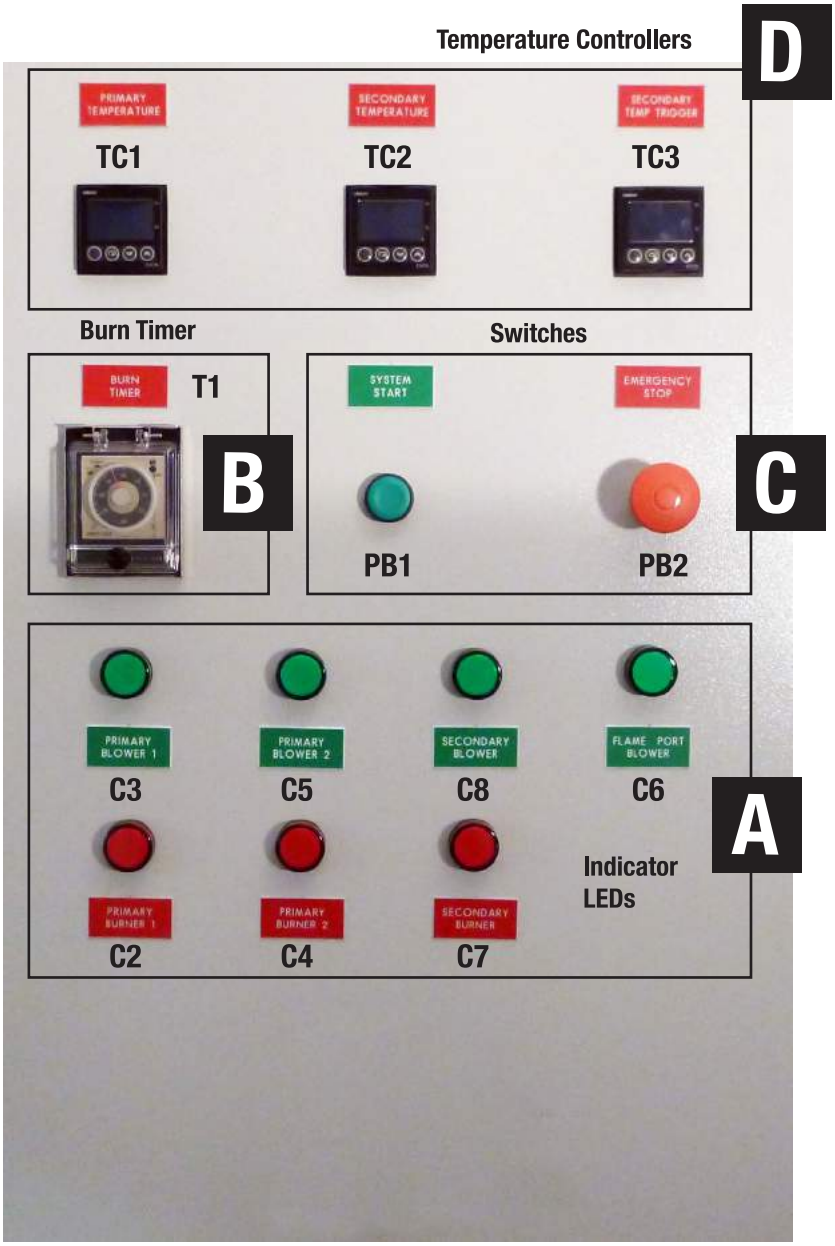


FIGURE 8 OVERVIEW OF CONTROL PANEL, SHOWING THE MAIN SECTIONS

6. Operation & Maintenance

The operation of the incinerator can be described by distinct sequential steps as shown in Figure 9. In addition there are additional necessary steps which involve safety, routine inspection and waste batch preparation, which will be first described.

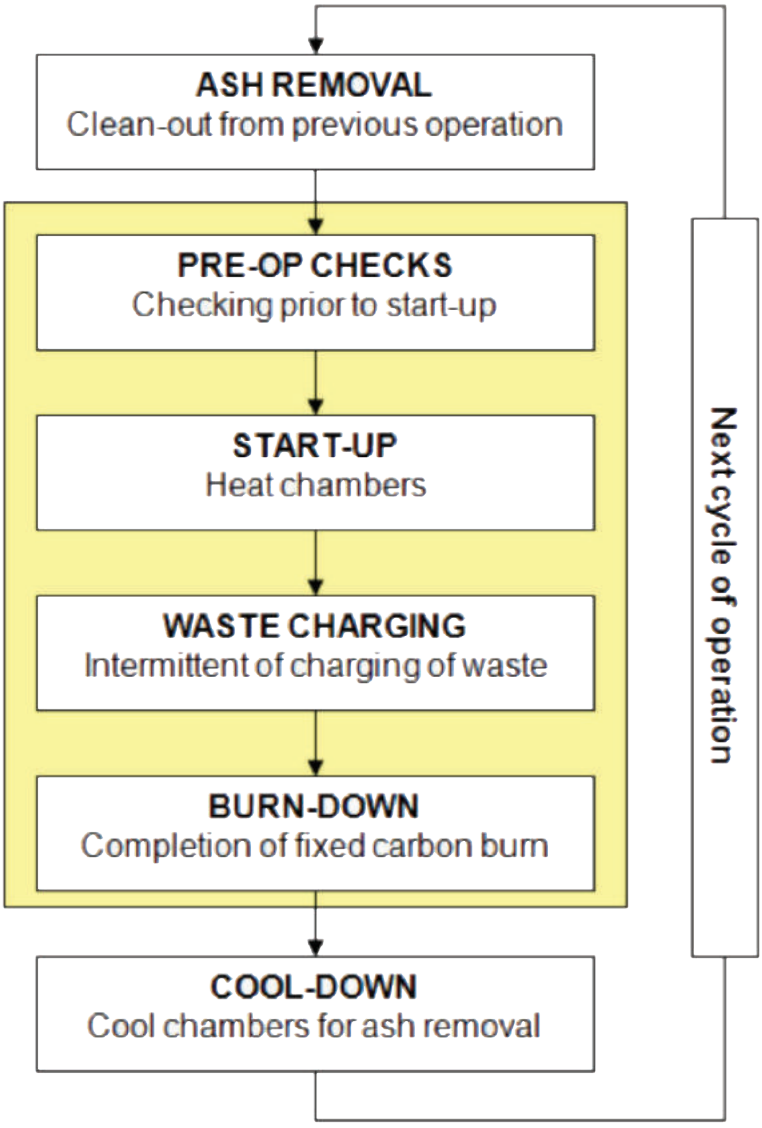


FIGURE 9 STEPS IN THE OPERATION OF THE INCINERATOR

6. Operation & Maintenance

6.1 Safety equipment

The following personal protective equipment should be used while operating the incinerator system:

- Long sleeved shirt and long pants;
- Long cuffed, puncture resistant gloves;
- CSA approved, Grade 1 safety footwear;
- CSA/ANSI approved safety glasses.

The personal protective equipment related to specific tasks are listed below:

- Ash removal and handling: NIOSH N95 respirator
- Waste charging: (i) heat protective clothing and gloves, and (2) CSA/ANSI approved full face shield.

The hazards that could be encountered arise from the following (not in any order of importance):

- Contact with waste (infectious or toxic components, or sharps);
- Exposure to heat, from contact with hot surface or radiation from the primary combustion chamber when the waste charging door or ash removal door is opened.

Therefore, the general precautionary actions include:

- Not opening waste batches
- Not touching hot surfaces, and minimum exposure to heat radiation through open doors (charging / ash doors while combustion is taking place).
- Wearing appropriate personal protective equipment (PPE) for charging waste and raking the primary chamber, AND minimizing the time for those tasks.

6.2 Routine inspection and maintenance

- Check fuel lines for leak and check connections
- Check spark arrestor to ensure no plugging
- During ash removal (see next section):
  - Inspect refractory for large cracks (not expansion cracks)
  - Inspect door gaskets for damages

6.3 Waste batch preparation

The following cautionary notes should be followed:

- NO explosives, aerosol cans or containers containing combustible liquids
- Make sure that every batch can go through the waste charging door easily, regardless of its weight. If others prepare the batches, the operator should tell them about the maximum batch size.
- DO NOT open batches and “rearrange” the contents for health/safety reasons.

6.4 Ash removal

Typically the ash from previous operation was left to cool, and ash removal is done first prior to current operation.

- Make sure combustion chamber is sufficiently cool
- (Do NOT spray water into the combustion chamber)
- While removing ash, avoid damaging the burner tip
- Use non-combustible container
- Minimize dust generation
- Light water spraying on ash in the container is OK to minimize dust generation
- Ash to be removed daily (After sufficient cool down period)
- Dispose of ash as specified in the guidelines or regulations

6.5 Pre-operational checks

- When diesel or propane is used: check fuel tank to make sure there is enough fuel (see Figure 14 for estimates of fuel consumption, depending on burner size and length of operation)
- Conduct inspection around incinerator, make sure there is no debris or fire hazards; area should be clean
- Open fuel valve
- Check fuel lines for leaks and check all connections
- Check for any physical damage on incinerator including stack and spark arrestor
- Inspect thermocouples, feed door/ash door seals, and blower inlets
- Re-check that the combustion chamber is empty
- Check power connection
- When diesel is used, bleed the diesel lines to the burners if necessary

6.6 Operational Procedure

1. The first step in managing waste is to understand the quantity and composition of the waste that is generated. A waste audit should be completed. (Ketek Group Inc. Sustainability Consulting can provide a Waste Audit for an additional charge) A waste audit can provide the following:

- Determine the quantity of waste from each type of operation
- Characterize the waste stream to determine what opportunities exist for:
- Reducing the quantity of waste generated; Reusing materials; and
- Recycling as much as possible before considering disposal.

2. Prior before operation of any incinerator the area surrounding the incinerator shall be free of any debris and tripping hazards; maintaining a proper housekeeping procedure for the incinerator is very important and will reduce safety hazards such as slips, trips and falls.

3. A pre-operational checklist should be completed prior before operation of the incinerator. (Pre-Operational Checklist can be created by Ketek Group Inc. for an additional charge) Make sure all ash is removed properly from the previous burn. Record the weight of ash on checklist.

4. The operational checklist should be continually filled out with the required information throughout the day and operation of the incinerator.

5. The incinerator should be loaded to the limited charging capacity (both in terms of waste quantity and the calorific value of waste charge). The incinerator should be charged with the appropriate mix and quantity of waste, the operator should close the door, ensure all interlocks are engaged, and start the burn cycle.

6. Turn the timer to 12 hours and press the Green “Start” button.

7. Proceed with inspecting of the incinerator and make certain that all burner blowers (2 burners in primary chamber and 1 in secondary chamber) are functioning correctly.

8. After 5 minutes primary burner motor will shut off and the secondary burner (flame) should be running and you will see the temperature increase on the temperature display “Secondary Chamber T.C”.

9. The secondary burner heats up to the specified temperature in “Secondary Temperature Trigger”.

10. At this point primary burners (flame and blowers) and flame port blower would come on and you will see the temperature increasing on the temperature display “Primary Chamber T.C” as well.

11. The temperature will keep increasing until it goes up to the set point and after that burners will continually function on/off to maintain the specified temperature set on the incinerator control system.

12. After about 2-3 hours into the burning process, open the door and check the status of the waste and rake if necessary. Always rake from the ash door side.

13. After about approximately 1 hour after the rake, check the waste status again, if not burned then rake it and close the door. If waste seems burned and you do not need to burn another batch then manually run the burn timer to zero, if you need to burn more batches then lower the set point on “Primary Chamber T.C” to 0 by pressing the “▼” down arrow. Give about 30-60 minutes for the primary chamber to cool down.

14. Load the next batch in the primary chamber and turn the timer to 12 hours and increase the set point on “Primary Chamber T.C” to 600˚C by pressing the “▲” up arrow.

15. Repeat steps 11 to 13 for other batches of the day.

16. For the final batch of the day turn the timer to about 5-6 hours. Rake in between if required.

17. After the timer runs out, the primary burners will no longer produce flames, but the blowers will continue to run. At this time the secondary chamber burner will still keep running for another half hour.

18. After secondary burners shuts down all the blowers will keep running for another 5-6 hours to give enough time for the incinerator to cool down and prevent any damage to the burners. If after the cool down process the temperature in the chambers is still above 250˚C then the blowers will continue to run until the temperature drops below the 250˚C value.

19. The pre-operational checklist should be given to the supervisor for documentation and any further procedures. Pre-Operational Checklist should be filed and kept for record.

Note:

a) Do not operate the incinerator if something is not functioning properly, immediately tell your supervisors.
b) Do not overload the incinerator
c) It is important that waste should neither be open-burned nor burned in a barrel
d) Wear all required PPE (gloves, face-shield, dust mask, flame retardant coveralls, etc.)
e) If flame detection control locks out try resetting it by pressing red button on the burner control, if it keeps resetting again and again, let your supervisor know immediately.
f) Always ask if unsure about something.

1. Perform Pre-Op Checks
2. Load First Waste Charge
3. Ensure Emergency Stop is Pulled Out
4. Set Burner Timer
5. Press Start
6. Observe Blowers in Pre-Purge
7. Set Trigger TC to 650˚C
8. Set Secondary TC to ~ 1100˚C
9. Set Primary TC to ~600˚C
10. Observe Secondary Burner
11. Once Trig Temp is Reached Observe All Blowers and Primary Chamber.
12. Automatic Operation until burn timer expires. Burn Down and Cool-Down Cycles follow Automatically.

FIGURE 10 OPERATING SEQUENCE

**Note: Temperatures in Steps 8 and 9 may be governed by regulations:
If so, SET TEMPERATURES TO THE REGULATORY VALUES**

6.7 Waste charging:

For Batch feeding (recommended) see **Figure 11.**

1. After de-ashing the cooled- down incinerator, load waste on the hearth. Refer to training notes and operating experience.

2. Ensure Burn Timer is set to 4-5 hours, depending on load size. Pressing Start button begins a new cycle.

3. Primary burners will start once secondary chamber is at trigger temperature (TC3 set-point typically at 650°C)

4. After 3 hours, open door, check state of ash, rake if needed.

FIGURE 11. PROCEDURE FOR BATCH WASTE CHARGING

Additional Notes to **Figure 11**:
**: The main danger is from exposure to heat radiation, and from waste catching fire before it is inside the primary chamber. Precautionary steps include:
(a) Wear proper PPE,
(b) Make sure waste batch can go through the charge door easily,
(c) Open door, charge waste and close door as quickly as possible.
***: The time for complete combustion varies, depending on batch size, weight and composition. Check burning conditions from charge door. Rake if necessary.

6.8 Waste Incineration Records

To demonstrate appropriate operation and maintenance of the incinerator, we recommend that the facility should maintain records containing at least the following information; or as per permits / regulations:

- A list of all staff who have been trained to operate the incinerator; type of training conducted and by whom; dates of the training; dates of the refresher courses.
- All preventative maintenance activities undertaken on the equipment.
- Records of operation of the incinerator.
- Records of quantities of waste incinerated
- Summarized annual auxiliary fuel usage.
- A list of all shipments / disposal of incinerator residues, including the weight transported and disposed of by type if necessary, and the location of the disposal site.
- Results of any stack emission monitoring and ash sampling information.

All raw data records from the operation of the incinerator will be retained for inspection by the appropriate authorities for a period of 3 years (or any other time period as deemed necessary).

6.9 Burn-Down and Cool-Down: see Figure 12

For Batch feeding (recommended) see **Figure 11**.

1. Automatic Burn-Down cycle begins after burner timer expires. Primary burners shut down immediately.
2. Automatic Cool-Down cycle follows. Secondary burner shuts down.
3. Blowers automatically shut down once chambers have cooled to 250°C. Cycle is complete.

FIGURE 12. PROCEDURE FOR BURN DOWN.

6.10 Maintenance and Inspection

In addition to the routine inspection and maintenance previously mentioned, only the burner(s) and the blower(s) require maintenance, which is quite minimal; see manuals in the binder. The following inspection steps are recommended:

TABLE 8 RECOMMENDED INSPECTIONS

How Often	Component	Inspection and checking
Daily	Thermocouples PC_T and SC_T	Check that the readings of temperature controllers are "close" to the estimated temperatures of the primary and secondary chambers
	Contact switches PC_S	Free movement, no obstruction
	Gasket/seal waste feed door PC_D	Wear and tear; proper sealing
	Refractory in primary chamber PC	No large (not expansion) cracks; pieces falling out repair if necessary.
Weekly	Blowers PC_B, SC_B, FP_B	Inspect clean in-takes, clean if necessary
Monthly	External surfaces of PC and secondary chamber SC	"Spotty" discoloration may indicates damage to refractory and/or insulation
Annual	Refractory in SC	No large (not expansion) cracks; repair if necessary

6.11 Trouble Shooting

Table 9 shows a list of operational problems that may be encountered, the possible causes and corrective measures. No list can cover all potential problems. Please report problems or unusual observations, even if you have corrected them yourself.

TABLE 9 TROUBLE SHOOTING GUIDELINES

Phases	Observation	Points/Items to look at.
Start -Up	Incinerator won't start	☐ Make sure there is power. ☐ Check emergency stop is not engaged. ☐ Timer is set to an actual value. ☐ Make sure there is power on all phases/legs coming into the incinerator.
Pre-Purge Phase	Skipping or not starting the Pre-purge.	☐ Check that pre-purge timer works correctly. ☐ Check emergency stop is not engaged. ☐ Make sure there is power on all phases/legs coming into the incinerator.
	Auxiliary burner blower(s) won't run in pre-purge cycle.	☐ Check Fuses. ☐ Check burner blower contacts are energized. ☐ Check that overload switch on the motor is not tripped. ☐ Check there is power at the burner on the wire supplying power to the motor (Use Multi meter) ☐ Check for a seized motor by manually spinning the blower wheel. (Make sure power is off and locked out)
Pre-heat Phase	Secondary auxiliary burner won't ignite	☐ Check Fuses. ☐ Check there is power at the Genisys Control. ☐ Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	☐ Check all fuel valves are on. ☐ Check Burner contacts are energized. ☐ Check there is sufficient fuel in the tank. ☐ Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles are present. If diesel is gelled it will not let the burner operate efficiently. ☐ If there is no fuel coming out of the pump and the motor is running then it could be a damaged coupling or seized pump. ☐ If bubbles do not disappear after a while then there is a possible minute leak in the supply line. Make sure all the fittings and joints are tight. ☐ Check that CAD cell is clean. ☐ Try and hear the spark at the electrodes.
Burn Phase	Primary auxiliary burner(s) won't ignite.	☐ Check Door Switch(s) are engaged. ☐ Check Fuses. ☐ Check there is power at the Genisys Control. ☐ Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	☐ Check all fuel valves are on. ☐ Check Burner contacts are energized. ☐ Check there is sufficient fuel in the tank. ☐ Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles

Phases	Observation	Points/Items to look at.
Start -Up	Incinerator won't start	☐ Make sure there is power. ☐ Check emergency stop is not engaged. ☐ Timer is set to an actual value. ☐ Make sure there is power on all phases/legs coming into the incinerator.
Pre-Purge Phase	Skipping or not starting the Pre-purge.	☐ Check that pre-purge timer works correctly. ☐ Check emergency stop is not engaged. ☐ Make sure there is power on all phases/legs coming into the incinerator.
	Auxiliary burner blower(s) won't run in pre-purge cycle.	☐ Check Fuses. ☐ Check burner blower contacts are energized. ☐ Check that overload switch on the motor is not tripped. ☐ Check there is power at the burner on the wire supplying power to the motor (Use Multi meter) ☐ Check for a seized motor by manually spinning the blower wheel. (Make sure power is off and locked out)
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Burn Phase	Primary auxiliary burner(s) won't ignite.	☐ Check Door Switch(s) are engaged. ☐ Check Fuses. ☐ Check there is power at the Genisys Control. ☐ Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	☐ Check all fuel valves are on. ☐ Check Burner contacts are energized. ☐ Check there is sufficient fuel in the tank. ☐ Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles

6.12 Auxiliary Fuel Consumption Rate

Figure 13 shows the volumetric flow rates of propane and diesel as a function of burner rating. If the TOTAL burner rating is X million Btu/h, and the operating time from start-up to the end of burn-down is t hours, the maximum fuel needed is:

V = Y * t USG
where Y is the fuel consumption rate for X million Btu/h rating, as shown in the graph.

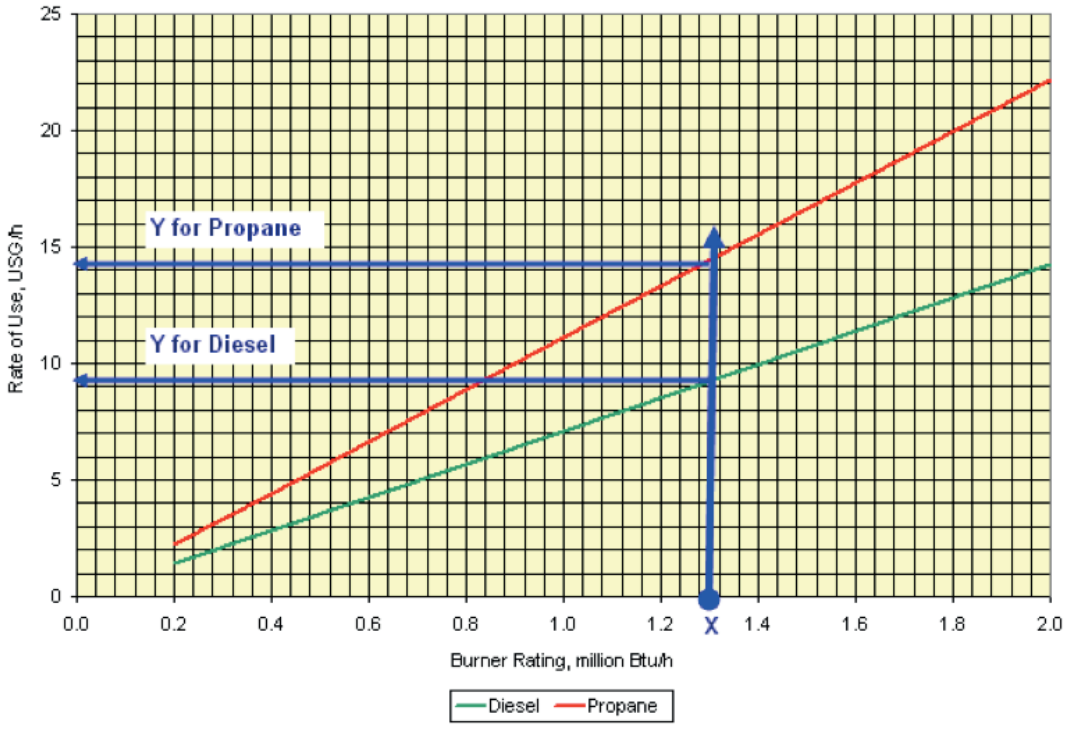

FIGURE 13 CONSUMPTION RATES OF PROPANE AND DIESEL

Attachment 4

Emission Testing Results

KETEK GROUP
Results Driven.

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Email: ketek@ketek.ca

July 11, 2017

Deborah Gibeault,
Baffinland,
Horizon North.

Re: Ketek Cyclonator Incinerator CY100CA D.

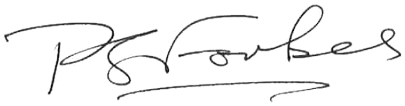
Ketek Group Inc. (Ketek) is pleased to confirm the emission results achieved by its CY100CA D dual chamber controlled air incinerators. These are manufactured to standard design that meets all CCME Operating and Emission Guidelines for Municipal Solid Waste Incinerators.

The design has been tested by third party subject to standards and protocols for air emission sampling and analysis. These results meet all emission standards for Dioxin/Furan and Mercury in Nunavut. Please see attached stack test report CY100CA D Emission Results (No Scrubber)

The Controlled Air thermal oxidation units are dual chambered for the destruction and disposal of waste types 1,2,3 and 4. The primary chamber is sized to meet the operating requirements based on daily waste generated. The secondary chamber is sized to comply with the required 2 second residency time with an operating temperature between 1000-1200 deg.C in a steady state. This design maintains a VOC destruction efficiency of +99.99%. The auxiliary burners are included for start-up and to maintain the minimum temperature in the primary and secondary chambers.

Other design parameters are based on best industry standards and practical experience.

Yours sincerely,



P.S.Forbes, P.Eng.,

Manager, Sustainability Consulting,

20204 110 Ave, NW,
Edmonton AB, T5S 1X8,
Phone 780 447 5050,
Fax 780 447 4912.

Attachments:

- CY-100-CA Emission Results (No Scrubber).

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Controlled Air Incinerator

CY-100-CA-D Emission Results

NWT- at Mine Location

Table 1 (No Scrubber)

Parameter	Test 1	Test 2	Test 3	Average
Test Date	July.17/2012	July.18/2012	July.19/2012	
Test Time	15:10-16:12	12:45-13:47	11:15-12:17	
Duration (minutes)	60	60	60	60
Particulate (mg/Rm^3)	16.6	12.8	13.2	14.2
Particulate (mg/Rm^3 @11% O_2)	14.0	10.2	10.1	11.4
Particulate (Kg/hr.)	0.021	0.015	0.016	0.017
Particulate (Kg/day)	0.5	0.4	0.4	0.4
Hg (ug/Rm^3 @ 11% O_2)	2.86	0.49	0.13	1.16
Flow rate (Rm^3/min)	20.7	19.4	20.1	20.0
Flow rate (acm/min)	103.5	96.1	100.6	100.0
Temperature (°C)	1051	1045	1051	1049
O_2 (vol. % dry)	9.1	8.5	7.9	8.5
CO_2 (vol. % dry)	11.9	12.6	13.0	12.5
H_20 (vol. %)	10.7	9.8	10.7	10.4
Isokinetic Variation (%)	101.6	100.2	101.7	101

*Standard conditions of 25 deg. C and 101.3 kPa

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Detailed PCDD/PCDF Emission Results

Jobsite: NWT Mine
Source: Incinerator Stack

Table 2

		Test 1		Test 2		Test 3	
Test Date:		July. 17/2012		July. 18/2012		July. 19/2012	
Component	TEF NATO	Analyzed (ng)	TEQ (ng)	Analyzed (ng)	TEQ (ng)	Analyzed (ng)	TEQ (ng)
2378 TCDD	1.0000	0.0039	0.0039	0.0000	0.0000	0.0000	0.0000
12378 PCDD	0.5000	0.0140	0.0070	0.0280	0.0140	0.0340	0.0170
123478 HxCDD	0.1000	0.0130	0.0013	0.0350	0.0035	0.0330	0.0033
123678 HxCDD	0.1000	0.0320	0.0032	0.0580	0.0058	0.0680	0.0068
123789 HxCDD	0.1000	0.0200	0.0020	0.0410	0.0041	0.0470	0.0047
1234678 HpCDD	0.0100	0.2600	0.0026	0.7600	0.0076	0.8200	0.0082
OCDD	0.0010	0.6100	0.0006	1.8000	0.0018	2.2000	0.0022
2378 TCDF	0.1000	0.0067	0.0007	0.0120	0.0012	0.0120	0.0012
12378 PCDF	0.0500	0.0015	0.0001	0.0360	0.0018	0.0330	0.0017
23478 PCDF	0.5000	0.0520	0.0260	0.1100	0.0550	0.1300	0.0650
123478 HxCDF	0.1000	0.0400	0.0040	0.1000	0.0100	0.1300	0.0130
123678 HxCDF	0.1000	0.0420	0.0042	0.1300	0.0130	0.1400	0.0140
234678 HxCDF	0.1000	0.0760	0.0076	0.2100	0.0210	0.3700	0.0370
123789 HxCDF	0.1000	0.0000	0.0000	0.0360	0.0036	0.0930	0.0093
1234678 HpCDF	0.0100	0.2700	0.0027	0.6900	0.0069	1.2000	0.0120
1234789 HpCDF	0.0100	0.0140	0.0001	0.0540	0.0005	0.1500	0.0015
OCDF	0.0010	0.0280	0.0000	0.1300	0.0001	0.6200	0.0006
Summed PCDD & PCDF TEQ (ng)			0.066		0.150		0.197
Sample Volume (Rm^3)			3.597		3.472		3.513
PCDD & PCDF TEQ ng/Rm^3			0.018		0.043		0.056
PCDD & PCDF TEQ ng/Rm^3 @ 11% O_2			0.014		0.034		0.040
PCDD & PCDF TEQ grams/day			0.000001		0.000001		0.000002
Particulate							
mg/dscm @ 11% O_2			14.0		10.2		10.1
Flow-rate (Rm^3/min)			20.5		19.6		19.6
Oxygen (Vol. %)			8.0		8.3		7.2
Carbon Dioxide (Vol. %)			11.6		11.8		12.8
Carbon Monoxide (ppm)			1 to 5		1 to 5		1 to 3
Moisture (Vol. %)			10.4		11.6		11.5
Temperature (°C)			1027		1032		1039
Isokinetic Variation (%)			99.4		101		101

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Incinerator Stack Particulate Gravimetric Results

Table 3

Test No.	Filter Particulate (mg)	Probe and Washings (mg)	Total Particulate (mg)
1	4.4	17.1	21.5
2	3.3	12.0	15.3
3	4.9	11.7	16.6