



BACK RIVER PROJECT
Responses to 2019 Annual Report Comments

June 29, 2020

BACK RIVER PROJECT

Responses to 2019 Annual Report Comments

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1. Introduction

Sabina Gold & Silver Corp. (Sabina), submitted its 2019 Annual Report to the Nunavut Impact Review Board (NIRB) on 3 April 2020, as required by the Back River Gold Mine Project Certificate No. 007. Interested Parties were then requested by the NIRB to provide comments on the 2019 Annual Report

On or before 21 May 2020 the NIRB received comments from the following interested parties:

- Kitikmeot Inuit Association (KIA) = 34 comments
- Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) = 8 comments
- Government of Nunavut (GN) = 9 comments
- Environment and Climate Change Canada = 1 comment
- Fisheries and Oceans Canada (DFO) = 0 comments
- Transport Canada (TC) = 0 comments

Section 2 provides responses to the comments received.

2. Responses to Comments

2.1 RESPONSE TO KITIKMEOT INUIT ASSOCIATION

KIA-1: References to 2018 and 2019 Wildlife Mitigation and Monitoring Program Report

References:

Back River Project 2019 Annual Report (March 31, 2020)

- Project Certificate Condition No. 39, 46, 49, 50, 59
- Project Certificate Condition No. 53, 54, 60, 63, 65

Appendix D. Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

Summary:

The Back River Annual Reports and Sabina's responses to reviewer comments have referred to the WMMP Report by multiple titles. Accurate and consistent referencing is needed to avoid confusion. Sabina also states that 2019 is the first year of monitoring but they submitted a 2018 Pre-Construction WMMP Report.

Detailed Review Comment

There is inconsistent naming of Back River project documents that caused confusion during the KIA's reviews in 2019. These inconsistencies remain in the 2019 Annual Report and should be rectified in the future to avoid misunderstandings. The document in Appendix D is officially titled, "2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report". However, two other titles are referenced within Sabina's performance reporting on Project Certificate Terms and Conditions:

- PC No. 39, 46, 49, 50, 59 refer to the "2019 Pre-Construction Wildlife Effects Monitoring Report"
- PC No. 53, 54, 60, 63, 65 refer to the "Pre- Construction Wildlife Monitoring Report"

Please ensure that those documents are consistently named, even within Sabina's responses to reviewer comments. Other large development projects may have a Wildlife Effects Monitoring Plan/Program separate from the WMMP and it was unclear whether Sabina would be providing a separate WEMP report with different information.

In their performance reporting for PC No. 49 and 50, Sabina also states that Trends are not applicable as "this is the first year of monitoring." However, since Sabina submitted a 2018 Pre-Construction WMMP Report to the NIRB, 2018 should have been the first year of monitoring, and inter-annual trends (if not quantitative then at least qualitative or semi-qualitative) could be investigated.

Recommendation/Request:

The KIA requests/recommends the following:

- Ensure that references to the WMMP Report in the Back River Annual Report and other Sabina responses are accurately and consistently named.
- Review the results of 2018 and 2019 wildlife monitoring to identify any trends.

Sabina Response:

Sabina will strive to ensure consistent naming of reports.

During 2018 and 2019, Sabina reported incidental observations of wildlife. However, discussion of trends based on two years of data would not be informative. Note that qualitative trends within the incidental data may be discussed (e.g., new species observed, earlier or later arrival of migrants). However incidental observations are generally not considered to be appropriate for quantitative trend analysis since the number of observations can be influenced by many outside factors beyond the number of animals present (e.g., number of observes, their jobs, the types of programs being conducted, observer enthusiasm, etc.).

KIA-2: Aircraft pilot incidental sightings reports**References:**

Back River Project, 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 5.1.1
- Section 5.1.2
- Section 5.6

Summary:

Fixed wing pilots and helicopter pilots are instructed to report all incidental wildlife sightings. Throughout all flights in 2019, there were zero reported incidental wildlife sightings by fixed wing or helicopter pilots.

Detailed Review Comment

Fixed wing pilots and helicopter pilots are instructed to report all incidental wildlife sightings. Throughout all 140 flights in 2019, there were zero reported incidental wildlife sightings (including terrestrial mammals, caribou, and birds) by fixed wing or helicopter pilots.

Incidental observation reports of terrestrial mammals in 2019 by on-site personnel in 2019 yielded 39 individual observations of 9 different terrestrial mammal species (excluding caribou), 36 individual observations of 14,979 caribou, and 2 incidental observations of birds.

These results prompt us to highlight that there may be a pilot incidental wildlife reporting issue rather than an absence of wildlife.

Recommendation/Request:

The KIA recommends the following:

- Ensure that pilot wildlife reporting training is thorough and that pilots are reminded often of their reporting duties, while emphasizing the value of incidental wildlife report data to properly assist in the project's compliance to monitor wildlife in the project area.
- Work to identify any potential obstacles to pilot reporting.
- Look at testing monitoring reporting compliance by cross-referencing recorded flight paths with caribou collar data or with large numbers of incidental observations made by ground crews within areas that are flown over.

Sabina Response:

Sabina recognizes and understands the importance of aircraft management for wildlife management. Helicopter management is described in the Wildlife Mitigation and Monitoring Program Plan (WMMP Plan) for wildlife, particularly caribou.

Sabina has acted on this management objective through three methods:

- 1) Reporting wildlife observations is a condition of the contracts established with helicopter operators.
- 2) Sabina produced a Fixed Wing and Helicopter Operations SOP (SOP # ENVIRO-3) that is delivered to helicopter operators.

- 3) The camp manager instructs pilots in the importance of wildlife mitigation and monitoring when they arrive on site.

During 2019, pilots did not report any caribou during flying operations.

It is possible that there were simply no caribou for pilots to observe. The dates when incidental observations of caribou were recorded fall outside the periods when helicopters were active on site. In addition, generally there are more than just pilots in the helicopter and thus reporting may have been completed by those individuals and not the pilot to eliminate duplications. Moving forward Sabina will consider requiring the helicopter pilot to be the sole reporter of observations while in flight.

During 2019, helicopters were active on site during only short periods:

- May 25 - May 31
- June 1 - June 7
- July 18 - August 1

The large groups of caribou observed on-site, were reported predominantly during spring migration between April 12 and 29 and on June 8.

Incidental reports of caribou from ground observations during the period when helicopters were on-site were limited to five caribou observed on July 22, 23, and 29, three at the MLA and two at Goose airstrip (Appendix 4A of the 2019 WMMP Report):

The WMMP Plan (V10, 2019) does not prohibit helicopters from flying below 610 m, and flying at low level is a requirement for conducting local-area drill moves, which is the primary role of helicopters on site. Helicopter pilots are instructed to: "avoid groups of caribou by 2 km horizontally or 610 m vertically during calving, post-calving and early summer (June 5 to July 31), and 1 km horizontally or 300 m vertically the rest of the year, including at the helicopter pads."

Sabina will increase efforts to communicate monitoring expectations for helicopter pilots through:

- 1) Delivering the existing Fixed Wing and Helicopter Operations SOP (SOP # ENVIRO-3) to helicopter companies and making it available on site directly to pilots via the camp manager.
- 2) Have the helicopter pilots report observations in flight, rather than passengers so that the observations are attributable to a helicopter flight.
- 3) Re-enforce the responsibilities of pilots to record incidental observations as they arrive at site.

KIA-3: Habitat suitability mapping and habitat loss comparisons for caribou**References:**

Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 3.1
- Section 5.6.1, Table 5.6-2

Summary:

Predicted vs. actual habitat loss for caribou was only analyzed for summer and fall. It is unclear why Sabina did not compare loss of suitable winter and spring habitat, especially because the majority of incidental caribou observations made in 2018 and 2019 occurred during the winter.

Detailed Review Comment

Section 3 of the 2019 Pre-Construction WMMP Report compares the FEIS predicted habitat loss with the area of habitat loss due to pre-construction activities in 2018, as well as habitat loss due to exploration activities prior to 2018. The methods described in Section 3.1 include GIS analysis of the existing footprint compared to habitat suitability mapping for caribou (summer and fall). It is unclear why habitat suitability mapping for winter and spring were not analyzed.

Table 5.6-2 of this report summarizes the incidental observations of caribou by season in 2019. The number of winter (November 1, 2018 - April 14, 2019) observations (n=4) as well as the total number of individuals observed (n=252) indicate that caribou are present in the area during winter. In the 2018 WMMP Report, winter observations (n=14), as well as the total number of individuals observed (n=1,603), were highest in the winter (November 1, 2017 - April 14, 2018).

Since caribou are known to occur in the area during the winter, the reason(s) why habitat suitability mapping for this season has not been completed, and reasons why losses due to the project are not being enumerated, should be provided. Is it possible to map suitable winter habitat using DEM and predicted snowpack, along with underlying vegetation? Subsequent WMMP reports should include a comparison between predicted vs. actual suitable habitat loss for caribou in all seasons where they may interact with the project.

Recommendation/Request:

The KIA requests the following:

- Clarification for why the 2019 Pre-Construction WMMP Report does not report suitable winter habitat loss for caribou.
- The KIA requests that Sabina complete winter habitat suitability mapping for caribou, if possible, and if this has not yet been done. We would think that an analysis of landscape features modifying snow depth and underlying vegetation (high percentage of ground cover of suitable lichen and herbaceous forage, proximity to frozen rivers and lakes) may be key factors in winter suitability maps.

Sabina Response:

The FEIS included a Habitat Suitability Report, which reported models of habitat suitability for Summer and Fall, the seasons when data indicated caribou were mostly likely to interact with the Project area. The annual WMMP Report, reports the total area of habitat lost due to the Project, as well as the area of high quality summer and fall habitat.

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The GN has requested that a winter habitat suitability model be produced and the area of high quality winter habitat also be reported. Sabina will update the habitat suitability modeling to include the winter season and report the area of high quality winter habitat lost in future WMMP Reports.

KIA-4: Enforcement of speed limits**References:**

Back River Project 2018 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 5.2.1

Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 5.2.1

Back River Project Wildlife Mitigation and Monitoring Program Plan (Version 10)

- Sections 7.1.4, 7.1.7, 8.1.2, 8.1.5, 9.1.2, 11.1.2, 12.1.2

Summary:

No speeding violations were reported in 2019. The Back River WMMP explains that speed limits will be monitored and enforced to mitigate project impacts on habitat loss and direct mortality/injury; however, there are no details about traffic monitoring methods or locations to infer whether traffic/speed violations are not occurring or simply missed.

Detailed Review Comment

The Back River WMMP explains that speed limits will be monitored and enforced to mitigate direct mortality and injury of caribou and muskox; as well as to manage dust generation that would contribute to habitat loss for caribou, muskox, grizzly bear and wolverine, water birds, and upland birds.

However, there are no additional details in the WMMP, or the 2019 Pre-Construction WMMP Report about how vehicle speed will be/was monitored and enforced, such as monitoring method (e.g., remote camera, traffic monitoring), locations, timing, etc. Without this information, the KIA cannot interpret whether there were no speeding violations in 2019 because all project staff obeyed the 60 km/hr. speed limit, or whether there was inadequate monitoring and enforcement.

Recommendation/Request:

The KIA recommends the following:

- Please provide more details about how the 60 km/hr. speed limit on all on-site roads and the winter ice road is being monitored and enforced, such as monitoring methods, locations, timing, etc. If speed limit monitoring has not yet been implemented due to the minimal amount of road use to date (preliminary and late use of winter ice road), please provide information on proposed methods going forward.
- Were any lessons learned during the 2018-2019 late winter ice road opening/use (for transportation of approximately 60 loads of equipment or fuel) about potential hazardous areas (areas with higher chances of large groups of caribou crossing, low visibility issues, etc.) or issues with driving conditions within certain road segments that can be brought forward in determining the best locations and methods to use for speed enforcement during the construction phase?

Sabina Response:

The Winter Ice Road (WIR) was first constructed and operated in 2019. For 2019, Sabina indicated to drivers their responsibilities to maintain the 60 km/hr speed limit and the mitigation requirements for wildlife. The WIR was a single lane in 2019, with quite a rough surface. In most cases, maximum operating speed of vehicles was considerably less than 60 km/hr maximum due to the small WIR.

Lessons learned from the first season of the WIR included:

- Several boulder fields and exposed rocky areas exist along the road route that are much slower to build the WIR.
- Due to the length of the road, and therefore the time that it takes to drive from the MLA, the only efficient way to construct the road is to *use a mobile camp, as was used in 2019*.
- To build the road in a suitable time, two road headings and mobile camps should be used.
- A formal procedure will be added to record how a caribou observation leads to a road closure so that this data can be better reported.
- The majority of incidental caribou observations on the WIR were recorded between 95-120 km south of the MLA; to the east of George Camp, at the intersection of the area of higher elevation rocky topography south of Bathurst Inlet, and the generally flat area of heath tundra north of Goose. This area of changing topography is visible in the road crossing analysis (2019 WMMP Report; Appendix 4A) in Figure 2.1-1. Caribou are observed during 2019 in the Brownian Bridge Model at this location both before the WIR and in 2019 when the WIR was active (2019 WMMP Report, Appendix 4A, Figure 3.2-2 and 3.2-3).

KIA-5: Back River Winter Ice Road Caribou Crossing Analysis**References:**

Back River Project, 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 5.3.4
- Appendix 5C

Back River Project, 2019 Annual Report for Project Certificate No. 007

Summary:

The WMMP Plan indicates that the winter ice road is to close after April 15th, prior to caribou spring migration. Upon operating the winter ice road after April 15th, a Caribou Road Crossing Study was conducted.

Detailed Review Comment

The Back River Project includes two centres of activity, the Marine Laydown Area on Bathurst Inlet and the Goose Site, 160 km to the south. Between mid-December 2018 and mid-April, 2019 the two sites were connected by a winter ice road. The WMMP Plan indicates that the winter ice road is designed to close after April 15th, prior to caribou spring migration. Upon operating the winter ice road after April 15th (between April 19 and May 10), where approximately 60 loads of equipment and fuel were transported using A-train trucks, and additional ancillary maintenance equipment and wildlife observation vehicle activity ran, a Caribou Road Crossing Study was conducted to investigate if there were detectable impacts on caribou migration and behaviour.

Through two qualitative methods and two statistical model methods, caribou movement was analyzed for avoidance, hesitation, and detectable response. Caribou collar data from the years 2008 - 2019 (Bathurst herd) and 2012 - 2019 (Beverly/Ahiak herd) were analyzed. Prior to 2017, caribou were not within a 20 km distance of the project area (including the planned area for the winter ice road). Between 2016 and 2017 a shift in migratory route occurred, and caribou movement routes shifted into the project area. Consequently, only data from 2017 and onwards was used in the analysis. For the analyses conducted, 2017 and 2018 were considered control years and 2019 was considered the treatment year. The statistical analyses showed that no significant change in caribou movement behaviour was detected between the control years and treatment year.

There were several observations of caribou slowing down prior to crossing the road, and then speeding up during crossing; however, this result was interpreted to not be due to human activity because the same pattern was observed in 2017 and 2018 (no winter ice road) as compared to 2019 when the winter ice road was present. Sabina speculates that there may be an impact of the corridor itself (area within which the road was built) on movement patterns. This logic may be particularly faulty if there were impacts being experienced along the corridor in both "control" and "impact" years. This may be possible due to a large number of activities occurring in 2018 that would affect the averaged patterns of movement in the proposed control years in 2017 and 2018.

In 2018, the following pre-development activities were conducted:

- Vegetation Monitoring for the winter ice road between July 11th and 16th.
- Assessment of Archaeological and Heritage Resources, where 30 km of winter ice road were assessed.

- Completion of earthworks and initial commissioning of the MLA.
- Completion of two cargo sealifts.
- Ongoing geotechnical drilling in key infrastructure sites.
- Detailed surveying of the winter ice road route for better refinement.
- Procurement of construction equipment, bulk fuel storage, and other infrastructure.
- Commencement of earthworks at Goose site, including quarry expansion, heavy equipment upgrades, and initial road and bridge construction.
- Helicopter use along the corridor.

The year 2018 may not be suitable to use as a pre-human activity year where caribou movement and behaviour would be unaltered alongside the aforementioned activities. The proponent also mentioned that the statistical power of the analysis is not high due to the small sample size, and that further years of movement analysis may improve the power conducted. Due to the reported issue with low statistical power of these analyses, they should not be used to conclude that the winter ice road does not affect the movements of caribou migrating through the area.

Recommendation/Request:

The KIA recommends the following:

- Please carefully consider the validity of lumping caribou collar data from 2018 with 2017 data (into a control group), as considerable activity was underway in 2018, and it may be more appropriately classified as an impact year.
- Consider re-evaluating the conclusion of the caribou crossing analysis by grouping 2018 and 2019 together as potential impact years, with 2017 as the control year, or via analyzing each year separately.
- Please provide details of the power analysis conducted, and the statistical power achieved for each test. The report states that the power is low, but values are not provided.
- Given the large number of animals observed moving through the area during spring migration, it is of greater importance that the proponent aim to complete use of the winter ice road in future years prior to the April 15th cut-off date.

Sabina Response:

The Back River Project includes two centres of activity, the Marine Laydown Area (MLA) on Bathurst Inlet and the Goose site, 160 km to the south. A WIR connected the two sites during the winter of 2019. The WIR was intended to be constructed in January through March, with a planned end date of April 15th, prior to spring migration for caribou. Due to delays in construction (as a result of less equipment onsite caused by a failed sealift in 2018), Sabina informed the Kitikmeot Inuit Association (KIA) and Government of Nunavut (GN) that they would operate the WIR after the planned April 15 closure date. The GN requested that Sabina investigate whether the movement of collared caribou were affected by WIR during spring migration. The report explores the movement of barren-ground caribou in relation to the operation of the WIR in 2019 compared to movements in previous years.

The authors of the report agree with the comment that if there were substantial pre-development activities occurring during the analysis period in 2018 and around of the route of the winter ice road, then 2018 should be included as an effect year along with 2019. However, the pre-development activities noted did not overlap spatially or temporally with the study area. The period of analysis for the winter ice road caribou crossing analysis was March 1st – June 15th in 2017, 2018, and 2019. This time period

was selected to fully capture any caribou in the area of the WIR during the period of spring migration and before calving. The pre-development activities noted by the KIA in 2018 did not occur during this time period and were also largely peripheral to the area of study (the WIR route). Archeology surveys occurred in July/August of 2018 as they can only occur when ground has thawed. Similarly, surveying for the winter ice road took place in the summer of 2018 as these surveys can only occur when there is no snow. Earthworks at Goose camp did not commence until after caribou season in July. As such, it is appropriate to use define the spring migration period of 2018 as a non-effect year and group it with 2017.

The authors acknowledge that the low degree of power stated in the analysis reduces the strength of statements related to effect or non-effect. However, having only one year of effect data in which the winter ice road was operational, there is no way to increase the power. In spite of this, the analysis indicated the same result across four separate types of analysis, which was that the caribou behavior was not statistically different in 2019 as compared to previous years. The stability of these results suggest that the conclusion can be considered valid for the temporal scale analyzed.

Sabina has agreed to planning and operating the WIR with a planned ending date of April 15th. This commitment is listed in the Wildlife Mitigation and Monitoring Program Plan (WMMP Plan, version 10).

KIA-6: Back River Winter Ice Road additional caribou mitigation

References:

Back River Project, 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 5.3

Summary:

The WMMP Report states that during the period from April 15th to May 10th, the winter ice road was open beyond its intended use date (of April 15). This extended period of winter road use triggered additional mitigation.

Detailed Review Comment

Back River Project includes a winter ice road that connects the Marine Laydown Area on Bathurst Inlet to the Goose Site, 160 km to the South. The winter ice road is designed to be closed by April 15th. Operation of the winter ice road extended beyond the intended closure date, and its use was extended until May 10th. The WMMP Report states that during this road use extension period (April 15th to May 10th); additional mitigation for caribou protection was implemented. The additional mitigation activities were to be included in the 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report under Section 5.3.1.3. No such Section exists in the WMMP Report document, however.

Recommendation/Request:

The KIA requests the following:

- Please indicate the additional mitigation actions implemented for caribou protection conducted in the period between April 15th and May 10th, which is missing from the WMMP Report

Sabina Response:

During 2019, Sabina constructed and operated the WIR for the first time between the MLA and the Goose Site. The plan was to construct the WIR in January and February and operate the WIR between February and April.

As part of the FEIS, Sabina considered potential effects of the WIR on migration of caribou. The WMMP Plan includes a variety of mitigations to allow caribou to cross the WIR, including a planned end date of the WIR by April 15th (WMMP Plan V10, Section 7.1.6). Collar data indicate that caribou transit the Project area primarily during May, with a portion crossing between April 15 and April 30.

The WMMP Plan indicates that:

- The plan for the WIR is to complete operation by April 15.
- If unforeseen circumstances force the operation of the WIR after April 15, then Sabina will discuss this with the KIA and GN.
- If the WIR is operated after April 15, caribou will be monitored using satellite collars and ground-based surveys, drivers will operate vehicles following more stringent management rules, and the road may be closed should caribou wish to cross the road.

During 2019, the construction of the WIR was delayed due to logistic and equipment reasons. Sabina advised the KIA and GN and discussed keeping the WIR open after April 15. A wildlife monitor was brought to site and conducted ground-based surveys between April 15 and May 9 when the WIR was closed.

The wildlife monitor reported observations of caribou, which were reported in the WMMP Report as incidental observations. Several road closures were conducted in response to these observations.

In future, should the WIR be operated after April 15, more detailed information will be recorded on the driving surveys for caribou and the circumstances of the road closures. To facilitate this data collection, Sabina will develop a WIR Observation SOP. The SOP will include caribou monitoring procedures and criteria and procedures for road closure and re-opening.

KIA-7: Photographs to show camp cleanliness

References:

Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Sections 5.5.1.1, 5.5-3

Summary:

The photograph of Forward camp (Photo 5.5-3) is inadequate to illustrate how wildlife attractants were mitigated at this camp.

Detailed Review Comment

Section 5.5.1.1 explains that the Goose and Marine Laydown Area (MLA) camps were kept clean and free of attractants for wildlife, but it does not mention Forward camp. Photograph 5.5-3 shows Forward camp from an aerial photograph, which makes it difficult to assess the how well Sabina mitigated attractants. The photograph of MLA camp (5.5-2) is more appropriate.

Recommendation/Request:

The KIA recommends the following:

- Please include more appropriate photographs for the intended purpose in subsequent WMMP reports.

Sabina Response:

Ground-based photos documenting camp cleanliness will be included in subsequent WMMP Reports, where available.

KIA-8: Shipping Management

References:

Back River Project, 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 1.2

Back River Project, 2019 Annual Report for Project Certificate No. 007

- Project Certificate Condition No. 52

Summary:

The proponent is required to manage caribou interactions with the project. In “fall of 2018”, a sea-lift of equipment was delivered to the MLA.

Detailed Review Comment

In Section 1.2, 2019 Project Activities, it is stated that:

“During the fall of 2018, the first sea-lift of equipment and fuel for the Goose site was delivered to the MLA.”

In the 2018 annual report, Project Certificate Condition No. 52 states that:

“The Proponent shall, in collaboration with the Government of Nunavut, the Government of the Northwest Territories, the Kitikmeot Inuit Association and other relevant parties, thoroughly evaluate the potential impacts to caribou from planned mineral exploration within its mineral tenures and outside the approved project development area. The Proponent must demonstrate that the potential for adverse effects to caribou populations can be prevented prior to exploration occurring.”

The Government of Nunavut & Government of Northwest Territories (2018) assessed threats to the Dolphin and Union caribou herd and categorized shipping lanes (marine traffic/ice breaking) as a high threat with serious severity to the population. The report also noted that shipping during summer (June to August) had a negligible effect on the Dolphin and Union caribou herd. After arriving at staging areas in southern Victoria Island in October, the Dolphin and Union caribou herd wait for sea ice to freeze before migrating south. These migration routes are spatially and temporally sensitive.

We encourage shipping deliveries to the MLA during periods of least potential impact to caribou wherever possible, and such that shipping avoids impacts to the integrity of ice formation along the migratory routes of the Dolphin-Union Caribou Herd.

Recommendation/Request:

The KIA requests/recommends the following:

- The KIA understands that Sabina has committed to not using ice breaking ships after freeze-up for deliveries. However, it would be helpful to cite the specific shipping dates and link those dates to the mitigation plan commitments for shipping management (e.g., cut-off dates/conditions) during the spring and fall shoulder seasons.
- Please note dates when shipping occurred, the shipping cut off dates, cut off ice thicknesses, etc., and an explanation of how shipping management avoided impacting ice formation along Dolphin Union caribou migration routes.

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- It would be helpful to also include any zones of avoidance around staging areas along the south shore of Victoria Island, if relevant.

Sabina Response:

Shipping dates were between August 25 and September 1, 2019 (Tuktoyaktuk to the MLA) and September 4 and 14, 2019 (MLA to Hay River). Sabina will ensure shipping dates are noted in future reports.

KIA-9: Shipping Management and Mitigation

References:

Back River Project, 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 7.1

Summary:

The proponent is required to follow Project Certificate (PC) Condition No. 58 for mitigation of impacts and disturbances to sea-ducks and waterfowl. It is unclear whether shipping in 2019 obeyed with the prescribed 500 m setback because these details were not included in the 2019 Pre-Construction WMMP Report.

Detailed Review Comment

Section 7.1 states that Sabina is required to meet the PC Condition No. 58 for mitigating impacts to seaducks and waterfowl. The Condition states:

“The Proponent shall include measures within the Wildlife Mitigation and Monitoring Program Plan to ensure that, subject only to vessel safety requirements, a setback distance of at least 500 metres is maintained from colonies and moulting aggregations of seaducks and waterfowl during Project shipping transiting through Bathurst/Elu Inlet, Lambert Channel, and Eastern Lancaster Sound.”

There is no mention in the WMMP Report of spatial setbacks from identified bird habitat areas; therefore, it is unclear whether shipping operators obeyed the setbacks outlined in PC Condition No. 58 as well as Sabina’s WMMP Plan v.10.

Recommendation/Request:

The KIA requests the following:

- Please clarify and update Section 7.1, Marine Shipping and Management, to follow PC Condition No. 58 for mitigation setbacks for migratory bird areas that fall along the shipping route.

Sabina Response:

Sabina has agreed to conduct shipboard marine mammal and seabird observations for wildlife management, which is described in the WMMP Plan (V10, Sections 13.2.2.3 and 14.2.2).

Sabina has advanced this monitoring program in two ways:

- 1) Reporting wildlife observations is a condition of the contracts established with vessel operators.
- 2) Sabina has produced a Marine Shipping Mitigation and Monitoring (MSMM) SOP (SOP # ENVIRO-2) which is delivered to vessel operators.

Sabina will increase efforts to communicate this expectation with its contractors, including by developing a brochure for shipping operators and crews that illustrates reporting requirements and procedures outlined in the MSMM.

KIA-10: MV Kelly Ouayuak did not conduct marine shipping wildlife monitoring

References:

Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 7.1.1, Figures 7.1-1

Appendix E. SOP: Marine Shipping Wildlife Mitigation and Monitoring (Version 2.0, September 30, 2019)
Back River Project 2019 Annual Report (March 31, 2020)

- Project Certificate Condition No. 63, 65

Summary:

The MV Kelly Ouayuak conducted one sailing in August of 2019; however, it did not conduct marine wildlife or seabird monitoring as per Sabina's Marine Shipping Wildlife Mitigation and Monitoring SOP.

Detailed Review Comment

Section 7.1.1 of the 2019 Pre-Construction WMMP Report indicates that the sailing of MV Kelly Ouayuak travelled between Tuktoyaktuk and the MLA between August 25 and September 1, and between the MLA and Hay River between September 4 and 14. However, despite Sabina providing an SOP to the shipping contractor describing management and monitoring requirements, it is stated that no surveys were conducted during the sailing of the MV Kelly Ouayuak. It is unclear why MV Kelly Ouayuak did not follow Sabina's required wildlife monitoring to be conducted.

The KIA brought a similar situation to attention in their review of the 2018 Pre-Construction WMMP Report (submitted in Dec 2019), where no shipping surveys was conducted by the MV MITIQ that year despite being one of two sailings in 2018.

We note that, in the Results sections of Sabina's performance reporting related to marine mammal monitoring (PC No. 63, 65), information from 2018 project activities is included. This information should be removed in the 2019 Annual Report as no marine mammal surveys were conducted during shipping in 2019.

Recommendation/Request:

The KIA requests the following:

- Provide an explanation for why the MV Kelly Ouayuak did not conduct marine wildlife monitoring as per the Back River Marine

Shipping Wildlife Mitigation and Monitoring SOP.

- Remove the 2018 marine mammal monitoring results from the performance reporting for PC No. 63 and 65 in the 2019 Annual Report.
- Please provide lessons learned about whether or not Sabina may need to provide personnel to complete wildlife monitoring during shipping (e., if shipping companies simply do not have personnel redundancy to undertake this task), or whether issues with shipping companies not monitoring can be corrected.

Sabina Response:

As discussed in the response to KIA-9, Sabina instructed the shipping company to collect marine mammal and seabird observations and provided methods on how to accomplish this. However, in 2019, the captain of the MV Kelly Ouayuak did not collect these observations. This lapse has been communicated to the shipping company.

The response to PC-63 is in relation to surveys for seal lairs. All on-ice construction in 2019 was complete prior to the seal pupping season, so no surveys were required for seal lairs. The response to PC-64 and 65 state that incidental observations were collected in 2018, but not in 2019, which is accurate.

During 2018, the MV Kelly Ouayuak collected marine mammal and seabird observations correctly during their voyage between Tuktoyaktuk and the MLA. Therefore, with proper motivation, the vessels crew are capable of collecting this type of observations and no additional Sabina personnel are required to conduct this work.

Sabina has re-iterated the importance of collecting these observations to the shipping company and will do so again prior to any sailings in 2020.

KIA-11: Remote camera and human activity data for 2018 and 2019

References:

Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 5.5.1, Page 5-11
- Appendix 2A - Overview of Wildlife Mitigation and Monitoring Programs during Phases of the Back River Project

Back River Project Wildlife Mitigation and Monitoring Program Plan (Version 10)

- Section 6.2, Table 6.2-1 Overview of Wildlife Monitoring Programs that Trigger Management Actions

Summary:

The WMMP Plan v.10 indicates that on-site camera monitoring and human activity monitoring are part of Sabina's baseline/pre-construction wildlife monitoring program; however, no data/results for remote cameras or illegal hunting and fishing on the Project site are shown in the 2019 Pre-Construction WMMP Report.

Detailed Review Comment

Table 6.2-1 of the WMMP Plan v.10 shows an overview of wildlife monitoring programs for each phase of the project, including Baseline/Pre-Construction. In addition to incidental wildlife reporting, on-site camera monitoring is supposed to be ongoing during the pre- construction phase for caribou, muskox, grizzly bear, and wolverine. Furthermore, human activity monitoring (to report hunting and fishing on the project site) is supposed to be ongoing as part of the caribou monitoring program during pre-construction.

A partial copy of Table 6.2-1 from the WMMP Plan v.10 has been included as Appendix 2A of the 2019 Pre-Construction WMMP Report. However, Appendix 2A only shows the first page of this table; the remaining wildlife monitoring programs for other wildlife VECs aside from caribou have been cut off.

The KIA commented on this missing information in our previous review of the 2018 Pre-Construction WMMP Report.

Recommendation/Request:

The KIA requests/recommends the following:

- Please provide the results of on-site remote camera monitoring and human activity monitoring for 2019.
- Please copy WMMP Plan v.10 Table 6.2-1 in full to be included in Appendix 2A of the 2019 Pre-Construction WMMP Report.

Sabina Response:

The WMMP Plan, V.10, Table 6.2-1 and 6.2-2 list the monitoring for wildlife during each Project phase, including Baseline/Pre-Construction. Baseline studies are referred to by the number of years that they were completed during the Baseline phase of the Project. Others are listed as ongoing, including recording incidental sightings and monitoring the site using remote trail cameras.

Sabina will be installing cameras to monitor interactions with the site during the summer of 2020.

KIA-12: Additional recommendations from bear safety audit**References:**

Back River Project 2018 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Appendix 5A - Bear Safety Site Audit Report, 2018

Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Appendix 5D - Back River Project: Standard Operating Procedure 0008 - Waste Management

Summary:

BEARWISE made several key recommendations during the 2018 bear safety audit. Sabina took direct action to address some recommendations and developed SOP-0008 to document their waste management procedures. However, as was pointed out in the KIA's review of the 2018 WMMP Report (submitted in Dec 2019), some outstanding recommendations from the BEARWISE report remain to be addressed.

Detailed Review Comment

In the Bear Safety Site Audit Report, 2018, BEARWISE made several key recommendations, which Sabina developed into SOP-008 to document waste management procedures. In the KIA's previous review of the 2018 Pre-Construction WMMP Report (submitted in Dec 2019) it was noted that some outstanding BEARWISE recommendations remain to be addressed. These further management actions were not found in Rev 0 of SOP-0008; including suggestions from camp manager Gordon, which Sabina can follow to further reduce wildlife attractants on site.

BEARWISE recommended that the MLA site have a dedicated incinerator operator (as Sabina has done at Goose and George Lake camps). It would be beneficial to explicitly list this person's roles and responsibilities in Section 4 of the SOP. Camp manager Gordon proposed solutions to the problems associated with outside storage of food garbage and assigned these as responsibilities of the incinerator operator; however, these solutions were not incorporated in the SOP:

- Garbage from the kitchen would be picked up by the incinerator operator twice daily, after the cleanup of breakfast and dinner, then taken directly to the incinerator and immediately place inside.
- Only the incinerator operator would be allowed to take garbage to the incinerator area.
- The incinerator operator would need to be informed of any plans to deliver non-food related waste (cardboard, plastic etc.) to the incinerator site.

BEARWISE's key recommendation No. 8 is to *"secure the lids of the chest freezers located on the back steps of the kitchen in a way that provides easy access by kitchen staff but prevents bears from gaining access"*). The SOP does not mention securing the lids of chest freezers, although this could be due to the prohibition that "no food will be stored outdoors" (Section 5.3.3) - Sabina should clarify if this is the case.

Section 5.4 regarding food waste needs to be amended with the following BEARWISE and camp manager Gordon's recommendations:

- Part of Incinerator Recommendation No. 2: No food waste should be stored outside anywhere on site.

- Part of Incinerator Recommendation No. 2: Any non-food related disposal bins and containers are labelled clearly as to what is allowed to be placed inside. These bins and containers must be labelled “No Food Wastes” as well.
- Segregation and Diversion of Waste Recommendation No. 3: If recyclables and returnables are to be collected, do so with care; do not allow them to become wildlife attractants.
- Cooking Grease Recommendation No. 2: Regularly inspect the walls around cooking grill’s exhaust hood for grease accumulation, clean walls and exhaust hoods regularly.
- All food-related garbage storage would be stored inside the kitchen storage area until it is picked up.
- Garbage from the kitchen would be picked up by the incinerator operator twice daily, after the cleanup of breakfast and dinner, then taken directly to the incinerator and immediately placed inside. (KIA also mentioned this mitigation measure above.)

Finally, Gordon suggested using a skid to transport garbage to the incinerator; however, this approach was not incorporated into SOP-0008 Section 5.6. If Sabina proceeds with this mitigation measure, Gordon recommended:

- A large skid would have a shallow wooden box built on it and the inside of the box would be lined with a material that could be easily cleaned. The skid would be kept at the incinerator area when not in immediate use.

Note that the KIA commented on the outstanding recommendations in our previous review of the 2018 Pre-Construction WMMP Report (submitted in Dec 2019).

Recommendation/Request:

The KIA recommends the following:

- Please revise SOP-0008 and implement the outstanding recommendations made by BEARWISE and camp manager Gordon.
- Where recommendations of the camp manager are not integrated into the SOP, please provide an explanation as to why they have not been, what is being done in lieu of the recommendation, and how alternative arrangements are working.

Sabina Response:

Sabina understands that waste management is important for wildlife management. Sabina developed a draft Waste Management Plan as part of the FEIS and updated that plan in 2019 to address waste management issues identified by the Bearwise Audit of the MLA and Goose site.

During 2020, Sabina will update the Waste Management SOP (SOP—008). Sabina will consider the comments provided by the GN and the KIA in this update.

KIA-13: Clear and comprehensive information about waste management**References:**

Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Appendix 5D - Back River Project: Standard Operating Procedure 0008 - Waste Management

Summary:

Revision 0 of SOP-0008 (Waste Management) could be improved by including a table clearly showing how various waste types expected at the project sites should be handled and disposed, including wastes compatible for incineration. Additional signage should be posted project staff.

Detailed Review Comment

Section 5.1.1 of SOP-0008 states that all solid, non-hazardous wastes (Domestic Waste) will be separated from hazardous wastes by category and provides a very brief list that includes both non-hazardous and hazardous waste. Section 5.7 through 5.9 subsequently describes items that can be incinerated, cannot be incinerated, or can be incinerated with special precautions. It would be much clearer and practical for regular use by project staff if Sabina presented waste management information in a table with the following information:

- Waste material (e.g., absorbents)
- Waste type (e.g., petroleum)
- Classification (e.g., hazardous)
- General management method (e.g., collects in Quatrex bags or open top drums. Keep in hazardous waste storage areas until final disposal.)
- Final disposal (e.g., off-site disposal)

This table, or a simplified version, can be posted at waste collection areas. If the Incinerator Operator finds unauthorized substances in the clear garbage bags (Section 5.6.4), Sabina should take corrective actions with camp staff – further training and/or signage may be required to ensure that waste management at project sites comply with all applicable environmental regulations.

Note that the KIA also commented on this issue in our previous review of the 2018 Pre-Construction WMMP Report (submitted in Dec 2019).

Recommendation/Request:

The KIA recommends the following:

- Please revise SOP-0008 to include a table that shows proper waste handling and disposal for various waste types.
- Post additional signage at waste collection sites to ensure that incompatible wastes are not sent for incineration.

Sabina Response:

Please refer to response to KIA-12.

KIA-14: SOP for wildlife (carnivore) interactions and deterrents

References:

Back River Project 2018 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Appendix 5C - Back River Project: Standard Operating Procedure 0011 - Wildlife Interactions and Deterrents

Summary:

The Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report does not include SOP-0011 for Wildlife Interaction and Deterrents (which was appended to the 2018 WMMP Report), despite SOP-0011 being followed in the incident of a grizzly sow and two cubs being observed near the MLA quarry and camp.

Detailed Review Comment

During the incident of a grizzly sow and two cubs being observed near the MLA quarry and camp, the SOP for wildlife (carnivore) interactions and deterrents (SOP-0011) was followed for deterring the bears away from the area using bear bangers. The bears returned an hour later and were deterred away again a final time.

The Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report do not include the SOP for Wildlife Interaction and Deterrents. It would be helpful if all applicable SOPs and other relevant documents were appended to the WMMP Report such that a comprehensive review of Project staff compliance to Sabina's policies and procedures can be completed.

Recommendation/Request:

The KIA requests the following:

- Please include the SOP for wildlife (carnivore) interactions and deterrents in further WMMP reports.

Sabina Response:

The Wildlife Interactions and Deterrents SOP (SOP-0011) will be appended to future WMMP Reports.

KIA-15: Sources and rationale for marine mammal and seabird sensitive habitats along the Project shipping route

References:

Appendix E. SOP: Marine Shipping Wildlife Mitigation and Monitoring (Version 2.0, September 30, 2019):

- Section 2, Figure 2.1-1, Figure 2.1-2, Table 3.5-1

Back River Project, 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report

- Section 7.1

Summary:

Figures 2.1-1 and 2.1-2 of the SOP show the sensitive habitat for seabirds/seaducks and marine mammals along the shipping route, respectively. References to data sources for marine mammals and further information about sensitive habitat vs. key marine habitat designations for seabirds/seaducks would allow for a more comprehensive review.

Detailed Review Comment

In response to the KIA's technical comments on Version 1.0 of the Marine Shipping Wildlife Mitigation Monitoring SOP as part of the Back River 2018 Annual Report review (KIA-12 to KIA-18), Sabina provided Version 2.0 of the SOP for review in October 2019. At that time, the KIA noted outstanding issues with Version 2.0 of the SOP that remain to be addressed.

In response to our previous review comment KIA-13, Sabina has updated Figure 2.1-1 (sensitive habitat for seabirds/seaducks) to reflect key habitat boundaries shown in the ECCC report, Key Habitat Sites for Migratory Birds in the Nunavut Settlement Area (ECCC, 2016). However, this figure still excludes Eastern Jones Sound as Sensitive Habitat for marine birds, which needs to be added. In Figure 2.1-1, Eastern Jones Sound is a "key marine habitat site" (presumably less sensitive, though this is unclear). According to ECCC (2016), both areas are "highly risk intolerant"; therefore, both should be indicated as sensitive habitat, and appropriate mitigation should be applied. Sabina does not provide an explanation for how their labelling of Sensitive Habitat vs. Key Marine Habitat Site correlates to ECCC's highly vs. moderately risk intolerant sites.

In Version 2.0 of the SOP, there are still no data sources for Figure 2.1-2 (sensitive habitat for marine mammals); the "Service Layer Credits/References" field in the legend is blank. Table 3.5-1 states that any group of marine mammals observed on the ocean surface, especially in the sensitive habitat areas identified in Figure 2.1-2, will trigger mitigation response(s) at the discretion of the ship's operator. Since mitigation responses will more likely be triggered within sensitive habitat, it is important to accurately and conservatively identify these sensitive areas. Sabina does not reference the data sources that were used to identify and map sensitive habitat for these wildlife groups.

Further, in the 2019 WMMP Report, Marine Shipping Mitigation and Monitoring section, the shipping route between Hay River and the Marine Laydown Area is shown in Figure 7.1-1. Several key migratory bird habitat sites in Nunavut as defined by ECCC (2016), and in Northwest Territories (NT) as defined by Latour et al. (2008), exist along this route and bird areas from NT are missing from the shipping route map (Figure 7.1-1.). Though these areas are not specified in PC Condition No. 58, they are still considered sensitive migratory bird areas by government regulators (ECCC/CWS). This includes the following key locations:

- Cape Parry (NT)

- McKinley Bay - Phillips Island (NT)
- Kukjuktuk and Hutchinson Bays (NT)
- Lower Mackenzie River Islands (NT)
- Middle Mackenzie River Islands (NT)
- Mills Lake (NT)

The KIA requests that these additional sensitive migratory bird areas be included in the WMMP Plan and held to the appropriate mitigation setbacks, the Marine Shipping Wildlife Mitigation and Monitoring SOP, and the 2019 shipping route map (Figure 7.1-1) of the WMMP Report to increase transparency in Sabina's activities and reporting. Consider including these sensitive migratory bird habitats in the Shipping Management Plan as well.

Recommendation/Request:

The KIA requests/recommends the following:

- Please provide the above noted missing information and supporting text to enable a more comprehensive review of mitigation alongside sensitive habitats for marine mammals, whale migration routes, and points of concentration.
- Include the additional sensitive migratory bird areas in the Northwest Territories into the WMMP Plan, as these locations fall along the Project shipping route, and hold these to the appropriate mitigation setbacks.
- Include these additional sensitive bird areas in the Marine Shipping Wildlife Mitigation and Monitoring SOP.
- Overlay these sensitive areas on the 2019 shipping route map (Figure 7.1-1) of the WMMP Report to increase transparency in Sabina's activities and reporting.
- Consider including these sensitive migratory bird habitats in the Shipping Management Plan for consistency amongst related management plans, SOPs, and other Project documents.

Sabina Response:

Sabina will be updating the Marine Shipping Wildlife Mitigation and Monitoring SOP (SOP # ENVIRO-02) in 2020. Comments provided by the KIA and GN will be considered in the planned update.

Sabina will include sensitive wildlife habitats consistent with the updated SOP on shipping route maps in future WMMP Reports.

KIA-16: Reporting timeline requirements for ship strikes of marine mammals or seabirds**References:**

Appendix E. SOP: Marine Shipping Wildlife Mitigation and Monitoring (Version 2.0, September 30, 2019):

- Section 3.7

Summary:

Reporting frequency requirements, as specified in Project Conditions No. 64 and 65, have been removed from the Reporting Process section of the SOP, Version 2.0.

Detailed Review Comment

In response to the KIA's technical comments on Version 1.0 of the Marine Shipping Wildlife Mitigation Monitoring SOP as part of the Back River 2018 Annual Report review (KIA-12 to KIA-18), Sabina provided Version 2.0 of the SOP for review in October 2019. At that time, the KIA noted outstanding issues with Version 2.0 of the SOP that remain to be addressed.

In response to our previous review comment KIA-14, Sabina has now included the reporting requirements for ship strikes as specified by the Marine Mammal Regulations, s.39, as well as DFO contact info in Inuvik and Iqaluit. However, we note that Section 3.7, Reporting Process, is now missing the reporting timeline specified in PC Conditions No. 64 and 65: "Initially report annually, then every 2 years once contracts have been set up."

Recommendation/Request:

The KIA requests the following:

Please reinstate the requirement to "initially report annually, then every 2 years once contracts have been set up" or explain why the sentence was removed and how they can still meet the Conditions without reporting frequency information.

Sabina Response:

The noted sentence was removed from Version 2.0 because the target audience of the SOP is vessel operators. Vessel operators have a responsibility to report to Sabina rather than the NIRB. Sabina will include the required reporting timelines in the planned SOP update.

KIA-17: Shipping setback distances and locations for seabirds and species at risk

References:

Appendix E. SOP: Marine Shipping Wildlife Mitigation and Monitoring (Version 2.0, September 30, 2019):

- Section 2.2, Table 3.2-1, Table 3.5-1

Back River Project Wildlife Mitigation and Monitoring Program Plan (Version 10, October 2019):

- Section 13.1.3.3

Summary:

The SOP describes two shipping setback distances: 30km from Prince Leopold Island and 500 m from large groups or colonies of seabirds in Bathurst Inlet/Elu Inlet and Lambert Channel. It is unclear why Eastern Lancaster Sound is not explicitly mentioned as sensitive habitat where mitigation should be applied. Furthermore, since the endangered Ivory Gull is one of the “most likely observed” species along shipping routes, an additional setback of 2 km from Ivory Gull breeding colonies needs to be included in the SOP. Adaptive management and mitigation should be applied if additional seabird colonies are observed.

Detailed Review Comment

In response to the KIA’s technical comments on Version 1.0 of the Marine Shipping Wildlife Mitigation Monitoring SOP as part of the Back River 2018 Annual Report review (KIA-12 to KIA-18), Sabina provided Version 2.0 of the SOP for review in October 2019. At that time, the KIA noted outstanding issues with Version 2.0 of the SOP that remain to be addressed.

The concerns in our previous review comment KIA-15 have not been addressed. Sabina has not updated the Marine Shipping Wildlife Mitigation and Monitoring SOP (nor the WMMP v.10) to include Eastern Lancaster Sound (identified as sensitive habitat in SOP Figure 2.1-1) and Eastern Jones Sound (identified as a highly risk intolerant, key habitat site by ECCC (2016); see KIA-NIRB-15 above) in the list of areas where a 500 m setback will be applied for observed bird colonies, nor have they explained their rationale for these omissions.

Sabina’s argument in their July 19, 2019 response that “asking the vessel’s crew to identify additional breeding colonies on shore is impractical” is inconsistent with the data expected to be collected on the Marine Mammal and Seabird Sightings Form, which includes species, number of individuals, and behaviour (including “resting on land”). For ease of interpretation, large numbers of marine birds observed on land during the nesting season (e.g., May-Sep) could be interpreted as breeding colonies. At minimum, Sabina should commit to the mitigation for the now-Critically-Imperiled (as per updated Table 4.1-1 of WMMP Plan v.10) Ivory Gull to maintain in compliance with the federal Species at Risk Act. The Ivory Gull is physically distinct and should be identifiable such that a 2-km setback can be applied if colonies (large and obvious aggregations) are observed.

Recommendation/Request:

The KIA requests/recommends the following:

- Please revise Section 2.2 of the SOP and Section 13.1.3.3 of the WMMP to include the 500 m buffer distance for large colonies of seabirds on land and large groups of seabirds on the ocean surface within the entire sensitive habitat areas identified: Bathurst/Elu Inlets, Lambert Channel, Eastern Lancaster Sound, and Eastern Jones Sound.

- Please include a 2 km buffer distance from Ivory Gull colonies in the SOP and WMMP; in particular, Eastern Lancaster Sound is likely to be identified as Critical Habitat for this species.
- Undertake adaptive management and application of ECCC-recommended buffer distances if additional seabird colonies are observed by bridge staff.

Sabina Response:

Please refer to response to KIA-15.

KIA-18: Marine shipping wildlife monitoring staff and procedures**References:**

Appendix E. SOP: Marine Shipping Wildlife Mitigation and Monitoring (Version 2.0, September 30, 2019):

- Sections 3.2, 3.4; Figure 3.4-1; Marine Mammal and Seabird Sightings Record

Summary:

Version 2.0 of the Marine Shipping Wildlife Mitigation and Monitoring SOP has been revised to follow ECCC/CWS protocols more closely for bird monitoring. However, the SOP and the Marine Mammal and Seabird Sightings Record would benefit from further revisions to improve clarity and the types/amount of data collected for better interpretation of wildlife sightings. A contingency plan may be needed if it is not feasible for regular bridge staff to dedicate 4 hours a day to wildlife monitoring.

Detailed Review Comment

In response to the KIA's technical comments on Version 1.0 of the Marine Shipping Wildlife Mitigation Monitoring SOP as part of the Back River 2018 Annual Report review (KIA-12 to KIA-18), Sabina provided Version 2.0 of the SOP for review in October 2019. At that time, the KIA noted outstanding issues with Version 2.0 of the SOP that remain to be addressed.

In response to our previous review comment KIA-16, Sabina has modified Section 3.4 to have different monitoring procedures for marine mammals and birds (the latter follows the Gjerdrum et al. (2012) moving platform protocol). There are some unclear statements amongst the revisions that require clarifications within the SOP. We have also made a few suggestions for improvements to the SOP and forms, noted in the bullet points below.

- The SOP states that observations for seabirds will be conducted on "either port or starboard side". Please note whether staff will be surveying both sides simultaneously (i.e., one person per side), or whether the location will be staggered between the four, 30-min periods dedicated to seabird observations?
- Sabina has now appended their Marine Mammal and Seabird Sightings Record to the SOP. Under Environmental Information, we recommend including sea state, wave height, cloud cover/fog, precipitation, glare, and ice - these factors will influence the visibility of animals. Gjerdrum et al. (2012) has codes in Appendices II-IV that would support precise observations; however, even broader, qualitative descriptions would allow for better interpretation of wildlife sightings (or lack thereof). Furthermore, a field for "Disturbance (e.g., other large vessels, fishing activities, foghorn sounding)" would be useful, as cumulative effects may affect wildlife presence and behaviours.
- Under Observation Information, we recommend that seabird observers indicate whether they are surveying from the ship's starboard or port side (as per Section 3.4, Monitoring Procedure). It may also be useful to list species codes in Tables 3.2-1 and 3.2-2, or in a separate Appendix, as the space for writing is minimal and mixed flocks of seabirds may be encountered. Please also update the footnote at the bottom of the form to include Table 3.2-2.
- Sabina indicated in their Jul 19, 2019 response that they committed to using the vessels' bridge crew to conduct monitoring rather than a separate marine monitor. They did not clarify which or how many bridge staff would be tasked with monitoring. A total of 4 hr. of survey effort per day (as per revised Section 3.4) is a lot of time for bridge staff to undertake as part of other routine duties. How will Sabina ensure that 4 hr. of monitoring can and will be completed? Will Sabina consider hiring a separate monitor if initial feedback from vessel crew indicates that the

plan is not feasible? It appears that implementation of monitoring by bridge staff has not been occurring to date.

Recommendation/Request:

The KIA recommends the following:

- Please determine whether the marine shipping wildlife monitoring procedures, with respect to staff requirements and observation schedule, are feasible and to make modifications as needed, such as hiring a dedicated monitor.
- Please revise the Marine Mammal and Seabird Sightings Record with our suggested changes (described in the Detailed Review Comment) to the Environmental Information and Observation Information sections.

Sabina Response:

Please refer to response to KIA-15.

KIA-19: Marine mammal and seabird species most likely observed along shipping routes, including species at risk

References:

Appendix E. SOP: Marine Shipping Wildlife Mitigation and Monitoring (Version 2.0, September 30, 2019):

- Tables 3.2-1, 3.2-2

Summary:

In the Marine Shipping Wildlife Mitigation and Monitoring SOP, which bridge staff (monitors) are expected to review, it would be beneficial for Tables 3.2-1 and 3.2-2 (marine mammals and seabirds most likely observed along shipping routes, respectively) to highlight the species of conservation concern.

Detailed Review Comment

In response to the KIA's technical comments on Version 1.0 of the Marine Shipping Wildlife Mitigation Monitoring SOP as part of the Back River 2018 Annual Report review (KIA-12 to KIA-18), Sabina provided Version 2.0 of the SOP for review in October 2019. At that time, the KIA noted outstanding issues with Version 2.0 of the SOP that remain to be addressed.

In response to our previous review comment KIA-17, Sabina has provided a much-expanded bird list in Table 3.2-2 with reference to project baseline info and Gjerdrum et al. (2012). Sabina also updated their bird field guide in the reference list in Section 3.8 to a 2016 Sibley Field Guide. However, the following items still require more information:

- Sabina did not address our request for Species at Risk/Species of Conservation Concern (SAR/SCC) to be identified (e.g., with asterisks) in the species lists. Although there is a table of SCC in the WMMP, it would be useful to identify these species in the SOP as well, especially if extra mitigation for SAR is planned (e.g., for Ivory Gull, see KIA-NIRB-17).
- Sabina has now included bearded seal in the list of marine mammals in Table 3.2-1, but still does not reference their data sources used to compile the marine mammal information.

Recommendation/Request:

The KIA recommends the following:

- Revise Table 3.2-1 and Table 3.2-2 to clearly identify species of conservation concern, such that bridge staff, if able to undertake the monitoring, would be more cognizant of observing and mitigating potential impacts to these species.

Sabina Response:

Please refer to response to KIA-15.

KIA-20: Mitigation responses for marine mammals, including speed reduction**References:**

Appendix E. SOP: Marine Shipping Wildlife Mitigation and Monitoring (Version 2.0, September 30, 2019):

- Table 3.5-1

Summary:

The SOP would be more protective of marine mammals if the wording of mitigation responses was stronger and clearer, and if more details could be provided about slowing down vessels when marine mammals are observed.

Detailed Review Comment

In response to the KIA's technical comments on Version 1.0 of the Marine Shipping Wildlife Mitigation Monitoring SOP as part of the Back River 2018 Annual Report review (KIA-12 to KIA-18), Sabina provided Version 2.0 of the SOP for review in October 2019. At that time, the KIA noted outstanding issues with Version 2.0 of the SOP that remain to be addressed.

In response to our previous review comment KIA-18, Sabina has now included the 100 m setback as per Marine Mammal Regulations s.7(3) as management response #1 in Table 3.5-1. In their July 19 response, Sabina argued that a decision tree of management options would make the SOP impractical for regular use. We have found that inclusion of an easy to follow diagram in mitigation plans makes it easier for regular use.

Sabina's management response #2 about slowing the vessel to avoid ship strikes with marine mammals would benefit from further clarification and justification. For example, what is the recommended slow-down speed when travelling through sensitive habitat areas, and what is the scientific rationale behind this speed? At what distance from the animal will vessels begin to reduce speed?

In Version 2.0 of the SOP, Sabina has removed the statement that they will "consider adaptively managing ship speed to reduce noise disturbance" from their table of recommended shipping mitigation responses for marine mammals. Keeping ship speed modification in the SOP is important as ship speed is known to modify underwater sound, and cumulative noise impacts to marine mammals and fish are known to be occurring and impacting these species in the Arctic. Decreased contributions to these cumulative effects should be attempted whenever possible.

Recommendation/Request:

The KIA requests/recommends the following:

- Please provide further clarification and justification about slowing down vessels for marine mammals in Table 3.5-1 of the SOP.
- Please reinstate modifying ship speed as a mitigation response to reduce cumulative noise impacts to marine mammal and fish.

Sabina Response:

Version 1.0 of the Marine Shipping Wildlife Mitigation and Monitoring SOP (SOP # ENVIRO-02) includes the following as a mitigation response to observations of marine mammals:

“Change ship’s heading to avoid groups of marine mammals. Consider adaptively managing ship speed to reduce noise disturbance. Noise disturbance can be reduced by 1.5 - 2.8 dB for every 1 knot reduction in speed.”

The mitigation response was revised in Version 2.0 to the following:

“Avoid ship strikes with marine mammals by slowing the vessel and allowing marine mammals to move out of the way. Noise can be reduced by 1.5 - 2.8 dB for every 1 knot reduction in speed. Change ship’s heading to avoid groups of marine mammals.”

Sabina notes that the revised shipping mitigation responses for marine mammals in Version 2.0 of the SOP are more clearly prescriptive than those in Version 1.0, including specifying slowing the vessel, rather than adaptively managing speed, as a mitigation response.

Sabina will consider the comments provided in the planned update of the SOP in 2020.

KIA-21: Number and allocation of vegetation monitoring plots**References:**

Appendix C. 2019 Vegetation Monitoring Program (Technical Memorandum dated 18 February 20120)

- Section 2.0
- Section 4.0, Table 1

Rescan 2013. Back River Project: 2012 Ecosystems and Vegetation Baseline Report.

- Table 3.3-1

Back River Vegetation Monitoring Plan, January 2020

- Section 5.5

Summary:

It is unclear how Sabina decided to allocate vegetation monitoring plots for WIR monitoring in 2019. The numbers are not proportional to the percentage area covered by each vegetation association in the LSA. Further rationale and relevant background information are needed to understand the methodology.

Detailed Review Comment

Table 1 of the 2019 Vegetation Monitoring Program technical memo presents the number of plots by Project Component (WIR, Goose Property, and MLA). Is the number of monitoring plots proportional to the area covered by each vegetation association in the study area? On page 1, Section 2.0 (Study Area and Monitoring Locations), the report states that that mesic dwarf-shrub tundra (TL), dry sparse tundra (TH), and shrubby tundra (TS) associations comprise >50% of the LSA, yet 18 plots are allocated to each of TH and TL, but only 2 plots are assigned to TS. Table 3.3-1 in the Back River 2012 Ecosystems and Vegetation Baseline Report shows that TL, TH, and TS make up 28.5%, 16.0%, and 8.4% of the LSA, respectively. Therefore, vegetation monitoring plot allocation is not proportional to the areas described in the baseline report.

However, Sabina's Vegetation Monitoring Plan (VMP) (Jan 2020) states that for Winter Ice Road Monitoring (Section 5.5), "the most common vegetation associations sampled along the WIR alignment are Dry Sparse Tundra, Mesic Dwarf Tundra, and Raised Bog Complex. The target vegetation association ... is expected to reflect the dominant habitat types present within the WIR..." Indeed, raised bog complex (WB) was assigned 4 plots for the 2019 monitoring program (the largest sample size after TH and TL).

It would be helpful if Sabina can provide rationale for their monitoring plot locations. Without scientifically justified rationale for plot allocation and sample sizes, it is difficult for the KIA to determine whether Sabina's vegetation monitoring program methodology is appropriate to meet the objectives. The ecosystems and vegetation baseline report does not provide separate summaries of vegetated ecosystems for each Project Component (sub-areas of the LSA). Since the Back River Vegetation Monitoring Plan is comprised of five different monitoring programs (footprint monitoring, vegetation monitoring, non-native plant monitoring, lichen monitoring, WIR monitoring), it would be more useful to present the most relevant background information for each program to enable better understanding of Sabina's monitoring methodology

Recommendation/Request:

The KIA requests/recommends the following:

- Please provide further rationale for vegetation monitoring plot allocation.

- Please present relevant background information for each vegetation monitoring program component - in this case, relevant study area and vegetation association information for WIR monitoring.

Sabina Response:

The selection of plots was chosen to be representative of landform, and vegetation within the study area. Given the extent of the Project Area and length of WIR, plots were established to capture variation introduced by terrain, landforms, drainage etc. Additionally, final plot locations were chosen based on available imagery, site access, and distributed along the entire length of the WIR to capture representative vegetation types.

KIA-22: Vegetation monitoring plots in 2019 compared to 2018**References:**

Appendix C. 2019 Vegetation Monitoring Program (Technical Memorandum dated 18 February 20120)

- Section 4.0, Table 1, Table 2

Summary:

The 2018 vegetation monitoring program assigned 72 plots (36 experimental, 36 reference) along the WIR. The 2019 program, however, consisted of only 46 paired experimental/reference plots along the WIR, meaning a 33% decrease in the sample size. Although the actual WIR alignment and, thus, the location of monitoring plots needed to change, the number of plots should be kept consistent for sufficient coverage of the study area.

Detailed Review Comment

Section 4.0 (Methods) of the 2019 Vegetation Monitoring Program technical memo indicates that, for the 2018 monitoring program, 72 baseline vegetation monitoring plots were established (36 reference and 36 experimental). Due to “several small route optimizations” for the inaugural WIR in 2019, “a portion of the experimental plots [fell] outside of the current footprint” and a total of 15 experimental plots were relocated to “provide sufficient experimental plot coverage on the WIR footprint”. Tables 1 and 2 then show that a total of 56 vegetation monitoring plots (46 paired experimental/reference along WIR, 10 standalone experimental within Goose Property and MLA).

This means that 26 plots along the WIR (amounting to 36%) have been removed between the 2018 and 2019 vegetation monitoring programs. This is a substantial change in sample size and it is unclear how experimental plot coverage can still be sufficient, unless the 2018 program involved much oversampling. The total length of the WIR has presumably not changed; therefore, a better study design would be to fully replace all plots that needed to move and to maintain a target of 72 plots for the WIR monitoring program. Without scientifically justified rationale for plot allocation and sample sizes, it is difficult for the KIA to determine whether Sabina’s vegetation monitoring program methods are appropriate to meet the objectives

Recommendation/Request:

The KIA requests/recommends the following:

- Please provide rationale for reducing the number of paired monitoring plots along the WIR by 33% between 2018 and 2019.
- Please assign more replacement plots for the next year of vegetation monitoring such that the overall monitoring

Sabina Response:

Paired plots were reduced along the WIR given that road alignment shifted between 2018 and 2019 and many plots from 2018 then fell outside of the current alignment, or were initially established along potential route spurs/options that were ultimately not used. Forty-six paired monitoring plots should be sufficient to capture variation in disturbance, and vegetation communities, within the WIR. As per the 2019 Vegetation Monitoring Plan (VMP), an additional 44 monitoring plots will be established at both the Goose and MLA locations at defined distance intervals from Potential Development Area (PDA) boundaries to quantify and capture project related effects.

KIA-23: Timing of vegetation monitoring program data collection

References:

Appendix C. 2019 Vegetation Monitoring Program (Technical Memorandum dated 18 February 20120)

- Section 4.0

Summary:

The timing of field data collection for the Back River vegetation monitoring program is not fully consistent with Sabina/Golder's rationale. Climate change effects may also need to be considered for Arctic plant phenology.

Detailed Review Comment

Section 4.0 (Methods) of the 2019 Vegetation Monitoring Program technical memo explains that 2018 data collection was completed from July 11 to 16, 2018 and that 2019 data collection was completed from July 24 to 31, 2019. The rationale for timing is presented on page 6 of the technical memo, which states that "sampling was conducted during the peak flowering period for most species when fruiting structures were likely to be present... in early summer (i.e., early July)." The KIA notes that the 2019 field data collection period would not be considered early July. Would vegetation identification have been compromised at this later time of year in 2019? It is important that data collection for the vegetation monitoring program be conducted at the most appropriate time for vegetation identification, since assessments of species richness will depend on accurate identification.

It is also important to consider the effects of climate change on Arctic plant phenology during subsequent years of vegetation monitoring for the Back River project. Panchen and Gorelick (2017) found that flowering times and seed dispersal times were most strongly correlated with June and July temperatures, respectively. The authors also noted that seed dispersal times have advanced over the past 120 years, likely as a result of increasing late-summer temperatures in Nunavut. Determining the optimal period(s) for vegetation data collection may require adaptive management and should integrate local knowledge and observations.

Recommendation/Request:

The KIA requests/recommends the following:

- Please provide an explanation for why the 2019 vegetation data collection was later than what was specified in their rationale. Was 2019 an abnormally cold year with much delayed phenology? If field data collection cannot be performed during the optimal survey period, acknowledgment of limitations/caveats should be provided in the monitoring report/memo.
- Please review and revise the optimal timing for vegetation data collection for subsequent years of monitoring, as appropriate, based on scientific and local knowledge.

Sabina Response:

Although vegetation sampling periods varied slightly between 2018 and 2019 monitoring events, sampling was still conducted during the peak flowering period for most species. The ability to correctly identify vegetation was not comprised due to these minor differences between years and the field sampling period in both 2018 and 2019 fell within the optimal flowering period. Phenology and optimal flowering period can vary from year to year and is likely dependent on temperature, with peak flowering generally occurring in the month of July.

KIA-24: Inconsistent number of non-vascular plant species identified in 2019

References:

Appendix C. 2019 Vegetation Monitoring Program (Technical Memorandum dated 18 February 20120)

- Section 5.0, Page 9; Tables 8 and 9
- Appendix C

Back River Vegetation Monitoring Plan, January 2020

- Section 5.5, Table 5.5-1

Summary:

There are discrepancies in the number of non-vascular plant species presented within the Results and between the Results and Appendix C (species list). Inaccuracies may have implications for comparisons of species richness by vegetation associations and between experimental and reference plots.

Detailed Review Comment

Section 5.0 (Results) of the 2019 Vegetation Monitoring Program technical memo begins with a summary of the number of vegetation species identified. A total of 36 non-vascular plants was reported; however, the numbers in brackets (18 bryophytes and 16 lichens) do not add up to 36 (adds to 34), and Appendix C only lists 12 bryophyte species rather than 16. Please ensure that the correct results are presented in this technical memo, as these numbers will have implications for the comparisons of species richness by vegetation association and between experimental and reference plots in Tables 8 and 9. One of the measurable parameters for the WIR Monitoring Program is “quantitative assessment of plant species richness (diversity)” (Table 5.5-1, Back River VMP [Jan 2020]), and accurate monitoring data (e.g., species identification and enumeration) are needed to produce accurate analyses of potential project impacts and the effectiveness of mitigation measures. Presentation of inaccurate monitoring results may also suggest inadequate QA/QC procedures for the Vegetation Monitoring Program.

Recommendation/Request:

The KIA requests/recommends the following:

- that Sabina review the 2019 vegetation monitoring data collected and make corrections to all applicable sections of the monitoring report/memo, as there appear to be several errors.
- If additional QA/QC measures are needed for the program to ensure accuracy, Sabina should document these measures in the next revision to the VMP and ensure that they are implemented.

Sabina Response:

Observed errors are likely related to reporting of plant species classified to Genus level only. Appropriate QA/QC processes have been, and will continue to be, implemented for this program. Numbers as reported can be revisited and clarified/confirmed, where required.

KIA-25: Additional vegetation species of conservation concern

References:

Appendix C. 2019 Vegetation Monitoring Program (Technical Memorandum dated 18 February 20120)

- Section 5.0, Page 9

Back River Vegetation Monitoring Plan, January 2020

- Section 5.2.2

Back River Project Wildlife Mitigation and Monitoring Program Plan (Version 10, October 2019):

- Section 4.1, Table 4.1-1

Rescan 2013. Back River Project: 2012 Ecosystems and Vegetation Baseline Report.

- Sections 2.7.1, 3.10.1

Summary:

There is additional vegetation species of conservation concern aside from those listed as Endangered, Threatened, or Special under the federal Species at Risk Act that should be noted during data collection for the Vegetation Monitoring Program. While Sabina considers territorial status for wildlife species, they do not give the same considerations to vascular and non-vascular plant species.

Detailed Review Comment

The first paragraph of Section 5.0 (Results) of the 2019 Vegetation Monitoring Program technical memo states that no invasive species or federally listed plant species were observed during field surveys. The Back River VMP (Jan 2020) focuses only on rare plants “defined as vascular and non-vascular species listed under SARA Schedule 1 and species with “Endangered”, “Threatened”, or “Special Concern” status” (presumably including those listed under Schedule 3, although this is unclear). The KIA requests that Sabina consider the territorial status for vegetation (which Sabina does for wildlife; see Table 4.1-1 of WMMP Plan v.10). In the Canadian Endangered Species Conservation Council’s (CESCC) Wild Species 2015 Report, there are 461 vascular plant, bryophyte, and microlichen species listed as S1, S2, or S3 (Critically Imperiled, Imperiled, or Vulnerable, respectively) in Nunavut (CESCC, 2016). Although not all of these species will be applicable to the Back River project, those that may be present in and around the study area should be identified and protected, even if they are not officially on Schedule 1 of the federal SARA. A more comprehensive consideration of rare plants and vegetation species at risk would demonstrate due diligence and Sabina’s commitment to protect species that are considered Critically Imperiled, Imperiled, and Vulnerable in Nunavut, particularly as these species may be added to Schedule 1 of the federal SARA in the future.

Neither the VMP (Jan 2020) nor the 2019 Vegetation Monitoring Program technical memo provides a list of the federal SARA-listed plant species to be aware of, which would be informative for the reviewer. To date, there is one plant species with its range in Nunavut listed under SARA Schedule 1 (Porsild’s Bryum), and several plant and lichen species listed under SARA Schedule 3 as Special Concern. The KIA notes that the Back River Ecosystems and Vegetation Baseline Report found a total of 90 rare species in the LSA and reference areas, including 41 vascular plants, 31 lichens, and 18 mosses. The baseline report acknowledged that none of these rare species were listed under SARA or by COSEWIC at the time. In addition, at the time of the 2012 rare plant surveys, there was no S-rank system for Nunavut plants and, thus, Table 3.10-4 (Summary of Rare Species Found in the LSA) had many “N/A” entries. However, the

CESCC has since implemented an S-rank system for Nunavut and a revised summary list may reveal that the project could impact a number of rare and at-risk species.

Recommendation/Request:

The KIA requests/recommends the following:

- Please identify S1, S2, and S3 vascular and non-vascular plant species that are known or potentially occurring at the Back River Project.
- Please include and list both federal and territorial vegetation species of concern in the Back River Vegetation Monitoring Plan, with regular review and revision as needed.

Sabina Response:

The focus of the VMP is to quantify the potential impacts on vegetation from the Project, specifically by looking at plant species composition, plant height, species and surface substrate percent cover and plant health or vigour. Should any federally listed plant species (those listed under Schedule 1 of SARA), be observed, these will be reported immediately. Subsequent year's monitoring reports will include the list of federally listed plant species with potential to occur in the LSA. Monitoring reports will also be updated to include the Wild Species Status (2015).

KIA-26: Lack of statistical analyses and comparisons against vegetation monitoring criteria to trigger adaptive management and mitigation

References:

Appendix C. 2019 Vegetation Monitoring Program (Technical Memorandum dated 18 February 20120)

- Section 5.0

Back River Vegetation Monitoring Plan, January 2020

- Section 5.5, Table 5.5-1
- Section 6, Page 22
- Section 8

Back River Project 2019 Annual Report (March 31, 2020)

- Section 4.5.9, Project Certificate Condition No. 34

Summary:

The 2019 Vegetation Monitoring Program technical memo does not include any statistical analyses and provides very little discussion on the results and data interpretation. There are no formal comparisons against the WIR monitoring criteria specified in the Back River Vegetation Monitoring Plan. However, the results presented in this memo suggest that these criteria may be exceeded, which should trigger adaptive management and additional mitigation measures to reduce the project's impact on vegetation.

Detailed Review Comment

The 2019 Vegetation Monitoring Program technical memo does not provide any statistical analyses comparing vegetation heights (Tables 4 and 5), surface substrate percentages (Tables 6 and 7), or species richness (Tables 8 and 9). Discussion of the results is extremely limited, and where the report did acknowledge apparent differences, there were no statistical analyses to support interpretations. This does not comply with Section 5.5, page 19 of the Back River VMP (Jan 2020), which states that "data analysis will focus on evaluating trends and determining if there are statistical differences in plant species composition and abundance between impacted WIR and control plots." The following are examples of results that would benefit from statistical comparisons and further discussion:

- Vegetation height: there appear to be marked differences between the heights of forbs in cottongrass sedge fen (WC) and mesic dwarf tundra (TL), heights of bryophytes in tundra seepage (TS), and heights of graminoids in undifferentiated tundra (TU) in impacted/disturbed experimental versus reference plots (Table 5).
- Surface substrate: there was less vegetation cover and more bare ground and litter on impacted experimental plots in raised box complex (WB) and dry sparse tundra (TH) than on the reference plots (Table 7). There was also more litter on impacted experimental TS and TU plots than on reference plots. The KIA assumes that litter is a proxy for plant community health, although a definition of litter for the purposes of vegetation monitoring was not provided in this technical memo or the VMP.
- Species richness: Within TL, there was lower species richness in impacted experimental plots compared to both non-impacted experimental plots and reference plots (Table 8). Table 9 shows that this difference is mostly due to 50% fewer lichen species in the impacted experimental plot. The brief results discussion does not mention the potential loss of lichen in visibly disturbed areas along the WIR.

In addition to the lack of statistical comparisons between experimental and reference plots for the 2019 vegetation monitoring program, there was no evaluation of trends between data collected in 2018 versus 2019. As discussed in KIA-NIRB-22, the Methods section explained that “a portion” of the experimental plots needed to be relocated. This wording implies that a number of plots were still useful for WIR monitoring and inter-annual comparisons of these plots could have been made. However, Table 2 shows that only 17 pre-existing plot locations (16 reference, 1 experimental) were retained for the 2019 program (meaning that 76% of the original 72 plots established in 2018 were not re-sampled). It is unclear whether the other 40 plots (minus the 15 plots that were adjusted in 2019) also fell outside the re-aligned WIR footprint. If these plots were useable and had been kept for the 2019 program, Sabina would have vegetation monitoring data before and after construction of the inaugural WIR in 2019, which may have provided further insight into project impacts on vegetation.

Furthermore, the 2019 Vegetation Monitoring Program technical memo does not evaluate the monitoring results against the WIR Monitoring criteria, which are described as follows: “It is anticipated that shrubby and woody plants will be damaged by winter ice road usage, but that overall vegetation ground cover will not be reduced (i.e. that ice road usage will not result in increase of exposed soils at the ground surface” (Table 5.5-1 of the VMP [Jan 2020]). Monitoring criteria are meant to inform project mitigation and adaptive management; page 22 of the VMP states that “indications of the need for corrective actions and additional control measures may include: If vegetation monitoring criteria are exceeded.” As shown in the 2019 Vegetation Monitoring Program technical memo, the largest difference in species richness between impacted and reference plots was the shrub layer (Table 9 and discussion on p. 16), and there was an increase in bare ground for two vegetation associations (Table 7 and discussion on p. 13). These results suggest that the vegetation monitoring criteria may have been exceeded (although statistical analyses would be more informative) and that adaptive management is needed for the WIR.

It is unclear whether Golder was not tasked with results interpretation, in which case the KIA would expect Sabina to append Golder’s technical memo with further discussion about the monitoring results in relation to the WIR monitoring program as a whole. Section 8 (Environmental Reporting) of the VMP (Jan 2020) states that an annual Vegetation Monitoring Summary Report will be completed and submitted with the annual report to the NIRB, which will “provide the methodology, results, as well as a comparison to impact predictions or historical results.” As detailed in this review comment, a comparison to impact predictions or historical results has not been provided. The Back River Project 2019 Annual Report (March 31, 2020) does not provide any additional information on vegetation monitoring aside from this technical memo.

Recommendation/Request:

The KIA requests the following:

- Please complete statistical analyses and a fulsome discussion of vegetation monitoring results, as outlined in the Back River Vegetation Monitoring Plan (Jan 2020).
- Please complete a comparison of vegetation monitoring data against WIR monitoring criteria to determine whether adaptive management and additional mitigation should be applied.
- Please provide further information on why only a certain percentage of pre-existing plots was retained for the 2019 vegetation monitoring program, as this information could have provided valuable vegetation data pre- and post-construction of the inaugural WIR.

Sabina Response:

Initial VMP plots were established in 2018. In 2019, portions of the WIR alignment shifted as compared to the 2018 WIR location. Therefore, new monitoring plots were established to replace plots from 2018 that were no longer relevant to the monitoring program. Consequently, 2018 and 2019 data will collectively represent baseline conditions. The VMP will be implemented moving forward (i.e., 2020 onwards). As additional data is collected in future years, analysis will focus on evaluating trends and determining if there are statistical differences in plant species composition and abundance between impacted WIR and control plots, and between monitoring years.

Given the baseline nature of the 2018 and 2019 data, statistical analysis of the data at this point provides little useful information. Statistical analyses will be completed moving into the true monitoring phase of the project and will be used to identify adaptive management and mitigation needs.

Only a certain percentage of pre-existing plots were included as part of the 2019 vegetation program because only plots occurring within the 2019 WIR alignment/disturbance were included. Data from 2018 omitted in the 2019 report is still retained by Sabina and may be included in future reports as additional baseline data, where applicable.

KIA-27: Missing information - specified as part of monitoring methods but not presented in results

References:

Appendix C. 2019 Vegetation Monitoring Program (Technical Memorandum dated 18 February 20120)

- Section 4.0, Pages 6-7
- Section 3.0

Back River Vegetation Monitoring Plan, January 2020

- Section 5.5, Table 5.5-1

Summary:

The vegetation monitoring program methods describe collection of several parameters, including plant vigour, moisture regime, and nutrient regime, that are necessary for meeting the program objectives. However, these parameters were not presented in the results of the monitoring report/memo. For some types of information, such as wildlife use and decayed wood, it is not clear whether none was observed, if the methodology changed, or if the results were not presented for another reason. Additional details about disturbance classes would improve understanding of the report/memo and may aid in meeting the objectives of the vegetation monitoring program.

Detailed Review Comment

The 2019 Vegetation Monitoring Program technical memo includes parameters to record as part of the program methodology; however, not all of these parameters are presented in the Results section. Pages 6-7 of Section 4.0 (Methods) list the information that was collected at each site as part of detailed plot assessments, including (but not limited to):

- Vigour class or overall plant health of vascular plant species, using qualitative analytical approaches following the Ecological Land Survey Site Description Manual (AEP 1994);
- Dominant structural stage, moisture regime, and nutrient regime; and,
- Wildlife sign (e.g., fecal pellets, browsing/grazing, beds, digging) observations, if present.

As shown in Table 5.5-1 of the Back River VMP (Jan 2020), Vegetation Vigour is the monitoring indicator for the WIR Monitoring Program, and the measurable parameters include quantitative and qualitative (photographic) assessment of vegetation vigour. This parameter is, therefore, a crucial part of the vegetation monitoring program but is missing from the monitoring results. Without collecting and/or presenting the results of critical parameters for the WIR Monitoring Program, Sabina is not complying with their VMP and it is unclear how they will meet their monitoring objectives.

While dominant structural stages are presented in Table 3, moisture regime and nutrient regime are not discussed further. Page 6 of the memo explains that “moisture and nutrient regimes signify the relative moisture and nutrient supply available to vegetation and are limiting factors in vegetation growth.” Changes in moisture and nutrient regimes would enable a better understanding of indirect effects of the WIR on plant communities, may help identify unanticipated effects of the project, and may provide an early warning of undesirable change to the environment and to inform adaptive management strategies – these are three of the objectives outlined in Section 3.0 of the 2019 Vegetation Monitoring Program technical memo.

Regarding wildlife sign, percent cover of animal pellets was one type of information collected for surface substrate materials; however, there was no reporting of other wildlife sign in the monitoring plots. There

was also no explanation of how the percent cover of animal pellets would be interpreted – do more pellets indicate higher quality habitat and better overall plant health (because this area has preferred forage), or are more pellets indicative of increased browsing and plant damage?

Furthermore, there is an inadequate explanation about disturbance classes (page 7) – is this assessment solely for human disturbance (i.e., WIR construction and operation) or does plant damage include wildlife use? The photographs in Appendix B are not of high enough resolution to be able to determine the type(s) of disturbance. Without separating/identifying the causes of disturbance (such as on the four plots assessed to have High and Very High levels of disturbance; Table 10), it would be difficult to measure and attribute direct loss and indirect effects to plant communities due to the WIR, and there would also be confounding factors when trying to monitor and evaluate the effectiveness of mitigation measures (objectives as stated in Section 3.0).

Finally, decayed wood was one category of information to record for percent cover of surface substrate materials. Decayed wood was not presented in Tables 6 and 7 – was this because none was found, or was decayed wood combined with another category (e.g., litter), or was it omitted completely? Decaying wood seems like an odd ground cover category to include in Arctic environments, and the reviewer wonders if this method was borrowed from a more southern site where decaying wood in the form of CWD is often measured.

Recommendation/Request:

The KIA requests the following:

- Please provide the monitoring results for plant vigour, moisture regime, and nutrient regime, as well as any observations of wildlife sign and decayed wood. These data are crucial for meeting the monitoring program objectives.
- Please provide additional details about the vegetation monitoring methods and data collected, including the purpose of collecting surface substrate information such as litter and animal pellets (i.e., how will these data be interpreted?), and whether disturbance classes consider both human and wildlife damage to vegetation.

Sabina Response:

Vegetation vigour is a qualitative parameter and although assessed, was only included in the monitoring results as part of the disturbance level. Moisture and nutrient regimes were also collected at each monitoring location and as these are measured qualitatively based on interpretations of vegetation species present, topographic position, and presence of standing water etc. These aspects were not discussed as there were no apparent changes resulting from use of the WIR.

Collecting incidental observations of wildlife pellets is completed only to illustrate that wildlife are present in the area. Wildlife pellet counts are beyond the scope of the vegetation monitoring program and collected incidentally to document wildlife presence and use. Disturbance to vegetation by wildlife is generally minor and easily discernable from anthropogenic damage, and therefore not included in disturbance classes. Any trails, browsing, or other wildlife-caused disturbance (if present) will be documented but no interpretations of this data will be made. Decayed wood as a litter substrate was included to indicate anthropogenic disturbance to shrubby species, being that damage to or death of shrubby species may increase the presence of decayed wood. Results of decayed wood were not presented in Tables 6 and 7 because no observations of decayed wood were made while collecting plot data.

KIA-28: Conclusion of the Rascal Stream East and Rascal Stream West - Supplemental Fish Habitat Assessment, Summer 2019

References:

Appendix G. Rascal Stream East and Rascal Stream West - Supplemental Fish Habitat Assessment, Summer 2019

Summary:

The Rascal Stream Fish Habitat Assessment lays out conditions for environmental data collection, and a primary task of surveying the fish habitat conditions during spring flows at the newly constructed bridge crossing; however, it is lacking in conclusory remarks to summarize the assessment.

Detailed Review Comment

The Rascal Stream Fish Habitat Assessment introduces the assessment with conditions for the environmental data collection, and a primary task of surveying the fish habitat conditions for Arctic Grayling during spring flows at the newly constructed bridge crossing, but is lacking in concise and clear conclusory remarks to summarize the assessment. This makes reading the assessment and gathering information from it difficult.

Recommendation/Request:

The KIA suggests the following:

- Include a designated conclusion Section summarizing the results along with concluding remarks on the tasks and conditions set out in Section C-1.0 Introduction.

Sabina Response:

The selected crossing design for Rascal Stream West (Reach 1) was a clear span bridge, which is a design that DFO can confirm will avoid impacts to fish and fish habitat (see DFO 2019). The results (and photographs) from the fish habitat inspection completed in 2019 also clearly demonstrate that the clear span bridge poses minimal risk to fish and fish habitat. There was no evidence of bank or shoreline erosion based on either a visual assessment or the summarized turbidity data, and the additional rockfill around the abutments of the bridge will provide additional protection during a high flow event in spring.

Reference:

DFO (Fisheries and Oceans Canada). 2019. Measures to protect fish and fish habitat. Available at: <https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html>

KIA-29: Rascal Stream West reach 1 - Turbidity Measurements

References:

Appendix G. Rascal Stream East and Rascal Stream West - Supplemental Fish Habitat Assessment, Summer 2019

Summary:

Turbidity measurements of Goose Lake Downstream are either lacking or duplicate data are presented.

Detailed Review Comment

In Section C-2.0, Table C-1, turbidity measurements for the different locations of Rascal Stream West Reach 1 are presented along with UTM Coordinates for each sampling location. The sampling locations for the three Goose Lake Downstream samples all share the same UTM Coordinates. Is the replicate sampling intentional (i.e., 3 replicate measurements taken at one location), or did the correct UTM coordinates not get included?

Recommendation/Request:

The KIA requests the following:

- Please provide clarification about the three samples collected downstream of Goose Lake. Please clarify if there are meant to be three replicate measurements for a single average measurement at one location (n=1, derived from 3 replicate measures), or whether the UTM coordinates are incorrect and should be three separate locations (n=3, with information on measurement replication requiring clarification).

Sabina Response:

The three measurements represent three separate surface water samples collected at the downstream sampling location, where each measurement was a mean of three sub-samples taken from each surface water grab. Given the accuracy of a Global Positioning System (GPS) in the North is highly variable depending on factors such as cloud cover and satellite coverage, reporting of one set of spatial coordinates seems reasonable given the small size of Rascal Stream where it enters Goose Lake.

KIA-30: Nunavut Environmental Guidelines related to air quality**References:**

Appendix H. Back River Project Air Quality Monitoring and Management Plan (July 2019)

- Section 6.1.2
- Section 6.1.3

Summary:

The AQMMP makes reference to an old version of the Nunavut Environmental Guidelines for Dust Suppression, and possibly an old version of the Nunavut guidelines/standards for incinerators. Sabina should ensure that the most up-to-date guidelines are adhered to.

Detailed Review Comment

Section 6.1.2 of the AQMMP concerns Sabina's Fugitive Dust Reduction Plan. The Plan makes several references to the GN's 2002 Environmental Guideline for Dust Suppression:

- "Dust suppression methods should be approved by the Government of Nunavut as outlined in the Nunavut Environmental Guideline for Dust Suppression (GN 2002a)."
- "As prescribed in the Nunavut Environmental Guideline for Dust Suppression (GN 2002a), application rate will follow the manufacturer's specifications and will be limited to the road surface."
- "If a product not currently approved for use in Nunavut will be used, an application for approval will be made to the GN following the requirements for new product approval which are outlined in the Nunavut Guideline for Dust Suppression (GN 2002a)."

The GN released an update of this guideline in April 2014, now entitled Environmental Guideline for Dust Suppression on Unpaved Roads (GN, 2014). If any of the guidelines that Sabina proposes to follow have changed, then the AQMMP would need to be updated and the new information communicated to relevant Project staff. References to the most updated guideline should be made, regardless.

In Section 6.1.3 (Incinerator Management Plan) of the AQMMP, Sabina states that incinerators installed for the project would comply with "Nunavut standards (GN 2002b)", which refers to the Nunavut Environmental Guideline for Air Quality - Sulphur Dioxide and Suspended Particulates. This document no longer appears to be available; the GN has released a 2011 Environmental Guideline for Ambient Air Quality, which includes standards for sulphur dioxide and total suspended particulates in Table 1 (GN, 2011). Regardless, the AQMMP's reference to this guideline seems incorrect as it does not have specifications for incinerators. A more appropriate reference would be to the GN's 2012 Environmental Guideline for the Burning and Incineration of Solid Waste, which includes air emission standards for solid waste incinerators in Section 2.4.1 (GN, 2012). The GN's 2012 guidelines are not currently referenced in the AQMMP (but they are noted in the Back River Incinerator Management Plan). Sabina should endeavour to present consistent information within related management plans and other Project documents.

Recommendation/Request:

The KIA recommends the following:

- Review the most up-to-date Government of Nunavut Environmental Guidelines and integrate any new standards or guidelines into the AQMMP, as needed.

- Ensure that related management plans have the same (and the most up-to-date) information by undertaking concurrent revisions.

Sabina Response:

As indicated by KIA, the Environmental Guideline for Dust Suppression on Unpaved Roads (GN 2014) has been updated from the original version (GN 2002a). Sabina will review the updated guidance from the Environmental Guideline for Dust Suppression on Unpaved Roads in its Fugitive Dust Reduction Plan, discussed in Section 6.1.2 of the AQMMP (July 2019). Future revisions of the AQMMP will reference the updated Environmental Guideline for Dust Suppression on Unpaved Roads.

As indicated by KIA, the Incinerator Management Plan discussed in Section 6.1.3 of the AQMMP (July 2019) refers to the 2002 Nunavut standards. This is a clerical error, as the current Nunavut Ambient Air Quality standards (GN 2011) are discussed in Section 4.1 of the AQMMP. Future revisions of the AQMMP will reference Table 3-1 of the Back River Project Incinerator Management Plan, which summarizes applicable legislation.

KIA-31: Mitigation schedule for emissions management**References:**

Appendix H. Back River Project Air Quality Monitoring and Management Plan (July 2019)

- Section 6.2, Table 6.2-1

Summary:

In the section of the AQMMP on emissions management, the summary mitigation schedule does not include the Project phases for which the Incineration Management Plan will be required/applied.

Detailed Review Comment

Section 6 of the AQMMP focuses on emissions management and describes three relevant project plans: Emissions and GHG Reduction Plan, Fugitive Dust Reduction Plan, and Incineration Management Plan (IMP). However, in the summary table of the various Project phases and relevant emissions management plans (Table 6.2-1), the IMP is not included. Although the KIA understands that there is also a standalone IMP, it would be useful to present a more complete summary table that includes all points discussed in the previous subsections.

Recommendation/Request:

The KIA recommends the following:

- Include the Incineration Management Plan in the summary table in Section 6.2, which will allow the reader to quickly understand the Project phases for which the IMP and other emissions management plans will be required and implemented.

Sabina Response:

Sabina will include the Incineration Management Plan in the summary table in Section 6.2 of the next revision of the AQMMP.

KIA-32: Adaptive management during extreme and abnormal weather conditions

References:

Appendix H. Back River Project Air Quality Monitoring and Management Plan (July 2019)

- Section 7.4
- Section 8

Back River Project 2019 Annual Report (March 31, 2020)

- Section 4.5.2, Project Certificate Condition No. 8

Summary:

Sabina's performance reporting for PC No. 23 states that the AQMMP includes a meteorological monitoring program to monitor local weather and adaptively manage potential impacts from extreme and abnormal weather conditions; however, no details about adaptive management for extreme conditions are presented in the AQMMP.

Detailed Review Comment

The objective of PC Condition No. 23 is "to monitor local weather and adaptively manage potential impacts from extreme or abnormal weather conditions." Sabina's performance reporting in the 2019 Annual Report for PC Condition No. 23, "Methods", indicates that their AQMMP includes a meteorological monitoring program to accomplish this objective. However, there is no discussion of extreme or abnormal weather conditions in either Section 7.4 (Meteorological Monitoring Program) nor Section 8 (Mitigation and Adaptive Management) of the AQMMP.

To ensure compliance with PC Condition No. 23, it would be helpful if Sabina outlined criteria or thresholds regarding what constitutes "extreme or abnormal weather conditions", clearly explained how these conditions may exacerbate known/anticipated project impacts, and provide specific mitigation measures in case these weather conditions arise (e.g., temporary shutdown of activities). Although the first paragraph of Section 8 includes a statement that "the need for any corrective actions to on-site emission management or installation of additional control measures will be determined on a case-by-case basis", Sabina should have planned mitigation measures for various scenarios in place prior to experiencing unusual situations.

Recommendation/Request:

The KIA recommends the following:

- Provide a description of extreme and abnormal weather conditions that may require adaptive management for potential impacts.
- Develop and include in the AQMMP specific mitigation or control measures that would be applied in the case of extreme or abnormal weather conditions.

Sabina Response:

Ideally 10 or more years of meteorological observations would be available to determine site-specific thresholds for extreme or abnormal weather conditions. Particulate matter was identified as a potential concern during the EA under high wind or dry conditions. The mitigation measures named in the Fugitive Dust Reduction Plan, discussed in Section 6.1.2 of the AQMMP (July 2019), will be applied proactively as part of the actions taken to monitor and manage dust. In addition to these actions, air quality monitoring for dustfall and particulate per the AQMMP will take place during Construction and Operations, which

can be compared against the relevant air quality standards and guidelines, and proactively mitigate dust impacts. The monitoring data will be used to adaptively modify the Fugitive Dust Reduction Plan procedures incorporated at site, if required. Industry guidance such as the Environmental Guideline for Dust Suppression on Unpaved Roads (GN 2014) during high wind and drought conditions will be applied in the absence of thresholds.

KIA-33: Operation of incinerator

References:

Appendix I. Back River Project Incineration Management Plan (July 2019)

- Section 6.0
- Section 6.2
- Appendix A. Ketek CY-100-CA Incinerator Manual, Section 6

Summary:

During each cycle of burning in the incinerator, the start of the burn cycle is to be observed by the operator for a defined amount of time. Although the burn cycle is automated, observation is required to confirm correct initial function and safety. Within the document, there are contradictory statements about the observation time for burns in the incinerator

Detailed Review Comment

In Section 6.0 Operation and Maintenance, the following is stated:

“The operator will observe the start of the burn cycle for at least 15 minutes to ensure the incinerators are operating correctly.”

In Section 6.2 Incinerator Operation, the following is stated:

“The complete system is automated from start to finish, however, after loading the waste, the operator is required to remain present to supervise the beginning of the process (start-up), generally the first hour of the burn.”

These contradictory statements for observation time of the starting cycle of the burn process need to be addressed. Improper instructions to the incinerator operator may lead to confusion and could become a safety issue, as well as the burning process not functioning properly or burning at incorrect temperature ranges, which could manifest in environmental impacts.

Further, in Section 6 (Operation and Maintenance) of the CY-100-CA Manual, the following is stated: “After about 2-3 hours into the burning process, open the door and check the status of the waste and rake if necessary.” And further, “After about approximately 1 hour after the rake, check the waste status again, if not burned then rake it and close the door.”

Please include these steps of the burning cycle into the Incineration Management Plan to ensure proper incineration of waste material. Improper burning of waste materials can lead to unwanted environmental ramifications.

Recommendation/Request:

The KIA requests the following:

- Please address the inconsistencies in the duties of the incinerator operators and the required observation period during burn start-up.
- Include raking procedure as dictated in Section 6, Operation and Maintenance, of the CY-100-CA Manual into the Incineration Management Plan.

Sabina Response:

Sabina has made the necessary clarifications in the attached updated Incinerator Management Plan (Attachment A).

KIA-34: Environmental Reporting

References:

Appendix I. Back River Project Incineration Management Plan (July 2019)

- Section 10

Summary:

Report on any open burning activity in the incineration summary report.

Detailed Review Comment

Of the information that is to be included in the incineration summary report, KIA would request that any instances of open fire burning, and the content of what is burnt, to be included. If no open burnings occur, this is also valuable information to include.

Open burning activity can lead to environmental impacts via spread of uncontrolled ash and smoke with varying content, and act as a wildlife attractant depending on what is being burned.

Recommendation/Request:

KIA requests the inclusion of information regarding any open fire burnings in the incineration summary report.

Sabina Response:

Open burning is conducted in accordance with the requirements of Water Licence 2AM-BRP1831 and is reported in the annual report for that licence. No open burning took place in 2019.

2.2 RESPONSE TO CROWN-INDIGENOUS RELATIONS AND NORTHERN AFFAIRS CANADA

CIRNAC-#1: Project Certificate (PC) Term and Condition (T&C) #7: Mine Closure and Reclamation Plan

References:

2019 Annual Report, Pages 4-16 to 4-17

Summary:

n/a

Detailed Review Comment

T&C #7 requires Sabina to submit the plan to the Nunavut Impact Review Board (NIRB) at least 60 days prior to the start of construction, with results submitted annually thereafter or as may otherwise be required by the NIRB. In the “Methods” section of the 2019 Annual Report, Sabina stated:

“in conjunction with the Type A Water Licence Application, Sabina submitted an updated Interim Closure and Reclamation (ICRP, October 2017)”.

As required by the reporting requirement of the Project Certificate, in the “Next Steps” section, Sabina stated:

“Sabina will update the latest version of the ICRP (October 2017) and submit to the NIRB at least 60 days prior to the start of construction, with results submitted thereafter annually or as may otherwise be required by the NIRB”.

But, in the “Result” section, Sabina stated:

“in July 2018, additional feedback was received from stakeholders during the Type A Water Licence regulatory review process. This feedback, as well as Sabina’s final response and commitments, will be incorporated into the next iteration of the ICRP. Sabina proposes to complete the next comprehensive iteration of the ICRP within 12 months following the commencement of the Operation Phase”.

The timelines proposed in the “Next Steps” and “Results” sections are inconsistent, and it is unclear if “the next comprehensive iteration of the ICRP” (mentioned in the “Results” section) is same as “the latest version of the ICRP” (mentioned in the “Next Steps” section). If “the next iteration of the ICRP” and “the latest version of the ICRP” are the same, it is unclear why different timelines are proposed in the “Results” section (12 months following the commencement of the Operation Phase) and the “Next Step” section (60 days prior to the start of construction).

Recommendation/Request:

CIRNAC recommends that Sabina provide clarification/justification for these discrepancies in timelines stated in the “Results” and “Next Steps” sections.

Sabina Response:

Sabina acknowledges the inconsistency in the above stated timelines and provides the following clarity.

Sabina anticipates that an amendment to the Type A Water Licence (2AM-BRP1831) may be required to update the approved Interim Closure and Reclamation Plan and cost estimate (ICRP; WL SD-26) to reflect changes associated with the 2020 Modification Package, as well as potential advancements in operation and technology. Sabina recognizes that additional consultation and discussion with KIA and CIRNAC, in conjunction with oversight from NWB, will be required to address any monetary and/or staging changes associated with this application. Sabina will follow all appropriate NWB processes associated with this Water Licence amendment, and will work in a timely, collaborative manner with KIA, CIRNAC, and NWB on any related Project security revisions in consideration of the 2020 Modification Package. Sabina notes that the current monetary amount, staging, and regulatory divisions between KIA and CIRNAC, required in Part C of the Type A Water Licence (2AM-BRP1831), remains valid until otherwise approved by the NWB.

In addition, Sabina clarifies a previously stated error that feedback received in July 2018 would be incorporated in future iterations of the ICRP. Sabina corrects this statement and confirms that the July 2018 feedback from KIA and CIRNAC received during the Type A Water Licence regulatory review process, as well as Sabina's final response and commitments, were addressed in the ICRP and closure cost estimate that were incorporated into the Type A Water Licence issued in September 2018 (2AM-BRP1831).

CIRNAC-#2: Project Certificate (PC) Term and Condition (T&C) #8: Weather Monitoring and Adaptive Management

References:

2019 Annual Report, Page 4-18

Summary:

n/a

Detailed Review Comment

T&C #8 requires Sabina to "...provide a summary report of meteorological conditions experienced within the project area..." during all project phases (Pre-construction, Construction, Operations, Temporary Closure/Care and Maintenance, Closure and Post-Closure).

In both 2018 and 2019 Annual Reports, Sabina stated that "results and analysis will be provided once monitoring during the Construction Phase of the Project has commenced". This statement suggests Sabina does not intend to submit monitoring results during Pre-construction as stipulated in the T&C #8. CIRNAC notes that failure to provide meteorological data during pre-construction phase may constitute non-compliance with this condition.

During the review of the 2018 Annual Report for Back River, CIRNAC recommended that Sabina provide justification for not providing a summary report of the meteorological conditions experienced within the project area during pre-construction or alternatively, provide summary results and analysis of pre-construction meteorological conditions within the project area in subsequent annual reports. In response, Sabina stated:

"In 2018, Sabina was undertaking on-site field inspections of existing monitoring equipment to assess its health and ensure its proper working order. With the completion of Atmospheric baseline data collection related to the Back River Project Environmental Assessment, meteorological stations on-site received minimal service. While servicing of the Project's meteorological stations is ongoing, Sabina will provide any available summary results and analysis of the 2019 meteorological conditions in the 2019 Annual Report".

The 2019 Annual Report provided for review does not contain any summary report of meteorological conditions nor justification for not providing this information.

Recommendation/Request:

CIRNAC recommends, as it recommended for the 2018 Annual Report, that Sabina provide justification for not providing a summary report of the meteorological conditions experienced within the project area during pre-construction phase.

Sabina Response:

Due to site logistics, meteorological station data were not available at the time of the report. The George and Goose meteorological stations have since been accessed and a summary of the meteorological conditions is presented below. Sabina continues to review the station conditions and is planning to perform scheduled routine maintenance in 2020.

The available data range was from 13 June to 9 September 2014 for the George Station, and 28 April 2017 to 1 June 2019 for the Goose Station. Averages in the graphs refer to the average hourly data over the monthly time periods presented.

George Station Data Summary

The George Station data were reviewed, and anomalous data were removed for this summary. Relevant data items are presented below. A full annual data set was not available.

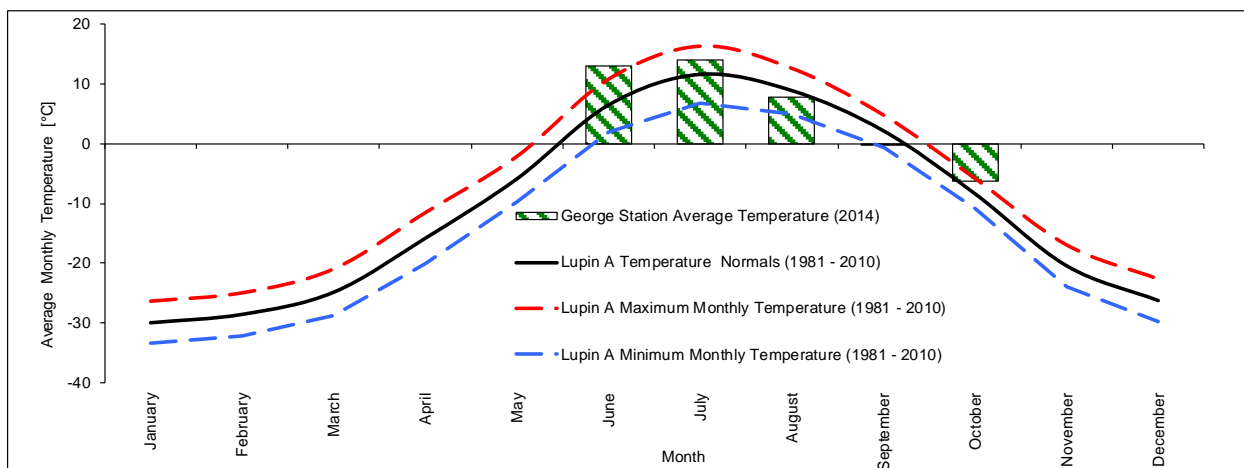


Figure 1: George Station 2014 Monthly Temperature Summary

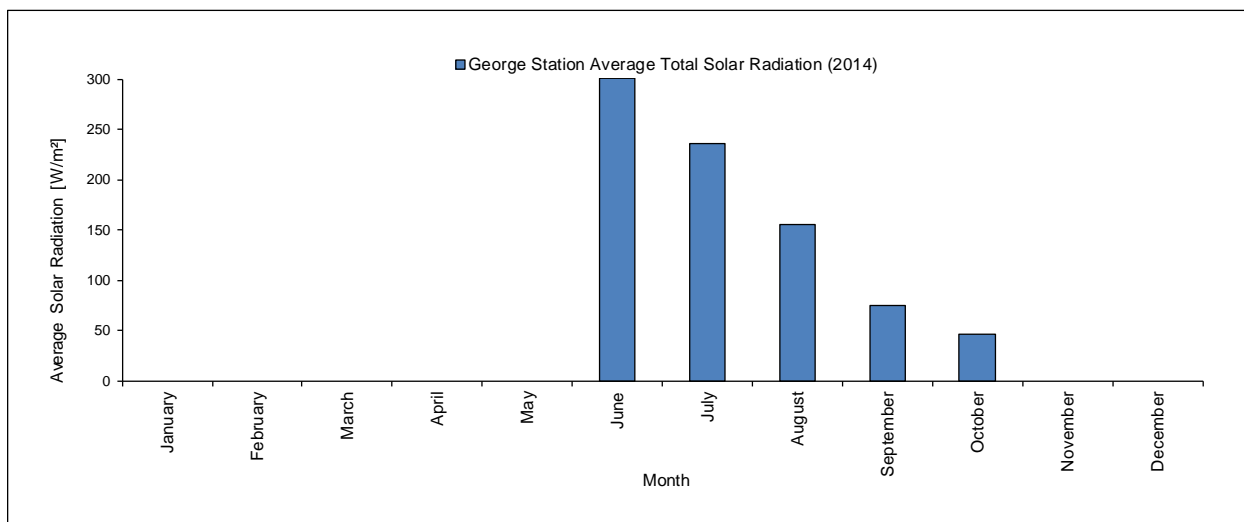


Figure 1: George Station 2014 Monthly Solar Radiation Summary

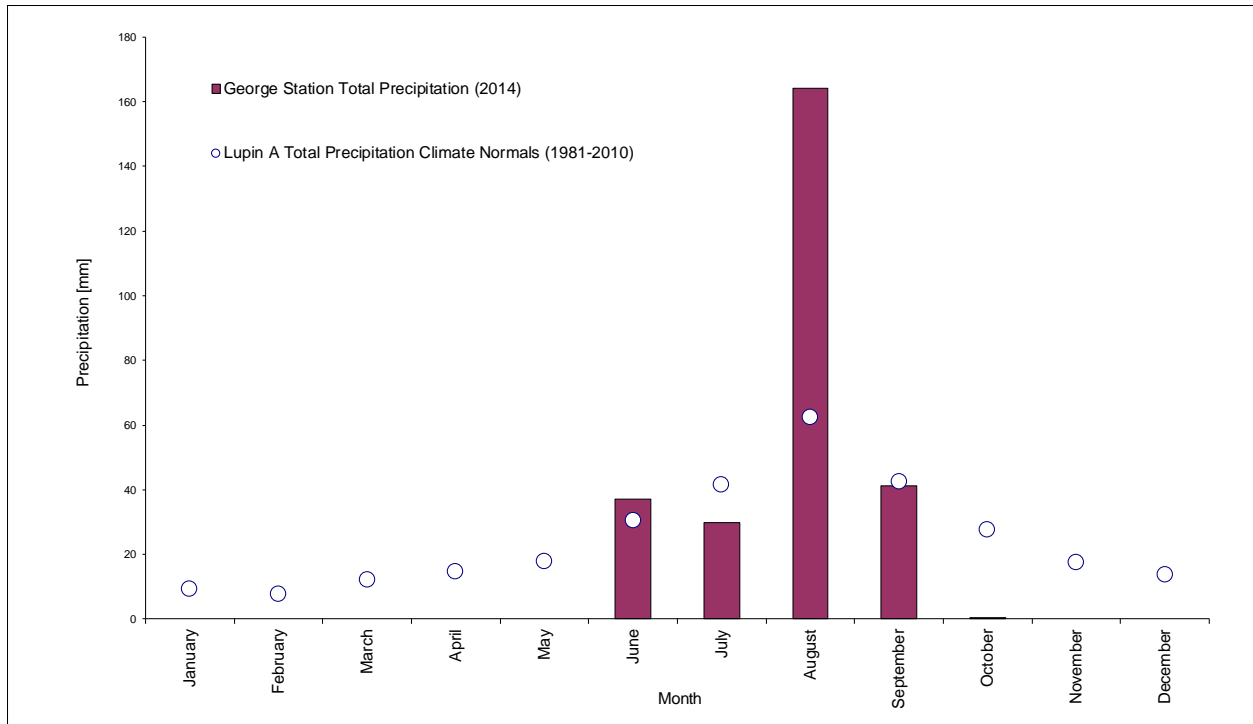


Figure 3: George Station 2014 Monthly Precipitation Summary

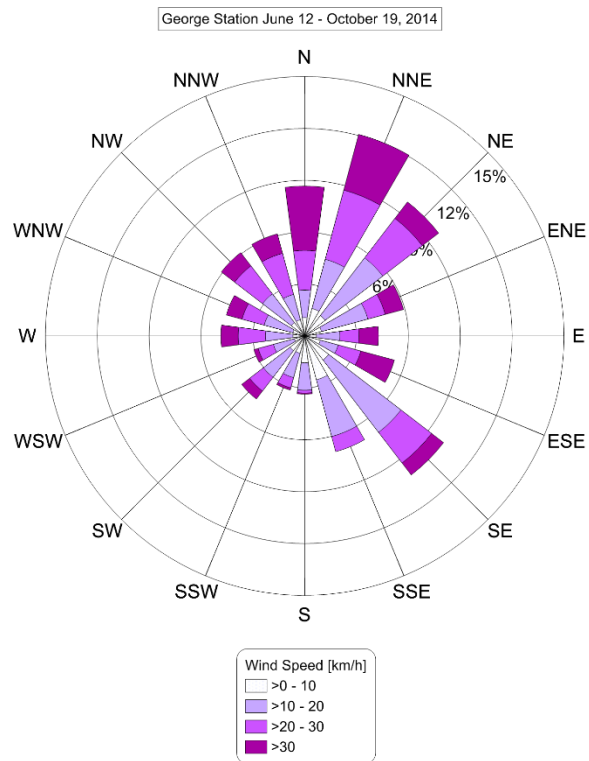


Figure 2: George Station 2014 Partial Year Wind Rose

Goose Station Data Summary

The Goose Station data were reviewed, and anomalous data were removed for this summary. Relevant data items are presented below. Excepting for 2018, a full annual data set was not available.

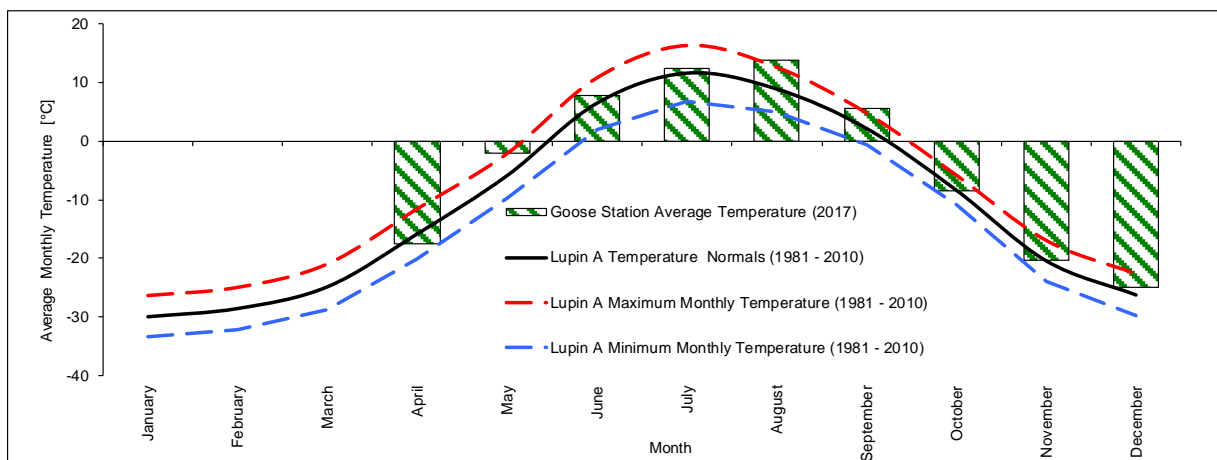


Figure 5: Goose Station 2017 Monthly Temperature Summary

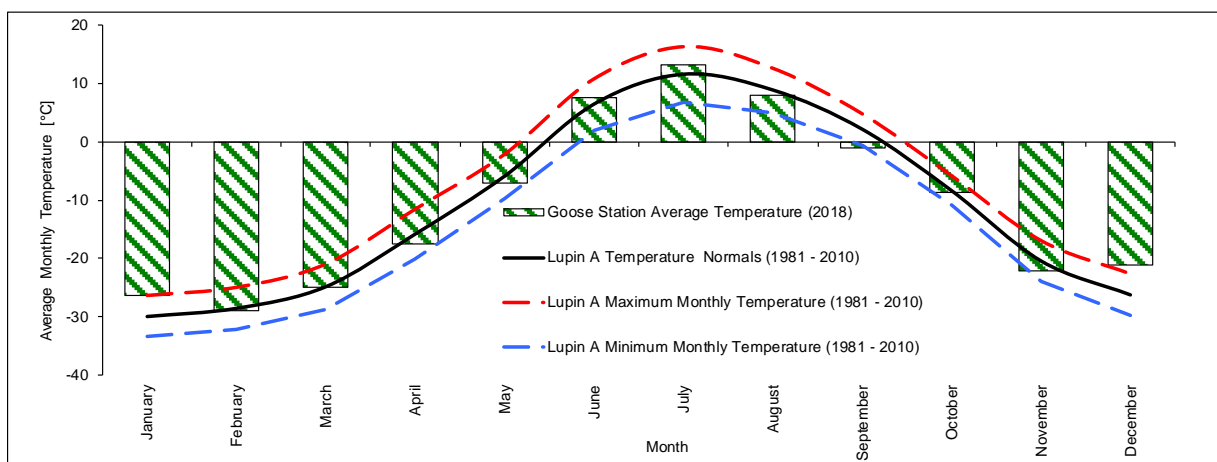


Figure 6: George Station 2018 Monthly Temperature Summary

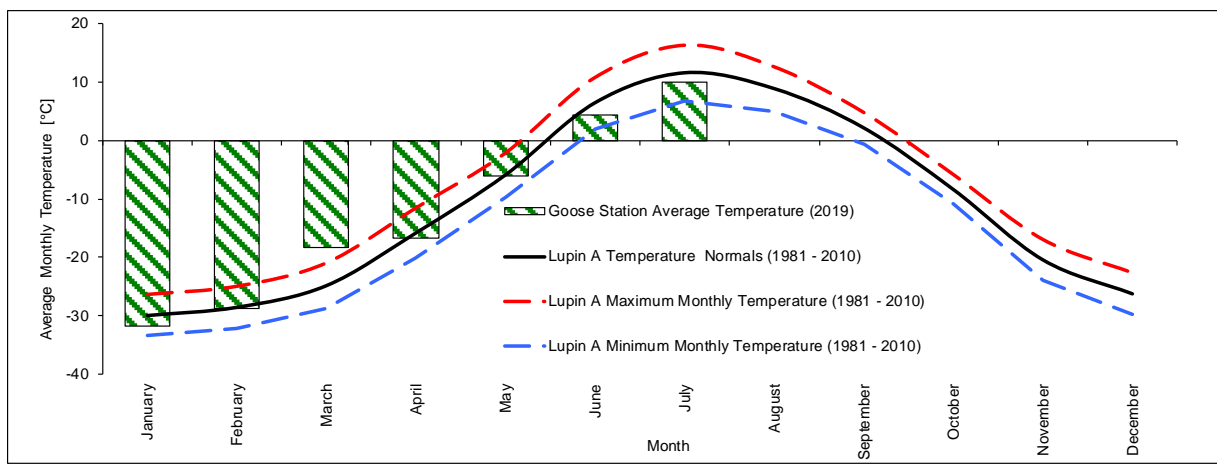


Figure 7: Goose Station 2019 Monthly Temperature Summary

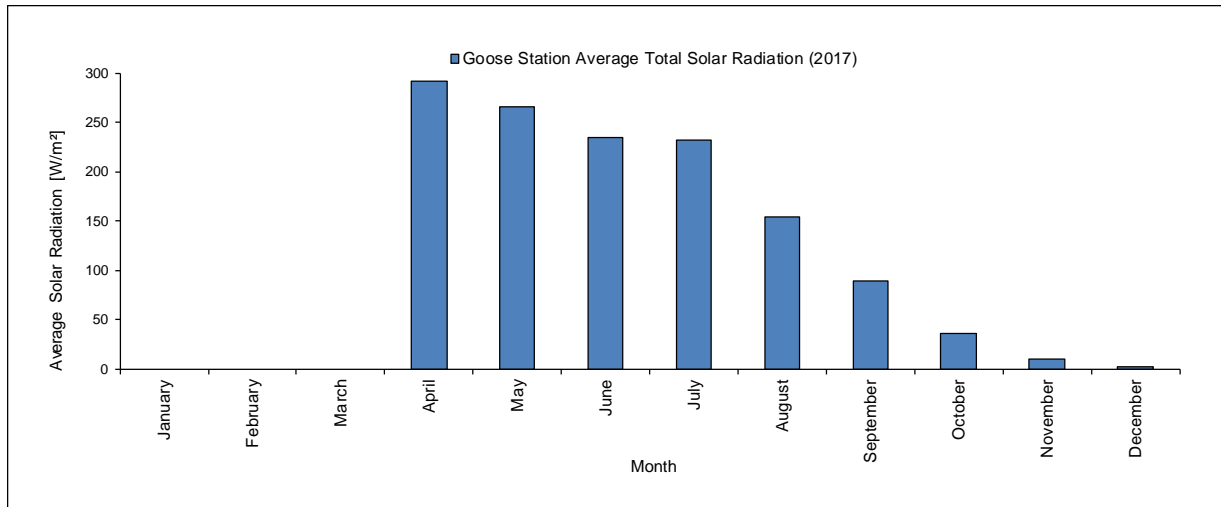


Figure 8: Goose Station 2017 Monthly Solar Radiation Summary

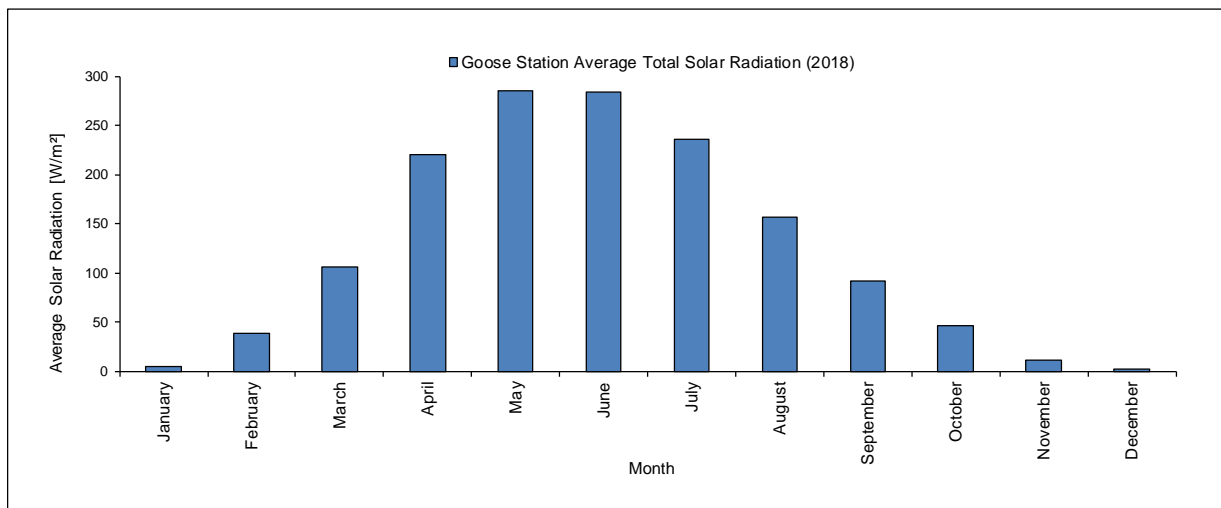


Figure 9: Goose Station 2018 Monthly Solar Radiation Summary

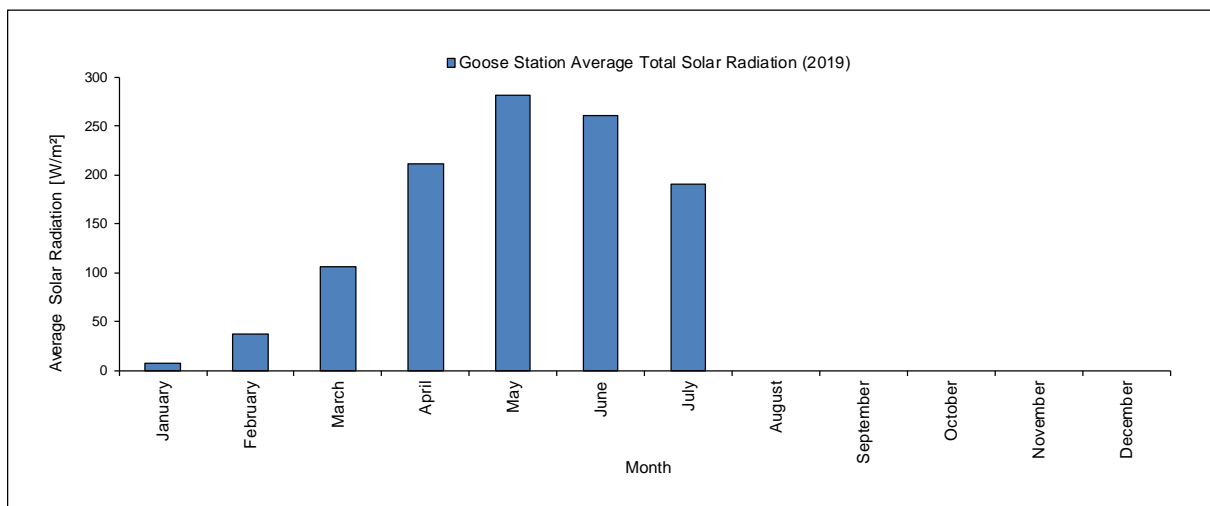


Figure 10: Goose Station 2019 Monthly Solar Radiation Summary

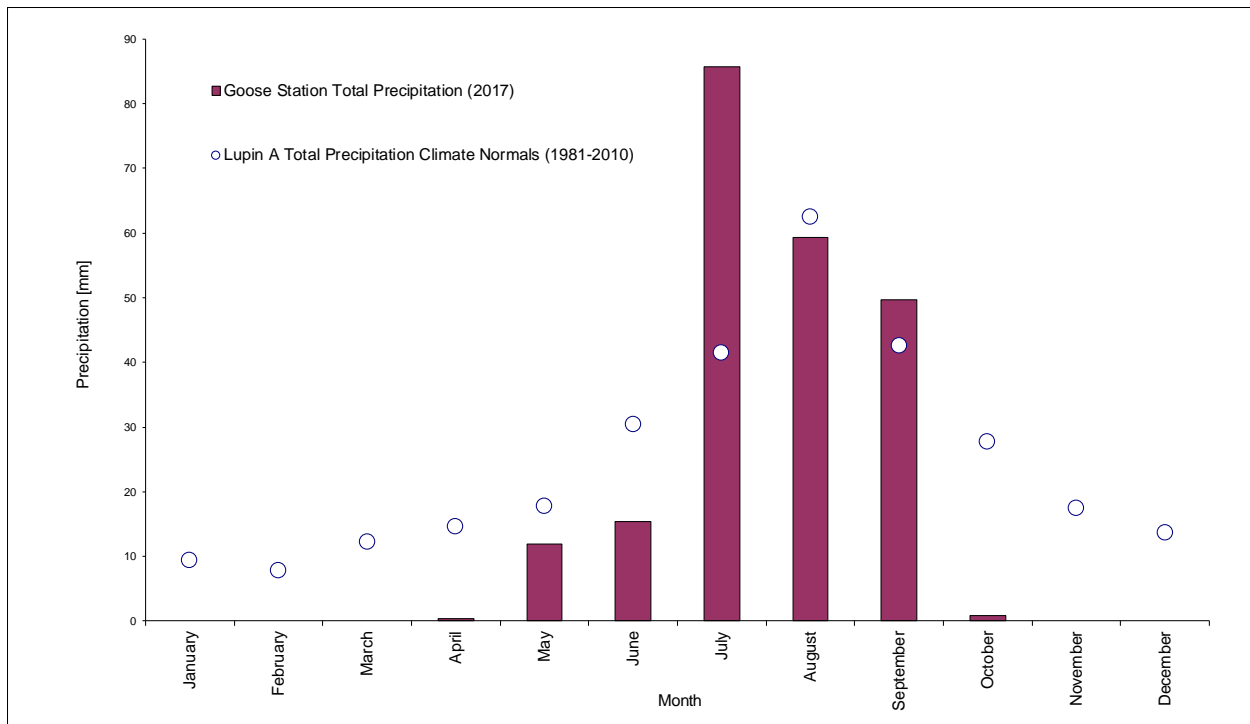


Figure 11: Goose Station 2017 Monthly Precipitation Summary

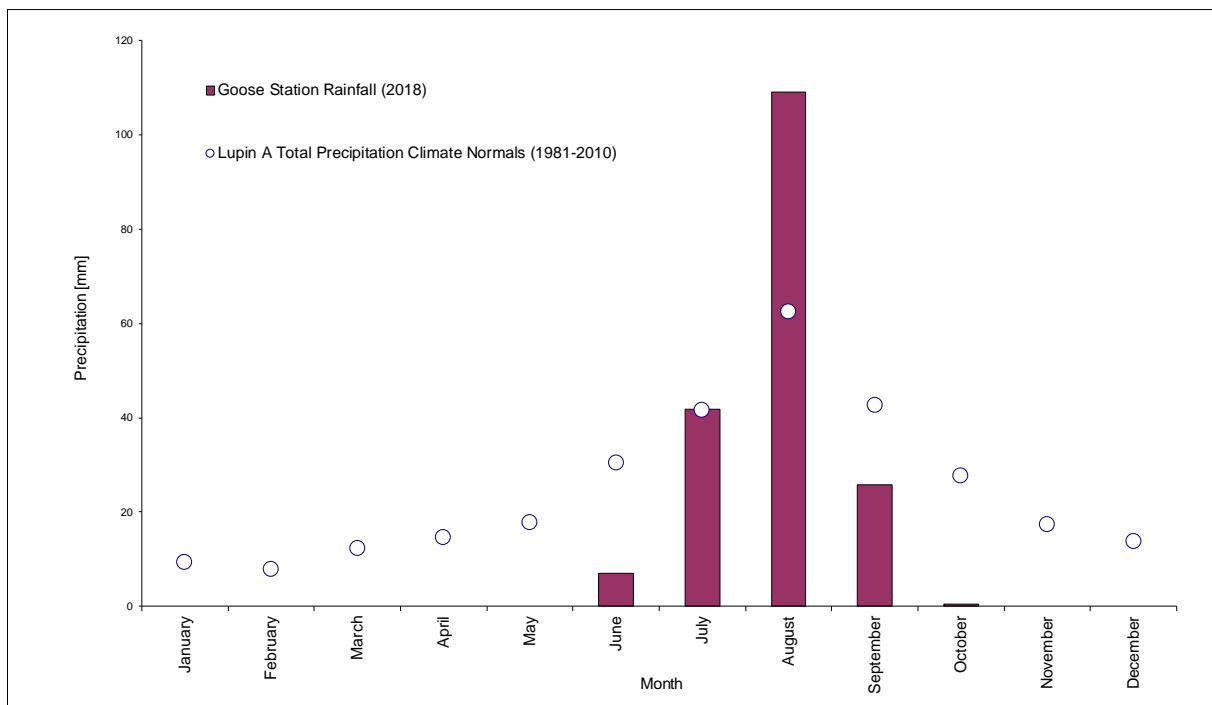


Figure 12: Goose Station 2018 Monthly Precipitation Summary

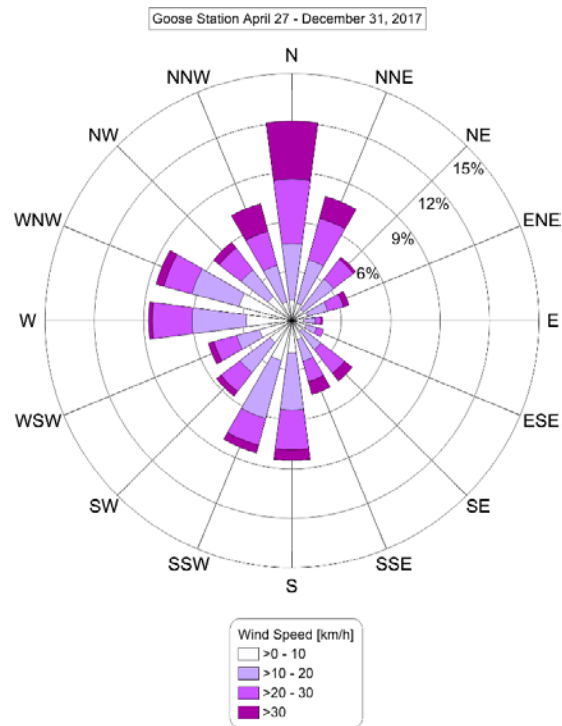


Figure 13: Goose Station 2017 Partial Year Wind Rose

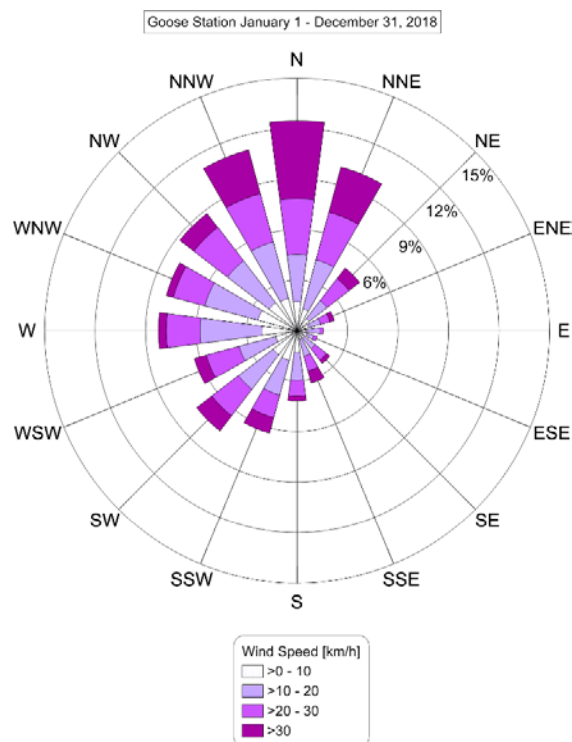


Figure 14: Goose Station 2018 Wind Rose

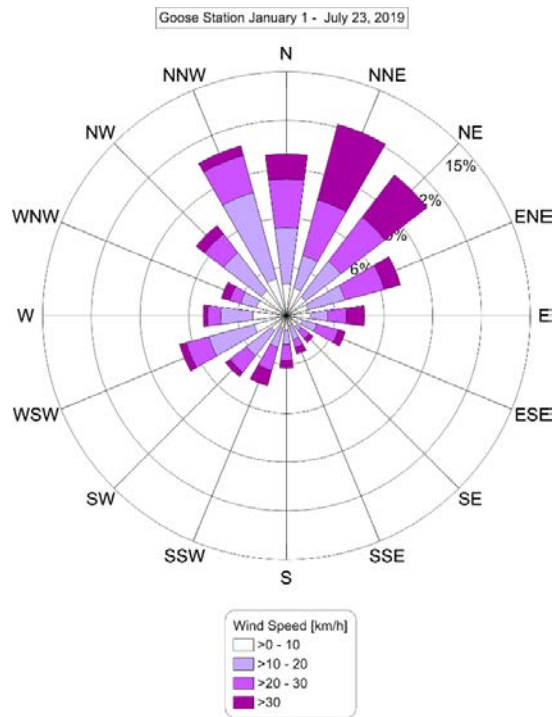


Figure 15: Goose Station 2019 Partial Year Wind Rose

CIRNAC-#3: PC T&C #15: Progressive Reclamation Plan**References:**

2019 Annual Report, Pages 4-27 to 4-28

Summary:

n/a

Detailed Review Comment

T&C #15 requires Sabina to:

“...have in place a plan for the progressive reclamation of project components, areas, and infrastructure throughout the life of the Project”.

Sabina is required to submit the plan to the Nunavut Impact Review Board (NIRB) at least 90 days prior to construction, with results and details submitted annually thereafter or as may otherwise be required by the NIRB.

Similar to the 2018 Annual Report, Sabina again indicated under the “Results” section of the 2019 Annual Report:

“in July 2018, additional feedback was received from stakeholders during the Type A Water Licence regulatory review process. This feedback, as well as Sabina’s final response and commitments related to progressive reclamation, will be incorporated into the next iteration of the ICRP. Sabina proposes to complete the next comprehensive iteration of the ICRP within 12 months following the commencement of the Operations Phase”.

Under the “Next Steps” section, Sabina stated:

“Sabina will update the latest version of the ICRP (October 2017) and resubmit to the NIRB at least 60 days prior to the start of construction, with results submitted annually thereafter or as may otherwise be required by the NIRB”.

As noted during CIRNAC’s review of the 2018 Annual Report, there is apparent inconsistency in the proposed timelines for submission of the ICRP to NIRB. Further, the proposed timelines do not match with the “90 days prior to construction” stipulated in this T&C.

In the review of the 2018 Annual Report for Back River, CIRNAC recommended that Sabina submit the updated ICRP to the NIRB at least 90 days prior to the start of construction, unless otherwise authorized by the NIRB. In response, Sabina stated the following:

“Sabina will submit the updated ICRP to the NIRB at least 90 days prior to the start of construction, unless otherwise authorized by the NIRB”

It is unclear why the 2019 Annual Report does not reflect this commitment.

Recommendation/Request:

CIRNAC recommends that subsequent annual reports reflect Sabina’s commitment to submit the updated ICRP to the NIRB at least 90 days prior to the start of construction, unless otherwise authorized by the NIRB.

Sabina Response:

Sabina acknowledges CIRNAC's request, and Sabina will include the following statement in future annual report submissions:

Sabina will submit the updated ICRP to the NIRB at least 90 days prior to the start of construction, unless otherwise authorized by the NIRB.

CIRNAC-#4: PC T&C # 94: Fuel Transportation**References:**

2019 Annual Report, Page 4-142

Summary:

n/a

Detailed Review Comment

T&C #94 requires Sabina to ensure fuel trucks meet industry design standards and receive regularly scheduled maintenance of fuel lines, nozzles and dust caps. To meet this requirement, Sabina is expected to submit in its annual report, a summary of results of the applicable maintenance schedules and summary of inspections throughout all project phases.

The 2018 and 2019 Annual Reports did not contain any maintenance schedules or inspection results. During our review of the 2018 Annual Report, CIRNAC requested that Sabina provide a rationale for not providing this information in the 2018 Annual Report. In response, Sabina indicated that there were no fuel trucks operating at the project site in 2018; hence no maintenance schedule or summary inspection data was provided.

In the 2019 Annual Report Sabina did not provide summary maintenance schedules or inspection data and did not indicate if there were fuel trucks or other vehicles in operation at the Back River project site in 2019. Instead, they stated: *"a summary of the results of the applicable maintenance schedules and a summary of inspections shall be included in Sabina's 2020 Annual Report to the Nunavut Impact Review Board"*, without providing any rationale why the information could not be provided in the 2019 Annual Report.

Recommendation/Request:

CIRNAC recommends that Sabina provide a rationale for not providing summary results of the applicable maintenance schedules and summary of inspections of fuel trucks in the 2019 Annual Report.

Sabina Response:

Sabina acknowledges that there were fuel trucks active during the 2019 field season; however, while maintenance was appropriately completed on the mobile equipment fleet, these records are currently located on the Project site and cannot be submitted at this time. Sabina acknowledges that providing this record of work completed is an oversight for the 2019 season and Sabina will provide a summary of all maintenance and inspection data in the following 2020 Annual Report.

CIRNAC-#5: Effects Assessment of Valued Socio-economic Component Indicators

References:

PC T&C #68: Economic Development and Opportunities - Socio-economic Monitoring 2019 Annual Report, Appendix F: 2019 Socio-economic Monitoring Report

Summary:

Detailed Review Comment

Sabina's 2019 Socio-economic Monitoring Report (SEMR) provides effects assessments for each of the project's valued socio-economic components (VSEC) pursuant to the requirements of T&C #68. These VSECs are:

1. Population Demographics;
2. Employment;
3. Business Opportunities;
4. Economic Development;
5. Education and Training;
6. Health and Community Well-being;
7. Non-traditional Land and Resource Use; and
8. Subsistence Economy and Land Use.

One of the requirements of T&C #68 is for Sabina to develop a project-specific Socio-economic Monitoring Program designed to:

"Monitor for project-induced effects, including the impacts predicted in the Final Environmental Impact Statement (FEIS) through indicators presented in the Back River Socio-economic Monitoring Plan".

There is an absence of direct comparisons between the SEMR's effects assessments and impacts predicted in the FEIS (i.e., references to specific FEIS document sections). This information would assist the evaluation of effects assessments.

Recommendation/Request:

CIRNAC recommends that future SEMR submissions reference FEIS document sections, as well as any other applicable documentation, relevant to VSEC effects assessments. Such details will facilitate the understanding of possible project effects and, when necessary, applied mitigation measures.

Sabina Response:

FEIS document section references will be added to the 'Effects Assessment' sections of future Socio-Economic Monitoring Reports, where appropriate.

CIRNAC-#6: Listing of Formal Certificates and Licences**References:**

PC T&C #74: Transferable Skills and Certifications

2019 Annual Report, Page 4-118

2018 Annual Report, Appendix L: Socio-economic Monitoring Report, Page 30

Summary:

n/a

Detailed Review Comment

Term and Condition #74 of Sabina's NIRB Project Certificate requires Sabina to:

"...develop and maintain an easily referenced listing of formal certificates and licences that may be acquired via on-site training or training during project employment. The listing shall indicate which of these certifications and licences would be transferable to a similar job site within Nunavut".

This requirement is applicable to the project's entire life cycle, including the present Pre-construction Phase. In November 2018, the Sabina provided the NIRB a summary of certificate courses offered on site that year. On Page 30 of the 2018 Socio-economic Monitoring Report (SEMR), Sabina stated that updates to this listing would be included in future SEMR submissions. An updated listing is not included in the 2019 SEMR.

Page 4-118 of the 2019 Annual Report and Page 30 of the 2019 SEMR stated that updated listings of formal certificates and licences offered to project personnel will be included in future SEMR submissions.

Recommendation/Request:

Pursuant to T&C #74, CIRNAC recommends that Sabina provide an updated listing of formal certificates and licences that may be acquired via on-site training or training during project employment.

Sabina Response:

An initial listing was provided by Sabina to NIRB in November 2018. No further updates to this list were completed in 2019, as training provided was informal and no new formal certificates and/or licences were offered through Project-related training programs that year. Updates to this list will be included in future Socio-Economic Monitoring Reports, where appropriate.

CIRNAC-#7: Community Engagement

References:

PC T&C #78: Traditional Activity and Knowledge - Incorporation of IQ and TK

2019 Annual Report, Page 2-1

2019 Annual Report, Appendix F: 2019 Socio-economic Monitoring Report

Summary:

n/a

Detailed Review Comment

Term and Condition (T&C) #78 of Sabina's NIRB Project Certificate encourages Sabina to:

"...ensure that the development of all project monitoring plans and associated reporting and updates are undertaken with active engagement of Kitikmeot communities, land users, and harvesters".

The Reporting Requirement for this T&C states:

"To the extent the sharing of such information is consistent with, and not limited by, any confidentiality or other agreements with the Kitikmeot Inuit Association, summaries addressing the Proponent's fulfillment of this Term and Condition should be included in the annual Back River socio-economic monitoring reports submitted to the Nunavut Impact Review Board".

Page 2-1 of the 2019 Annual Report provided a high level summary of the number of community engagements conducted to date by community in the Kitikmeot Region. No details are provided on whether Sabina actively engaged with community stakeholders regarding the development of project monitoring plans, reporting, and updates.

It would be helpful for Sabina to provide details of any community engagement efforts undertaken in 2019 regarding the development of project monitoring plans. The following information would help demonstrate community involvement:

- meeting dates;
- participants;
- means of communication (e.g., in-person meetings, conference calls, email correspondence, etc.);
- issues discussed, including monitoring plans and associated reporting requirements; and
- follow-up measures (where applicable).

Recommendation/Request:

Pursuant to T&C #78, CIRNAC recommends that Sabina provide details of active engagement conducted with Kitikmeot communities, land users, and harvesters regarding the development of project monitoring plans, associated reporting, and updates. This information should also be provided in future annual report submissions.

Sabina Response:

Sabina continues to actively engage community members on all aspects of the Project and has a Community Involvement Plan (Sabina 2018) to guide its activities. Sabina also continues to maintain its Traditional Knowledge (TK) licence in good standing with the KIA, which was established in 2012.

Sabina's community engagement activities specific to monitoring were focused on socio-economics in 2019 (e.g., limited to participation in the April 2019 KSEMC in Cambridge Bay), however the Company is committed to additional engagement moving forward. With this in mind, Sabina has developed the document 'Guidance for Incorporating Community Perspectives and Traditional Knowledge in the Back River Project's Monitoring Programs' (dated January 2020), which was provided to the NIRB as Appendix B of the 2019 Socio-Economic Monitoring Report. This document provides guidance on how Sabina will incorporate community perspectives and TK in the Project's monitoring programs moving forward, which will help address related Terms and Conditions in Project Certificate No. 007. Sabina will begin to more fully incorporate this guidance in future annual report submissions to NIRB. Northern and Community engagement activities undertaken by Sabina in 2019 are detailed in the below Table 2.2-1.

Table 2.2-1. Northern and Community Engagement Log 2019

Date	Individual/Organization	Type of Activity
29-Jan-19	Hamlet of Kugluktuk	Met with the Hamlet in Vancouver BC to discuss Long Term Care Facility/Regional Wealth Creation Fund
February 7-8, 2019	Arctic Council	Sabina Presented to the Arctic Council on the Back River Project
February 12-13, 2019	Kitikmeot Trade Show	Sabina attended the Kitikmeot Trade Show in Cambridge Bay, NU
6-Mar-19	KIA	KIA/Sabina Presidents Meeting in Toronto, Ontario
April 1-4, 2019	Nunavut Mining Symposium	Sabina participated in the Nunavut Mining Symposium in Iqaluit
April 11-12, 2019	Kitikmeot Socio-Economic Monitoring Committee	Sabina participated in Government of Nunavut 2019 KSEMC and Back River SEMCWG in Cambridge Bay
May 25 - 31, 2019	Cambridge Bay, Kugluktuk, Taloyoak, Gjoa Haven, Kugaaruk	Sabina hosted a Kitikmeot Tour. Visiting each of the five communities, holding public meetings as well as delivering 80 Leitz Microscopes and hosting Microscope workshops in each school
9-Sep-19	Kugluktuk	Sabina met with the Hamlet to discuss the Long Term Care Centre Project /Regional Wealth Creation Fund
9-Sep-19	Kugluktuk	Sabina hosted a public meeting to consult on possible upcoming project changes
10-Sep-19	Cambridge Bay	Sabina met with NIRB and NPC to discuss possible upcoming project changes
10-Sep-19	Cambridge Bay	Sabina hosted a public meeting to consult on possible upcoming project changes
11-Sep-19	Kugaaruk	Sabina presented at the KIA Board Meeting
11-Sep-19	Gjoa Haven	Sabina met with Nunavut Water Board to discuss possible upcoming project changes

CIRNAC-#8: Land use in close proximity to project infrastructure - consultation

References:

PC T&C #81: Non-Traditional Activity and Resource Use

2019 Annual Report, Appendix F: 2019 Socio-economic Monitoring Report

Summary:

n/a

Detailed Review Comment

Included as an Appendix to the 2019 Socio-economic Monitoring Report is an “Outfitting/Guiding Business Protocol” that Sabina prepared pursuant to T&C #81 of their NIRB Project Certificate. This T&C requires Sabina to:

“...consult with outfitting and guiding businesses that operate in the regional study area regarding use of the land and marine areas in proximity to project infrastructure or activities and any noted project effects, particularly for effects in relation to the experience of the natural environment”.

Although this T&C does not apply to the project’s current Pre-construction Phase, Sabina has committed to distributing information letters to licensed outfitter companies that operate out of Cambridge Bay and Kugluktuk, the two communities in closest proximity to the project. Sabina will also distribute information letters to the Hunters and Trappers Organizations (HTO) of Iqaluktuuttiaq (Cambridge Bay), Kugluktuk, Burnside (Bathurst Inlet), and Umingmaktok. CIRNAC appreciates Sabina’s efforts to communicate with licensed outfitter companies and community organizations that have an interest in the natural environment.

Recommendation/Request:

CIRNAC commends Sabina’s efforts to implement T&C #81 during the project’s Pre-construction Phase.

Sabina Response:

Sabina acknowledges CIRNAC’s comment and appreciates their recognition of our ongoing work in this area.

2.3 RESPONSE TO GOVERNMENT OF NUNAVUT

GN-#01: Use of Ethylene Glycol

References:

Amstrup, S.C., Gardner, C., Myers, K.C., and Oehme, F.W. (1989) Ethylene glycol (antifreeze) poisoning in a free-ranging polar bear. *Veterinary and Human Toxicology*, 31(4):317-319.

LaKind, J.S., McKenna, E.A., Hubner, R.P., Tardiff, R.G. (1999). A review of the comparative mammalian toxicity of ethylene glycol and propylene glycol. *Critical Reviews in Toxicology* 29, 331-365.

Merck Veterinary Manual (2020). Overview of Ethylene Glycol Toxicity [Online]. Available from: <https://www.merckvetmanual.com/toxicology/ethylene-glycol-toxicity/overview-of-ethylene-glycol-toxicity> [Accessed 6 May, 2020].

Sabina (2020). Back River Project 2019 Annual Report.

Sabina (2014) FEIS Appendix C - Spill Contingency and Emergency Response Plan (Comprehensive Spill Contingency & Emergency Response Plan 2015 Site Preparation Activities)

Siroka Z., Bily, R., Polacek, V., Dvorak, J., and Svoboda, M. (2014). Massive death of wild boars caused by ethylene glycol: a case report. *Veterinarni Medicina*, 59(8), 388-395.

Summary:

Ethylene glycol was spilled and subsequently cleaned up, as reported in the 2019 Annual Report (Sabina 2020, Section 4.4.2, pp. 4-3, 4-4). Ethylene glycol is highly toxic to wildlife, which necessitates extra care during its use, transport, and cleanup of any spills.

Detailed Review Comment

A spill of 5L of ethylene glycol occurred on the winter ice road in March (Spill No. 2019-09, 3/16/2019). This substance is highly toxic to wildlife, even in small amounts - in canids the minimum lethal dose of undiluted ethylene glycol is 4.4 mL/kg (Merck Veterinary Manual 2020, LaKind et al 1999). This is about 15mL for a typical Arctic Fox, 200-350mL for a typical Arctic Wolf. No lethal dose value has been established for caribou, however in cattle (also an ungulate) the lethal dose is 2-10mL/kg (Merck Veterinary Manual, 2020), meaning as little as 270mL could be lethal for an average caribou.

Ethylene glycol also has the capacity to be lethal to large animals, such as polar bears (Amstrup et al. 1989), or a large number of animals simultaneously, contributing to mass deaths (Siroka et al. 2014).

Sabina has recognized the harmful nature of this substance and identified it as a chemical requiring "special attention and handling" in the Spill Contingency and Emergency Response Plan, Section 6.4 Chemicals, pg. 16 (Sabina 2014).

Recommendation/Request:

Regarding the use of ethylene glycol:

- The GN suggests substituting propylene glycol for ethylene glycol, wherever possible, due to the former being much less toxic to wildlife. Additional reasons for the substitution include:

- Small amounts of ethylene glycol can easily be missed during cleanup or not observed as leaks from vehicles and equipment. Extra care and diligence are required in the maintenance and operation of equipment using ethylene glycol.
- The high toxicity of ethylene glycol requires extra care and diligence in the assessment and cleanup of spills.

Sabina Response:

The use of ethylene glycol is managed under the Hazardous Materials Management Plan. Any spills of ethylene glycol are managed through the Spill Contingency Plan, which aims to protect workers and the environment. The Spill Contingency Plan is designed to meet all Canadian legislation and is updated as part of the Type A Water Licence.

Sabina will review the use of ethylene glycol and consider replacing with propylene glycol where appropriate.

More information on the management of potentially hazardous fuel and goods, as well as spill response is below.

GN-#02: Unauthorized Discharge**References:**

Sabina (2020). Back River Project 2019 Annual Report. March 2020.

- Section §4.4.2 Unauthorized Discharges and Spills, pg. 4-3
- Table 4.4-1. Unauthorized Discharges in 2019, pg. 4-4

Sabina (2014) FEIS Appendix C – Spill Contingency and Emergency Response Plan (Comprehensive Spill Contingency & Emergency Response Plan 2015 Site Preparation Activities) External Reporting Volumes Table, pg. 33

Summary:

There appears to be either a lack of information or inconsistency in spill reporting. A spill of ethylene glycol (Spill No. 2019-09, 03/16/2019) met the criteria for external reporting per Sabina's Spill Contingency and Emergency Response Plan but was not reported at the time of the spill.

Detailed Review Comment

A spill of 1L hydraulic oil was reported to the spill line (Spill No. 2019-17, 5/9/2019), with no additional information about the spill or why 1L was reported when 90L (Spill No. 2019-07, 2/24/2019) and 80L (Spill No. 2019-10, 3/21/2019) spills of hydraulic oil were not (Table 4.4-1, 2019 Annual Report). Further information about these spills is needed to understand this discrepancy.

The Proponent's Spill Contingency and Emergency Response Plan (SCERP) summarizes reporting volumes for various classifications of materials, specifically that the Transportation of Dangerous Goods Act (TDGA) Class 6.1, Poisonous Substances, have a 5L or 5kg threshold for reporting. While not regulated under the TDGA in Canada, ethylene glycol is designated as Class D2A – Poisonous and Infectious Materials, Very Toxic Materials, by Health Canada, through the Workplace Hazardous Materials Information System (WHMIS). This designation is found on most materials safety data sheets for ethylene glycol. The poisonous nature of ethylene glycol and its designation as such within WHMIS, aligns with the Proponent's SCERP volume requirements for external reporting as a poisonous substance; this spill should have been reported at the time of the spill per the Proponent's protocols.

Recommendation/Request:

1. Regarding other unauthorized discharges in 2019:

- The GN recommends that the Proponent report:
 - All Spills of 100L or more have a legal reporting requirement; and
 - All Spills of 1L or more on surface water have a legal reporting requirement
- The GN recommends reporting all spills.
 - 80L & 90L spills are within a reasonable estimation error of 100L and should be reported on a precautionary basis.

2. Regarding ethylene glycol:

- The GN suggests substituting propylene glycol for ethylene glycol, wherever possible, due to the former being much less toxic to wildlife, as per comment #1

- Spills of 5L or more of ethylene glycol have a reporting requirement per the Proponent's protocols

Additional information on spill management can be found on the GN website at <https://gov.nu.ca/environment/documents/spill-response>.

Sabina Response:

Sabina notes the 1-L spill occurred on solid ice (not liquid water) during the 2019 season, and the spill was reported due to a direct request from CIRNAC. Sabina will continue to adhere to the legal requirements of reporting all spills of 100 L or more, and Sabina will also continue to conservatively estimate any potential spill volumes for comprehensive and complete reporting.

Please refer to response to GN-1.

GN-#03: Helicopter Flights and Pilot Observations in 2019**References:**

Baffinland Iron Mines Inc. (BIMC), (2019). Baffinland Iron Mines 2018 Annual Report to the Nunavut Impact Review Board.

Côté, S D. (1996). Mountain goat responses to helicopter disturbance. *Wildlife Society Bulletin*, 24(1), 681-685.

ERM Consultants (2020) Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report. Prepared for Sabina. 103 pp.

Fisher, C.A., Thomas, D.C., Wooley R.L., and Thompson, P.S. (1977). Ecological studies of caribou on the Boothia Peninsula and the District of Keewatin, NWT, 1976, with observations on the reaction of caribou and muskoxen to aircraft disturbance, 1974-1976. Prepared for Polar Gas project, Renewable Resource Consulting Services Ltd. 239 pp.

Miller, F. L. and Gunn, A. (1979). Responses of Peary caribou and muskoxen to helicopter harassment. *Canadian Wildlife Service Occasional Paper No.40*. 90pp.

Sabina (2020). Back River Project 2019 Annual Report. March 2020.

Sabina (2019). Back River Project Wildlife Mitigation and Monitoring Program Plan (Version 10), October 2019.

Sabina (2018). Back River Project Standard Operating Procedure: Fixed Wing and Helicopter Operations (July 2018).

Trailmark Systems Inc. [TSI] (2015). Review of post-2010 Literature on Human Effects on Barren-Ground Caribou: Focus on Traditional Knowledge, Western Science, and Caribou Protection Measures. Prepared for the Nunavut Wildlife Management Board. 92 pp.

Weladji, R.B. and Forbes, B.C. (2002). Disturbance effects of human activities on *Rangifer tarandus* habitat: implications for life history and population dynamics. *Polar Geography*, 26, 171-186.

Summary:

The Proponent has recognized that the use of aircraft to support Project activities has the potential to negatively affect wildlife, including caribou. The Proponent has developed mitigation measures and standard operating procedures to reduce or eliminate negative impacts, including stating that pilots have responsibilities to monitor, report, and avoid caribou (ERM 2020, WMMP Report, Section 5.1.1, pg. 5-1).

The Proponent states that mitigation and monitoring in compliance with Project Certificate Condition 61 was effective and that no wildlife incidents were observed. (Annual Report (Sabina 2020), pg. 4-99). The Proponent also states no caribou were reported by pilots in 2019 (WMMP Report (ERM 2020), pg. 4-2).

However, the Proponent recorded nearly 15,000 observations of caribou during 2019, primarily during the spring migration and calving periods when, as described in the Annual Report, "Caribou were observed in all project areas during this period [April 15 to June 15]." (ERM 2020, WMMP Report Section 4, pg. 4-2).

The apparent lack of pilot observations is inconsistent with the numbers of caribou observations reported during the year. This implies that the relevant sections of the WMMP and Aircraft SOP are not being applied in a consistent manner, or that current methods for detection to prevent helicopter disturbance to caribou are insufficient.

Detailed Review Comment

The presence of caribou in such high numbers and proximity to Project activities led to the short-term shutdown of the Winter Ice Road (WIR) in April (AR response to PCC No. 39, pg. 4-65). Air operations continued during the closure, and in spite of the numbers observed by staff on the ground and closure of the WIR, which included monitoring to evaluate conditions for re-opening, no caribou were reported by pilots during this time.

The WMMP report states that "pilots avoided groups (of caribou)..." and "large groups of caribou were avoided..." but that "no caribou were reported by helicopter pilots and as such, no management actions were reported." Additionally, the report notes that "helicopter pilots did not report any incidental sightings of caribou or other wildlife" (ERM 2020, pg. 5-2).

This is inconsistent with the data illustrated in Fig. 5.1-1 "Frequency of Helicopter Flights Below 610m, May to August, 2019". (ERM 2020, pg. 5-3) There are clear indications of a high frequency of flights (~70 flights) below 610m, originating at the Marine Laydown Area (MLA) and stretching southward for approximately 60km. Modeling within the Caribou Road Crossing Analysis (Appendix 5C) clearly shows reasonable probability of caribou in this area during these stages of seasonal migration.

An even higher frequency of low level flights extends from the Goose Camp area ~10km. Multiple ground-based observations by site staff between Mid-April to early June, 2019 indicated hundreds, sometimes thousands of caribou observed in all areas of the Project (Goose Camp, MLA, WIR, & Forward Camp)(ERM 2020, WMMP Report, Appendix 4A: Incidental Caribou Observations, 2019).

Given the numbers and extent of caribou present around site areas, flight path records below 610m, and contemporaneous ground-based observations, it is unlikely effective monitoring from helicopters would not detect caribou. A lack of effective observations from helicopters has direct implications on the outcome and success of the mitigation measures applied to aircraft (AR 5.1.1 pg. 5-1) and is contrary to the stated approaches within the WMMP.

Aircraft have the potential to cause disturbance to caribou (TSI 2015). Low altitude flights often result in strong negative responses in ungulates (Côté 1996). Low altitude flights can increase energetic costs to caribou through interruption of foraging behaviour and eliciting flight and avoidance responses (Weladji and Forbes 2002). Large groups of caribou can be more sensitive to overflights than smaller groups, and these large groups are more sensitive in certain seasons, such as post-calving (Fisher et al. 1977).

Recommendation/Request:

1. The GN recommends that, in addition to tracking the number and locations of flight paths below 610m as is currently done, the Proponent implement a requirement that all helicopter pilots provide justification for flying at altitudes below 610m in the flight log. This action has been applied to other projects in Nunavut (e.g. Baffinland's Mary River Project (BIMC 2019)).
2. The GN also recommends that wildlife observations become a required part of flight log reporting protocols for all flights. This will necessitate increased effort from the Proponent to ensure pilots provide wildlife observations made during flights, particularly as such observations would require short route deviations and/or alterations of the current flight path, per the Proponent's protocols, depending on the scenario.
3. The GN recommends that near real-time collar monitoring data, already in-use by the Proponent, be used to understand the likelihood of encountering caribou along a planned flight path.

4. The GN recommends that subsequent annual reports compare the caribou collar data to flight log data to evaluate the extent to which there is spatial-temporal overlap between caribou and low-level flights.

Sabina Response:

Please refer to response to KIA-2.

GN-#04: Progressive Reclamation

References:

Sabina (2020). Back River Project 2019 Annual Report. March 2020

Summary:

In reviewing the Annual Report, it is not clear whether or not any progressive reclamation activities took place.

Detailed Review Comment

The Proponent notes that there was no new construction in 2019 (Annual Report response to PCC No. 32, pg. 4-54). However, new construction and progressive reclamation are not the same activity and are not mutually exclusive.

Recommendation/Request:

The GN Recommends that the Proponent provide an explicit description of any progressive reclamation activities planned or undertaken during the reporting year, in this case, 2019.

Sabina Response:

Sabina acknowledges the omission regarding progressive reclamation and provides the clarity that no progressive reclamation activities were completed in 2019 at the Back River Project.

GN-#05: Shipboard Marine Mammal Observations in 2019**References:**

ERM Consultants (2020) Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report. Prepared for Sabina. 103 pp.

Sabina (2020) Back River Project Annual Monitoring Report. March 2020.

Sabina (2019a). Back River Project Wildlife Mitigation and Monitoring Program Plan (Version 10), October 2019.

Sabina (2019b) Back River Project Standard Operating Procedure: Marine Shipping Wildlife Mitigation and Monitoring. September 2019.

Summary:

Shipboard wildlife observations (e.g. seals, polar bears, etc.) were recorded in August 2018 (2019 Annual Report pg.4-107), but not in August 2019 (2019 Annual Report pg. 4-104), even though the same vessel and route was used. A copy of the WMMP was available and in use for both shipments. Wildlife observations are valuable data in understanding and mitigating potential negative impacts to wildlife from the project.

Detailed Review Comment

The Proponent indicates that it provided the relevant SOP to the shipping company, who is reported to have followed the guidance within the SOP. The Proponent also states that the SOP will be used for shipping in 2020 (Annual Report response to PCC 58).

The Proponent is responsible for ensuring that staff and contractors follow established protocols and standard operating procedures. This includes receiving reports and wildlife observations where required.

Recommendation/Request:

1. The GN recommends that the Proponent clarify why there is a lapse in observations between 2018 and 2019, and identify what steps it will take to avoid a similar lapse in the future.
2. The GN recommends the Proponent increase its efforts to convey the importance of reporting required wildlife observations to its shipping contractor and other staff and operators employed directly or indirectly at the site.

Sabina Response:

Please refer to response to KIA-9.

GN-#06: Fuel Transportation

References:

Sabina (2020) Back River Project Annual Monitoring Report. March 2020.

Summary:

The Proponent has provided a self-evaluation of “Partially Compliant” in respect of PC term and condition 94 which states that “The Proponent shall ensure fuel trucks meet industry design standards and receive regularly scheduled maintenance of fuel lines, nozzles and dust caps”, but it has given no details to justify this evaluation.

Additionally, the 2019 Annual Report does not describe the volumes or types of fuel stored or transported at any of the various project sites.

The lack of this information prevents the adequate evaluation of this aspect of the Proponent’s Annual Report.

Detailed Review Comment

Appropriate spill contingency planning involves a detailed understanding of the volumes and types of fuels stored and transported at the Project site. The GN asserts that this information is a valuable part of the description of Project activities for the year, and supports Project monitoring and evaluation undertaken by stakeholders and regulators. The inclusion of this information would allow for a more complete review of the Annual Report.

Recommendation/Request:

1. The GN recommends that the Proponent provide a description of:
 - its efforts toward compliance with PC T&C 94 to reach the status “Partially Compliant”; and
 - what efforts remain in order to achieve full compliance.
2. The GN also requests that the Proponent provide information about the volumes and types of fuel stored and transported at various Project sites in 2019. This information should also be included in future Annual Monitoring Reports.

Sabina Response:

1. Sabina acknowledges that there were fuel trucks active during the 2019 field season; however, while maintenance was appropriately completed on the mobile equipment fleet, these records are currently located on the Project site and cannot be submitted at this time. Sabina acknowledges that providing this record of work completed is an oversight for the 2019 season and Sabina will provide a summary of all maintenance and inspection data in the following 2020 Annual Report.
2. Fuel was transferred and used internally within each of the Project sites: MLA and the Goose Property. Sabina can report that, as of the close of the 2019 field season, the following total diesel volumes are stored at each of the following locations:
 - Goose Property = 428,987 L;
 - Marine Laydown Area = 155,852 L; and
 - George Exploration Camp = 88, 090 L.

GN-#07: Standard Operating Procedure for Waste Management**References:**

Coogan, S.C.P. and Raubenheimer, D. (2016). Might macronutrient requirements influence grizzly bear-human conflict? Insights from nutritional geometry. *Ecosphere* 7, 1-15.

ERM Consultants (2020) Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report. Prepared for Sabina. 103 pp.

Appendix 5D, Back River Project: Standard Operating Procedure 008 – Waste Management

Marquard-Petersen, U. (2011). Invasion of eastern Greenland by the high arctic wolf *Canis lupus arctos*. *Wildlife Biology* 17, 383-388.

Sabina (2020). Back River Project Annual Monitoring Report. March 2020.

Sabina (2019). Back River Project Incineration Management Plan. July 2019.

Savory, G.A. et al. (2014). Anthropogenic food use and diet overlap between red foxes (*Vulpes vulpes*) and Arctic foxes (*Vulpes lagopus*) in Prudhoe Bay, Alaska. *Canadian Journal of Zoology* 92, 657-663.

Summary:

The Proponent's Standard Operating Procedure (SOP) for waste management doesn't adequately describe protocols and locations for storage of potential wildlife attractants (e.g. cooking oils, food contaminated cardboard, kitchen waste, etc.) between becoming 'waste' and being incinerated.

Detailed Review Comment

Waste, when not properly managed, can become a preferred source of food for scavenging species, including bears [*Ursus* spp], foxes [*Vulpes* spp.], wolves [*Canis lupus*], wolverines [*Gulo gulo*], and birds (e.g. ravens [*Corvus corax*], gulls [e.g. *Larus* sp.], especially at crucial times of an animal's lifecycle (e.g. pre-denning hyperphagy in grizzly bears [*Ursus arctos*]) (Coogan & Raubenheimer (2016), Savory et al. (2014)). These patterns can lead to habits and reliance on anthropogenic food sources as well as range shifts and expansions (Marquard-Petersen 2011, Savory et al. 2014).

It is crucial that site staff are aware of the best practices related to waste management, and that waste is handled and securely stored at each step in the waste stream, from generation to incineration.

Recommendation/Request:

The GN recommends that the Proponent include additional information within the Waste Management SOP for the benefit of staff, training efforts, and review by stakeholders including:

- Description of explicit handling of each waste type at each point in the waste stream, from becoming 'waste' to being handled as ash. This should include location and procedures for secure temporary storage, prior to incineration.
 - These steps are only partially described in the SOP, with some waste categories receiving more detailed descriptions than others.
- The SOP should also include an anticipated incineration schedule, which may include different days and times for different burns as incinerator capacity (e.g. min/max) and waste type requires.

- In addition to an incineration schedule, explicit instructions should be included for how waste types should be securely stored between burns, with attention given to the containment of liquids and odours that may serve to attract wildlife.

Sabina Response:

Please refer to response to KIA-12.

GN-#08: Extended Use of the Winter Ice Road**References:**

ERM Consultants (2020) Back River Project 2019 Pre-Construction Wildlife Mitigation and Monitoring Program Report. Prepared for Sabina. 103 pp.

Nunavut Impact Review Board (NIRB) (2017). Companion Document to NIRB Project Certificate [No.: 007]. 61 pp.

Sabina (2020). Back River Project Annual Monitoring Report. March 2020. 171 pp.

Summary:

The Project Certificate describes use of the construction and use of the Winter Ice Road (WIR) as being from mid-January to April, annually (NIRB 2017). The Proponent described its anticipated use in 2019 as being from mid-December to mid-April (ERM 2020). However, due to delays in resupply arrival, the Proponent requested that use for 2019 be extended. The Proponent then operated the WIR from April 19-May 10.

The 2019 Annual Monitoring Report states that caribou in proximity to the WIR resulted in the short-term closure of the WIR in April 2019 (BR-AR pg. 4-65). This closure was not reported within the Pre-Construction Wildlife Mitigation and Monitoring Program Report, and no further details are provided within the Annual Report.

Detailed Review Comment

The majority of wildlife observations on the WIR occurred after the proposed closure date (April 15). This illustrates the importance of wildlife habitat near the road during the spring season, which is recognized by the Proponent; "In a typical year, the WIR is designed to be closed by April 15 to minimize disturbance to caribou during spring migration." (WMMP Report, §5.3, pg. 5-6).

As evidenced by the short-term closure of the road, its continued use in the operation period after April 15th would likely have resulted in disturbance to caribou.

While the Proponent's analysis of caribou movement patterns around the road in 2019 did not show an effect of the road on migration, extended seasonal use of the road and increased road traffic as the Project scales up could affect movement patterns.

Recommendation/Request:

While the GN recognizes the additional steps taken by the Proponent to address impacts to wildlife from extended use of the WIR, future ice road use should be limited to the date range for the permitted Project, from mid-January to April (NIRB 2017, pg. 6), as the impacts of WIR usage during this date range were assessed during Project review.

The GN requests additional information relating to the short-term closure of the WIR relating to concentrations of caribou in the immediate vicinity of the WIR. It is encouraging to see that mitigation measures are being implemented but more information is warranted.

Details could include:

- The number of caribou observed up to the time of closure(s);
- The duration of the closure(s);

RESPONSES TO 2019 ANNUAL REPORT COMMENTS

- Descriptions of actions taken by staff to initiate the closure(s);
- Steps taken to monitor caribou during closure(s); and
- Steps taken to evaluate conditions that would permit reopening of the road.

Sabina Response:

Please refer to response to KIA-6.

GN-#09: Vegetation Monitoring**References:**

Golder (2019). Back River Project 2019 Vegetation Monitoring Plan. Prepared for Sabina. 37 pp.

Sabina 2020a). Back River Project Annual Monitoring Report. March 2020.171 pp.

Summary:

The findings of the 2019 Vegetation Monitoring Report show clear impacts to vegetation from the construction and use of the Winter Ice Road (WIR). The Report states “the majority (75%) of vegetation plots surveyed showing low to no disturbance” (§6.0, pg. 18). This indicates that 1 of every 4 plots was observed to have moderate to high disturbance.

Detailed Review Comment

Vegetated ecosystems in the PDA are valuable resources and habitat for species of interest, and a basic premise of the vegetation monitoring programs is to track, reduce, or eliminate the impacts to these ecosystems.

Monitoring is valuable, as is taking steps to reduce impacts and following recommendations stemming from monitoring reports.

Recommendation/Request:

2019 Vegetation Monitoring Report contains recommendations on how to reduce the impact that construction and use of the WIR have on vegetation (Section 6.0, pg. 18). The GN suggests that the Proponent provide additional information on how it has and/or will demonstrate efforts to act on those recommendations.

Sabina Response:

A number of measures will continue to be implemented to help mitigate the effects of the WIR on local vegetation including:

- Minimizing WIR footprint thereby minimizing disturbance to terrestrial environment;
 - The width of the WIR, on the portions traversing the terrestrial environment, are/will be kept to the necessary width required to permit successful operations, as well as maintenance of the banks which must be kept to heights conducive to caribou passage.
- All vehicle traffic restricted to designated road surfaces including consideration of additional WIR route demarcation;
 - Only vehicles with low bearing pressure (i.e. tracked vehicles or oversized tires) are permissible to traverse outside of the bounds of the WIR, and only during activities specific to construction and maintenance of the WIR with permission from the Construction Manager.
 - Sabina is reviewing methods to further demarcate the bounds of the WIR, which can be hard to identify during certain weather conditions (i.e. flat light).
- Load allowance do not exceed design of WIR;
 - Weights of all equipment and supplies shipped to Back River are known. Truck weights as well as their trailers are also known. Cumulative weights are maintained to ensure

they do not exceed design of the WIR. Scales are on site and used to verify weight, especially if they approach design.

- Vehicles driven at designated speeds along WIR; and
 - Information pertaining to designated speeds along the WIR can be found in Sabina's Road Management Plan (SD-02; 2AM-BRP1831).
- Travel on WIR only when conditions permit.
 - Snow/ice thickness on land must sufficient to prevent damage to soil and vegetation.

2.4 RESPONSE TO ENVIRONMENT AND CLIMATE CHANGE CANADA

ECCC-1: Incinerator Stack Testing

References:

Sabina Back River Project – Incineration Management Plan (2019). Section 8.1 Incinerator Emissions Testing.

Canadian Council of Ministers of the Environment (2001). Canada Wide Standards for Dioxins and Furans

Summary:

n/a

Detailed Review Comment

Inefficient or improper incineration of waste can result in the release of dioxins and furans (PCDD/Fs) and mercury. These contaminants bioaccumulate in the environment, and may cause adverse effects to human health and the environment. Appropriate adaptive management is necessary in order to reduce these emissions. This includes stack testing of incinerator emissions. The proponent indicated that they will conduct stack testing of the incinerator once within the first year of operations. However, the proponent did not indicate any plans for follow-up stack testing. Follow-up stack testing is recommended within a specified time-period (e.g. within 6 months), if stack testing exceeds the Canada Wide Standards for Dioxins and Furans or Mercury. Follow-up stack testing at 3-year intervals after initial testing, to ensure that emissions of these contaminants continue to be limited is industry best practice.

Recommendation/Request:

ECCC recommends that the proponent provide details on actions they will take should initial incinerator stack testing results exceed Canada-Wide standards, including implementation of a follow-up test. ECCC also recommends that the proponent provide details on what management actions they will take to monitor emissions after the initial stack test. ECCC recommends that the proponent conduct additional stack testing at a 3-year interval and recommend that the proponent revise relevant management plans accordingly.

Sabina Response:

Following the initial stack testing in the first year of operations, Sabina will conduct routine follow-up stack testing every 3 years when incineration quantities meet the testing threshold. Should emissions exceed Canada Wide Standards for Dioxins and Furans or Mercury Sabina would consult the incinerator manufacturer for recommendations on improvement and/or conduct a waste stream audit to determine the possible source of elevated emissions and further refine the incinerator waste stream. Manufacturer recommendations and waste stream refinement would be implemented to the extent feasible and the success of these measures would be verified in the subsequent round of stack testing. This information has been added to the updated IMP included in this response package.

Attachment A: Incinerator Management Plan



BACK RIVER PROJECT Incineration Management Plan

June 2020

BACK RIVER PROJECT

INCINERATION MANAGEMENT PLAN

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Revision Log

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Acronyms

CCME	Canadian Council of Ministers of the Environment
EC	Environment Canada
GHG	Greenhouse Gas
GN	Government of Nunavut
IMP or Plan	Incineration Management Plan
MAD	Main Application Document
MLA	Marine Laydown Area
Project	Back River Project
Sabina	Sabina Gold & Silver Corp.
QA	Quality Assurance
QC	Quality Control
WIR	Winter Ice Road

Executive Summary

This Plan describes the waste management processes at the Back River Project relevant to on site incineration. This Plan ensures that 1) only appropriate burnable material enters the incinerator waste stream, 2) animal attractants are promptly incinerated or safely stored, 3) the incinerator is operated in a manner that reduces harmful emissions, 4) residual ash is handled and disposed of properly, and 5) that all compliance monitoring and reporting associated with incinerator operations occurs.

1. Introduction

The Back River Project (the Project) is a gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of southwestern Nunavut. It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. The Project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4).

The Project is comprised of two main areas, Goose Property and the Marine Laydown Area (MLA) with interconnecting winter ice roads. The majority of annual resupply will be completed using the MLA situated along the western shore of southern Bathurst Inlet, which is connected seasonally to Goose via an approximately 160 km long winter ice road.

The Incineration Management Plan (IMP or Plan) outlines the approach for managing waste appropriate for incineration at both the MLA in southern Bathurst Inlet and at the Goose Property. These measures demonstrate how Sabina will avoid, minimize, mitigate and/or manage to an acceptable level, the potential adverse effects on the environment associated with waste incineration.

The Plan was prepared following the requirements of the Nunavut Impact Review Board (NIRB) to Sabina (NIRB 2013), Project Certificate No. 007, Water Licence 2AM-BRP1831, and in accordance with best management practices and in conformance with current Federal and Territorial statutory requirements.

This plan is a living document to be updated upon changes in related regulatory requirements, management reviews, incident investigations, changes to facility operation or maintenance, and environmental monitoring results, best practice updates or other Project specific protocols once construction starts through to Project closure activities. Any updates will be filed with the Annual Report submitted to the NIRB in accordance with Project Certificate No.007 and the Nunavut Water Board (NWB) in accordance with Water Licence 2AM-BRP1831.

The information presented herein is current as of June 2020. The Plan will be reviewed as needed for changes in operation and technology and as directed by regulators where appropriate.

2. Scope and Objectives

The IMP is one of the documents that forms part of Sabina's overall Waste Management Program for the Project. This plan addresses requirements of the Type A Water Licence 2AM-BRP1831 as well as Project Certificate No. 007 and applies to all Sabina projects in the Kitikmeot region.

This plan is divided into the following components:

- Applicable Legislation and Guidelines (Section 3);
- Planning and Implementation (Section 4);
- Roles and Responsibilities (Section 5);
- Operational and Maintenance (Section 6);
- Environmental Protection Measures (Section 7);
- Monitoring (Section 8);
- Record Keeping (Section 9);
- Environmental Reporting (Section 10);
- Adaptive Management (Section 11); and
- Reclamation (Section 12).

Incineration is an essential part of waste management at the Back River site. The incineration of acceptable solid waste from the accommodation complex, kitchen, lunch rooms, shops, warehouses, and offices minimizes accumulation of wildlife attractants and will divert waste transported off-site and from the on-site landfill once constructed. Sewage sludge from the planned sewage treatment plant at the Goose Property will also be incinerated, as is any Pacto waste generated (i.e. human waste from waterless toilets). Incineration has the advantage of eliminating waste that could potentially attract wildlife to the Project and landfill, thereby reducing possible interactions between humans and wildlife.

Waste products are safely managed from the time they are produced to their final disposal. Reduce, reuse, and recycle initiatives, as well as a waste segregation program are used to minimize the quantity of waste incinerated or directed to the landfill. Waste that is deemed unsuitable for incineration, including hazardous materials, will be handled appropriately as per the Landfill and Waste Management Plan and Hazardous Materials Management Plan.

By implementation of the waste management program and selection of appropriately designed incinerators incineration practices will comply with air quality requirements for the protection of the environment and human health.

The objectives of incineration management through all phases of the Project are to:

1. Characterize the quantity and composition of the waste products to be generated at the Back River site, and effectively separate wastes acceptable for incineration from waste that is not;
2. Select appropriate batch waste incinerators based on the characteristics and quantity of waste;

3. Locate incinerators at appropriate sites and set back an appropriate distance from other infrastructure;
4. Operate incinerators to achieve optimal combustion and avoid the formation of dioxins, furans, and mercury in the combustion process;
5. Implement incinerator operational practices and to document frequency and incinerator operating parameters, including the safe handling and disposal of incinerator residues; and
6. Demonstrate compliance with applicable Federal and Territorial regulations for environmental protection.

2.1 RELATED DOCUMENTS

This Plan is intended for use in conjunction with the following Plans:

- Air Quality Monitoring and Management Plan;
- Environmental Management and Protection Plan;
- Landfill and Waste Management Plan;
- Hazardous Materials Management Plan;
- Risk Management and Emergency Response Plan;
- Spill Contingency Plan; and
- Fuel Management Plan.

3. Applicable Legislation and Guidelines

Federal and Territorial legislation that is applicable to solid waste incineration management in Nunavut is presented in Table 3-1.

Provincial and/or territorial regulations that pertain to emissions from incinerators are not available for Nunavut or the Northwest Territories. Therefore, performance limits for Project incinerators will be in accordance with the emission guidelines set out by the Canadian Council of Ministers of the Environment (CCME): Canada-Wide Standard for Dioxins and Furans (CCME 2001), and Canada-Wide Standards for Mercury Emissions (CCME 2000).

Ash produced from the incineration process will be disposed of in accordance with the Nunavut Environmental Guideline for Industrial Waste Discharges (GN 2011b).

Table 3-1. Applicable Legislation to the Incineration Management Plan

Acts	Regulations	Guidelines
Federal		
<i>Canadian Environmental Protection Act</i> (CEPA 1999 c.33)	Schedule 1: List of Toxic Substances Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2002-301)	Environment Canada (EC) Technical Document for Batch Waste Incineration (EC 2010) Canada-Wide Standards for Dioxins and Furans (CCME 2001) Canada-Wide Standards for Mercury (CCME 2000)
<i>Hazardous Products Act</i>	Controlled Products Regulations	Workplace Hazardous Materials Information System (WHMIS 2015)
Territorial – Nunavut		
<i>Nunavut Environmental Protection Act</i>		Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities (GN 2011b) Environmental Guidelines for the Burning and Incineration of Solid Waste (GN 2012a) Environmental Guidelines for Ambient Air Quality (GN 2011a) Environmental Guideline for Mercury-Containing Products and Waste Mercury (GN 2010) Environmental Guideline for Used Oil and Waste Fuel (GN 2012b)

Additionally, the NIRB Project Certificate No. 007 condition 4 states that *“The Proponent shall develop and implement an Incineration Management Plan that demonstrates consideration for the recommendations provided in Environment and Climate Change Canada’s Technical Document for Batch Waste Incineration (2010).”* Additional commentary related to Condition 4 indicates that:

“The initial Incineration Management Plan must be submitted to the Nunavut Impact Review Board at least 60 days prior to the commencement of construction and must be tested within the first year of operations.

Subsequently, unless otherwise directed by Environment and Climate Change Canada, every (3) three years the Proponent shall provide the Nunavut Impact Review Board with confirmation of any changes to the Proponent’s Incineration Management Plan in the Proponent’s annual report to the Nunavut Impact Review Board.”

The Incineration Management Plan is also a plan applicable to NWB Water Licence 2AM-BRP1831, which requires reporting of incinerator test results and materials burned.

4. Planning and Implementation

4.1 INCINERATOR SELECTION

The Project will select and operate incinerators based on Environment Canada's Technical Document for Batch Waste Incineration (EC 2010). Typical modern, controlled-air, batch, dual chamber incinerators are designed using the principles of pyrolysis (starved-air burning condition) in the primary chamber and complete oxidation (high temperature, excess oxygen, and sufficient combustion time) in the secondary chamber. The incineration system will be a two-stage process. In the first stage, waste will be converted to gas in the primary chamber at approximately 650 to 850 degrees Celsius (°C). This process will be self-fueling until the volume is reduced by 90%. Gasses from the primary chamber will enter the secondary chamber of oxygen-rich and turbulent conditions, which is typically at a higher temperature of approximately 1000°C. Combustion will be complete after a retention time of about two seconds. The temperature of combustion gases exiting the stack is anticipated to exceed 700°C and to flash cool in the ambient air, thereby leaving little opportunity for the de novo synthesis of dioxins/furans. Heat capture will not be used on the exhaust gases.

Critical process parameters, such as temperature, air flow, and burner output will be computer-controlled to maintain optimal combustion conditions.

A controlled-air, batch, dual chamber Ketek CY-100-CA-D incinerator has been purchased for use at the Goose Property and will be installed and commissioned during Project construction. The existing incinerator at Goose, a Ketek CY-50-CA, will continue to be used at Goose until that time, at which point it will be transferred to the MLA to upgrade from the existing Firelake MFG Model # A850X-20 incinerator. Both the CY-100 and the CY-50-CA incinerators meet the selection criteria described above. Operational manuals for the Ketek incinerators are provided in Appendix A and B of this Plan.

4.2 INCINERATOR LOCATIONS

The incinerators at both the Goose Property and the MLA will continue to be located more than 31 meters from any waterbody and are equipped with sufficient secure storage and workspace to allow waste drop off and sorting in one location and to prevent wildlife access to food scraps.

5. Roles and Responsibilities

The Construction Manager is ultimately responsible for the success and implementation of this plan including overall operator training, operation, adaptive management, operational record keeping and execution of stack testing.

The Manager, Environmental Permitting is responsible for the development and revision of this Plan, waste management audits, coordination of stack tests and compliance reporting.

Other relevant personnel designated by the Construction Manager or Environmental Permitting Manager which may be responsible for incineration management will be required to complete and maintain compliance with appropriate training requirements as defined in this plan, Sabina's Standard Operating Procedures, current Best Management Practices, and applicable Health and Safety Laws and Regulations.

5.1 TRAINING

Incinerator operators complete a training program prior to commencement of incinerator operation. This training includes recommendations presented in Environment Canada's Technical Document for Batch Waste Incineration (2010) and has been developed in conjunction with the training manual provided by the incinerator supplier.

The training program educates operators in the following areas:

- hazard recognition and safety protocols;
- identification of waste types and understanding of how waste composition affects operation;
- incinerator start-up and operating procedures, including identification of adjustments to increase operating efficiency;
- incinerator clean-out and maintenance procedures; and
- record keeping and reporting requirements.

Initial operator training on a new incinerator is provided by a qualified technician experienced in the operation of controlled-air, batch, dual chamber incinerators in compliance with regulatory guidelines. The incineration process of this incinerator is automated and requires minimal attendance during operation. A computerized incinerator will typically require one operator to interact with the equipment for approximately 1 to 1.5 hours per day, largely for ash removal, loading, and start-up. Each incinerator will be designed, installed, and operated so that the operators are not exposed to high temperatures during loading or ash removal in accordance with the complete cool down after each burn cycle.

6. Operation and Maintenance

This section provides general guidance and standard operating procedures for the operation of the incinerator. The incinerator operator is to refer to the operational manual provided by the manufacturer for specific instructions and optimal operating conditions for each incinerator. If there is a disagreement between the information provided below and the operational manual, the operational manual is to be followed. Any needed additional incinerator operating procedures will be developed in consultation with the supplier/manufacturer prior to use of a new incinerator. The Standard Operating Procedures shall include the following general procedures:

- Waste sorting on the basis of origin and heating value. Food waste and waste that has been in contact with food will have priority for incineration.
- Waste mixing to ensure a calorific value within incinerator specifications and to achieve good combustion inside the primary chamber.
- The operator will observe the start of the burn cycle to ensure incinerators are operating correctly, and the primary and secondary chambers operate in the temperature ranges specified by the manufacturer.
- Incinerator doors will only be opened after the burn cycle is complete and the unit is fully cooled except if required otherwise in the operator's manual (i.e. see raking requirements specific to the CY-100-CA).

Ash disposal procedures are provided in Section 6.2.1.

Operation of the incinerators will be conducted in accordance with Environment Canada's Technical Document for Batch Waste Incineration (EC 2010). Additional acts, regulations, and guidelines applicable to the operation of the incinerators are listed in Section 3.

Key operational control procedures that will help maintain good operation of the incinerator are provided in the following sections.

6.1 WASTE STREAM MANAGEMENT

Only authorized waste may be incinerated. Table 6.1-1 provides a list of waste that is considered acceptable for incineration and examples of waste that is considered unacceptable. To facilitate the initial sorting of material, waste will be collected in transparent bags so that the contents are readily visible. Verification of correct sorting and mixing procedures will be ensured by periodic spot checks and Quality Assurance (QA)/Quality Control (QC) management by a trained staff member.

Table 6.1-1. Waste Classification for Incineration

Acceptable Wastes for Incineration	Unacceptable Wastes for Incineration
<ul style="list-style-type: none"> organic matter including food; food containers and packaging, including plastics that are contaminated by food; untreated wood including lumber and plywood; medical waste from the Health Care Station; paper, cardboard; painted wood except wood painted with lead or PCB-amended paint hydrocarbon spill absorbents; plastic and Styrofoam, except plastic containing chlorine; dead animals; used oils and waste fuel; Pacto waste; and dewatered sewage sludge from the Goose Site Sewage Treatment Plant. 	<ul style="list-style-type: none"> chlorinated plastics; inert materials, such as concrete, bricks, ceramics, ash; machinery parts or large metal goods (i.e., appliances); radioactive materials, such as smoke detectors; potentially explosive materials, such as propane tanks, other pressurized vessels, unused or ineffective explosives; hazardous materials such as organic chemicals (pesticides), other toxic substances (arsenic, cyanide); electronics and/or batteries; asbestos; dry wall; vehicles and machinery; fluorescent light bulbs; whole tires; paints and solvents; any materials containing mercury; and any other wastes not considered 'acceptable'.

6.1.1 Waste Volumes

Quantity of waste incinerated will be recorded by batch in kg and as an estimate of volume in cubic meters.

6.2 INCINERATOR OPERATION

Each day, the Primary Chamber should be loaded to design capacity or, at a minimum, to half capacity with waste types and quantities conducive to a clean burn. If waste quantities are not sufficient to operate the machine daily, the waste may temporarily be stored in a secure area, such as a seacan, to prevent wildlife access. A front-end loader may be used to manually load feed waste.

Pre operational inspections, loading, operation and unloading should occur as outlined in the applicable operators manual. The operator is required to remain present to supervise the beginning of the process (start-up) to ensure that the primary and secondary chambers reach and operate in the temperature ranges specified by the manufacturer. The entire process is controlled by computer in the Main Control Panel. The Operator can see the status of all the critical components and parameters, such as temperature, air flow, and burner output in addition to any malfunction alarms.

6.2.1 Ash Disposal

Incinerator ash should be handled and disposed of appropriately, following these steps:

- Ash is removed from each incinerator before a new burn cycle is initiated.
- Incinerator ash is packaged in labelled drums or sacks and the whole container landfilled, minimizing wind-blown effects.

- The concentration of trace metals will be tested as per the Government of Nunavut's Environmental Guidelines for Industrial Waste Discharges (GN 2011b).
- Ash exceeding the above standard will be handled as per the Hazardous Materials Management Plan.
- Ash generated at Goose Property and MLA and meeting the standard will be disposed in the on-site landfill at Goose or be back-hauled off site for disposal.
- Containers of ash will be labelled in a manner to ensure ash sampling results can be traced back to specific containers/incineration batch(es) of concern, in case results indicate landfilling is not appropriate.

6.2.2 Odour and Dust Control

Current state of the art incinerators are designed with a non-turbulent atmosphere in the primary burn chamber which reduces the formation of particulate matter. Additional dust or odour control is therefore not anticipated. Ash residues generated in the primary chamber will be manually removed and packaged in a drum or sack before being disposed of in the on-site landfill, thus eliminating wind-blown effects.

6.2.3 Used Oil and Waste Fuel

The incinerator will be capable of efficiently and safely burning oil and waste fuel. Sabina will manage used oil and waste fuel according to the Environmental Guideline for Used Oil and Waste Fuel (GN 2012b). The regulations stipulate the maximum level of contaminants in used oil that is allowed for incineration. Specifics of the used oil and waste fuel regulations are referenced in the Fuel Management Plan.

6.3 CONTINGENCIES

In the event of an incinerator breakdown, the operator should consult the manufacturer-provided operations manual to try and diagnose the cause. A local technician should be contacted for assistance if needed. The operator should assess the likely downtime of the incinerator and alternative disposal and/or secure waste storage methods should be implemented until the incinerator is repaired. Contingency or alternative waste storage procedures to be implemental until the incinerator is repaired, which are dependent on the length of incinerator down time may include:

- short-term shutdown of incinerator will be mitigated through temporary storage in sealed, wildlife-proof containers;
- long-term shutdown of incinerator will require backhauling to an operational on-site incinerator or off-site disposal by a waste services provider; and
- food waste would be prioritized for storage in both instances with alternative disposal methods for other material considered.

Long-term storage due to the presence of putrescibles in the domestic waste is impractical due to the potential of attracting wildlife. In the event of long-term shutdown generation of organic wastes would be minimized as much a feasibly possible.

Spills associated with the incinerator or waste disposal steams will trigger the implementation of the Spill Contingency Plan. Any accidents and malfunctions will trigger the implementation of the Risk Management and Emergency Response Plan.

7. Environmental Protection Measures

Sabina has an ongoing commitment to implementing environmental protection measures in all aspects of its operations and is committed to reducing incinerator emissions using technologically advanced, best available, and economically feasible procedures.

Sabina is committed to reducing waste volumes to be incinerated, while managing and minimizing dioxin, furan, and mercury emissions. Sabina also implements appropriate material handling procedures for the disposal of ash material generated by incineration.

A summary of the Canada-Wide Standards, as prepared by CCME, for dioxins, furans and mercury emission limits is presented in Table 7-1.

Table 7-1. Canada-Wide Standards for Waste Incineration Emissions

Waste Incineration Compound	Sector	Emission Limit (Max)
Dioxins and Furans ¹	Municipal Solid Waste ³ Sewage Sludge Incineration	80 picograms of International Toxic Equivalents (I-TEQ) per cubic metre (pg/m ³)
Mercury ²	Municipal Solid Waste Sewage Sludge Incineration	20 micrograms per cubic metre (µg/m ³) 70 micrograms per cubic metre (µg/m ³)

¹ CCME 2001

² CCME 2000

³ According to the Canada-Wide Standards (CWS), "municipal solid waste" includes any waste that might be disposed of in a non-secure landfill site if not incinerated (i.e., non-hazardous wastes regardless of origin), but does not include "clean" wood waste.

These emission limits apply to waste incineration at new facilities across Canada. Compliance with these standards will be achieved through the installation and use of state of the art technologies and a detailed and conscientious waste management program. The permanent incinerators at the Project are expected to achieve full compliance immediately upon attaining normal full-scale operation. Should elevated concentrations be found adaptive management strategies would be implemented (see Section 11).

7.1 WASTE REDUCTION AND MITIGATION STRATEGIES

Waste reduction, reuse, and recycling are undertaken where reasonable to minimize the quantity of waste to be incinerated or directed to the landfill. These initiatives include:

Reduce

- Purchasing only the required amounts of materials and buying in bulk when the opportunity is available.
- Employing inventory control methods to ensure that quantities of materials are completely utilized.
- Establishing maintenance schedules that are consistent with the equipment manufacturers' suggested replacement.
- Maintaining and protecting materials to prevent damage and breakage.

- Eliminating unnecessary plastic and bulky packaging by buying kitchen supplies in bulk (i.e. ketchup, salad dressings, syrups, etc.).
- Cutting down on plastic food packaging.
- Substituting less hazardous chemicals where possible.
- Selecting products that provide the maximum "life-of-material".

Re-Use

- If appropriate, collect and return materials to the system (i.e. equipment, operations, etc.) following maintenance or repair.
- Evaluation of use of waste oil burners to heat selected facilities.
- Use of oil/water separators to reduce the amount of contaminated water.
- If appropriate, filter and/or use additives to replenish lost properties of material in order to extend its useful life.
- Testing to ensure items (i.e. batteries) are "spent" before removing from service.

Recycle

- Commercial companies are used to the maximum extent practical to recycle appropriate materials on a fee for service basis.
- Explore waste management options that allow for the recycling of a material or product instead of disposal.

7.2 DIOXANS AND FURANS

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, commonly known as dioxins and furans, are toxic chemicals which persist in the environment for long periods of time and are subject to bio-accumulation in plants and animals. Their presence in the environment results predominantly from human activity, most notably the large-scale incineration of municipal and medical wastes. The quantity of dioxins and furans in the incinerator emissions will vary depending on the type and volume of the waste stream. Sabina recognizes the importance of reducing the presence of dioxins and furans in emissions. Monitoring of dioxins and furans in the exhaust stream will be conducted and is described in more detail in Section 8.1.

7.3 MERCURY

Mercury is a naturally occurring substance, which can be transformed through biological processes to methyl mercury, a persistent substance which bio-accumulates in the food chain and is particularly toxic to humans and wildlife. The quantity of mercury in the incinerator emissions will vary depending on the type and volume of the waste stream. Sabina understands the importance of reducing the concentrations of mercury in emissions. Monitoring of mercury content in the exhaust stream will be conducted and is described in more detail in Section 8.1.

7.4 PREVENTION OF WILDLIFE ATTRACTION

Project personnel are educated on the importance of proper food waste (or other potential attractant) management to ensure animals are not attracted to worksites. All food waste is returned daily to the main camp facilities so it is captured in the domestic waste stream. Collection and transfer of food

wastes is performed so that these attractants are stored safely, moved between facilities securely and are burned in the incinerator promptly.

8. Monitoring

Sabina will implement a testing and monitoring program to ensure that criteria for applicable air quality standards and guidelines and ash disposal are being met. The monitoring program is outlined in the following sections.

8.1 INCINERATOR EMISSIONS TESTING

The incinerator stack design will allow stack testing to be undertaken during incineration. Stack emissions testing will occur within the first year of operations when quantities incinerated exceed 26 tonnes/year to ensure achievement of the Canada-wide Standards for Dioxins and Furans and the Canada-wide Standards for Mercury (CCME 2000, 2001) and every 3 years thereafter or as recommended. Should emissions exceed Canada Wide Standards for Dioxins and Furans or Mercury Sabina would consult the incinerator manufacturer for recommendations on improvement and/or conduct a waste stream audit to determine the possible source of elevated emissions and further refine the incinerator waste stream. Manufacturer recommendations and waste stream refinement would be implemented to the extent feasible and the success of these measures would be verified in the subsequent round of stack testing.

8.2 ASH TESTING

Provided the materials that go into the incinerator are controlled to exclude all hazardous materials, then the incinerator ash should be non-hazardous. Ash testing will be implemented as required to ensure that the incinerator ash is suitable for disposal in the landfill. The samples will be compared to the *Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities* (GN 2011b) presented in Table 8.2-1.

Table 8.2-1. Guidelines for Solid Waste/Process Residuals (Ash) Leachate Suitable for Landfill

Parameter	Maximum concentration (mg/L)
Arsenic	2.5
Barium	100
Cadmium	0.5
Chromium	5
Lead	5
Mercury	0.1
Selenium	1
Silver	5
Zinc	500

If monitoring indicates the ash is above the guidelines and not suitable for landfilling, an investigation will be undertaken to identify the cause and eliminate the source of exceedance. If monitoring indicates the ash meets the guidelines, ash containers will be stored and backhauled to an off-site licenced landfill or landfilled at an on-site landfill as per the Landfill Management Plan in the container to eliminate any windblown effects.

Containers of ash identified as having elevated metals concentrations will be sent to a licensed hazardous waste disposal facility. Hazardous waste shipments will follow the Transportation of

Dangerous Goods (TDG) regulations as well as the Interprovincial Movements of Hazardous Waste regulations. Certificates of Disposal for waste shipped off site are provided by the off-site waste handling facility. This is provided so waste generators can demonstrate to regulatory authorities that their waste is being handled by an approved facility and that the waste was disposed according to applicable federal and territorial regulations.

8.3 WASTE AUDITING

A waste audit will be completed following incinerator commissioning and periodically thereafter to confirm adherence to waste segregation practices and identify waste stream volumes that can be minimized prior to incineration. The waste audit will inform the improvement of waste segregation procedures and policies as well as revisions to the comprehensive list of acceptable and unacceptable waste for incineration. The identification of unacceptable waste for incineration will be based on the EC Technical Document for Batch Waste Incineration (EC 2010) and the regulations discussed in Section 3.

8.4 QUALITY ASSURANCE/QUALITY CONTROL

The collection and analysis of incinerator emissions samples will be conducted in compliance with appropriate stack test methods and undertaken by an accredited laboratory. Following each stack emissions testing program an Incinerator Stack Testing Compliance Report will be completed. This report will include a description of the incinerator and how it was being operated at the time of the stack emissions testing program, the methods used for sampling and analysis.

Incinerator ash samples will be collected in lab-provided containers and will be appropriately labelled to allow tracking to individual ash containers if exceedances are identified. The samples will be analyzed by an accredited laboratory.

Additional QA/QC procedures for incineration include:

- Incinerator operational data including temperature, differential pressure in the primary chamber, auxiliary burner operation, fan amperage will be recorded continuously, consistent with detailed written operating instructions from qualified personnel;
- Detailed training programs will be implemented to ensure that all staff working with the incinerator are competent and qualified for their respective task;
- Analysis of sampled emissions during monitoring will be completed by an accredited laboratory;
- Stack testing samples of emissions and ash samples will be collected and handled according to operating instructions prepared by qualified personnel; and
- Qualified personnel will calculate emission concentrations for monitored air quality parameters based on laboratory results and compare against the applicable guidelines.

9. Record Keeping

Maintenance and inspection procedures should be carried out in accordance with the manufacturer's specifications.

A maintenance log is required to be kept for regulatory review. The maintenance log will be used to record routine maintenance activities or operational changes, the date completed, personnel responsible, and observations during maintenance activities. The maintenance log will also note any problems encountered. Maintenance personnel should determine the cause of any failure to help avoid or reduce similar failures.

Operational data will be collected by a data logger and stored continuously, even when the incinerator is not operating. The data will be used to monitor operating conditions to ensure that normal operating parameters are not exceeded. In the event that normal operating conditions are not met, the data will be used to identify causes of failure and to optimize the system.

Prior to incineration, the type of waste in each bag will be determined, weighed and the source noted. The total weight of each type of waste will be recorded before the burn cycle is started. After the cool-down period, the ash will be removed and weighed before it is sent for disposal. This information will be stored electronically with the operational data from the incinerator. This data will assist Sabina in determining incinerator waste generation rates at the facility, and in turn, provide data on the effectiveness of waste diversion, reduction and recycling programs.

Regulatory compliance reporting requirements will be defined in various regulatory authorization issued including the water licence.

10. Environmental Reporting

To demonstrate conformity with performance limits, an annual incineration summary will be prepared and submitted as part of annual reporting to authorizing agencies. Any stack testing results will also be integrated into the annual air quality monitoring report.

The following information will be included in the incineration summary report:

- the quantity and type of materials incinerated on-site during operations;
- results from any stack emissions and ash monitoring;
- record of ash disposal, including weight of ash disposed, location of disposal, and the transportation/load details;

The annual reporting will also identify any major changes to the operation and efficiency of the incinerator or necessary changes to this Plan.

11. Adaptive Management

The IMP will be reviewed annually and updated as needed to incorporate any lessons learned, major changes to the incinerator operation or maintenance, and environmental monitoring results and to reflect the operating conditions at the Project during Construction, Operations, and Closure.

The need for any corrective actions related to emission management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:

- monitoring data showing concentration greater than applicable standards (i.e., elevated metals, dioxins, and furans);
- monitoring data showing an increasing trend in contaminant concentrations; and
- issues raised by on-site staff, regulators, or local communities.

Discussions will be initiated to resolve any issues as soon as possible after the issue has been identified.

Relevant employees will be informed of updates to incineration management procedures and the updated IMP will be stored appropriately on-site.

Sabina will retain all raw data records and annual reporting for at least two years. The updated IMP, raw data, and annual reporting will be made available by Sabina at all times for review by the Government of Nunavut, Nunavut Impact Review Board, and Environment and Climate Change Canada.

12. Reclamation

In accordance with the Interim Closure and Reclamation Plan, all buildings, machinery, and equipment that is not salvageable will be disposed of in an on-site landfill after any hazardous material has been removed.

13. References

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Appendix A. Ketek CY-100-CA Incinerator

MANUAL **OPERATION &** **MAINTENANCE**

CY-100-CA



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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

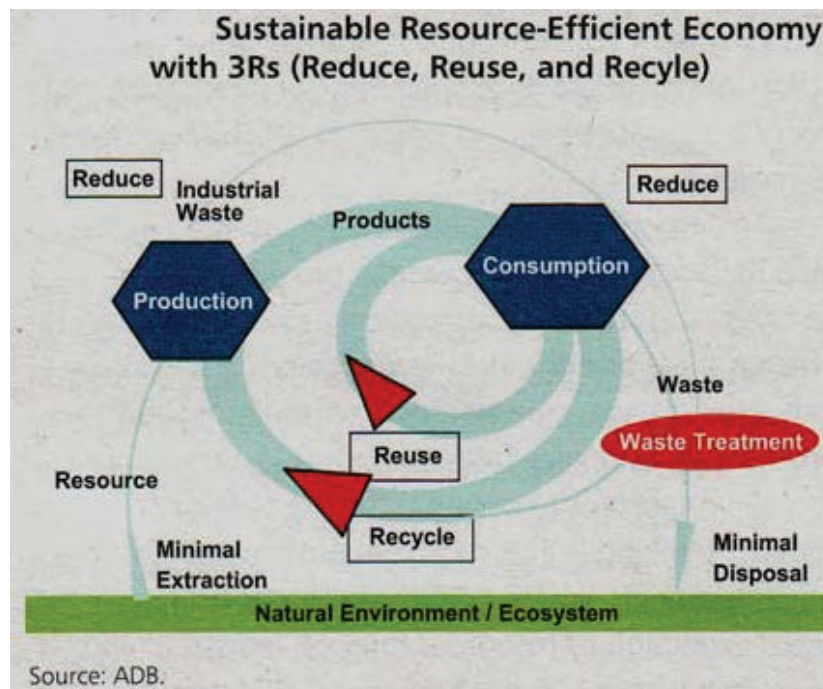
2. Waste Incineration and General Guidelines for Waste Management

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 dibenzop-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.



3.1 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 at regular intervals.
- Ensure the safety of all personnel and the site.
- Carry out periodic inspections and record observations in the 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 temperature¹ 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.

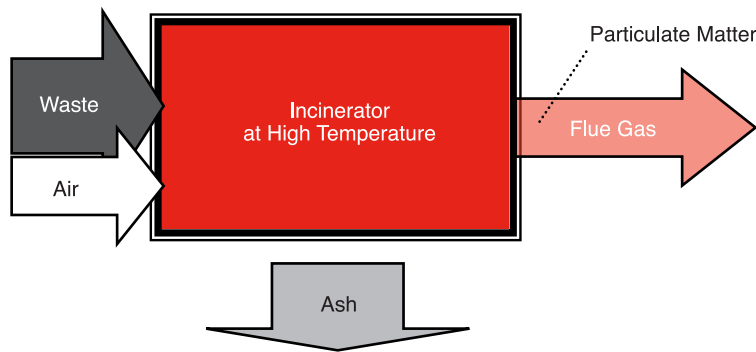


FIGURE 1 SCHEMATIC DIAGRAM OF INCINERATION PROCESS

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**.

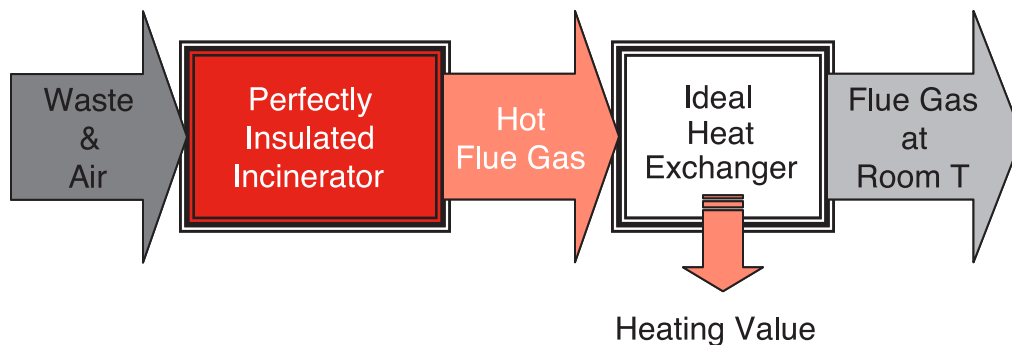


FIGURE 2 THE CONCEPT OF HEATING VALUE

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”.

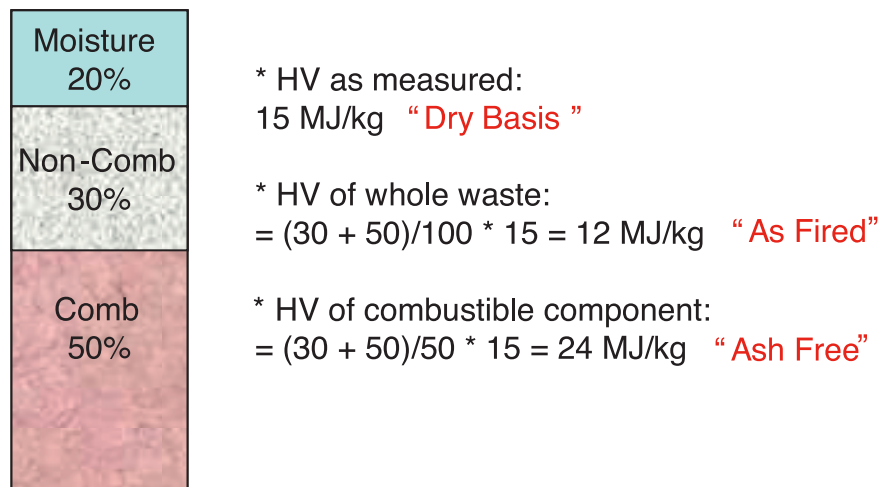


FIGURE 3 DIFFERENT BASES FOR EXPRESSING HEATING VALUE (HV)

4. Principles of Waste Incineration

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 HHV (A/F)
			Moist	Comb	Non-C	
0	Trash	Paper, cardboard, cartons wood boxes and combustible floor sweepings from commercial 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 abattoir, animal pound, veterinary sources	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. Principles of Waste Incineration

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

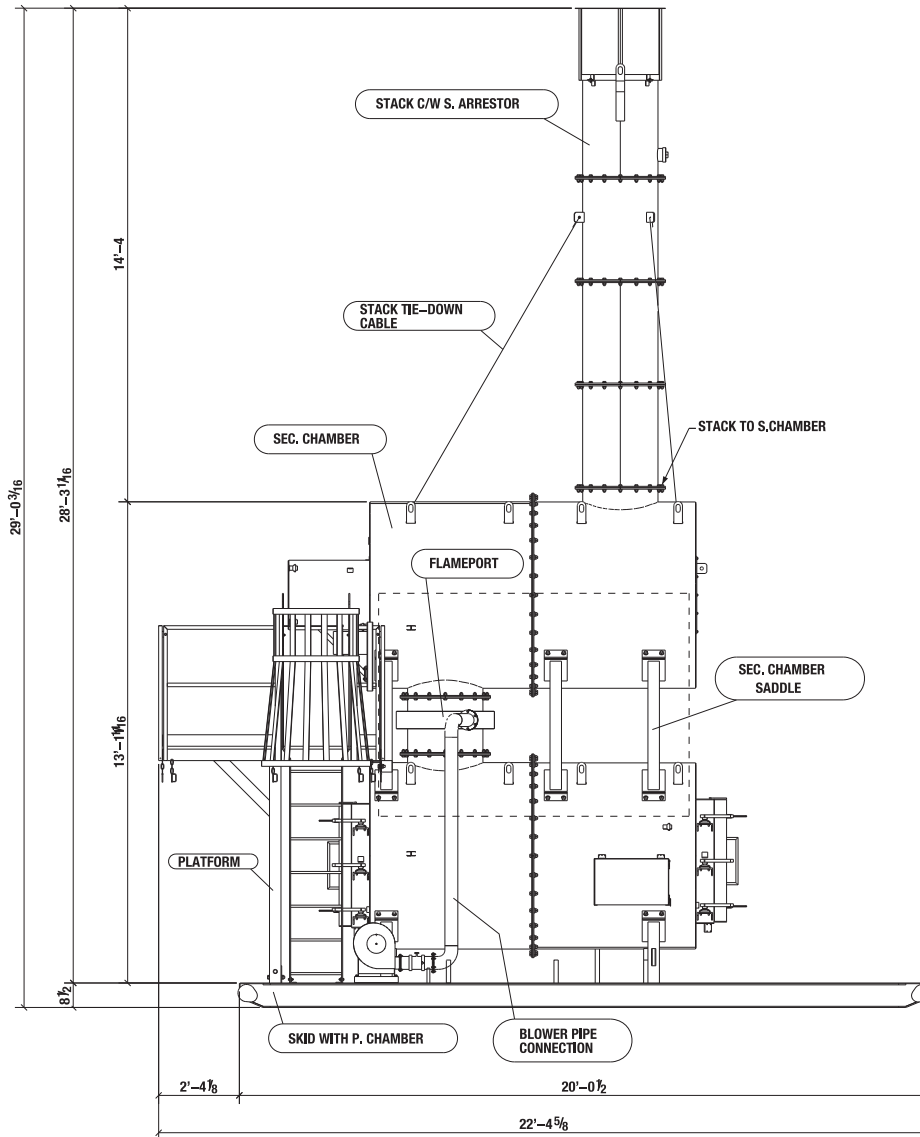


FIGURE 4 SCHEMATIC OF THE INCINERATION SYSTEM

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.

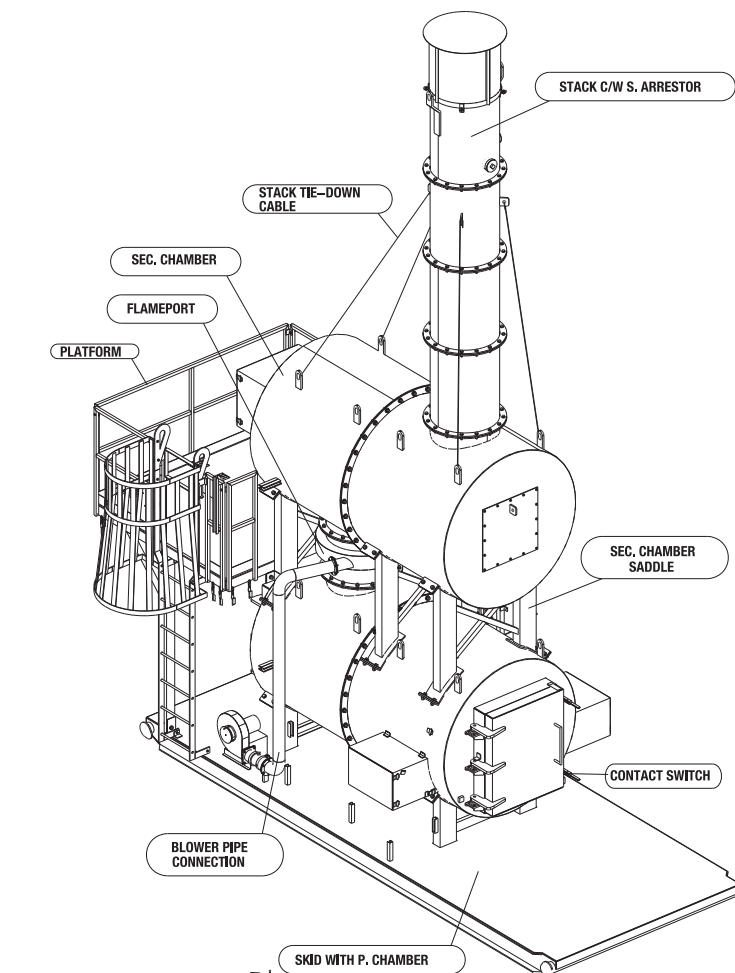


FIGURE 5 OVERALL VIEW SHOWING THE SECTIONS

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 in-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 in-house. Feed Door: 90 cm(Height) x 70 cm (Width) Ash Door : 86cm(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 in-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

5. System Description

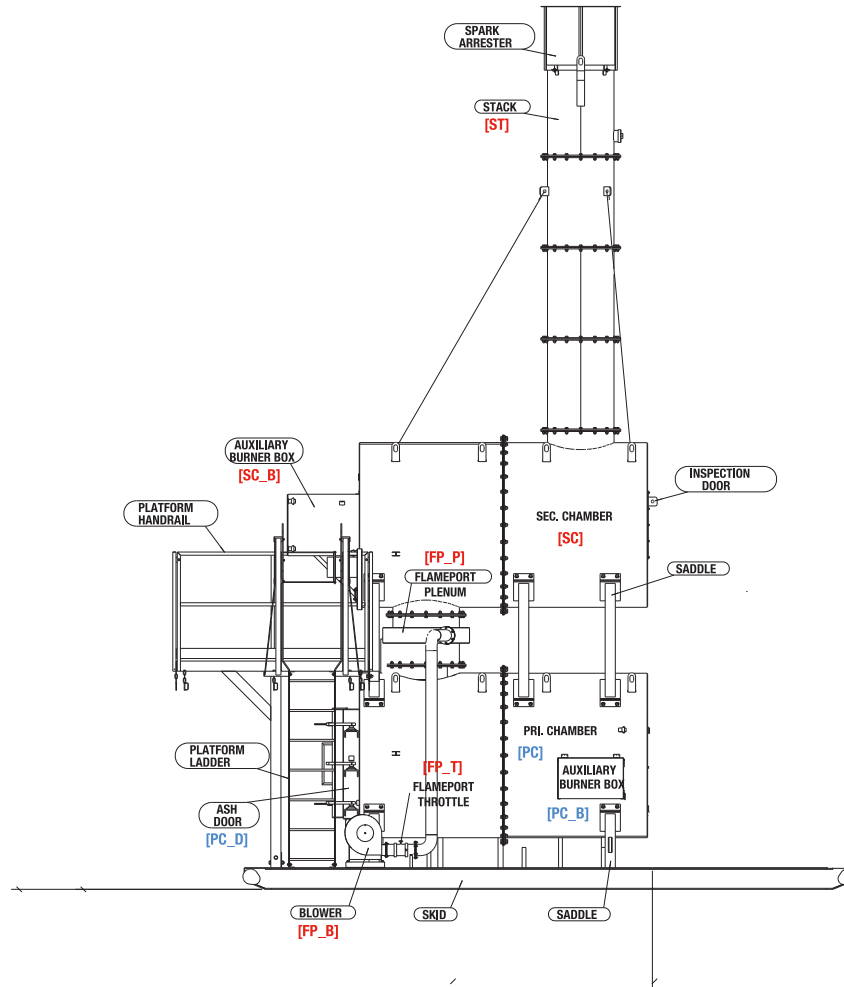


FIGURE 6 COMPONENTS IN THE PRIMARY AND SECONDARY CHAMBER SECTIONS (1)

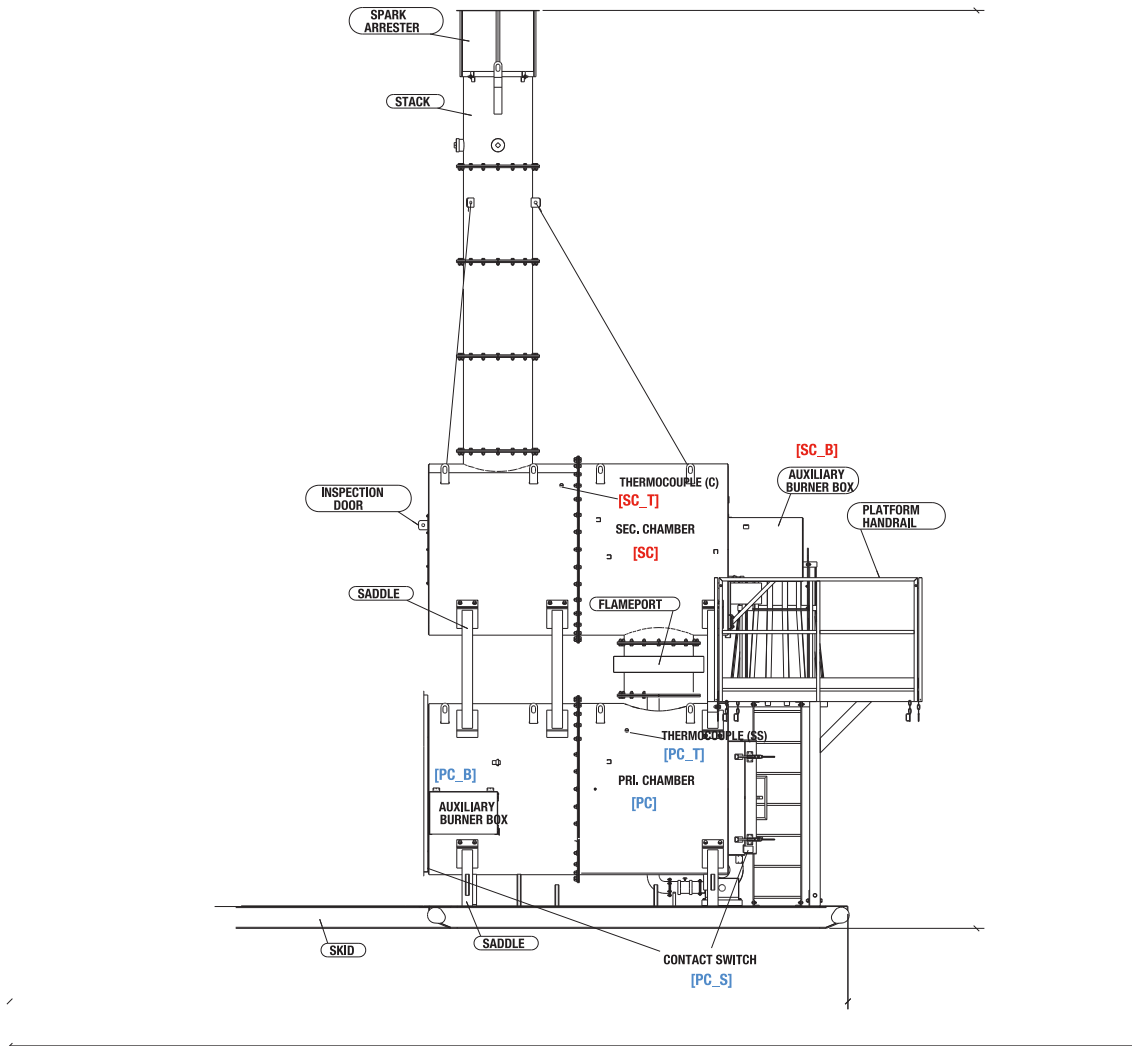


FIGURE 7 COMPONENTS IN THE PRIMARY AND SECONDARY CHAMBER SECTIONS (2)

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	Start Switch	Initiate Pre-Purge, Burn, Burn-Down, Cool-Down Automatic Cycles.
PB2	Emergency Stop	Emergency Use Only. For Normal Stop, Set Burn Time to 0.
R1	Contact Switch	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

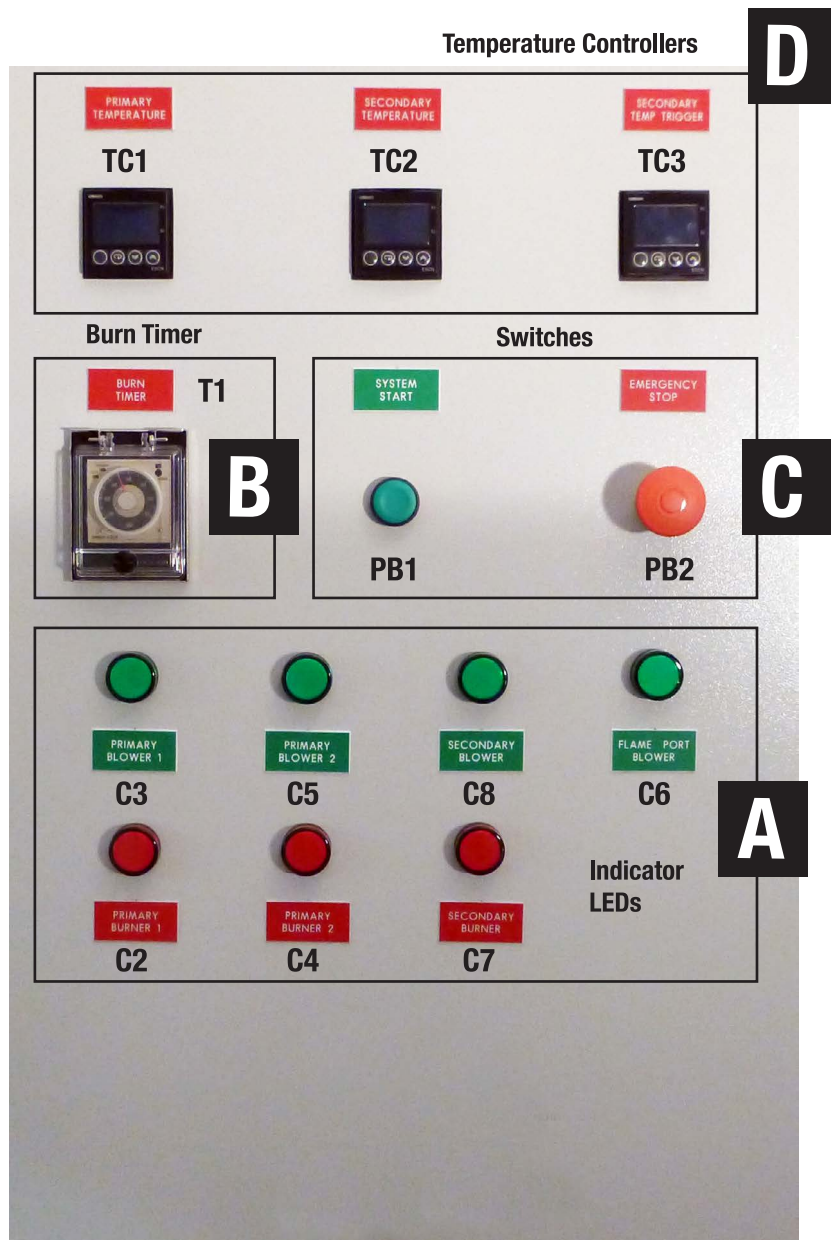


FIGURE 8 OVERVIEW OF CONTROL PANEL, SHOWING THE MAIN SECTIONS

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.

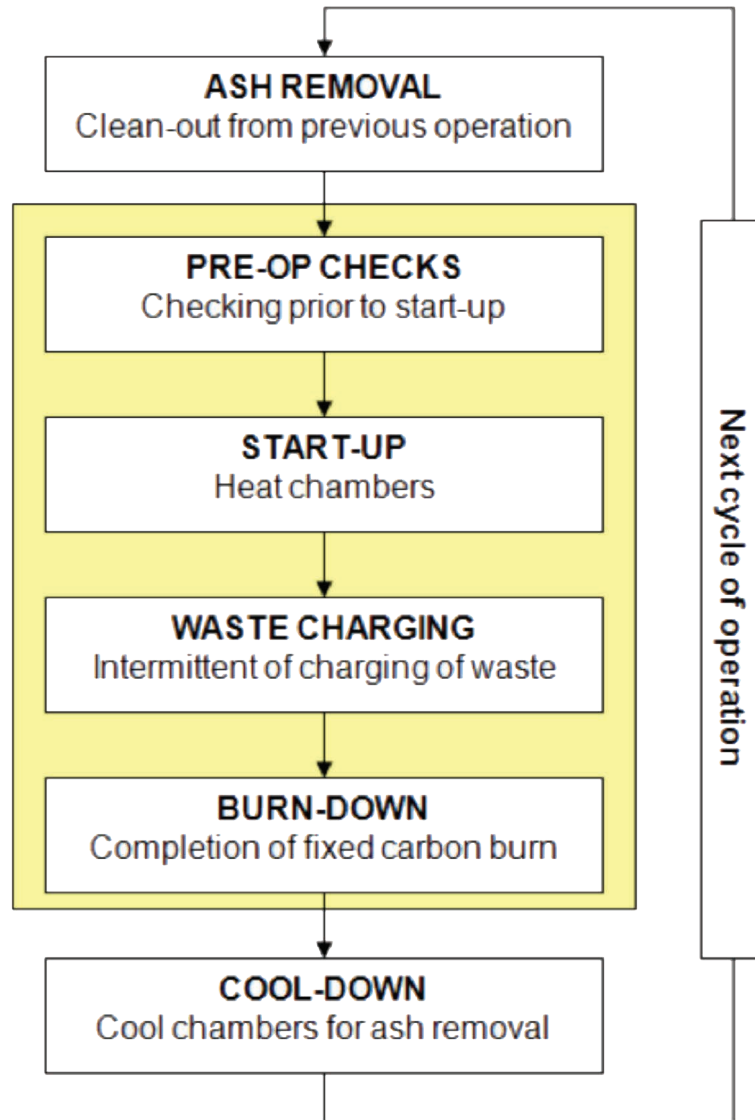


FIGURE 9 STEPS IN THE OPERATION OF THE INCINERATOR

6.1 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):
 - o Inspect refractory for large cracks (not expansion cracks)
 - o 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. Operation & Maintenance

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.

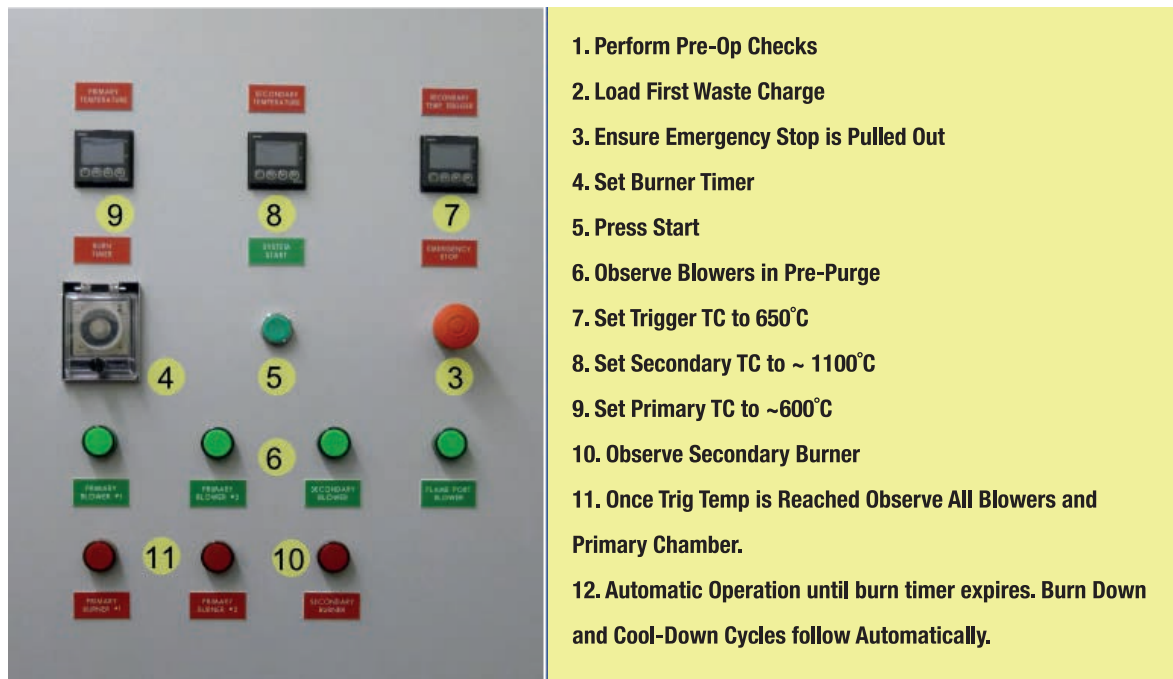


FIGURE 10 OPERATING SEQUENCE

**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	<input type="checkbox"/> Make sure there is power. <input type="checkbox"/> Check emergency stop is not engaged. <input type="checkbox"/> Timer is set to an actual value. <input type="checkbox"/> Make sure there is power on all phases/legs coming into the incinerator.
Pre-Purge Phase	Skipping or not starting the Pre-purge.	<input type="checkbox"/> Check that pre-purge timer works correctly. <input type="checkbox"/> Check emergency stop is not engaged. <input type="checkbox"/> Make sure there is power on all phases/legs coming into the incinerator.
	Auxiliary burner blower(s) won't run in pre-purge cycle.	<input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check burner blower contacts are energized. <input type="checkbox"/> Check that overload switch on the motor is not tripped. <input type="checkbox"/> Check there is power at the burner on the wire supplying power to the motor (Use Multi meter) <input type="checkbox"/> 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	<input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check there is power at the Genisys Control. <input type="checkbox"/> Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	<input type="checkbox"/> Check all fuel valves are on. <input type="checkbox"/> Check Burner contacts are energized. <input type="checkbox"/> Check there is sufficient fuel in the tank. <input type="checkbox"/> 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. <input type="checkbox"/> 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. <input type="checkbox"/> 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. <input type="checkbox"/> Check that CAD cell is clean. <input type="checkbox"/> Try and hear the spark at the electrodes.
Burn Phase	Primary auxiliary burner(s) won't ignite.	<input type="checkbox"/> Check Door Switch(s) are engaged. <input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check there is power at the Genisys Control. <input type="checkbox"/> Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	<input type="checkbox"/> Check all fuel valves are on. <input type="checkbox"/> Check Burner contacts are energized. <input type="checkbox"/> Check there is sufficient fuel in the tank. <input type="checkbox"/> Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles

6. Operation & Maintenance

Phases	Observation	Points/Items to look at.
Start -Up	Incinerator won't start	<input type="checkbox"/> Make sure there is power. <input type="checkbox"/> Check emergency stop is not engaged. <input type="checkbox"/> Timer is set to an actual value. <input type="checkbox"/> Make sure there is power on all phases/legs coming into the incinerator.
Pre-Purge Phase	Skipping or not starting the Pre-purge.	<input type="checkbox"/> Check that pre-purge timer works correctly. <input type="checkbox"/> Check emergency stop is not engaged. <input type="checkbox"/> Make sure there is power on all phases/legs coming into the incinerator.
	Auxiliary burner blower(s) won't run in pre-purge cycle.	<input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check burner blower contacts are energized. <input type="checkbox"/> Check that overload switch on the motor is not tripped. <input type="checkbox"/> Check there is power at the burner on the wire supplying power to the motor (Use Multi meter) <input type="checkbox"/> 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	<input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check there is power at the Genisys Control. <input type="checkbox"/> Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	<input type="checkbox"/> Check all fuel valves are on. <input type="checkbox"/> Check Burner contacts are energized. <input type="checkbox"/> Check there is sufficient fuel in the tank. <input type="checkbox"/> 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. <input type="checkbox"/> 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. <input type="checkbox"/> 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. <input type="checkbox"/> Check that CAD cell is clean. <input type="checkbox"/> Try and hear the spark at the electrodes.
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	Burner keeps Locking out after manual reset.	<input type="checkbox"/> Check all fuel valves are on. <input type="checkbox"/> Check Burner contacts are energized. <input type="checkbox"/> Check there is sufficient fuel in the tank. <input type="checkbox"/> 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:

$$V = Y * t \text{ USG}$$

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

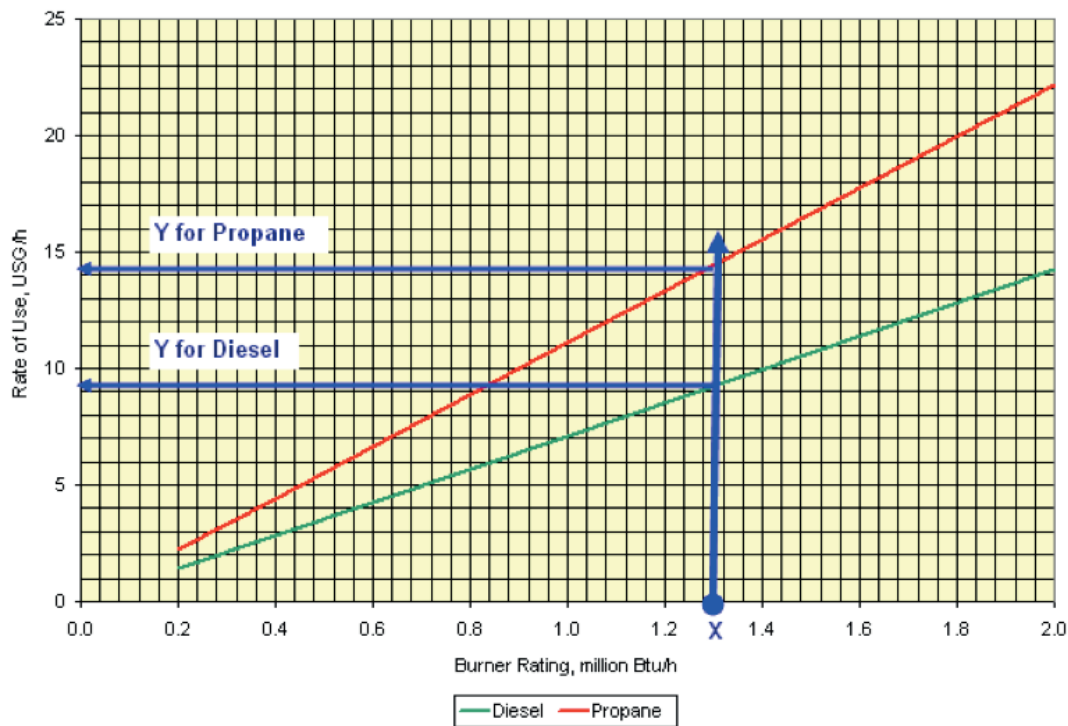


FIGURE 13 CONSUMPTION RATES OF PROPANE AND DIESEL

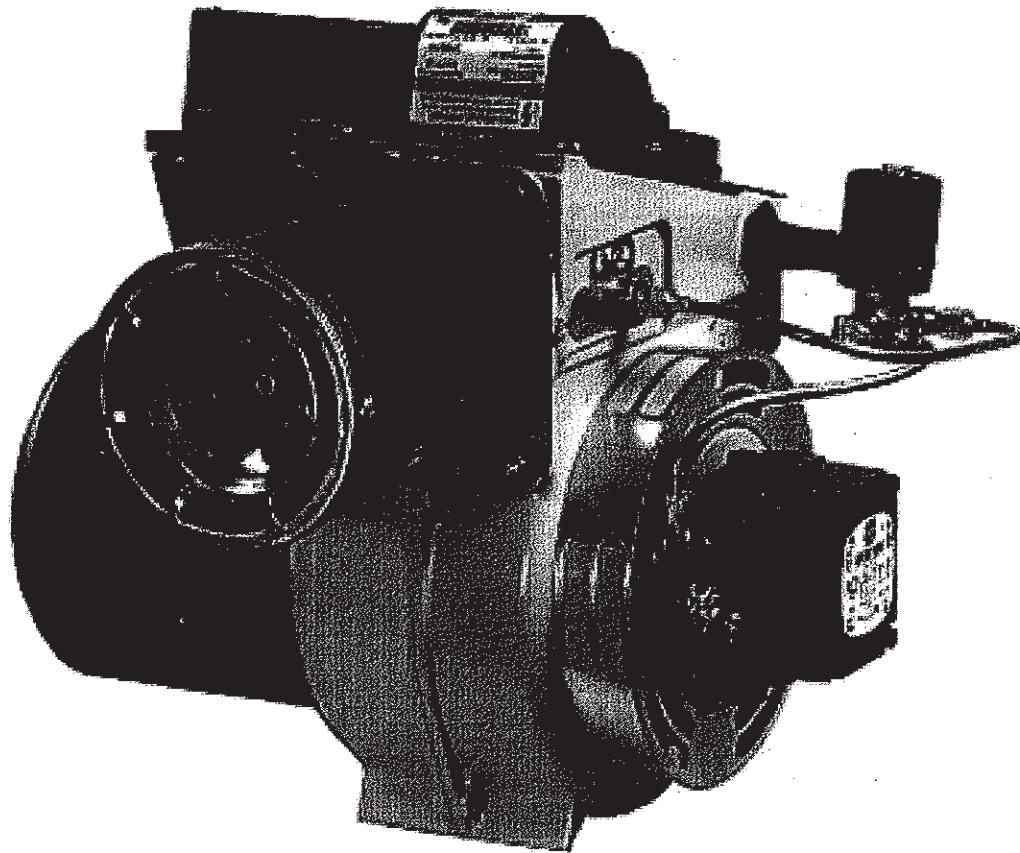
1. **Suggested Spare Parts List**
2. **Burner WIC 201**
3. **Burner WIC 301**
4. **Blower Dayton 4C 108**
5. **Inspection Checklist**
6. **Wiring Diagram**

7.1 Suggested Spare Parts List

CY-100-CA-D Recommended Spare Parts List

Description	Qty	KETEK Part No.
Gun Burner Beckett, WIC 201 16" (5.5GPH)	2	129230
Gun Burner Beckett, WIC 301 10-1/4" (7.0GPH)	1	129240
Dayton 4C-108 Flameport Blower	1	129305
Air Tube Combination for WIC 201 6 5/8	2	129420
Air Tube Combination for WIC 301 10-1/4"	1	129455
Motor for WIC 201	2	129480
Motor for WIC 301	1	129520
Coupling, Flex for WIC 201	4	129400
Coupling, Flex for WIC 301	2	129510
Fuel Pump A2YA-7916 Suntec	2	129320
Fuel Pump B2TA-8851 Suntec	1	129321
Blower Wheel for WIC 201	2	129410
Blower Wheel for WIC 301	1	129411
Transformer, Ignition "S" for WIC 201	2	129360
Transformer, Ignition "S" for WIC 301	1	129530
Nozzle (5.5 GPH 60° B)	2	144700
Cad Detector Cell (If Applicable)	4	120730
Beckett Genysis Control (If Applicable)	2	177800
Timer, H3CR-A 11pin	1	152760
Omron Temperature Controller	1	131850
Panel Fuse 10A	2	no item #
Panel Fuse 15A	6	no item #
Thermocouple Ceramic (Secondary Chamber)- 12.75"	2	130140
Thermocouple Stainless Steel (Primary Chamber)- 12.75"	2	163670
Proximity Switch Door	1	132600
Limit Switch Assembly	1	130090
Gasket, Ceramic Fibre 1/4" x 2"(price per foot)	100 ft.	132610
Gasket Cement, HT Silicone Tube	4	132620
Spark Arrester, Stainless Steel (Crating Not Included in Price)	1	130341
Filter Adapter (For Fuel Tank)	1	147840
Filter, Fuel LFF2 (For Fuel Tank)	2	133460

Models SF & SM Oil Burners



Potential for Fire, Smoke and Asphyxiation Hazards



Incorrect installation, adjustment, or misuse of this burner could result in death, severe personal injury, or substantial property damage.

To the Homeowner or Equipment Owner:

- Please read and carefully follow all instructions provided in this manual regarding your responsibilities in caring for your heating equipment.
- Contact a professional, qualified service agency for installation, start-up or service work.
- Save this manual for future reference.

To the Professional, Qualified Installer or Service Agency:

- Please read and carefully follow all instructions provided in this manual before installing, starting, or servicing this burner or heating system.
- The Installation must be made in accordance with all state and local codes having jurisdiction.

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Owner's Information

To the Owner:

Thank you for purchasing a Beckett burner for use with your heating appliance. Please pay attention to the Safety Warnings contained within this instruction manual. Keep this manual for your records and provide it to your qualified service agency for use in professionally setting up and maintaining your oil burner.

Your Beckett burner will provide years of efficient operation if it is professionally installed and maintained by a qualified service technician. If at any time the burner does not appear to be operating properly, **immediately contact your qualified service agency** for consultation.

We recommend annual inspection/service of your oil heating system by a qualified service agency.

Daily – Check the room in which your burner/appliance is installed. Make sure:

- Air ventilation openings are clean and unobstructed
- Nothing is blocking burner inlet air openings
- No combustible materials are stored near the heating appliance
- There are no signs of oil or water leaking around the burner or appliance

Weekly

- Check your oil tank level. Always keep your oil tank full, especially during the summer, in order to prevent condensation of moisture on the inside surface of the tank.



Owner's Responsibility



Incorrect installation, adjustment, and use of this burner could result in severe personal injury, death, or substantial property damage from fire, carbon monoxide poisoning, soot or explosion.

Contact a professional, qualified service agency for the installation, adjustment and service of your oil heating system. This work requires technical training, trade experience, licensing or certification in some states and the proper use of special combustion test instruments.

Please carefully read and comply with the following instructions:

- Never store or use gasoline or other flammable liquids or vapors near this burner or appliance.
- Never attempt to burn garbage or refuse in this appliance.
- Never attempt to light the burner/appliance by throwing burning material into the appliance.
- Never attempt to burn any fuel not specified and approved for use in this burner.
- Never restrict the air inlet openings to the burner or the combustion air ventilation openings in the room.

NOTICE

This manual contains information that applies to both SM and SF burners. These burners may appear to be basically identical, but there are differences in design and performance. Please review the comparison chart below:

Feature	SM	SF
Firing Rate Range	1.25 to 3.00 gph	1.25 to 5.50 gph
Motor	1/5 HP	1/4 HP
Fuel pump capacity	3 gph (standard)	7 gph (standard)
UL Air Tube Combinations	See Table 2	See Table 2
Blocking oil solenoid valve	Optional	Required above 3 gph
Primary control lockout timing	15 to 45 seconds (optional)	15 seconds maximum

Hazard Definitions

! DANGER Indicates an imminently hazardous situation, which, if not avoided, will result in death, serious injury, or property damage.

! WARNING Indicates a potentially hazardous situation, which, if not avoided, could result in death, severe personal injury, and/or substantial property damage.

! CAUTION Indicates a potentially hazardous situation, which, if not avoided, may result in personal injury or property damage.

Within the boundaries of the hazard warning, there will be information presented describing consequences if the warning is not heeded and instructions on how to avoid the hazard.

NOTICE

Intended to bring special attention to information, but not related to personal injury or property damage.

General Information

Table 1 – Burner Specifications

Model SM Capacity (Note1)	Firing rate range: 01.25 – 3.00 GPH Input: 175,000 – 420,000 Btu/hr
Model SF Capacity (Note1)	Firing rate range: 1.25 – 5.50 GPH Input: 175,000 – 770,000 Btu/hr
Certifications/ Approvals	Model SM - UL listed to comply with ANSI/UL296 & certified to CSA B140.0. Model SF - UL listed to comply with ANSI/UL 296 & certified to CSA B140.0.
Fuels	U. S.: No.1 or No.2 heating oil only (ASTM D396) Canada: No. 1 stove oil or No. 2 furnace oil only
Electrical	Power supply: 120 volts AC, 60 Hz, single phase Operating load (SM): 5.8 Amps max Operating load (SF): 7.1 Amps max Motor (SM): 1/5 hp, 3450 rpm, NEMA 'N' flange, manual reset over load protection Motor (SF): 1/4 hp, 3450 rpm, NEMA 'N' flange, manual reset over load protection Ignition: ... Continuous duty solid-state igniter
Fuel pump	Outlet pressure: Note 2
Air tube	ATC code: See Table 2
Dimensions (Standard)	Height 12.5 inches Width 15 inches Depth 8.50 inches Air tube diameter 4.00 inches
Air tube	ATC code: See Table 2

Note 1: Approval agency listed rating for Model SM is 1.25 to 3.00 gph and Model SF is 1.25 to 5.50 gph. However, the firing rate range is limited by the specific air tube combination being used. Refer to Table 2.

Note 2. UL Recognized to 4.0 GPH with a CleanCut pump for use in pressure washers.

Note 3. See appliance manufacturer's burner specifications for recommended pump discharge pressure.

• Notice Special Requirements

- For recommended installation practice in Canada, refer to the latest version of CSA Standard B139 & B140.
- Concealed damage — If you discover damage to the burner or controls during unpacking, notify the carrier at once and file the appropriate claim.
- When contacting Beckett for service information — Please record the burner serial number (and have available when calling or writing). You will find the serial number on the silver label located on the left rear of the burner. Refer to Figure 1.



Professional Service Required



Incorrect installation, adjustment, and use of this burner could result in severe personal injury, death, or substantial property damage from fire, carbon monoxide poisoning, soot or explosion.

Please read and understand the manual supplied with this equipment. This equipment must be installed, adjusted and put into operation only by a qualified individual or service agency that is:

- Licensed or certified to install and provide technical service to oil heating systems.
- Experienced with all applicable codes, standards and ordinances.
- Responsible for the correct installation and commission of this equipment.
- Skilled in the adjustment of oil burners using combustion test instruments.

The installation must strictly comply with all applicable codes, authorities having jurisdiction and the latest revision of the National Fire Protection Association Standard for the installation of Oil-burning Equipment, NFPA 31 (or CSA B139 and B140 in Canada).

Regulation by these authorities take precedence over the general instructions provided in this installation manual.

Table 2 – Air Tube Combination (ATC) codes

Firing Rate (gph)	Head	Static plate size	ATC Codes for usable air tube lengths ('A' in inches; See Figure 3.)			
(min-max)		(inches)	6-5/8	9	13	16
For SF Burner Only						
1.25-2.25	F12	2-3/4	SF65VW	SF90VW	SF130VW	SF160VW
1.75-2.75	F22	2-3/4	SF65VP	SF90VP	SF130VP	SF160VP
1.75-3.25	F220	None	SF65FD	SF90FD	SF130FD	SF160FD
2.5-5.5	F310	None	SF65FU	SF90FU	SF130FU	SF160FU
For SM Burner Only						
1.25-2.00	F12	2-3/4	SM65VW	SM90VW	SM130VW	SM160VW
2.00-3.00	F220	None	SM65FF	SM90FF	SM130FF	SM160FF
2.00-3.00	F22	None	SM65VM	SM90VM	SM130VM	SM160VM

Inspect/Prepare Installation Site

• Chimney or vent

- Inspect the chimney or vent, making sure it is properly sized and in good condition for use.
- For those installations not requiring a chimney, such as through-the-wall vented appliances, follow the instructions given by the appliance and power venter (if used) manufacturers.

• Combustion air supply



Adequate Combustion and Ventilation Air Supply Required

Failure to provide adequate air supply could seriously affect the burner performance and result in damage to the equipment, asphyxiation, explosion or fire hazards.

- The burner cannot properly burn the fuel if it is not supplied with a reliable combustion air source.
- Follow the guidelines in the latest editions of the NFPA 31 and CSA-B139 regarding providing adequate air for combustion and ventilation.

See NFPA 31 Standard for complete details.

Appliance located in confined space

The confined space should have two (2) permanent openings: one near the top of the enclosure and one near the bottom of the enclosure. Each opening shall have a free area of not less than (1) one square inch per 1,000 BTU's per hour of the total input rating of all appliances within the enclosure. The openings shall have free access to the building interior, which should have adequate infiltration from the outside.

Exhaust fans and other air-using devices

Size air openings large enough to allow for all air-using devices in addition to the minimum area required for combustion air. If there is any possibility of the equipment room developing negative pressure (because of exhaust fans or clothes dryers, for example), either pipe combustion air directly to the burner or provide a sealed enclosure for the burner and supply it with its own combustion air supply.

• Clearances to burner and appliance

- Provide space around burner and appliance for easy service and maintenance.
- Check minimum clearances against those shown by the appliance manufacturer and by applicable building codes.

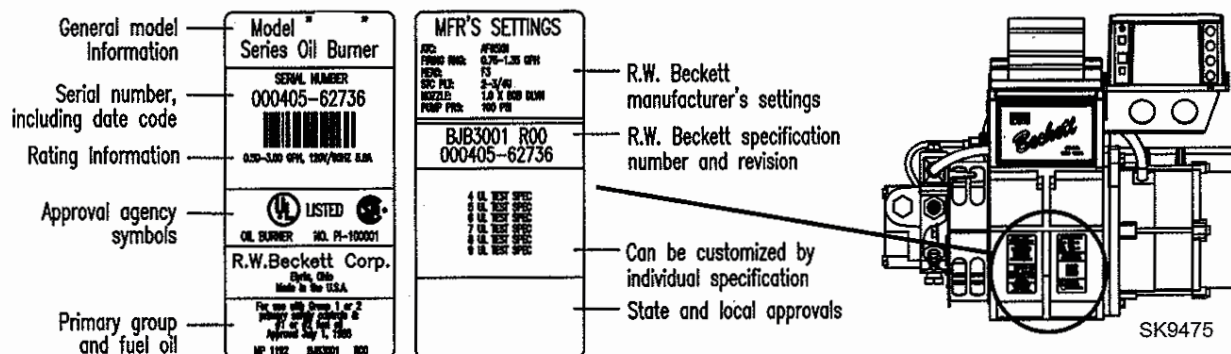
• Combustion chamber — Burner retrofitting

Verify that the appliance combustion chamber provides at least the minimum dimensions given in Table 3.

Table 3. Chamber Dimensions

Chamber Dimensions (inches)					
Firing Rate (GPH)	Round I.D.	Rectangular		Height	Floor to nozzle
		Width	Length		
1.25	11	10	11	12	5-6
1.50	12	11	12	13	6-7
2.00	14	12	15	13	6-7
2.50	16	13	17	14	7-8
3.00	18	14	18	15	7-8
3.50	19	15	19	15	7-8
4.00	20	16	21	16	8-9
5.00	23	18	23	18	9-10
5.50	24	19	24	19	10-11

Figure 1. Burner Label Location



Protect Steel Combustion Chamber From Burnout

Failure to comply could result in damage to the heating equipment and result in fire or asphyxiation hazards.

- When retrofitting appliances that have unlined stainless steel combustion chambers, protect the chamber by lining the inside surfaces with a ceramic fiber blanket, such as a wet-pac or other suitable refractory material.
- Some steel chambers may not require liners because the appliance was designed and tested for use with flame retention burners. Refer to the manufacturer's instructions.

Prepare the Burner

• Burner fuel unit

Verify that the burner fuel unit is compatible with the oil supply system. For more details, refer to "Connect fuel lines" later in this manual.

• Attach air tube (if not already installed)

If using a flange and gasket, slide them onto the air tube. Then attach the air tube to the burner chassis using the four sheet metal screws provided. Refer to Figure 3 for details.

• Install burner nozzle (if not already installed)

1. Remove the plastic plug protecting the nozzle adapter threads
2. Place a $\frac{3}{4}$ " open-end wrench on the nozzle adapter. Insert the nozzle into the adapter and finger tighten. Finish tightening with a $\frac{5}{8}$ " open-end wrench. Use care to avoid bending the electrodes.

WARNING Correct Nozzle and Flow Rate Required

Incorrect nozzles and flow rates could result in impaired combustion, under-firing, over-firing, sooting, puff-back of hot gases, smoke and potential fire or asphyxiation hazards.

Use only nozzles having the brand, flow rate (gph), spray angle and pattern specified by the appliance manufacturer.

Follow the appliance manufacturer's specifications for the required pump outlet pressure for the nozzle, since this affects the flow rate.

- Nozzle manufacturers calibrate nozzle flow rates at 100 psig.
- When pump pressures are higher than 100 psig, the actual nozzle flow rate will be greater than the gph stamped on the nozzle body. (Example: A 1.00 gph nozzle at 140 psig = 1.18 gph)

Securely tighten the nozzle (torque to 90 inch pounds). For typical nozzle flow rates at various pressures refer to Table 5.

Table 5. Nozzle Flow Rate by Size

Nozzle flow rate U. S. gallons per hour of No. 2 fuel oil when pump pressure (psig) is:					
Nozzle size (rated at 100 psig)	125 psi	140 psi	150 psi	175 psi	200 psi
1.25	1.39	1.48	1.53	1.65	1.77
1.35	1.51	1.60	1.65	1.79	1.91
1.50	1.68	1.77	1.84	1.98	2.12
1.65	1.84	1.95	2.02	2.18	2.33
1.75	1.96	2.07	2.14	2.32	2.48
2.00	2.24	2.37	2.45	2.65	2.83
2.25	2.52	2.66	2.76	2.98	3.18
2.50	2.80	2.96	3.06	3.31	3.54
2.75	3.07	3.25	3.37	3.64	3.90
3.00	3.35	3.55	3.67	3.97	4.24
3.25	3.63	3.85	3.98	4.30	4.60
3.50	3.91	4.14	4.29	4.63	4.95
3.75	4.19	4.44	4.59	4.96	5.30
4.00	4.47	4.73	4.90	5.29	-
4.50	5.04	5.32	5.51	-	-
5.00	5.59	-	-	-	-
5.50	-	-	-	-	-

Table 6. Nozzle Spray Angles

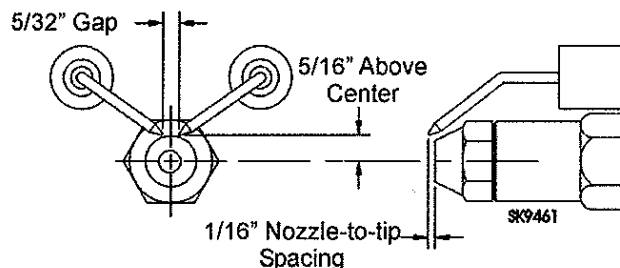
Recommended nozzle spray angles	
"F" head	70°, 80° or 90° nozzle

Note: Always follow the appliance manufacturer's nozzle specification, when available.

3. If the nozzle is already installed, remove the nozzle line assembly to verify that the nozzle size and spray pattern are correct for the application (per appliance manufacturer's information). Verify that the electrode tip settings comply with Figure 2.
4. If the nozzle is not installed, obtain a nozzle having the capacity and spray angle specified in the appliance manufacturer's information. For conversions or upgrades, when information is not available for the application:
 - Refer to Table 6 to select the mid-range nozzle spray angle for the head type being used.
 - Fire the burner and make sure the combustion is acceptable and the flame is not impinging on chamber surfaces.
 - If a shorter flame is needed, select a wider spray angle. If a longer flame is needed, select a narrower spray angle.
 - Either hollow or solid spray patterns may be used. If combustion results are not satisfactory with the selected spray pattern, try the other pattern.

• Check/adjust electrodes

Figure 2. – Electrode Tip Adjustment



Check the electrode tip settings. Adjust if necessary to comply with the dimensions shown in Figure 2. To adjust, loosen the electrode clamp screw and slide/rotate electrodes as necessary. Securely tighten the clamp screw when finished.

• Servicing nozzle line assembly

1. Turn off power to burner before proceeding.
2. Disconnect oil connector tube from nozzle line.
3. Loosen the two screws securing igniter retaining clips and rotate both clips to release igniter baseplate. Then tilt igniter back on its hinge.
4. Remove splined nut.
5. "F" head air tube. - Remove nozzle line assembly from burner, being careful not to damage the electrodes or insulators while handling. To ease removal of long assemblies (over 9 inches), rotate assembly 180° from installed position after pulling partially out of tube.
6. To replace the nozzle assembly, reverse the above steps.

Mount Burner on Appliance



Do Not use Adjustable Mounting Flange on Mobile Units

The shock and vibration could cause loss of burner alignment and insertion problems resulting in flame impingement, heavy smoke, fire and equipment damage.

- Only use specified factory-welded flange and air tube combinations.

• Mounting options

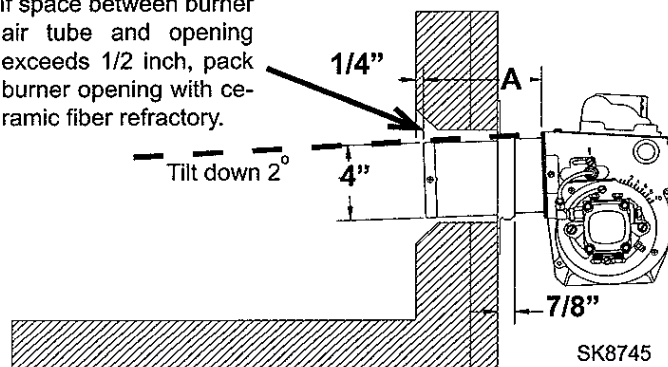
Bolt the burner to the appliance using the factory-mounted flange or an adjustable flange.

• Mounting dimensions

1. When using the Beckett universal adjustable flange, mount the air tube at a 2° downward pitch unless otherwise specified by the appliance manufacturer.
2. Verify that the air tube installed on the burner provides the correct insertion depth. See Figure 3.
3. The end of the air tube should normally be 1/4" back from the inside wall of the combustion chamber. Never allow the leading edge of the head assembly to extend into the chamber, unless otherwise specified by the heating appliance manufacturer. Carefully measure the insertion depth when using an adjustable flange. Verify the insertion depth when using a welded flange.

Figure 3. – Mounting Burner in Appliance

If space between burner air tube and opening exceeds 1/2 inch, pack burner opening with ceramic fiber refractory.



• Connect fuel lines

Carefully follow the fuel unit manufacturer's literature and the latest edition of NFPA 31 for oil supply system specifications.



Do Not Install By-pass Plug with 1-Pipe System

Failure to comply could cause immediate pump seal failure, pressurized oil leakage and the potential for a fire and injury hazard.

- The burner is shipped without the by-pass plug installed. **EXCEPTION:** Unless specified by the equipment manufacturer and noted on the label at top of pump cover.
- Install the by-pass plug in two-pipe oil supply systems **ONLY**.



Oil Supply Pressure Control Required

Damage to the filter or pump seals could cause oil leakage and a fire hazard.

- The oil supply inlet pressure to the burner **cannot exceed 3 psig**.
- Insure that a pressure limiting device is installed in accordance with the latest edition of NFPA 31.
- Do not install valves in the return line. (NFPA 31, Chapter 8)
- **Gravity Feed Systems:** Always install an anti-siphon valve in the oil supply line or a solenoid valve (RWB Part # 2182602U or 2233U) in the pump/nozzle discharge tubing to provide backup oil flow cut-off protection.

Fuel supply level with or above burner –

The burner may be equipped with a single-stage fuel unit for these installations. Connect the fuel supply to the burner with a single supply line if you want a one-pipe system (making sure the bypass plug is NOT installed in the fuel unit.) Manual bleeding of the fuel unit is required on initial start-up. If connecting a two-pipe fuel supply, install the fuel unit bypass plug.

Fuel supply below the level of the burner –

When the fuel supply is more than eight feet below the level of the burner, a two-pipe fuel supply system is required. Depending on the fuel line diameter and horizontal and vertical length, the installation may also require a two-stage pump. Consult the fuel unit manufacturer's literature for lift and vacuum capability.

Check/Adjust 'Z' Dimension for 'F' Heads

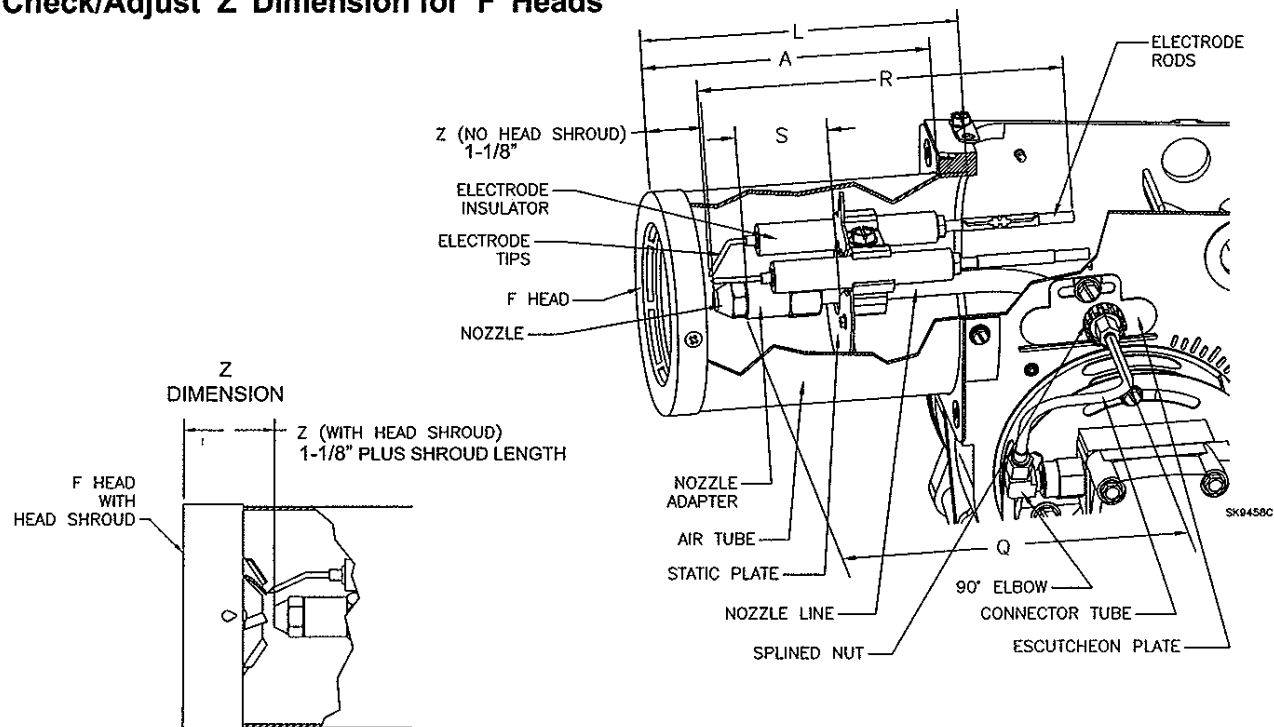


Figure 4. 'F' Head

• Check/Adjust 'Z' Dimension - 'F' heads

WARNING Adjust the 'Z' dimension to the required specification.

Incorrect Adjustments could cause combustion problems, carbon deposition from flame impingement, heavy smoke generation and fire hazard.

- Make all adjustments exactly as outlined in the following information.

1. The important 'Z' dimension is the distance from the face of the nozzle to the flat face of the head (or heat shield, if applicable). This distance for F heads is $1\frac{1}{8}$ " ($1\frac{3}{8}$ " if the air tube has a heat shield). The "Z" dimension is factory set for burners shipped with the air tube installed. Even if factory set, verify that the "Z" dimension has not been changed.
2. Use the following procedure to adjust the "Z" dimension, if it is not correct:
 - Turn off power to the burner.
 - Disconnect the oil connector tube from the nozzle line.
 - See above figure. Loosen the splined nut from the nozzle line. Loosen the hex head screw securing the escutcheon plate to the burner housing.
 - Place the end of a ruler at the face of the nozzle and, using a straight edge across the head, measure the distance to the face of the head. A Beckett T501 or T650 gauge may also be used.

- Slide the nozzle line forward or back until the Z dimension for F heads is $1\frac{1}{8}$ " ($1\frac{1}{8}$ " plus shroud length, if using a straight edge).
 - Tighten the hex head screw to secure the escutcheon plate to the burner chassis. Then tighten the splined nut and attach the oil connector tube.
3. Recheck the "Z" dimension periodically when servicing to ensure the escutcheon plate has not been moved. You will need to reset the "Z" dimension if you replace the air tube or nozzle line assembly. The Beckett Z gauge (part number Z-2000) is available to permit checking the F head "Z" dimension without removing the burner from the appliance.

• Burner Dimensions - Models SM & SF

Dimension (inches)	F Head
A = Usable air length (inches)	(Measure accurately)
L (Total tube length)	A+1/2
R (electrode length), $\pm 1/4$	A+2-1/4
S (adapter to static plate), $\pm 1/16$	(Note 1)
Q (nozzle line length),	A+ 15/16
Z (F head w/o head shroud)	1-1/8
Z (F head-with head shroud)	1-1/8 + shroud length. (Note 2)

Note 1: $1\frac{3}{8}$ for dimension A less than 4"; $1\frac{5}{8}$ for dimension A from 4" through 4-1/2", $2\frac{13}{32}$ for dimension A greater than 4-1/2".

Note 2: When using a straight edge.

Fuel line installation –

CAUTION Do Not Use Teflon Tape

Damage to the pump could cause impaired burner operation, oil leakage and appliance soot-up.

- Never use Teflon tape on fuel oil fittings.
- Tape fragments can lodge in fuel line components and fuel unit, damaging the equipment and preventing proper operation.
- Use of Teflon tape will void the Suntec warranty.
- Use oil-resistant pipe sealant compounds.

Continuous lengths of heavy wall copper tubing are recommended. **Always use flare fittings. Never use compression fittings.**

- Always install fittings in accessible locations. Proper routing of fuel lines is required to prevent air cavitation and vibration.

Fuel line valve and filter –

- Install two high quality fusible-handle design shutoff valves in accessible locations on the oil supply line to comply with the NFPA 31 Standard and authorities having jurisdiction. Locate one close to the tank and the other close to the burner, upstream of the filter.
- Install a generous capacity filter inside the building between the fuel tank shutoff valve and the burner, locating both the filter and the valve close to the burner for ease of servicing. Filter should be rated for 50 microns or less.

Wire Burner

WARNING Electrical Shock Hazard



Electrical shock can cause severe personal injury or death.

- Disconnect electrical power before installing or servicing the burner.
- Provide ground wiring to the burner, metal control enclosures and accessories. (This may also be required to aid proper control system operation.)
- Perform all wiring in compliance with the National Electrical Code ANSI/NFPA 70 (Canada CSA C22.1)

• **Burner packaged with appliance**

Refer to appliance manufacturer's wiring diagram for electrical connections.

• **Burner installed at jobsite**

Refer to Figure 5, for typical burner wiring, showing cad cell primary controls. Burner wiring may vary, depending on primary control actually used.

The R7184 primary control with valve-on delay (prepurge) and burner motor-off delay (postpurge), requires a constant 120 volts AC power source supplied to the BLACK wire on the control. The RED wire goes to the appliance limit circuit. Please note that other control manufacturers may use different wire colors for power and limit connections.

Start Up Burner/Set Combustion

WARNING Explosion and Fire Hazard



Failure to follow these instructions could lead to equipment malfunction and result in heavy smoke emission, soot-up, hot gas puff-back, fire and asphyxiation hazards.

- Do not attempt to start the burner when excess oil has accumulated in the appliance, the appliance is full of vapor, or when the combustion chamber is very hot.
- Do not attempt to re-establish flame with the burner running if the flame becomes extinguished during start-up, venting, or adjustment.
- **Vapor-Filled Appliance:** Allow the unit to cool off and all vapors to dissipate before attempting another start.
- **Oil-Flooded Appliance:** Shut off the electrical power and the oil supply to the burner and then clear all accumulated oil before continuing.
- If the condition still appears unsafe, contact the Fire Department. Carefully follow their directions.
- Keep a fire extinguisher nearby and ready for use.

1. Open the shutoff valves in the oil supply line to the burner.
2. If the air control is not preset, close air band and partially open air shutter. This is an initial air setting for the pump bleeding procedure only. Additional adjustments must be made with instruments to prevent smoke and carbon monoxide generation.
3. Set the thermostat substantially above room temperature.

Typical Burner Wiring & Burner Sequence of Operation for R7184 Control.

Refer to the appliance manufacturer's wiring diagram for actual specifications.

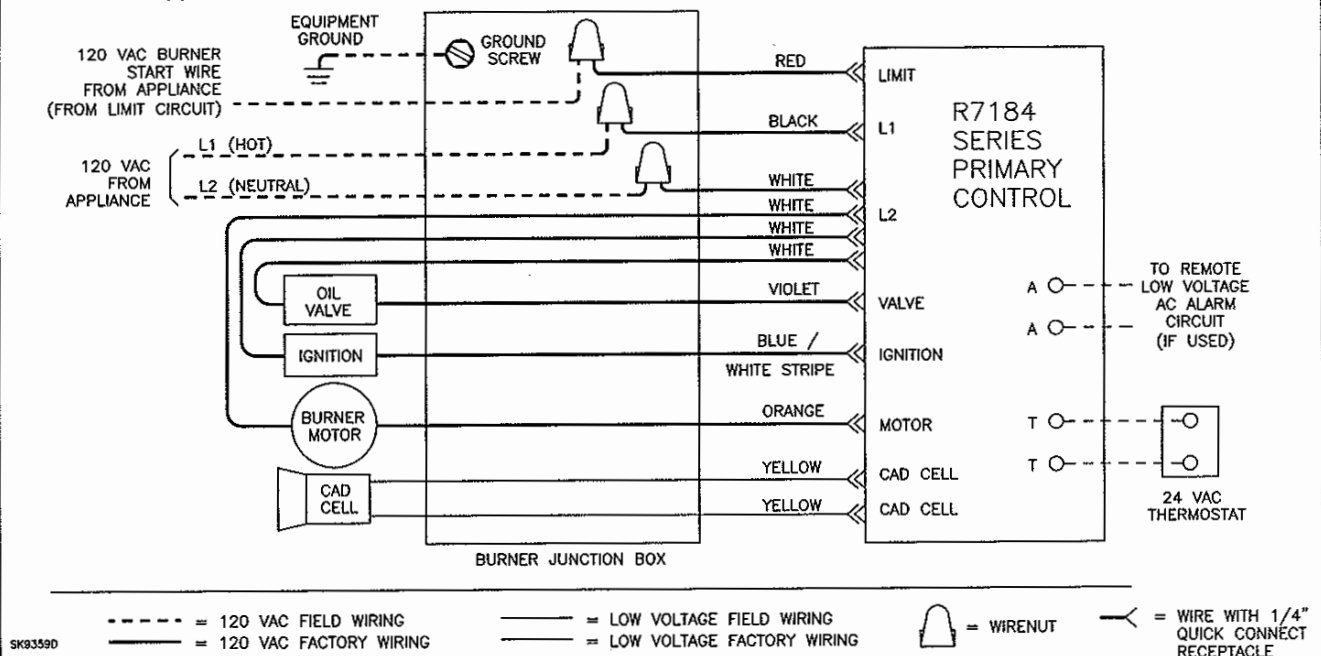
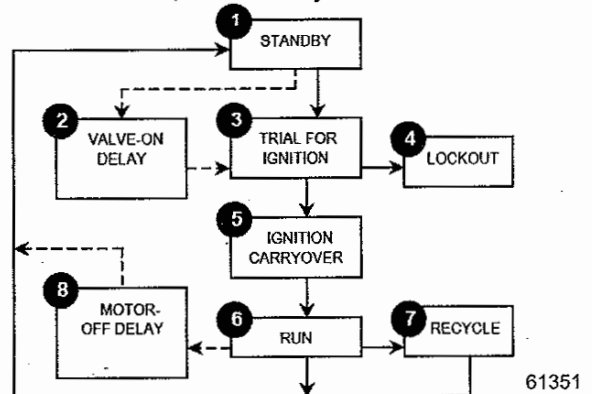


Figure 5. – Typical Burner Wiring

- 1. STANDBY.** The burner is idle, waiting for a call for heat. When a call for heat is initiated, there is a 3-10 second delay while the control performs a safe start check.
- 2. VALVE-ON DELAY.** The ignition and motor are turned on for a 15 second valve-on delay.
- 3. TRIAL FOR IGNITION (TFI).** The fuel valve is opened. A flame should be established within the 15 second lockout time.
- 4. LOCKOUT.** If flame is not sensed by the end of the TFI, the control shuts down on safety lockout and must be manually reset. If the control locks out three times in a row, the control enters restricted lockout.
- 5. IGNITION CARRYOVER.** Once flame is established, the ignition remains on for 10 seconds to ensure flame stability before turning off. If the control is wired for intermittent duty ignition, the ignition unit stays on the entire time the motor is running.
- 6. RUN.** The burner runs until the call for heat is satisfied. The burner is then sent to burner motor off delay, if applicable, or it is shut down and sent to standby.

- 7. RECYCLE.** If the flame is lost while the burner is firing, the control shuts down the burner, enters a 60 second recycle delay, and then repeats the above ignition sequence. If flame is lost three times in a row, the control locks out to prevent cycling with repetitious flame loss due to poor combustion.
- 8. BURNER MOTOR-OFF DELAY.** The fuel valve is closed and the burner motor is kept on for the selected motor-off delay time before the control returns the burner to standby.



Control System Features

Feature	Interrupted ignition	Limited reset, Limited recycle	Diagnostic LED, cad cell indicator	Valve-on delay	Burner motor off delay	Alarm Contacts
R7184A	YES	YES	YES	—	—	—
R7184B	YES	YES	YES	YES	—	—
R7184P	YES	YES	YES	YES	YES	Optional

4. Close the line voltage switch to start the burner. If the burner does not start immediately you may have to reset the safety switch of the burner primary control.
5. Bleed air from fuel unit as soon as burner motor starts rotating.
 - To bleed the fuel unit, attach a clear plastic hose over the vent fitting. Loosen the fitting and catch the oil in an empty container. Tighten the fitting when all air has been purged from the oil supply system.
 - If the burner locks out on safety during bleeding, reset the safety switch and complete the bleeding procedure. Note — Electronic safety switches can be reset immediately; others may require a three- to five-minute wait.
 - If burner stops after flame is established, additional bleeding is probably required. Repeat the bleeding procedure until the pump is primed and a flame is established when the vent fitting is closed.
 - For R7184 primary controls, see Technician's Quick Reference Guide, part number 61351 for special pump priming sequence.
 - Prepare for combustion tests by drilling a 1/4" sampling hole in the flue pipe between the appliance and the barometric draft regulator.
6. Initial air adjustment — Test the flue gas for smoke. Adjust the air shutter (and air band, if necessary) to obtain a clean flame. Now the additional combustion tests with instruments can be made

• Set combustion with instruments

1. Allow the burner to run for approximately 5 to 10 minutes.
2. Set the stack or over-fire draft to the level specified by the appliance manufacturer.
 - **Natural Draft Applications;** typically over-fire draft is -0.01" or -0.02" w.c.
 - **Direct Venting;** typically may not require draft adjustment.
 - **High Efficiency/Positive Pressure Appliances;** also vary from traditional appliances (see manufacturer's recommendations).
3. Follow these four steps to properly adjust the burner:
 - Step 1:** Adjust the air shutter/band until a trace of smoke is achieved.
 - Step 2:** At the trace of smoke level, measure the CO₂ (or O₂) . This is the vital reference point for further adjustments. Example: 13.5% CO₂ (2.6% O₂)
 - Step 3:** Increase the air to reduce the CO₂ by 1.5 to 2 percentage points. (O₂ will be increased by approximately 2.0 to 2.7 percentage points.) Example: Reduce CO₂ from 13.5% to 11.5% (2.6% to 5.3% O₂).
 - Step 4:** Recheck smoke level. It should be Zero.
 - This procedure provides a margin of reserve air to accommodate variable conditions.
 - If the draft level has changed, recheck the smoke and CO₂ levels and readjust the burner, if necessary
4. Once combustion is set, tighten all fasteners on air band, air shutter and escutcheon plate.
5. Start and stop the burner several times to ensure satisfactory operation. Test the primary control and all other appliance safety controls to verify that they function according to the manufacturer's specifications.

Perform Regular Maintenance



Annual Professional Service Required



Tampering with or making incorrect adjustments could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- Do not tamper with the burner or controls or make any adjustments unless you are a trained and qualified service technician.
- To ensure continued reliable operation, a qualified service technician must service this burner annually.
- More frequent service intervals may be required in dusty or adverse environments.
- Operation and adjustment of the burner requires technical training and skillful use of combustion test instruments and other test equipment.

- ☐ Replace the oil supply line filter. The line filter cartridge must be replaced to avoid contamination of the fuel unit and nozzle.
- ☐ Inspect the oil supply system. All fittings should be leak-tight. The supply lines should be free of water, sludge and other restrictions.
- ☐ Remove and clean the pump strainer if applicable.
- ☐ Replace the nozzle with the exact brand, pattern, gph flow rate and spray angle..
- ☐ Clean and inspect the electrodes for damage, replacing any that are cracked or chipped.
- ☐ Check electrode tip settings. Replace electrodes if tips are rounded.
- ☐ Inspect the igniter spring contacts.
- ☐ Clean the cad cell lens surface, if necessary.
- ☐ Inspect all gaskets. Replace any that are damaged or would fail to seal adequately.
- ☐ Inspect the combustion head and air tube. Remove any carbon or foreign matter. Replace all damaged units with exact parts.
- ☐ Clean the blower wheel, air inlet, air guide, burner housing and static plate of any lint or foreign material.

- ☐ If motor is not permanently lubricated, oil motor with a few drops of SAE 20 nondetergent oil at each oil hole. DO NOT over oil motor. Excessive oiling can cause motor failure.
- ☐ Check motor current. The amp draw should not exceed the nameplate rating.
- ☐ Check all wiring for secure connections or insulation breaks.
- ☐ Check the pump pressure and cutoff function.
- ☐ Check primary control safety lockout timing.
- ☐ Check ignition system for proper operation.
- ☐ Inspect the vent system and chimney for soot accumulation or other restriction.
- ☐ Clean the appliance thoroughly according to the manufacturer's recommendations.
- ☐ Check the burner performance. Refer to the section "Set combustion with test instruments".
- ☐ It is good practice to make a record of the service performed and the combustion test results.

• Replacing the blower wheel:

- When replacing the blower wheel, insure that the wheel is centered between the two sides of the burner housing as shown below.

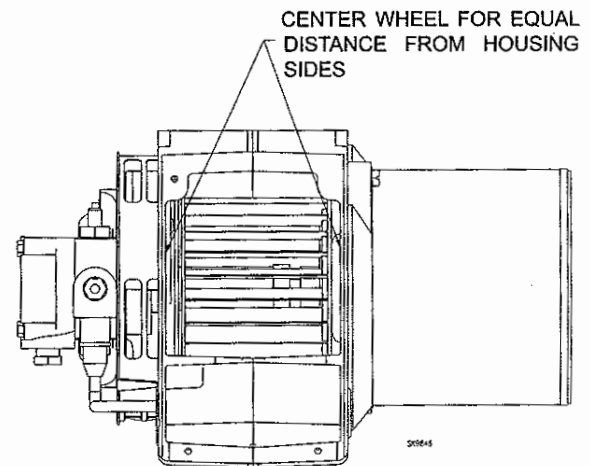


Figure 6. Blower Wheel Assembly

This exploded view diagram illustrates the assembly of a 2500W 220V AC motor. The components are numbered as follows:

- 1: Motor frame
- 2: Motor base
- 3: Motor terminal box
- 4: Motor winding
- 5: Motor housing
- 6: Motor fan
- 7: Motor fan cover
- 8: Motor fan cover
- 9: Motor shaft
- 10: Motor terminal box
- 11: Motor terminal box
- 12: Motor terminal box
- 13: Motor terminal box
- 14: Motor terminal box
- 15: Motor terminal box
- 16: Motor terminal box
- 17: Motor terminal box
- 18: Motor terminal box
- 19: Motor terminal box
- 20: Motor terminal box
- 21: Motor terminal box
- 22: Motor terminal box
- 23: Motor terminal box

6104BSF/SM R03



For best performance specify genuine *Beckett* replacement parts

#	Part No.	Description
1		Burner Housing Assembly with Inlet Bell
2	3215	Air shutter, 10 Slot
3	3819	Bulk Air Band, 10 Slot
4	3493	Nozzle-line Escutcheon Plate
5	Specify ** 3399	Unit Flange or Square Plate
Not Shown	3416	Air Tube Gasket
6	2139	Hole Plug - Wiring Box
7	2900U 2364U	Drive Motor, 1/5 HP (SM Models) Drive Motor, 1/4 HP (SF Models)
8	2383U	Blower Wheel (6-1/4 X 3-7/16)
9	2433	Flexible Coupling (Fits 5/16" pump shaft)
10	2591U 21188U	Fuel Units SF only Single-Stage 'A' Two-Stage 'B'
10	2184404U 2460	Fuel Units SM only CleanCut Single-Stage 'A'
12	2256	Pump outlet fitting
	482	Pump holding screws (not shown)
13	5394	Connector tube assembly, pump to nozzle line

#	Part No.	Description
14	51824U	Igniter and Base Plate
14	2289U	Ignition Transformer (10,000 V/23mA)
15	7455U	R7184A - Interrupted Ignition
	7456U	R7184B - Pre-purge
	7457U	R7184P - Pre and Post-purge
	7458U	R7184P w/ Alarm Contacts
16	5770	Electrical Box
17	7006U	Cad Cell Detector
18	Specify **	Air Tube Combination
	5780	Electrode Kit - F Head up to 9"
19	5782	Electrode Kit - F Head over 9"
20	5432 3616	Universal Flange w/ Gasket Gasket Only
21	3666	Splined Nut
22	2182602U	Blocking Oil Solenoid Valve
23	5685	Base Pedestal Kit

** Contact your Beckett Representative for part number and pricing.



Beckett
COMMERCIAL

CF1400
CF2300

OIL BURNER MANUAL

Operation: Low/High

Rate: CF1400: 4.0 to 13.6 GPH

CF2300: 7.0 to 19.9 GPH



WARNING

Potential for Fire, Smoke and Asphyxiation Hazards



Incorrect installation, adjustment, or misuse of this burner could result in death, severe personal injury, or substantial property damage.

To the Homeowner or Equipment Owner:

- Please read and carefully follow all instructions provided in this manual regarding your responsibilities in caring for your heating equipment.
- Contact a professional, qualified service agency for installation, start-up or service work.
- Save this manual for future reference.

To the Professional, Qualified Installer or Service Agency:

- Please read and carefully follow all instructions provided in this manual before installing, starting, or servicing this burner or heating system.
- The Installation must be made in accordance with all state and local codes having jurisdiction.

Before you begin . . .

The following resources will give you additional information for your installation. We suggest that you consult these resources whenever possible. Pay particular attention to the appliance manufacturer's instructions.

Appliance manufacturer's instructions -Always follow the appliance manufacturer's instructions for burner installation, equipment and set-up.

1-800-OIL-BURN - Beckett's technical services hot-line.
www.beckettcorp.com - Beckett's website.

To the Owner:

Thank you for purchasing a Beckett burner for use with your heating appliance. Please pay attention to the Safety Warnings contained within this instruction manual. Keep this manual for your records and provide it to your qualified service agency for use in professionally setting up and maintaining your oil burner.

Your Beckett burner will provide years of efficient operation if it is professionally installed and maintained by a qualified service technician. If at any time the burner does not appear to be operating properly, **immediately contact your qualified service agency** for consultation.

We recommend annual inspection/service of your oil heating system by a qualified service agency.

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Start the burner	18-19
Start burner and vent air from oil line	18
Set high-fire air	18
Set low-fire air	18
Maintenance and Service	20
Annual Professional Service	20
Monthly maintenance	20
Replacement Parts	22-23
Warranty	Back Cover

Hazard definitions



Indicates an imminently hazardous situation, which, if not avoided, will result in death, serious injury, or property damage.



Indicates a potentially hazardous situation, which, if not avoided, could result in death, severe personal injury, and/or substantial property damage.



Indicates a potentially hazardous situation, which, if not avoided, may result in personal injury or property damage.

NOTICE

Intended to bring special attention to information, but not related to personal injury or property damage.

Note: Within the boundaries of the hazard warning, there will be information presented describing consequences if the warning is not heeded and instructions on how to avoid the hazard.

Specifications

Fuels	#1 or #2 Fuel Oil
Firing Range	BCF1400 - 4.0 to 13.6 gph BCF2300 - 7.0 to 19.9 gph
Motor	CF1400: 1/2 HP 3450 rpm 120/60 Hz Standard 6.5 amps @ 120 VAC CF2300: 3/4 HP 3450 rpm 120/60 Hz Standard 12.5 amps @ 120 VAC Optional Voltages (CF1400 & CF2300): 240 VAC/1-PH, 208, 240, 480 VAC/3-PH, 50 Hz
Ignition Trans.	Continuous Duty, 120V/12,000V
Housing	Cast aluminum
Fuel Unit	100 to 300 psig
Oil Nozzle	45° to 70° Solid
Dimensions	Refer to Figure 7.

Agency approvals



- UL listed to comply with ANSI/UL296 and certified to CSA B140.0.
- Accepted by N.Y.C. M.E.A.
- Other approvals may be available and must be specified at time of order.

Owner's Responsibility:



WARNING

Follow These Instructions Exactly



Failure to follow these instructions, misuse, or incorrect adjustment of the burner could lead to equipment malfunction and result in asphyxiation, explosion or fire.

Contact a professional, qualified service agency for the installation, adjustment and service of your oil burning system. Thereafter, have your equipment adjusted and inspected at least annually to ensure reliable operation. This work requires technical training, trade experience, licensing or certification in some states and the proper use of special combustion test instruments.

Please carefully read and comply with the following instructions:

- Never store or use gasoline or other flammable liquids or vapors near this burner or appliance.
- Never attempt to burn garbage or refuse in this appliance.
- Never attempt to light the burner by throwing burning material into the appliance.
- Never attempt to burn any fuel not specified and approved for use in this burner.
- Never restrict the air inlet openings to the burner or the combustion air ventilation openings in the room.

Professional Installer/Service Agency Responsibility:



WARNING

Follow These Instructions Exactly



Failure to follow these instructions could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- Please read all instructions before proceeding. Follow all instructions completely.
- This equipment must be installed, adjusted and started by a qualified service agency that is licensed and experienced with all applicable codes and ordinances and responsible for the installation and commission of the equipment.
- The installation must comply with all local codes and ordinances having jurisdiction and the latest editions of the NFPA 31 and CSA-B139 & B140 in Canada.

NOTICE

50 Hz Motors - The burner ratings, air settings and nozzle ratings are based on standard 60 Hz motors (at 3450 rpm). Derate all ratings 20% when using 50 hz motors. Consult factory for specific application data.

NOTICE

High altitude installation - Accepted industry practice requires no derate of burner capacity up to 2000 feet above sea level. For altitudes higher than 2000 feet, derate burner capacity 2% for each 1000 feet above sea level.

Pre-installation checklist

☐ Combustion air supply



WARNING

Adequate Combustion and Ventilation Air Supply Required

Failure to provide adequate air supply could seriously affect the burner performance and result in damage to the equipment, asphyxiation, explosion or fire hazards.

- The burner cannot properly burn the fuel if it is not supplied with a reliable combustion air source.
- Follow the guidelines in the latest editions of the NFPA 31 and CSA-B139 regarding providing adequate air for combustion and ventilation.

The burner requires combustion air and ventilation air for reliable operation. Assure that the building and/or combustion air openings comply with National Fire

Protection Standard for Oil-Burning Equipment, NFPA 31. For appliance/burner units in confined spaces, the room must have an air opening near the top of the room plus one near the floor, each with a free area at least one square inch per 1,000 Btu/hr input of all fuel burning equipment in the room. For other conditions, refer to NFPA 31 (CSA B1139-M91 in Canada).

If there is a risk of the space being under negative pressure or of exhaust fans or other devices depleting available air for combustion and ventilation, the appliance/burner should be installed in an isolated room provided with outside combustion air.

☐ Clearances

With the burner installed in the appliance, there must be adequate space in front of and on the sides of the burner to allow access and operation. Verify that the clearance dimensions comply with all local codes and with the appliance manufacturer's recommendations.

☐ Fuel supply



Oil Supply Pressure Control Required

Damage to the filter or pump seals could cause oil leakage and a fire hazard.

- The oil supply inlet pressure to the burner *cannot exceed 3 psig*.
- Do not install valves in return line.
- Insure that a pressure limiting device is installed in accordance with the latest edition of NFPA 31.
- Gravity Feed Systems: Always install an anti-siphon valve in the oil supply line or a solenoid valve (RWB Part # 21789) in the pump/nozzle discharge tubing to provide backup oil flow cut-off protection.

- The fuel supply piping and tank must provide #1 or #2 fuel oil at pressure or vacuum conditions suitable for the fuel unit (oil pump) on the burner. Refer to fuel unit literature in the literature envelope in the burner carton to verify allowable suction pressure.

If fuel supply is level with or higher than fuel unit —

- When the fuel unit is not required to lift the oil, the installation is usually suitable for either a one-pipe or two-pipe oil system. The oil pressure at the inlet of the fuel unit must not exceed 3 psig.
- The fuel unit is shipped with the by-pass plug installed. Leave the by-pass plug installed for all low/high firing burners, regardless whether one-pipe (with by-pass loop) or two-pipe. See **Figure 9** for installation of the by-pass loop required for one-pipe fuel supply installations. See **Figure 10** for connections to the fuel unit for two-pipe fuel supply installations.

When fuel supply is below the burner fuel unit —

- Use a two-pipe oil system when the fuel unit must lift the oil more than 8 feet. The return line provided by the two-pipe system is needed to minimize the effects of air-related problems during operation.

☐ Nozzle pressure



Correct Nozzle and Flow Rate Required



Incorrect nozzles and flow rates could result in impaired combustion, under-firing, over-firing, sooting, puff-back of hot gases, smoke and potential fire or asphyxiation hazards.

Use only nozzles having the brand, flow rate (gph), spray angle and pattern specified by the appliance manufacturer.

Follow the appliance manufacturer's specifications for the required pump outlet pressure for the nozzle, since this affects the flow rate.

- Nozzle manufacturers calibrate nozzle flow rates at 100 psig.
- This burner utilizes pressures higher than 100 psig, so the actual nozzle flow rate will be greater than the gph stamped on the nozzle body. (Example: A 8.00 gph nozzle at 150 psig = 9.80 gph and at 300 psig = 13.86 gph)

For typical nozzle flow rates at various pressures see accompanying chart.

- The fuel unit nozzle port pressure is factory set at 300 psig. Some original equipment manufacturer burner applications may call for a lower pressure to obtain a required firing rate. Do not change this pressure unless directed to do so by the appliance manufacturer.

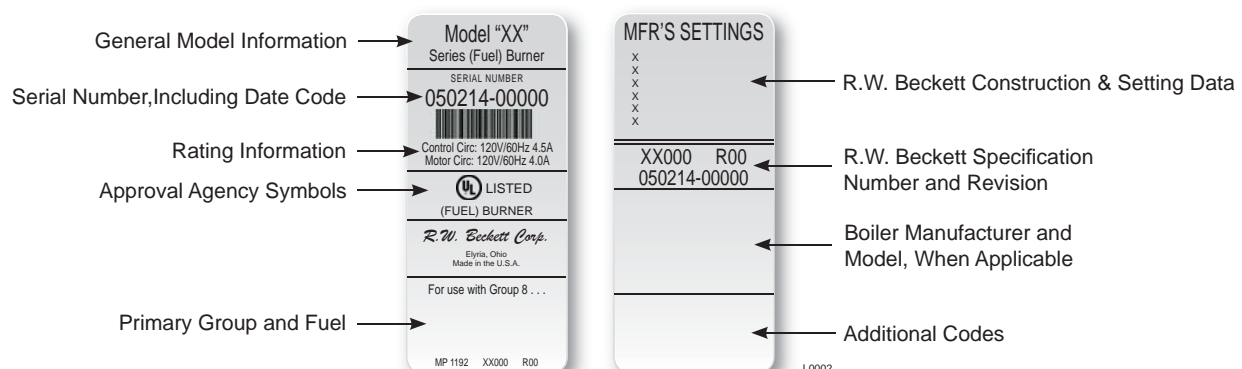
☐ Electrical supply

Verify that the power connections available are correct for the burner. Refer to **Figure 1**. All power must be supplied through fused disconnect switches.

☐ Vent system

The flue gas venting system must be in good condition and must comply with all applicable codes.

Figure 1 – Typical Nameplate



❑ Verify burner components —

- Burner nameplate (*figure 1*), Model CF1400 or CF2300A
- Air tube assembly
- Mounting flange kit
- Pedestal mounting assembly kit (recommended)
- Oil nozzle, per *Table 1* — Use only 45° to 70° solid pattern nozzles unless otherwise shown by appliance manufacturer or on the burner nameplate rating label.

Find the required firing rate in the 300 psig column (high fire rate).

Select the corresponding nozzle from column 1 (*Rated gph @ 100 psig*).

(Example: a 500 gph nozzle @ 300 psi = 8.66 gph)

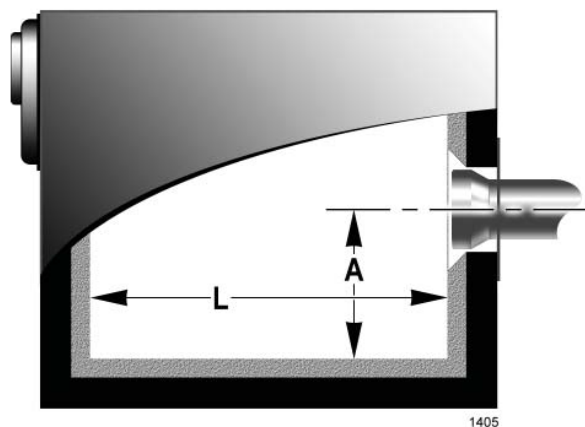
Table 1 - Nozzle capacities

Rated gph @ 100 psig	Pressure - Pounds per square inch							
	125	140	150	175	200	250	275	300
3.00	3.35	-	3.67	3.97	4.24	4.74	4.97	5.20
3.50	3.91	-	4.29	4.63	4.95	5.53	5.80	6.06
4.00	4.47	-	4.90	5.29	5.66	6.32	6.63	6.93
4.50	5.04	5.32	5.51	5.95	6.36	7.11	7.46	7.79
5.00	5.59	5.92	6.12	6.61	7.07	7.91	8.29	8.66
5.50	6.15	6.51	6.74	7.27	7.78	8.70	9.12	9.53
6.00	6.71	7.10	7.35	7.94	8.49	9.49	9.95	10.39
6.50	7.26	7.69	7.96	8.60	9.19	10.28	10.78	11.26
7.00	7.82	8.28	8.57	9.25	9.90	11.07	11.61	12.12
7.50	8.38	8.87	9.19	9.91	10.61	11.86	12.44	12.99
8.00	8.94	9.47	9.80	10.58	11.31	12.65	13.27	13.86
8.50	9.50	10.06	10.41	11.27	12.02	13.44	14.10	14.72
9.00	10.06	10.65	11.02	11.91	12.73	14.23	14.93	15.59
9.50	10.60	11.24	11.64	12.60	13.44	15.02	15.75	16.45
10.00	11.18	11.83	12.25	13.23	14.14	15.81	16.58	17.32
10.50	11.74	12.42	12.86	13.89	14.85	16.60	17.41	18.19
11.00	12.30	13.02	13.47	14.55	15.56	17.39	18.24	19.05
12.00	13.42	14.20	14.70	15.88	16.97	18.97	19.90	20.79

❑ Verify firing rate

Refer to appliance manufacturer's instructions (if available) for firing rate and nozzle selection. Otherwise, the maximum recommended firing rate for the burner depends on the length of the firing chamber and the distance from the burner center to the chamber floor. Verify that the chamber dimensions are at least as large as the minimum values given in *Figure 2*. If the appliance dimensions are smaller than recommended, reduce the firing rate accordingly.

Figure 2 – Chamber Dimensions



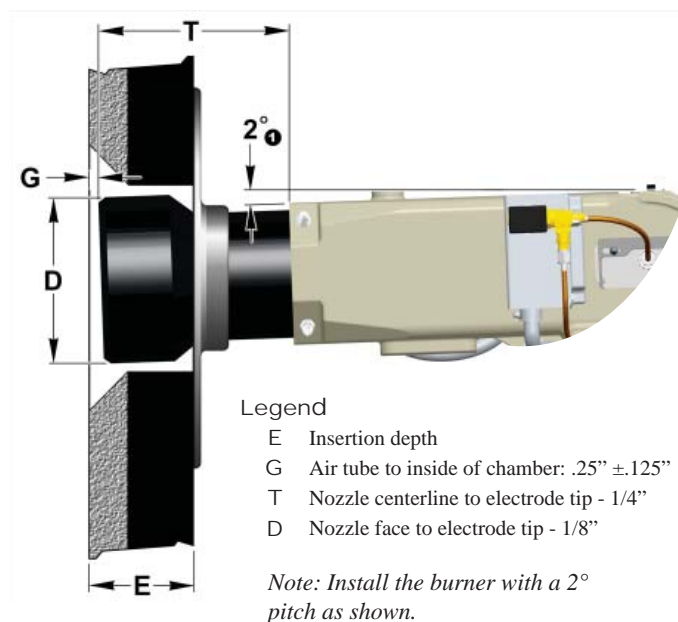
Model	Firing Rate (gph)	Minimum Dimensions			
		Refractory Lined		Wet-based Boilers	
		A	L	A	L
CF1400	0 to 5	7.0"	25.0"	7.0"	25.0"
	5 to 10	8.0"	35.0"	8.0"	40.0"
CF2300	5 to 10	8.0"	35.0"	8.0"	40.0"
	10 to 15	9.0"	40.0"	9.0"	50.0"
	15 to 20	11.0"	55.0"	11.0"	60.0"

❑ Verify air tube

The information in this section may be disregarded if the air tube is supplied by the appliance manufacturer.

- On the **CF1400**, there are two tube arrangements available –
Tube A — 4.0 to 11.0 GPH per Table 2
Tube B — 7.0 to 13.6 GPH per Table 2
- The **CF1400** maximum firing capacity depends on the firebox pressure. Use *Table 2* to verify the correct air tube type for the firing rate required. Use Tube B only when Tube A cannot provide the firing rate required.
- On the **CF2300**, there are two tube arrangements available –
Tube A — 7.0 to 19.9 GPH per Table 2
Tube B — 10.0 to 19.9 GPH per Table 2
- The **CF2300** maximum firing capacity depends on the firebox pressure. Use *Table 2* to verify the correct air tube type for the firing rate required. Use Tube B only when Tube A cannot provide the firing rate required.
- See *Figure 3* to verify the correct air tube length and air tube combination code.

Figure 3 – Air tube mounting dimensions



Air Tube Combination Codes					
Model	Tube	Dimension T	Dimension D	Code	Dimension E
CF1400	A	6.75"	5.5"	CF 66 KD	-
		10.25"	5.5"	CF 102 KD	-
		13.75"	5.5"	CF 136 KD	-
		17.75"	5.5"	CF 176 KD	-
	B	6.75"	5.75"	CF 66 KE	-
		10.25"	5.75"	CF 102 KE	-
		13.75"	5.75"	CF 136 KE	-
		17.75"	5.75"	CF 176 KE	-
CF2300	A	6.75"	6.5"	CF 66 KG	2.94"
		10.25"	6.5"	CF 102 KG	2.94"
		13.75"	6.5"	CF 136 KG	2.94"
		17.75"	6.5"	CF 176 KG	2.94"
	B	6.75"	8.125"	CF 66 KS	3.69"
		8.375"	8.125"	CF 86 KS	3.69"
		11.0"	8.125"	CF 110 KS	3.69"
		14.5"	8.125"	CF 144 KS	3.69"
		18.5"	8.125"	CF 184 KS	3.69"

Table 2 - Air tube capacity Versus firebox pressure

Air Tube Capacity vs Firebox Pressure				
Model	Tube	Firebox Pressure (In W.C.)	No Reserve Air	10% Turndown* (GPH)
CF1400	A	0.0	11.0	10.0
		0.2	10.5	9.45
		0.4	10.1	9.10
		0.6	9.6	8.64
		0.8	9.2	8.30
		1.0	8.7	7.83
	B	0.0	13.6	12.20
		0.2	13.1	11.70
		0.4	12.5	11.20
		0.6	12.0	10.80
CF2300	A	0.0	19.9	19.90
		0.2	19.2	19.10
		0.4	18.5	18.30
		0.6	17.9	17.60
		0.8	17.2	16.80
		1.0	16.5	16.00
	B	0.0	19.9	19.90
		0.2	19.7	19.60
		0.4	19.5	19.30
		0.6	19.4	19.10
		0.8	19.2	18.80
		1.0	19.0	18.50

Note: 10% turndown indicates sufficient reserve air to reduce the CO₂ in the flue to 90% of its value. The above ratings may vary 5% due to variations in actual job conditions.

***CF2300** can fire higher but is limited by UL requirements

☐ Stray light

CAUTION Protect Against Stray Light Lockout

Failure to follow these instructions could cause loss of burner operation resulting in no heat, an unplanned process interruption, work stoppage and the potential for frozen plumbing or other cold weather property damage.

- The control must detect a dark, no-flame condition in order to start the burner or it will hold in the stray light lockout mode.
- Shield the burner view window from direct exposure to intense light.

☐ Dust and Moisture

WARNING Protect Against Dust and Moisture

Wet, dusty environments could lead to blocked air passages, corrosion damage to components, impaired combustion performance and result in asphyxiation, explosion or fire.

- This burner is designed for clean, dry installations.
- Electrical controls are not protected against rain or sprayed water.
- Keep the installation clear of dust, dirt, corrosive vapors, and moisture.
- Protective covers and more frequent maintenance may be required.

Mount the burner

☐ Mount flange(s) on air tube

CAUTION Protect the Air Tube From Overheating

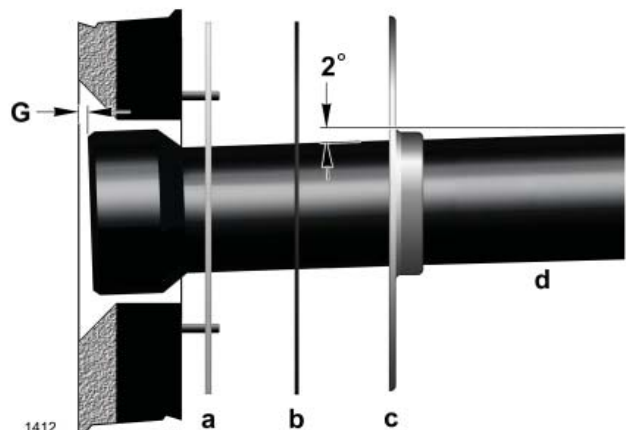
Overheating could cause damage to the air tube and other combustion components leading to equipment malfunction and impaired combustion performance.

- The end of the air tube must not extend into the combustion chamber unprotected unless it has been factory-tested and specified by the appliance manufacturer.
- Position the end of the air tube 1/4" back from flush with the refractory inside entry wall to prevent damage from overheating.

the air tube as shown. Wrap ceramic fiber rope (not shown) around the air tube and press tightly into the inside diameter of the flange (item c).

- Slide the air tube (item d) into position in the appliance front. Tighten the flange-mounting-stud nuts. Set the insertion of the air tube so dimension G is 1/4" nominal.
- Pitch the air tube at 2° from horizontal as shown and secure the flange to the air tube.

Figure 4 – Mount flange(s) on air tube



This section does not apply to burners with welded flanges.

- Do not install air tube on burner.
- For non-pressure firing flange, refer to **Figure 4**: Install gasket (item a) and flange (item c). Ignore the next paragraph.
- For pressure-firing flange, refer to **Figure 4**: Slide gasket (item a) onto the air tube, making sure the top of the air tube is up. Predrill holes in the pressure firing plate (item b) to match the appliance studs. Slide the pressure firing plate (item b) and flange (item d) onto

□ Mount air tube to burner

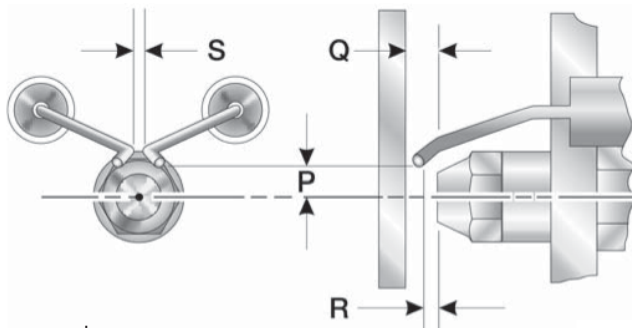
- Remove the rear access door from the back of the burner for improved access to the interior.
- Attach the air tube to the burner with the bolts and acorn nuts provided. The acorn nuts must go on the outside of the burner, with the bolts inserted from the inside.

□ Install nozzle

See **Figure 5**. Install the oil nozzle in the nozzle adapter. Use a $\frac{3}{4}$ " open-end wrench to steady the nozzle adapter and a $\frac{5}{8}$ " open-end wrench to turn the nozzle. Tighten securely but do not overtighten.

Check, and adjust if necessary, the critical dimensions **P**, **Q**, **R** and **S** shown in the drawing. Verify that the oil tube assembly and electrodes are in good condition, with no cracks or damage.

Figure 5 – Nozzle and nozzle line assembly



Legend

- S Electrode spacing - $\frac{3}{32}$ "
- Q Nozzle to head - $\frac{1}{4}$ "
- P Nozzle centerline to electrode tip - $\frac{1}{4}$ "
- R Nozzle face to electrode tip - $\frac{1}{8}$ "

□ Check electrode settings

WARNING Maintain Electrode Specifications

Failure to properly maintain these specifications could cause ignition malfunction, puff-back of hot gases, heavy smoke, asphyxiation, explosion and fire hazards.

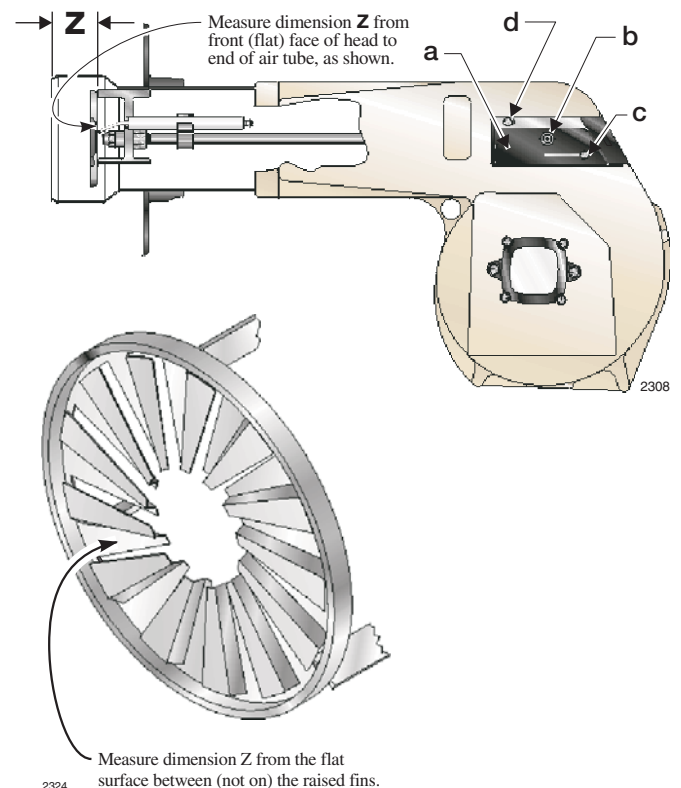
- Adjust the electrode gap and position in relation to the nozzle to the specifications shown in **Figure 5**.

Check, and adjust if necessary, the critical dimensions shown in **Figure 5**. Verify that the oil tube assembly and electrodes are in good condition, with no cracks or damage.

□ Install nozzle line assembly

- Insert the nozzle line assembly into the burner air tube as in **Figure 6**.
- See **Figures 6 and 7**. Assemble the adjusting plate assembly per the instructions in the assembly packet.
- Slide the secondary adjusting plate (item **f**) completely to the left on the indicator adjusting plate (item **e**). Finger-tighten acorn nut (item **c**) to secure the two plates together. Slide both plates completely to the left on the primary adjusting plate (item **g**) and finger-tighten acorn nut (item **d**).
- Slide the completed adjusting plate assembly over the nozzle line end. Move the plate assembly and the nozzle line so the plate assembly fits into position as shown in **Figure 6**.
- Install the spline nut (**Figure 6**, item **b**) on the end of the nozzle line, leaving the nut loosely placed so the plates can be moved.
- Connect the high-voltage leads from the ignition transformer to the electrodes.

Figure 6 – Nozzle line assembly in burner



$$Z = 1\text{-}\frac{3}{4}\text{' } \pm \frac{1}{16}\text{'}$$

Legend (Figure 6)

- a Adjusting plate assembly
- b Spline nut for securing nozzle line
- c Bottom acorn nut
- d Top acorn nut (for setting dim. Z only)

❑ Set dimension Z

- Replace the rear access door on the burner, making sure that the adjusting plate assembly is now securely in the groove.
- Loosen acorn nut (item **d**) in *Figure 5*. Slide the nozzle line and plate assembly until dimension Z in *Figure 5* is **1-3/4 ±1/16"** (CF1400 and CF2300). When dimension Z (from end of air tube to flat area of front face of head) is correctly set, tighten acorn nut (item **d**). Verify that the adjusting plate assembly is properly seated in the groove.
- Attach the oil line from the oil valve to the nozzle line end. Tighten securely.
- Before proceeding, check dimension Z once again. Loosen acorn nut (item **d**) if necessary to reposition the nozzle line. Once dimension Z is set, **do not loosen acorn nut** (item **d**) again.

❑ Insert burner

- Position the burner in the front of the appliance and loosely tighten the nuts on the mounting studs. The burner should be pitched downward 2° as shown in *Figures 4 and 8*.
- See *Figure 8*. Install the pedestal support kit (recommended) by attaching the 3/4" npt flange (item **a**) to the bottom of the burner using the (4) #10 screws provided. Cut and thread (one end only) a 3/4" pipe nipple (item **b**) with length **11 inches less than dimension D** in *Figure 8*. Thread the pipe into the flange. Then slip the pipe end into the floor flange (item **c**).
- Secure the burner to the appliance by tightening the nuts on the burner flange mounting studs. Then secure the pedestal support floor flange set screw to the pipe.

Figure 7 – Adjusting plate assy.

Legend

- a Adjusting plate assembly
- b Spline nut for securing nozzle line
- c Bottom acorn nut
- d Top acorn nut (for setting dim. Z only)
- e Indicator adjusting plate
- f Secondary adjusting plate
- g Primary adjusting plate

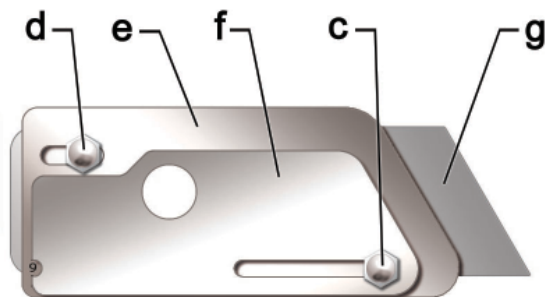
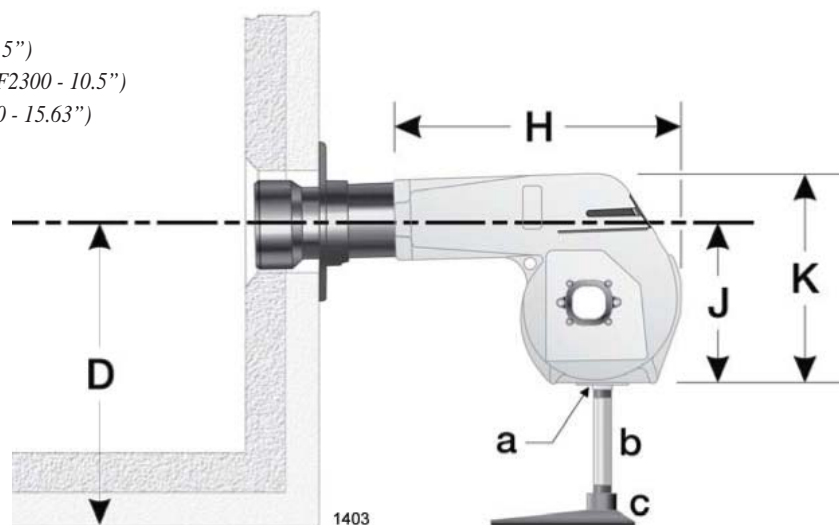


Figure 8 – Burner installed in appliance front

Legend

- H Housing total length (CF1400 - 18", CF2300 - 18.5")
- J Center to bottom of housing (CF1400 - 10.88", CF2300 - 10.5")
- K Overall housing height (CF1400 - 13.63", CF2300 - 15.63")



□ Fuel unit by-pass plug



WARNING

Install Oil Supply To Specifications



Failure to properly install the oil supply system could cause oil leakage, equipment malfunction, puff-back of hot gases, heavy smoke, asphyxiation, explosion and fire

- Carefully install the oil supply lines, fittings and components using the guidelines provided in this section.
- The oil supply must comply with the latest edition of NFPA 31 (Canada CSA B139) and all applicable codes.
- Do NOT install valves in the return line.
- If the oil supply inlet pressure to the pump exceeds 3 psig or for gravity feed systems, install an oil safety or pressure reducing valve (Webster OSV, Suntec PRV or equivalent).

The burner is shipped with a by-pass plug installed in the fuel unit. For low/high operation, the by-pass plug must be left in the fuel unit, regardless of the fuel system used (one-pipe with by-pass loop or two-pipe). Do not remove the by-pass plug.

□ One-pipe oil system by-pass loop



WARNING

Factory-Installed Pump Bypass Plug

Failure to follow these guidelines will cause the fuel pump seals to rupture and result in oil leakage, burner malfunction and potential fire and injury hazards.

- Models CF1400 and CF2300 are shipped with the pump bypass plug installed.
- Do not remove the bypass plug from the pump. It is required for step-firing (Lo/Hi) operation.
- Do not operate the burner unless a return line or bypass loop is installed or the pump seal will rupture.
- Carefully comply with the following instructions provided in this section of the manual.

Refer to **Figure 9** (item **m**). Note the addition of a field-installed by-pass loop (use 3/8" copper tubing) from the fuel unit Return port to the Inlet port. This line is required for low/high operation. It simulates the flow of a two-pipe system at the fuel unit.

□ Oil supply/return lines

- Install the oil tank and oil lines in accordance with all applicable codes.
- Size the oil supply and return lines using the

guidelines given in the fuel unit literature included in the literature envelope. Oil line flow rate will equal the burner rate for one-pipe systems. For two-pipe systems, refer to **Table 3** for the fuel unit gearset capacity - the rate at which fuel is recirculated when connected to a two-pipe system. Size two-pipe oil lines based on this flow rate.

- Use continuous lengths of heavy-wall copper tubing, routed under the floor where possible. Do not attach fuel lines to the appliance or to floor joists if possible. This reduces vibration and noise transmission problems.
- Install an oil filter sized to handle the fuel unit gearset flow capacity (**Table 3**) for two-pipe systems. However, size the filter for the firing rate for one-pipe systems. Locate the filter immediately adjacent to the burner fuel unit.
- Install two high-quality shutoff valves in accessible locations on the oil supply line. Locate one valve close to the tank. Locate the other valve close to the burner, upstream of the fuel filter.

□ Burner fuel flow

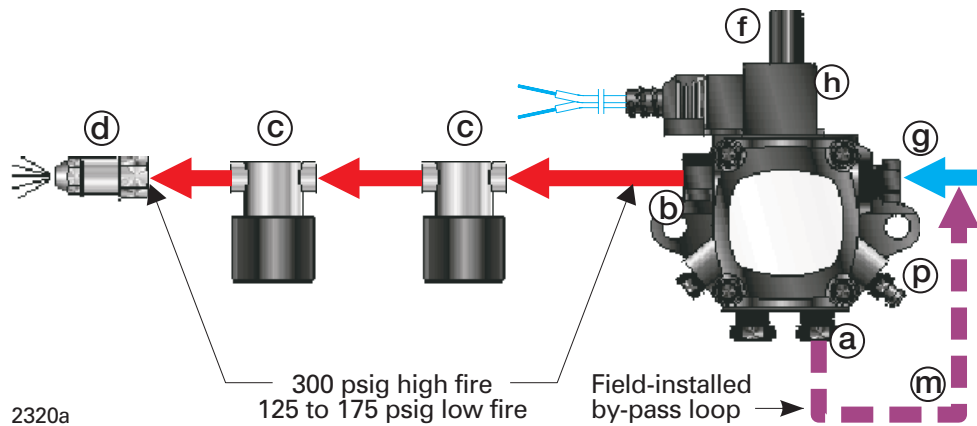
One-pipe systems – See **Figure 9** for the fuel flow paths for high-fire and low-fire operation. The low-fire by-pass regulation is done internally for type **B** fuel units. Oil supply connects to one of the fuel unit Inlet ports.

Two-pipe systems – See **Figure 10** for the fuel flow paths for high-fire and low-fire operation. The low-fire by-pass regulation is done internally for type **B** fuel units. Oil supply connects to one of the fuel unit Inlet ports. Oil return connects to the fuel unit Return port.

Low-fire/high-fire operation – The fuel unit nozzle port pressure is factory set at 300 psig.

- At high fire, full pressure (300 psig) is applied at the oil nozzle, causing full input.
- At low fire, the by-passing is done inside the fuel unit when the by-pass valve operates.
- This by-passing of oil reduces the oil pressure at the nozzle (to between 125 psig and 175 psig), reducing the input.

Figure 9 – One-pipe oil flow with “B” pump



Legend (figure 9 & 10)

- a Return port
- b Nozzle port
- c Oil valves
- d Nozzle & adapter
- f By-pass pressure regulator
- g Inlet port
- h By-pass valve (“B” pump)
- k Return line to oil tank
- m One-pipe by-pass loop, 3/8”
- p Air bleed valve

Figure 10 – Two-pipe oil flow with “B” pump

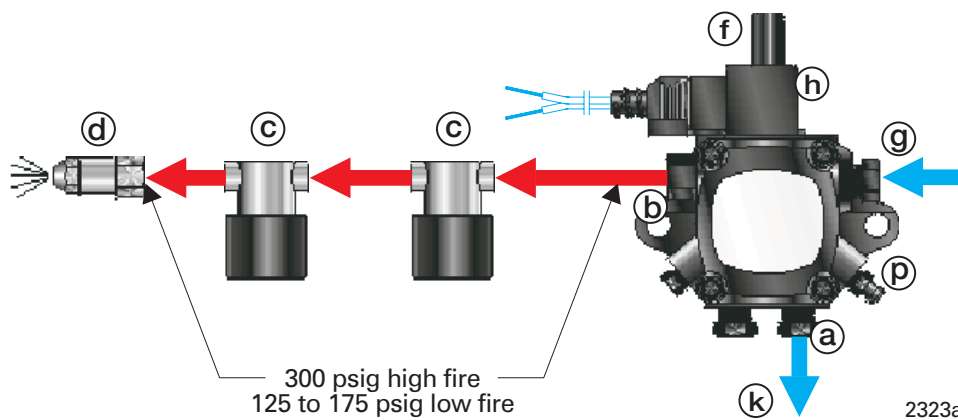


Table 3 – Fuel unit gearset capacities

Model	Fuel Unit Model Number	Gearset Capacity (gph)
CF1400	B2TA-8245	21
CF2300	B2TA-8852	39

- **Nozzle pressure** – The fuel unit nozzle port pressure is factory set at 300 psig. Some original equipment manufacturer burner applications may call for a lower pressure to obtain a required firing rate. Do not change this pressure unless directed to do so by the appliance manufacturer.

Wire the burner — R7184B



WARNING Electrical Shock Hazard

Electrical shock can cause severe personal injury or death.

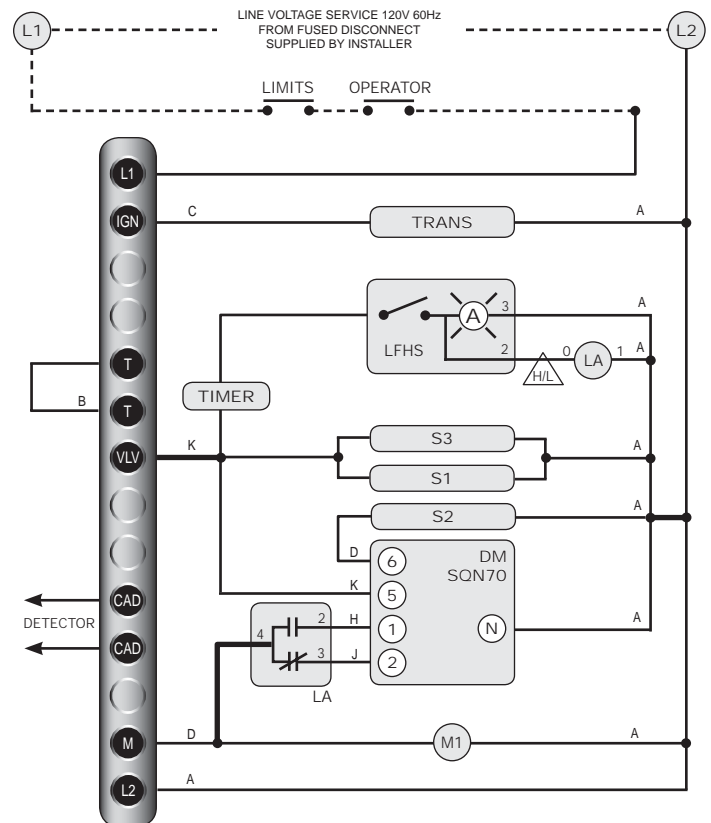
- Disconnect electrical power before installing or servicing the burner.
- Provide ground wiring to the burner, metal control enclosures and accessories. (This may also be required to aid proper control system operation)
- Perform all wiring in compliance with the National Electric Code ANSI/NFPA 70 (Canada CSA C22.1).

Install the burner and all wiring in accordance with the National Electrical Code and all applicable local codes or requirements.

Wire the burner in compliance with all instructions provided by the appliance manufacturer. Verify operation of all controls in accordance with the appliance manufacturer's guidelines.

See **Figure 11** for a typical wiring diagram, with R7184 oil primary, for reference purposes only.

Figure 11. - Typical wiring (R7184B)



Legend

- CC Flame sensor, cad cell typical
- DM Damper motor
- FD Fused Disconnect, by others
- F-F Cad cell flame sensor terminals
- H/L Low/high control wiring tag
- LFHS Low fire hold switch
- LM Limit controls, by others
- M1 Burner motor
- OP Operating controls, by others
- PR Oil primary control, R7184 typ.
- S2 High/low valve
- S1, S3 On/off valve
- TR Ignition transformer
- T-T 24-volt thermostat/limit terminals

Sequence of operation — typical

Install the burner and all wiring in accordance with the National Electrical Code and all applicable local codes or requirements.

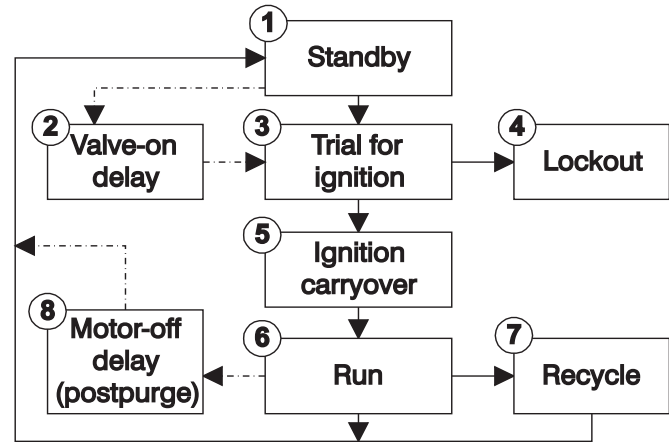
Wire the burner in compliance with all instructions provided by the appliance manufacturer. Verify operation of all controls in accordance with the appliance manufacturer's guidelines.

Sequence of operation — typical

1. **Standby** — The burner is idle, waiting for a call for heat. When a call for heat is initiated, there is a 3- to 10-second delay while the control performs a safe start check.
2. **Valve-on delay** — As applicable, the ignition and motor are turned on for a 15-second prepurge.
3. **Trial for ignition (TFI)** — The fuel valve is opened, as applicable. A flame should be established within the 15-second lockout time (30-second lockout time is available).
4. **Lockout** — If flame is not sensed by the end of the TFI, the control shuts down on safety lockout and must be manually reset. If the control locks out three times in a row, the control enters restricted lockout. Call a qualified service technician.
5. **Ignition carryover** — Once flame is established, the ignition remains on for 10 seconds to ensure flame stability. It then turns off.
6. **Run** — The burner runs until the call for heat is satisfied. The burner is then sent to burner motor-off delay, as applicable, or it is shut down and sent to standby.
7. **Recycle** — If the flame is lost while the burner is firing, the control shuts down the burner, enters a 60-second recycle delay, and then repeats the ignition steps outlined above. If the flame is lost three times in a row, the control locks out to prevent continuous cycling with repetitious flame loss caused by poor combustion.
8. **Burner motor-off delay** — If applicable, the fuel valve is closed and the burner motor is kept on for the selected postpurge time before the control returns the burner to standby.

Resetting to OHM

- If the control locks out three times in a row without a complete heat cycle between attempts, the lockout becomes restricted. A qualified service technician should be called to inspect the burner.



Prepare the burner for start-up



WARNING

Professional Installation and Service Required

Incorrect installation and mishandling of start-up could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- This burner must be installed and prepared for start-up by a qualified service technician who is trained and experienced in commercial oil burner system installation and operation.
- Do not attempt to start the burner unless you are fully qualified.
- Do not continue with this procedure until all items in the “Prepare the burner for start-up” section have been verified.
- Carefully follow the wiring diagrams, control instruction sheets, flame safeguard sequence of operation, test procedures and all appliance manufacturer’s directions that pertain to this installation.
- If any of these items are not clear or are unavailable, call Beckett at 1-800-645-2876 for assistance.



WARNING

Do Not Bypass Safety Controls

Tampering with, or bypassing safety controls could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- Safety controls are designed and installed to provide protection.
- Do not tamper with, or bypass any safety control.
- If a safety control is not functioning properly, shut off all main electrical power and fuel supply to the burner and call a qualified service agency immediately.



CAUTION

Keep Service Access Covers Securely Installed

These covers must be securely in place to prevent electrical shock, damage from external elements, and protect against injury from moving parts.

- All covers or service access plates must be in place at all times except during maintenance and service.
- This applies to all controls, panels, enclosures, switches, and guards or any component with a cover as part of its design.

Start-up checklist – Verify the following before attempting to start burner.

- ☐ Combustion air supply and venting have been inspected and verified to be free of obstructions and installed in accordance with all applicable codes.
- ☐ Oil nozzle has been selected correctly and securely installed in the nozzle adapter.
- ☐ Fuel unit by-pass plug **has not** been installed for one-pipe oil system.
- ☐ By-pass plug **has been** installed for two-pipe oil system.
- ☐ Fuel connection to nozzle line assembly is secure.
- ☐ Dimension Z has been set per this instruction manual.
- ☐ Fuel supply line is correctly installed, the oil tank is sufficiently filled, and shut-off valves are open.
- ☐ Burner is securely mounted in appliance, with pressure firing plate and gasket installed for pressurized chamber application.
- ☐ Appliance has been filled with water (boilers) and controls have been operationally checked.
- ☐ Burner has been installed in accordance with appliance manufacturer’s instructions (when available).
- ☐ Also refer to appliance manufacturer’s instructions (when available) for start-up procedures.

☐ Z dimension

Should be set per these instructions (see **page 10**). The top acorn nut (**Figure 12**, item **d**) should never be loosened once the Z dimension is initially set.

☐ Adjusting plate assembly (Figure 12)

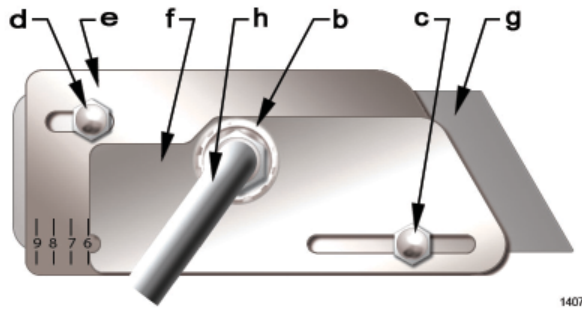
Make sure spline nut (item **b**) and bottom acorn nut (item **c**) are loose before proceeding to next section.

☐ Initial head position (Figure 12)

The indicator plate assembly (item **e**) markings correspond to head position settings.

- Slide the secondary adjusting plate (item **f**) toward the rear of the burner until the number on the indicator plate corresponds to the initial head setting given in **Tables 4a** and **4b** for the desired firing rate and burner (high-fire).
- **Figure 12** shows a typical example, with a head setting of 6.
- When the head position has been set, tighten the bottom acorn nut (item **c**) and the spline nut (item **b**).

Figure 12 – Adjusting plate initial setting, typical



Legend

- b Spline nut for securing nozzle line
- c Bottom acorn nut (for head adjustments)
- d Top acorn nut (for setting dim. Z only - do not loosen after setting Z)
- e Indicator adjusting plate
- f Secondary adjusting plate
- g Primary adjusting plate
- h Copper oil line from oil valve to nozzle line

Table 4a. CF1400 Initial indicator adjustment plate settings

CF1400	Tube	Head Position		Damper Position	
		Approximate Head Setting	Firing Rate (gph)	Approximate Air Damper Setting	Firing Rate (gph)
	A	0	4.00	0	--
		1	4.50	10	--
		2	5.00	20	4.00
		3	6.00	30	5.00
		4	7.00	40	7.00
		5	7.50	50	8.00
		6	8.00	60	10.00
		7	9.00	70	11.00
		8	9.50	80	--
		9	10.00	90	--
		10	11.00	100	--
		--	--	110	--
		--	--	120	--
	B	0	7.00	0	--
		1	7.50	10	--
		2	8.00	20	--
		3	9.00	30	--
		4	10.00	40	7.00
		5	10.50	50	8.00
		6	11.00	60	10.00
		7	12.00	70	11.00
		8	13.00	80	12.00
		9	13.25	90	12.50
		10	13.60	100	13.00
		--	--	110	13.25
		--	--	120	13.60

Table 4b. CF2300 Initial indicator adjustment plate settings

CF2300	Tube	Head Position		Damper Position	
		Approximate Head Setting	Firing Rate (gph)	Approximate Air Damper Setting	Firing Rate (gph)
	A	0	11.0	0	--
		1	12.0	10	7.0
		2	13.0	20	10.0
		3	14.0	30	13.0
		4	15.0	40	14.0
		5	16.0	50	15.0
		6	17.0	60	16.0
		7	18.0	70	17.0
		8	19.0	80	18.0
		9	20.0	90	19.0
		--	--	100	20.0
	B	0	12.5	0	--
		1	13.0	10	10.0
		2	14.0	20	13.0
		3	15.0	30	14.0
		4	16.0	40	15.0
		5	17.0	50	16.0
		6	18.0	60	17.0
		7	18.5	70	18.0
		8	19.0	80	18.5
		9	20.0	90	19.0
		--	--	100	20.0

□ Initial air settings

The following steps outline the procedure for initially setting the damper. Refer to **Figure 13** and **Tables 4a** or **4b** for this procedure.

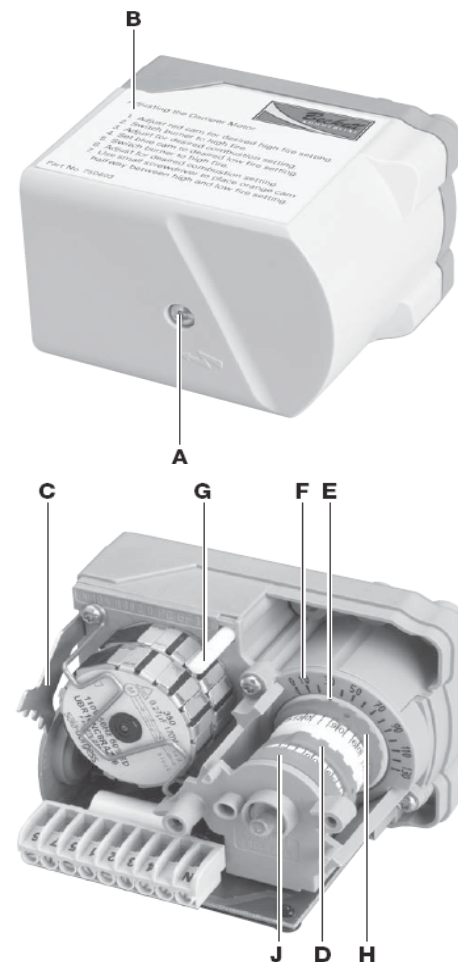
1. Remove the cover screw (A) then the cover (B) and place to one side.
2. Using the wrench (C) supplied with the damper motor, adjust the blue low fire cam (D) to the initial setting listed in **Tables 4a** or **4b**.
3. Using the same wrench, adjust the red high fire cam (H) to the initial settings listed in **Tables 4a** or **4b**.
4. Ensure the damper plate is in the correct position. The cam notch (E) should align with the low fire setting on the damper motor scale (F).
5. If the damper plate is not in the correct position, disengage the motor by pushing in on the motor pin (G), then rotating the damper plate until the cam notch and motor scale setting are aligned. Re-engage the pin.
6. To adjust the high fire transition, use a small straight edge screw driver, turn the white adjustment screw, located in the orange transition cam, either clockwise or counterclockwise until the cam indicator is half way between the high and low settings on the scale.
 - Rotate the air adjusting plate until the lower edge of the pointer is opposite the number from **Tables 4a** or **4b** corresponding to the desired low fire rate.
 - This initial setting should be adequate for starting the burner at low fire. Once the burner is in operation, the air setting will be adjusted for best performance as discussed later in this manual.
 - Follow the procedures described later in this manual to fine tune the air settings.

NOTICE

The damper plate is attached by screws to its shaft, and bears against a flat on the shaft for alignment. The shaft is secured to the damper motor by a sleeve coupling with two setscrews bearing against the damper shaft and two more against the motor shaft. The motor shaft has a flat matching the one on the damper shaft. The flats on the damper shaft and the motor shaft should be aligned so that the position indicator in the damper motor reads accurately. The best way to align the flats is to tighten the setscrews that bear against the flats on the shafts first, and then tighten the ones that bear against the round surface of the shafts afterward.

The test for proper alignment is to disengage the damper motor from its shaft using the disengaging pin (Item G in **Figure 13B**) and rotate the damper plate to its full closed position. The position indicator should point to 0° within + 5° tolerance.

Figure 13 - Damper Motor



Legend (figure 13)

A	Cover screw	F	Damper motor scale
B	Cover	G	Disengaging pin
C	Wrench	H	High fire cam (red)
D	Low fire cam (blue)	J	Transition cam (orange)
E	Cam notch		

□ Set appliance limit controls

- Set the appliance limit controls in accordance with the appliance manufacturer's recommendations.
- Move the low-fire hold switch (not shown) to the low fire hold position. This will hold the burner in low fire during initial start-up.

□ Prepare the fuel unit for air venting

- To vent air from one-pipe oil systems, attach a clear hose to the vent plug on the fuel unit. Provide a container to catch the oil. Loosen the vent plug.
- Vent the air as described under 'Start the Burner'.

Start the burner



WARNING

Explosion and Fire Hazard



Failure to follow these instructions could lead to equipment malfunction and result in heavy smoke emission, soot-up, hot gas puff-back, fire and asphyxiation hazards.

- Do not attempt to start the burner when excess oil has accumulated in the appliance, the appliance is full of vapor, or when the combustion chamber is very hot.
- Do not attempt to re-establish flame with the burner running if the flame becomes extinguished during start-up, venting, or adjustment.
- **Vapor-Filled Appliance:** Allow the unit to cool off and all vapors to dissipate before attempting another start.
- **Oil-Flooded Appliance:** Shut off the electrical power and the oil supply to the burner and then clear all accumulated oil before continuing.
- If the condition still appears unsafe, contact the Fire Department. Carefully follow their directions.
- Keep a fire extinguisher nearby and ready for use.



WARNING

Professional Service Required



Incorrect installation, adjustment, and use of this burner could result in severe personal injury, death, or substantial property damage from fire, carbon monoxide poisoning, soot or explosion.

Please read and understand the manual supplied with this equipment. This equipment must be installed, adjusted and put into operation only by a qualified individual or service agency that is:

- Licensed or certified to install and provide technical service to oil heating systems.
- Experienced with all applicable codes, standards and ordinances.
- Responsible for the correct installation and commission of this equipment.
- Skilled in the adjustment of oil burners using combustion test instruments.

The installation must strictly comply with all applicable codes, authorities having jurisdiction and the latest revision of the National Fire Protection Association Standard for the installation of Oil-burning Equipment, NFPA 31 (or CSA B139 and B140 in Canada).

Regulation by these authorities take precedence over the general instructions provided in this installation manual.

Do not proceed unless all prior steps in this manual have been completed.

- Start burner and vent air from oil line



WARNING

Hot Gas Puff-back and Heavy Smoke Hazard



Failure to bleed the pump properly could result in unstable combustion, hot gas puff-back and heavy smoke.

- Do not allow oil to intermittently spray into a hot combustion chamber while bleeding.
- Install a gauge in the nozzle discharge port tubing or fully open the pump bleed valve to prevent oil spray from accumulating in the combustion chamber when venting air from the fuel pump.
- Ensure that all bubbles and froth are purged from the oil supply system before tightening the pump air bleed valve.

- Disable function

- Any time the motor is running, press and hold the reset button to disable the burner. The burner will remain off as long as the button is held and will return to standby when released.

- CAD cell resistance check

- While the burner is firing, and after the ignition has been turned off, press and release the reset button (hold 1/2 second or less) to check the cad cell resistance. The LED will flash 1 to 4 times, depending on the cad cell resistance (refer to the table below).

Number of LED flashes	Cad Cell Resistance (ohms)
1	Normal (0 to 400)
2	Normal (400 to 800)
3	Normal (800 to 1600)
4	Limited (1600-Lockout)*

* Lockout can occur above 4000 ohms.

LED Indicator	Status
On	Flame sensed
Off	Flame not sensed
Flashing (1/2 sec off - 1/2 sec on)	Lockout/Restricted Lockout
Flashing (2 sec off - 2 sec on)	Recycle

❑ Operating the burner

1. Move the **low-fire hold** switch to the **low fire hold** position (to hold burner in low fire when started).
2. Verify that the air adjusting cam (*Figure 13b*, item **d**) has been set to the initial low-fire air setting as described under Initial air settings.
3. Open the oil shutoff valves in the oil supply (and return) line(s) to the burner.
4. Set the thermostat (or operating control) to call for heat.
5. Close the line switch to the burner. The burner motor should start immediately.
6. If the burner motor does not start, reset the motor overload switch (if so equipped) and press the reset switch of the burner primary control.
7. Vent the fuel unit as soon as the burner motor starts rotating. To vent —
 - Attach a clear plastic tube to the air bleed valve (*Figure 9 or 10 as applies, item p*).
 - Place the end of the tube in a container to catch the oil. Then loosen the fuel unit air vent valve.
 - Tighten the air vent valve after all air has been purged.
 - **IF burner stops during venting** —
 - The burner primary control will lockout if flame is not established within its time limit. This is typically 15 seconds for R7184B primary controls, but may be less for other flame supervisory controls.
 - The burner may lockout several times during the period needed to purge all the air. To extend air venting time, press the red reset button for 1/2 second during the prepurge cycle to continue purging.
 - **IF burner stops after flame established** —
 - Additional venting is probably required. Repeat the air venting procedure.
8. Once flame is steady, proceed to Set high-fire air.

❑ Set high-fire air

1. Allow the burner to run at **low fire** until the appliance has warmed sufficiently.
2. Visually check the flame. The flame should not be dark orange or smoky. If the flame appears to be smoking, increase the amount of air by readjusting the damper indicator to a higher number.

3. Once the appliance has warmed, the **high-fire** setting can be checked and adjusted.
4. Locate the approximate air adjusting plate setting for **high fire** in *Table 4a or 4b*.
5. Place the **low-fire hold** switch in the **high-fire position**. The damper motor will begin to rotate after four seconds.
6. Use combustion test instruments to adjust the burner.
 - a. Adjust the air by moving the red cam to a lower number until a trace of smoke is achieved with CO₂ level as high as possible (lowest possible O₂).
Example: 13.5% CO₂ (2.5% O₂) with a trace of smoke.
 - b. Increase the air by increasing the red cam number to reduce CO₂ by 2 percentage points at a zero smoke level. (Increase O₂ by 3 percentage points at a zero smoke level.)
Example: Reduce CO₂ from 13.5% to 11.5%, with zero smoke (or increase O₂ from 2.5% to 5.5%).
 - c. A margin of reserve air has been added to accommodate variable conditions.
7. Check the breech draft pressure against the appliance manufacturer's recommended setting (typically + 0.1" W.C.).
8. If the breech pressure is higher or lower than recommended level, adjust the appliance breech damper to achieve the specified setting. Recheck the smoke and CO₂ levels. Adjust burner air if necessary.
9. Once all settings are complete and satisfactory, proceed to 'Set low-fire air'.

❑ Set low-fire air

1. Move the **low-fire hold** switch from the "**High Fire position**" to the "**Low Fire Hold**" position.
 - a. The damper will return to the **low-fire** air setting.
2. Check the smoke and CO₂ (O₂) levels.
 - a. Pull a smoke sample from the flue.
 - b. The sample should be clean (zero smoke level).
 - c. Check the CO₂ (O₂) level:
CO₂ should be at 11 to 12% (O₂ at 5.9 to 4.5%).
If the CO₂ is less than 11% (O₂ more than 5.9%), decrease the air and check the smoke level.
3. Operate the burner from **low fire** to **high fire** and back to verify operation.
4. Turn the burner off. Wait one or two minutes (for chamber to clear) and then turn on again to verify starting characteristics.
5. Perform limit circuit performance test specified by appliance manufacturer to verify operation of burner/appliance combination.

Maintenance and Service



WARNING

Annual Professional Service Required



Tampering with or making incorrect adjustments could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- Do not tamper with the burner or controls or make any adjustments unless you are a trained and qualified service technician.
- To ensure continued reliable operation, a qualified service technician must service this burner annually.
- More frequent service intervals may be required in dusty or adverse environments.
- Operation and adjustment of the burner requires technical training and skillful use of combustion test instruments and other test equipment.

Annual Service

- ☐ Replace the oil supply line filter. The line filter cartridge must be replaced to avoid contamination of the fuel unit and nozzle.
- ☐ Inspect the oil supply system. All fittings should be leak-tight. The supply lines should be free of water, sludge and other restrictions.
- ☐ Remove and clean the pump strainer if applicable.
- ☐ Replace the nozzle with the exact brand, pattern, gph, flow rate and spray angle.
- ☐ Clean and inspect the electrodes for damage, replacing any that are cracked or chipped.
- ☐ Check electrode tip settings. Replace electrodes if tips are rounded.
- ☐ Inspect the igniter spring contacts.
- ☐ Clean the cad cell lens surface, if necessary.
- ☐ Inspect all gaskets. Replace any that are damaged or would fail to seal adequately.
- ☐ Inspect the combustion head and air tube. Remove any carbon or foreign matter. Replace all damaged units with exact parts.
- ☐ Clean the blower wheel, air inlet, air guide, burner housing and static plate of any lint or foreign material.
- ☐ If motor is not permanently lubricated, oil motor with a few drops of SAE 20 nondetergent oil at each oil hole. DO NOT over oil motor. Excessive oiling can cause motor failure.

- ☐ Check motor current. The amp draw should not exceed the nameplate rating.
- ☐ Check all wiring for secure connections or insulation breaks.
- ☐ Check the pump pressure and cutoff function.
- ☐ Check primary control safety lockout timing.
- ☐ Check ignition system for proper operation.
- ☐ Inspect the vent system and chimney for soot accumulation or other restriction.
- ☐ Clean the appliance thoroughly according to the manufacturer's recommendations.
- ☐ Check the burner performance. Refer to the section "Set combustion with test instruments".
- ☐ It is good practice to make a record of the service performed and the combustion test results.

Monthly maintenance — by owner

- ☐ Observe combustion air openings and vent system for integrity. Openings must be clean and free of obstructions.
- ☐ Check oil lines and fittings to verify there are no leaks.
- ☐ Observe burner ignition and performance to verify smooth operation.
- ☐ Shut the system down if you observe abnormal or questionable operation. Call a qualified service agency for professional inspection and service.

See next page for *Beckett* replacement parts ►

Replacement Parts

For best performance specify genuine *Beckett* replacement parts

Item	Part Name	Description	Part No.
1	Timer	Nozzle valve delay	21295U
2	Oil Valve	Box mounted	21789U
3	Knurled Nut	All models	3666
4	Adjusting plate assembly	w/ cast aluminum door w/ stamped sheet-metal door	5994U 5201701U
5	Fuel pump	B2TA-8245 H3PAN-C150H	21313U 21309U
6	Damper motor	2-stage	750601U
7	Pedestal kit	All models	51193
8	Fuel lines	Specify length	-
9	Sight glass	All models	31346
10	Rear cover door assembly	w/ cast aluminum door* w/ stamped sheet-metal door*	CF1400 5994U CF2300 51204U CF1400 5201301U CF2300 5201302U
11	Control	Specify	-
12	Coupling hole plug Coupling access door	use with threaded hole use with rectangular opening	32439U 16703GY
13	Head assembly	CF1400 CF2300	5978 51203
14	Electrode assembly	All models	51212
15	Ignition leads	8-1/4" long 11-3/4" long 15-1/4" long 19-1/4" long	5990082 5990116 5990152 5990192
16	Nozzle line assembly	Refer to Figure 5, Page 9	
17	Air tube	Refer to Figure 4, Page 8	
18	Transformer	12,000 volt	51214
19	Coupling	B pump H pump	21290 21308
20	Blower wheel	CF1400 - 5.59" x 3.09" CF2300 - 6.75" x 3.13"	21268U 21267U
21	Motor	120/208-230 single phase 208-230/460 three phase	CF1400 21401U CF2300 21402U CF1400 21638U CF2300 21499U
	Motor relay (not shown)	120V single phase 208V single phase three phase	7273 7300 2194301
	Adjustable flange	see Figure 15 on opposite page	

Figure 14 – Burner Replacement Parts

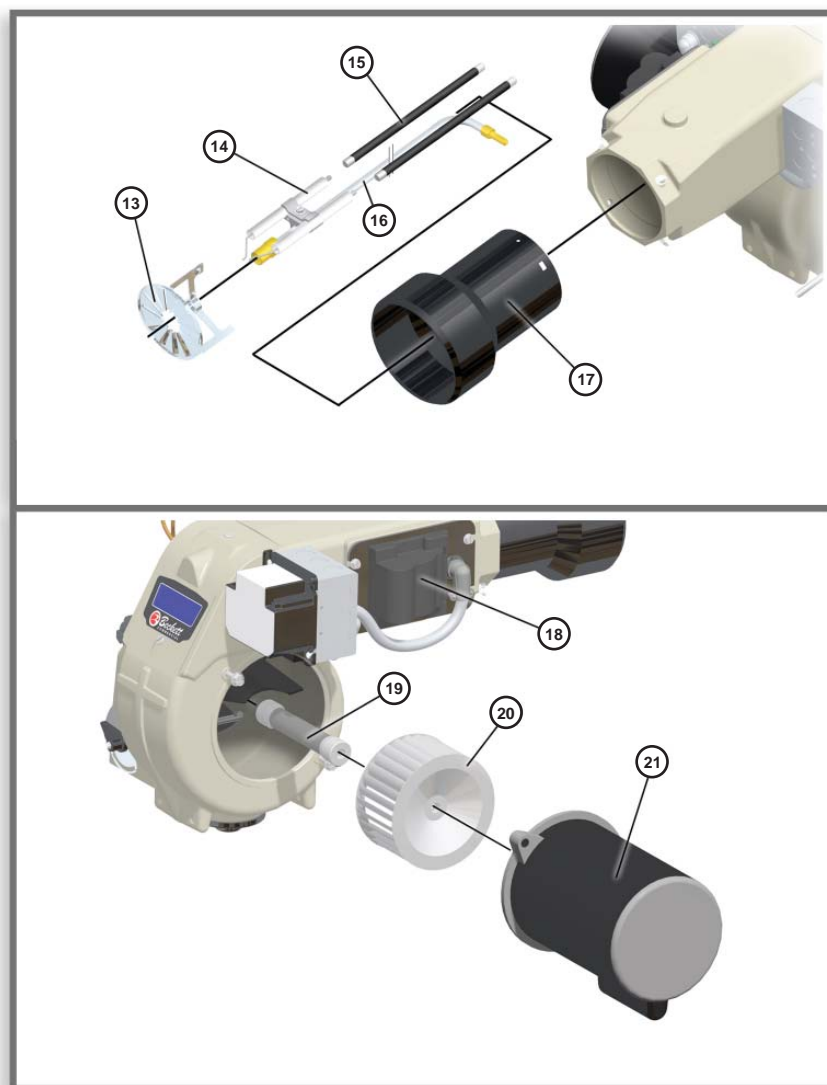
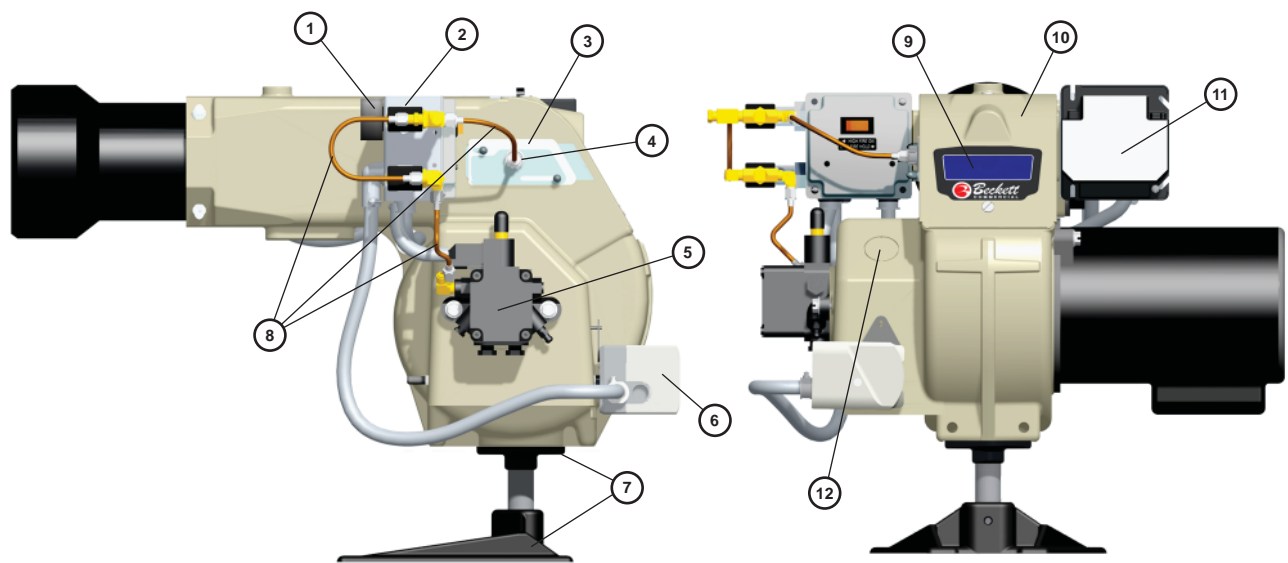
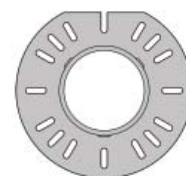
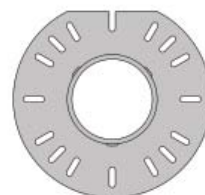


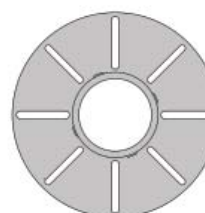
Figure 15 – Adjustable mounting plates



Flange A



Flange B



Flange C

Model	Flange A	Flange B	Flange C
CF1400	51312 (10.00" DIA.)	n/a	51629 (12.25" DIA.)
CF2300	51313 (12.44" DIA.)	51498 (13.92" DIA.)	51630 (16.00" DIA.)

Limited Warranty Information

Limited WARRANTY

For Residential, Commercial and Specialty Burners

The R. W. BECKETT CORPORATION ("Beckett") warrants to persons who purchase its Beckett burners from Beckett for resale or for incorporation into a product for resale ("Customers") that its equipment is free from defects in material and workmanship under normal use and service for 60 months from the date of manufacture for Residential Burners and 18 months from the date of manufacture for Commercial and Specialty Burners. *Residential burner models include:* AF, AFG, AFII, NX, SF, SR and SMG. *Commercial burner models include:* CF375, CF500, CF800, CF1400, CF2300A, CF2500, CF3500A, CG10, CG15, CG25 and CG50. *Specialty burner models include:* ADC, ADCP, ARV, SDC and SM. The provisions of this warranty are extended to individual major burner components as follows:

- a) 60 months from date of manufacture for all Beckett-branded major components, except for 12 Vdc components.
- b) 18 months from date of manufacture for all non-Beckett-branded major components and Beckett branded 12 Vdc components.

Note: Normal service items found to be defective upon receipt by the customer are covered by this warranty.

THIS WARRANTY DOES NOT EXTEND TO EQUIPMENT SUBJECTED TO MISUSE, NEGLIGENCE, OR ACCIDENT; NOR DOES THIS WARRANTY APPLY UNLESS THE PRODUCT COVERED BY IT IS PROPERLY INSTALLED BY A QUALIFIED, COMPETENT TECHNICIAN, WHO IS LICENSED WHERE STATE AND LOCAL CODES REQUIRE, AND WHO IS EXPERIENCED IN MAKING SUCH INSTALLATIONS, IN ACCORDANCE WITH THE LATEST EDITION OF NFPA NO. 31 OF THE NATIONAL FIRE PROTECTION ASSOCIATION, THE LATEST EDITION OF THE NATIONAL FUEL GAS CODE (NFPA NO. 54) AND IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE AND NATIONAL CODES HAVING JURISDICTIONAL AUTHORITY.

Equipment, which is defective in material or workmanship and within the warranty period, may be returned for credit as follows:

Beckett Burners, Beckett-branded major components and non-Beckett-branded major components that came as original equipment on a Beckett burner or were sold as a replacement part by Beckett should be returned, freight prepaid, to Beckett's home office. Credit will be issued to the customer unless the returned equipment is determined by Beckett to be out of warranty or damaged by user, in which case the equipment will be scrapped.

Note: Beckett is not responsible for any labor cost for removal and replacement of equipment.

THIS WARRANTY IS LIMITED TO THE PRECISE TERMS SET FORTH ABOVE, AND PROVIDES EXCLUSIVE REMEDIES EXPRESSLY IN LIEU OF ALL OTHER REMEDIES, AND IN PARTICULAR THERE SHALL BE EXCLUDED THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT WILL BECKETT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGE OF ANY NATURE. Beckett neither assumes nor authorizes any person to assume for Beckett any other liability or obligation in connection with the sale of this equipment, Beckett's liability and Customer's exclusive remedy being limited to credit as set forth above.

R.W. BECKETT CORPORATION

P.O. Box 1289 Elyria, Ohio 44036

Form No. 61545 R72905

The Oilheat Manufacturers' Association supports the use of low sulfur fuels as defined by ASTM D396, Grades No. 1 Low Sulfur and No. 2 Low Sulfur, as the preferred heating fuel for the following reasons:

- Low sulfur fuels reduce deposits on heat exchanger surfaces, extending the service interval between cleanings.
- The reduced deposits increase the efficiency of the appliance.
- Low sulfur fuels reduce particulate emissions.
- Low sulfur fuels reduce oxides of nitrogen emissions.

R.W. BECKETT CORPORATION

U.S.A.: P.O. Box 1289 · Elyria, Ohio 44036

www.beckettcorp.com

Canada: R.W. Beckett Canada, Ltd. · Unit #3, 430 Laird Road · Guelph, Ontario N1G 3X7

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INSTALLATION INFORMATION



MODEL A SINGLE STAGE TWO-STEP MODEL B TWO-STAGE TWO-STEP FUEL UNITS AND MODEL B TWO-STAGE HIGH PRESSURE FUEL UNITS

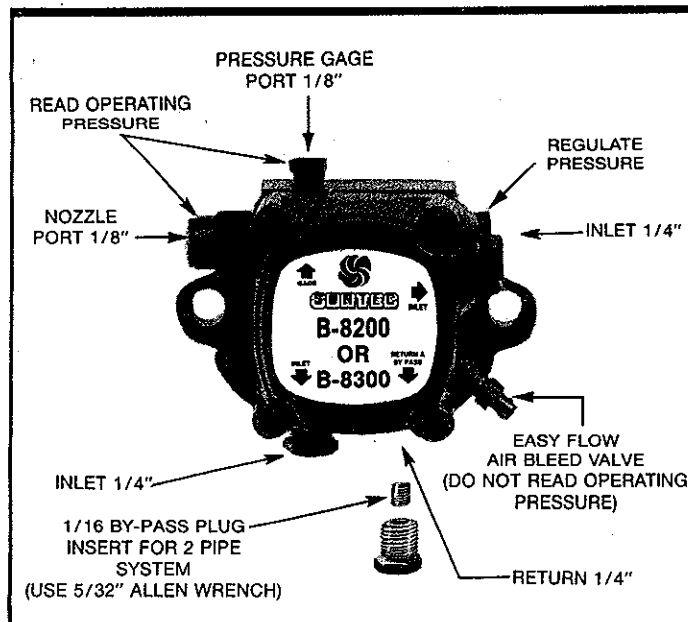


FIGURE 1

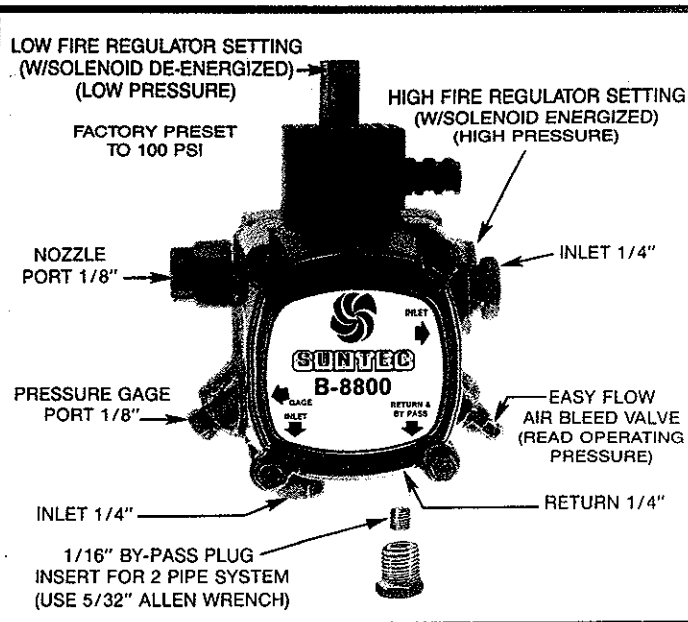


FIGURE 2

ONE-PIPE SYSTEM • FIGURE 3

DO NOT INSTALL BYPASS PLUG! Connect inlet line to pump inlet. Start burner. Arrange primary burner control for continuous operation during purging. Open easy flow bleed valve 1 turn CCW. Bleed unit until all air bubbles disappear — **HURRIED BLEEDING WILL IMPAIR EFFICIENT OPERATION OF UNIT.** Tighten easy flow bleed valve securely.

TWO-PIPE SYSTEM • FIGURE 4

REMOVE 1/16" BY-PASS PLUG FROM PLASTIC BAG ATTACHED TO UNIT. Remove 1/4" plug from return port. Insert by-pass plug (See Figure 1 or 2), tighten plug. Attach return and inlet lines. Start burner — Air bleeding is automatic. Opening Easy Flow Air Bleed Valve will allow a faster bleed if desired. Return line must terminate 3-4" above supply line inlet. (See Figure 4). Failure to do this may introduce air into the system and could result in loss of prime.

TWO STEP PUMPS • FIGURE 2

MODEL SHOWN IS RIGHT HAND ROTATION; ALL PORTS ARE REVERSED FOR LEFT HAND ROTATION.

SOLENOID WIRING Refer to burner manufacturer's manual for instructions.

NOTE: Wiring of the solenoid in parallel with the safety control circuit will bypass the low fire regulator.

REGULATOR SETTING Install pressure gage in gage port (remove after adjustment) with proper nozzle in nozzle line

- Low Fire — Factory preset to 100 PSI with rated nozzle.
- High Fire — With solenoid energized adjust high fire regulator to desired pressure. (Range 200 to 300 PSI)

NOTE: EXTERNAL CUTOFF VALVE (120V MAXIMUM) IS REQUIRED.

GENERAL INFORMATION • ALL SYSTEMS

IMPORTANT INFORMATION Long or oversized inlet lines may require the pump to operate dry during initial bleeding period. In such cases, the priming may be assisted by injecting fuel oil into the pump gearset. Under lift conditions, oil lines and fittings must be air tight. To assure this, "Pipe Dope" may be applied to both the used and unused inlet and both return fittings. **DO NOT USE TEFLON TAPE!! DO NOT USE COMPRESSION FITTINGS!!**

MOUNTING POSITION Model "A" Single Stage Fuel Unit may be mounted in any position. Model "B" Two Stage Fuel Unit may be mounted in any position except upside down (1/8" ports pointed down).

VACUUM CHECK A Vacuum Gage may be installed in either of the 1/4" inlet ports or in the 1/8" return port (on single pipe installations), whichever is most convenient. The Model "A" pump should be used where the vacuum does not exceed 6" hg. single pipe and 12" hg. two pipe. The Model "B" should be used where vacuum does not exceed 17" hg. Running vacuum is the total of all pressure drops (ΔP) from the tank to the inlet of the pump.

CAUTION

Pressurized or gravity feed installations must not exceed 10 P.S.I. on inlet line or return line at the pump. A pressure greater than 10 P.S.I. may cause damage to the shaft seal.

ONE-PIPE SYSTEM • MODEL A

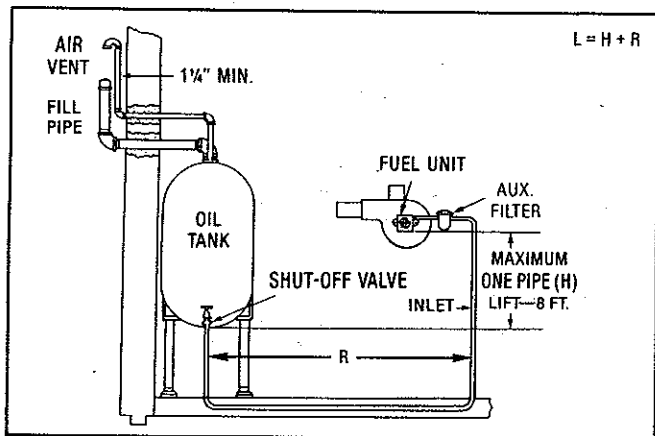


FIGURE 3

The SUNTEC MODEL "A"-70 FUEL UNIT may be installed ONE-PIPE with Gravity Feed or Lift.

The maximum allowable lift is 8 ft. — See Figure 3.

IMPORTANT: One-pipe installations must be absolutely air tight or leaks or loss of prime may result. Bleed line and fuel unit completely. Bleed for 15 seconds after last air is seen from easy flow to be certain lines are air free.

L = Line Length in Feet H = Head in Feet Q = Firing Rate in GPH

$$\frac{3}{8}" \text{ line } L = 6 - .75H$$

$$\frac{1}{2}" \text{ line } L = 6 - .75H$$

$$.0086 Q$$

$$.00218 Q$$

If tank is above pump change - to +. Fittings, valves, and filters will reduce total length allowed.

TWO-PIPE SYSTEM • MODEL A AND B

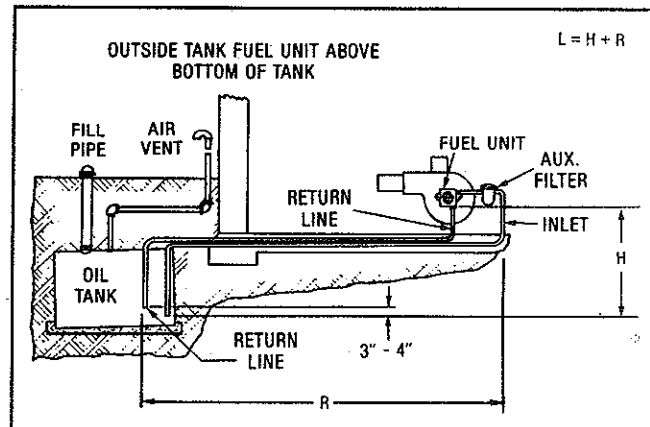


FIGURE 4

Always terminate return line as shown in Figure 4. Line lengths include both vertical and horizontal lengths.

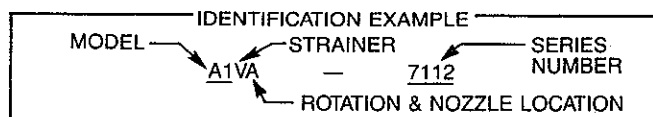
MODEL A SINGLE-STAGE TWO-STEP • TWO-PIPE MAXIMUM LINE LENGTH (H + R)

Lift "H" Figure 4	3450 RPM					
	3/8" OD Tubing		1/2" OD Tubing		5/8" OD Tubing	
	10 GPH	16 GPH	10 GPH	16 GPH	23 GPH	23 GPH
0'	33'	29'	100'	100'	72'	100'
1'	31'	27'	100'	100'	66'	100'
2'	28'	25'	100'	98'	59'	100'
3'	25'	23'	100'	89'	53'	100'
4'	23'	20'	92'	80'	46'	100'
5'	21'	18'	82'	72'	40'	100'
6'	18'	16'	72'	63'	34'	100'
7'	16'	14'	62'	55'	27'	88'
8'	13'	12'	52'	46'	20'	72'
9'	11'	9'	43'	37'	14'	56'
10'	—	—	33'	29'	8'	39'

MODEL B TWO-STAGE TWO-STEP AND TWO-STAGE HIGH PRESSURE • TWO-PIPE MAXIMUM LINE LENGTH (H + R)

Lift "H" Figure 4	3450 RPM					
	3/8" OD Tubing		1/2" OD Tubing		5/8" OD Tubing	
	10 GPH	16 GPH	10 GPH	16 GPH	23 GPH	23 GPH
0'	70'	60'	100'	100'	100'	100'
2'	64'	55'	100'	100'	100'	100'
4'	58'	50'	100'	100'	100'	100'
6'	52'	44'	100'	100'	100'	100'
8'	45'	39'	100'	100'	100'	100'
10'	39'	34'	100'	100'	100'	100'
12'	33'	28'	100'	100'	94'	100'
14'	27'	23'	100'	91'	76'	100'
16'	21'	18'	81'	70'	59'	100'
18'	—	—	57'	49'	41'	100'

PUMP USAGE IDENTIFICATION



STRAINER TYPE	UL Strainer Rating (GPH)* #2 Fuel Oil
V	3
Y	7
T	23
G	34

*Max. firing rate not to exceed max. nozzle capacity or strainer rating whichever is LESS. A greater firing rate requires a suitable external strainer.

ALL INSTALLATIONS SHOULD BE MADE WITH LOCAL AND NATIONAL CODES.

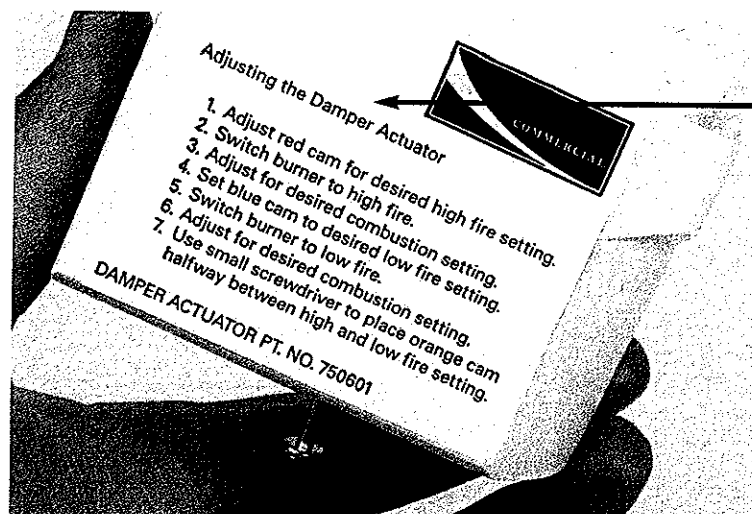


GLASGOW, KY 42142-5000

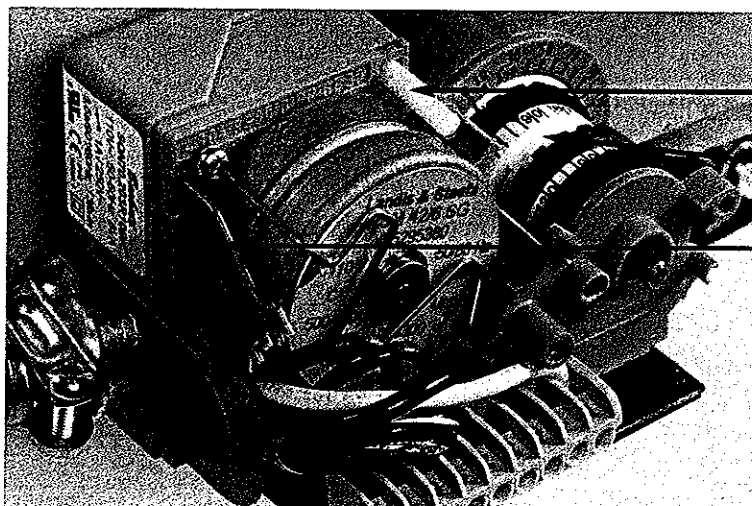
... working harder to serve you even better.

Beckett

Damper Actuator For Commercial Two-Stage Burners Adjustment Instructions



Adjustment Instructions
Printed on Cover



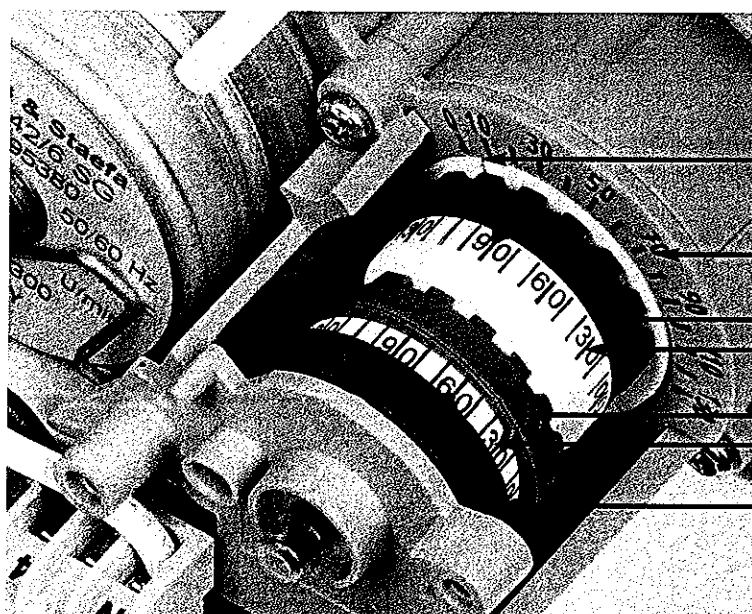
Disengaging Pin in the
Engaged (out) Position

Cam Stack

Adjustment Wrench

The **Disengaging Pin** allows the Damper and Cam Stack to be rotated by hand.

The Disengaging Pin must be in the engaged position (out) when the burner is operating.



Damper Position Indicator
(Notch in White Ring)

Damper Position Scale

Red High Fire Cam with
White Adjustment Scale

Blue Low Fire Cam with
White Adjustment Scale

Transition Cam shares
Adjustment Scale

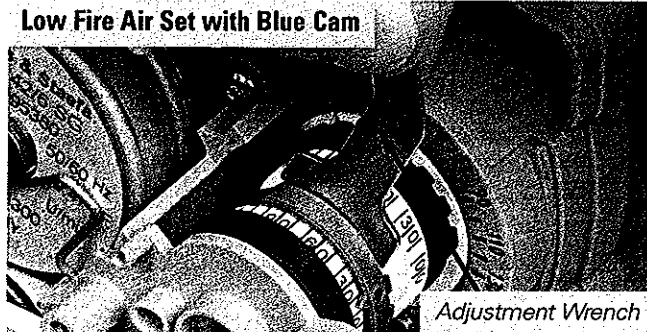
Damper Actuator

For Commercial Two-Stage Burners

Adjustment Instructions

Setting the High Fire Air and Low Fire Air

Low Fire Air Set with Blue Cam



High Fire Air is set with the Red Cam

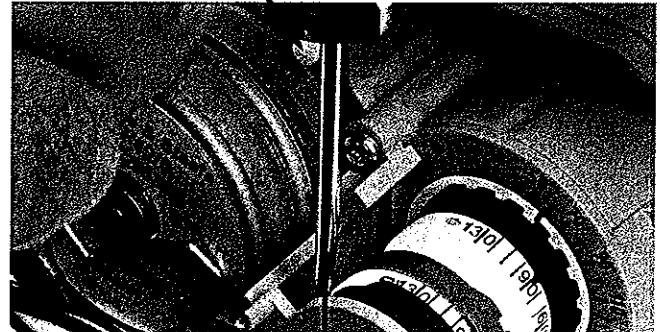


An old air setting specification of 7 is equal to 70° on the damper position scale of this new damper actuator.

If adjusting the air settings while the burner is operating, it is necessary to cycle the burner from High to Low Fire or Low to High by using the lighted low fire hold switch.

Setting the Transition

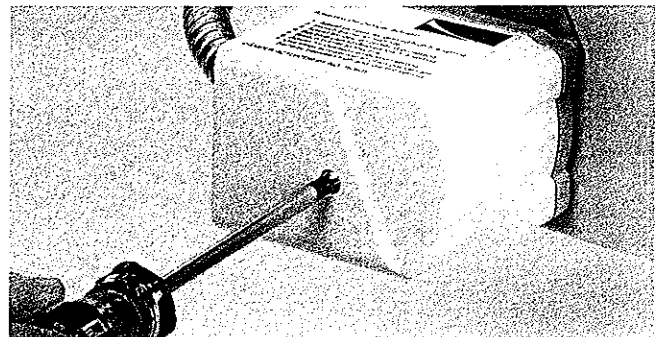
Cam is disengaged



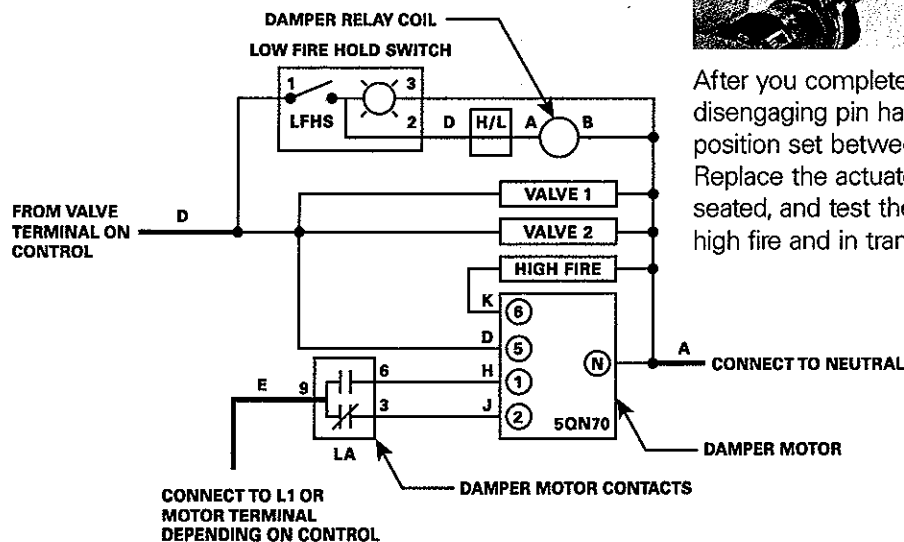
Transition Cam is set with Screwdriver

The **ORANGE CAM** sets the transition point between Low Fire Oil and High Fire Oil.

It should be set halfway between the settings of the RED Cam and the BLUE Cam.



After you complete your adjustments make certain the disengaging pin has been reengaged with the damper position set between the high fire and low fire limits. Replace the actuator cover, making sure it is correctly seated, and test the burner for proper firing at low fire, high fire and in transition between low and high.



For more information, contact:

www.beckettcorp.com

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Form No. 61578 09/04
Printed in U.S.A.

KEY

DM = DAMPER MOTOR
H/L = LOW FIRE HOLD AQUISTAT
LA = LOW FIRE AIR RELAY
LFHA = LOW FIRE HOLD AQUISTAT
LFHS = LOW FIRE HOLD SWITCH
LWCO-P = LOW WATER CUTOFF - PRIMARY
LWCO-S = LOW WATER CUTOFF - SECONDARY (IF USED)
M = MOTOR
MC = MOTOR CONTACTOR
S1, S3 = ON/OFF VALVE
S2 = HIGH/LOW VALVE
TRANS = IGNITION TRANSFORMER

LEGEND

- = CONTACT/DAMPER COIL
- = LIGHT
- = WIRING SUPPLIED BY INSTALLER
- = CROSSOVER WIRES
- = FACTORY JUMPER TO BE CUT FOR FIELD WIRING TIE-IN

WIRE COLOR

- A = WHITE
- B = BLACK
- C = BLUE
- D = ORANGE
- E = BROWN/RED
- F = RED
- G = BROWN
- H = RED/WHITE
- J = BLUE/WHITE
- K = VIOLET
- L = BLACK/RED
- M = BLACK/WHITE
- P = GREEN

MOTOR WIRE - 14GA.
ALL OTHER WIRE - 16 GA.
UNSPECIFIED WIRE COLORS
BASED ON COMPONENTS

LIGHT COLOR

- R = RED
- G = GREEN
- A = AMBER

NOTES

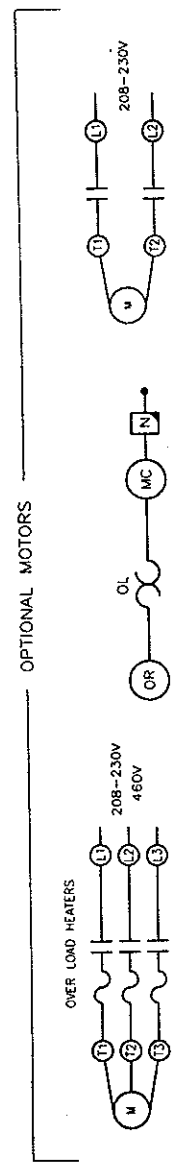
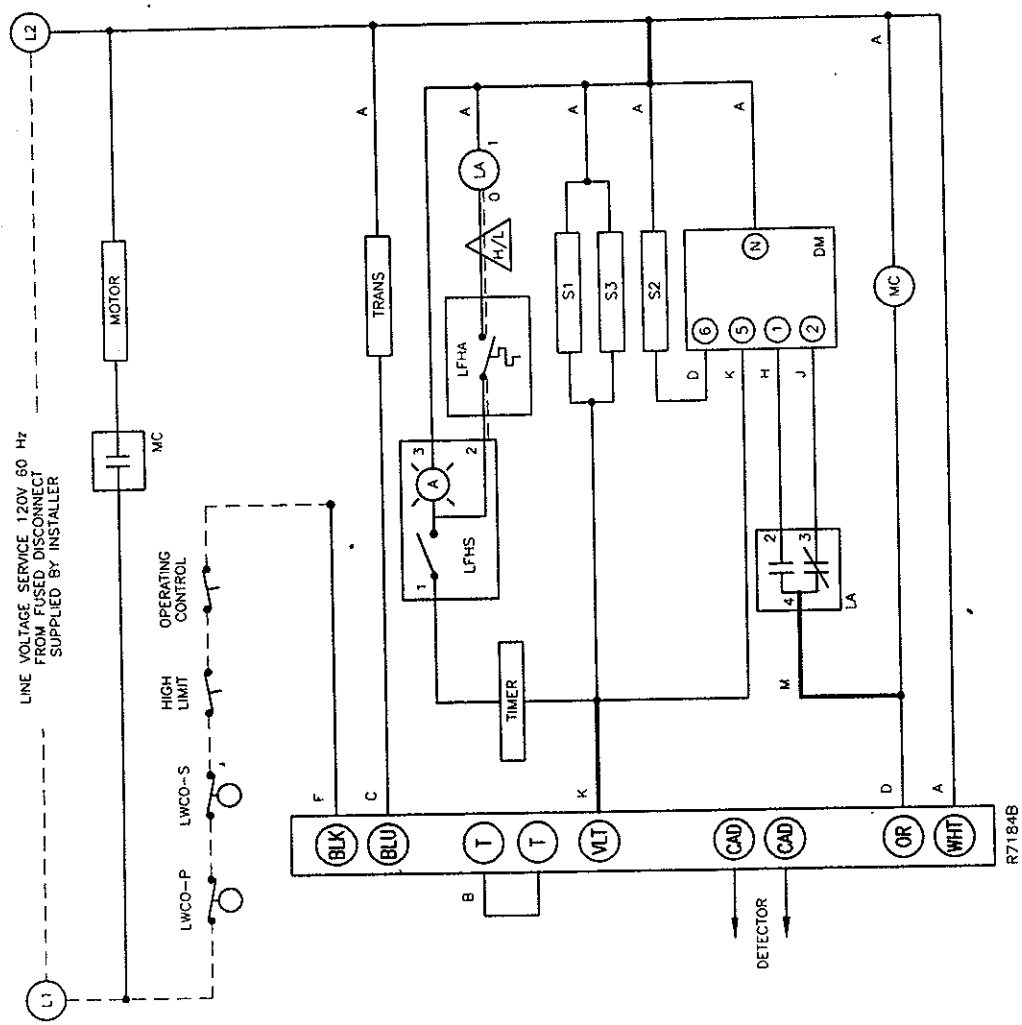
1. LOCATE HIGH/LOW OPERATOR BETWEEN DAMPER MOTOR AND LFHS.

Beckett
COMMERCIAL

CF1400 / CF2300
LOW/HIGH/OFF
R7184B CONTROL

DATE	REV	BY	DATE
12/07/06	1		

6998004





OPERATING INSTRUCTIONS & PARTS MANUAL

HIGH PRESSURE DIRECT-DRIVE BLOWERS

MODELS 2C940, 2C820, **4C108**, 4C329 AND 4C330

FORM 5S2052

06820
0390/073/5M

READ CAREFULLY BEFORE ATTEMPTING TO ASSEMBLE, INSTALL, OPERATE OR MAINTAIN THE PRODUCT DESCRIBED. PROTECT YOURSELF AND OTHERS BY OBSERVING ALL SAFETY INFORMATION. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE! RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

Description

Dayton direct-drive high pressure blowers are used for small exhaust systems where air is laden with dust or where dust-collection bags are necessary. Applications include handling long stringy material, paper trim, fibrous material such as textile scrap, wool and ensilage. Not suitable for coarse material. Heavy or abrasive dust. Dynamically balanced self-cleaning cast aluminum wheels. 16 GA housing and motor base. Maximum operating temperature 180°F (82°C). Finished in baked-on gray enamel. Blower can be assembled for CW or CCW rotation and any one of eight standard discharge positions. See Figure 2. Dayton motors packed separately when blowers are ordered complete.

General Safety Information

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).
2. Blower must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system by using a separate ground wire connected to the bare metal of blower frame, or other suitable means.
3. Always disconnect power source before working on or near a motor or its connected load. If the power disconnect point is out-of-sight, lock it in the open position and tag to prevent unexpected application of power.
4. Be careful when touching the exterior of an operating motor — it may be hot enough to be painful or cause injury. With modern motors this condition is normal when operated at rated load and voltage — modern motors are built to operate at higher temperatures.
5. Protect the power cable from coming in contact with sharp objects.
6. Do not kink power cable and never allow the cable to come in contact with oil, grease, hot surfaces, or chemicals.
7. Make certain that the power source conforms to the requirements of your equipment.
8. When cleaning electrical or electronic equipment, always use an approved cleaning agent such as dry cleaning solvent.
9. Not recommended as an explosion proof blower. Do not use where explosive fumes or gases are present.
10. If blower is operated without an inlet or outlet duct, guard openings in accordance with OSHA regulations to prevent contact with rotating blower wheel.

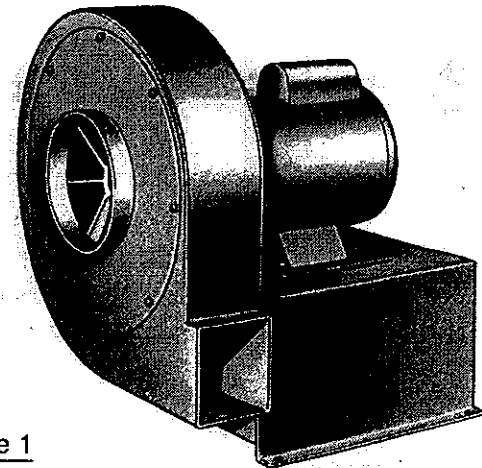


Figure 1

▲ WARNING ▲

KEEP HANDS AWAY FROM INLET WHILE BLOWER IS IN OPERATION.

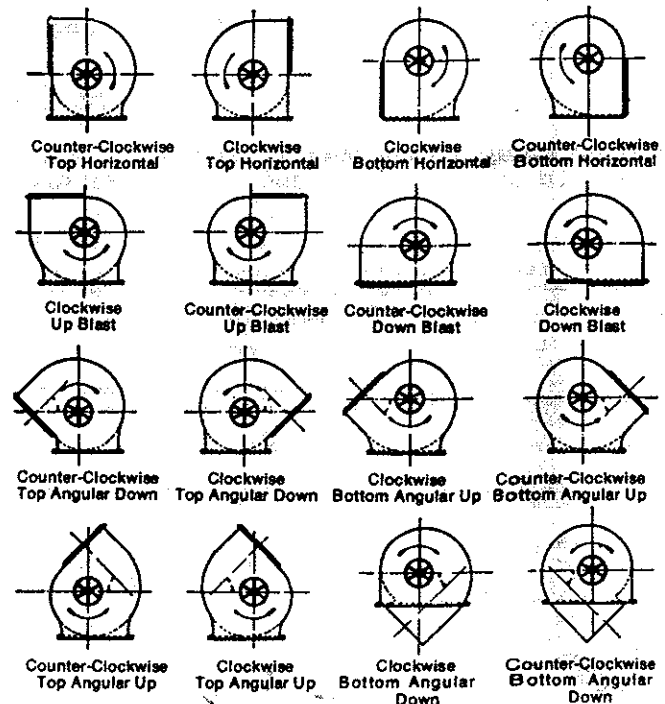


Figure 2

Specifications

MODEL	WHEEL			HIGH-PRESSURE BLOWER DIMENSIONS																X ADJ. MIN.	X ADJ. MAX.
	DIA.	W	BORE	A	B	C	D	E	F	G	H	J	K	L	O	P	R	S	V		
2C940	7 $\frac{3}{4}$ "	2 $\frac{5}{16}$ "	$\frac{1}{2}$ "	11"	8"	3"	3"	5"	7"	$\frac{1}{2}$ "	5 $\frac{3}{8}$ "	4 $\frac{7}{8}$ "	5 $\frac{7}{8}$ "	5 $\frac{7}{8}$ "	12 $\frac{1}{4}$ "	4"	6 $\frac{5}{8}$ "	5 $\frac{1}{2}$ "	—	8 $\frac{1}{4}$ "	9 $\frac{3}{4}$ "
2C820	9	2 $\frac{13}{16}$	$\frac{1}{2}$	12 $\frac{1}{8}$	8	3 $\frac{1}{2}$	3 $\frac{1}{2}$	5 $\frac{5}{8}$	7	$\frac{1}{2}$	6 $\frac{3}{8}$	5 $\frac{3}{4}$	6 $\frac{7}{8}$	6 $\frac{3}{4}$	12 $\frac{3}{4}$	5	7 $\frac{1}{2}$	6 $\frac{3}{8}$	—	9 $\frac{1}{8}$	10 $\frac{5}{8}$
4C108	10 $\frac{9}{16}$	3	$\frac{5}{8}$	14 $\frac{3}{4}$	9	4	3 $\frac{1}{2}$	6 $\frac{7}{8}$	7 $\frac{1}{2}$	$\frac{3}{4}$	7 $\frac{1}{4}$	6 $\frac{1}{2}$	8	7 $\frac{5}{8}$	14	6	8 $\frac{5}{8}$	8 $\frac{1}{4}$	—	11 $\frac{5}{8}$	12 $\frac{7}{8}$
4C329	12 $\frac{1}{2}$	3	$\frac{7}{8}$	17	11 $\frac{1}{4}$	5	4	8	9 $\frac{3}{4}$	$\frac{3}{4}$	8 $\frac{1}{4}$	7 $\frac{1}{2}$	9	9 $\frac{5}{8}$	17	7	10	7 $\frac{1}{8}$	—	10 $\frac{5}{8}$	10 $\frac{5}{8}$
4C330	13 $\frac{1}{2}$	4 $\frac{3}{8}$	1 $\frac{1}{8}$	17 $\frac{1}{2}$	11 $\frac{1}{4}$	7 $\frac{1}{8}$	5 $\frac{1}{4}$	8	9 $\frac{1}{2}$	1	10 $\frac{1}{2}$	9 $\frac{5}{8}$	11 $\frac{1}{8}$	11	18 $\frac{1}{8}$	8	11 $\frac{1}{2}$	8 $\frac{1}{8}$	7 $\frac{1}{4}$	12 $\frac{5}{8}$	12 $\frac{5}{8}$

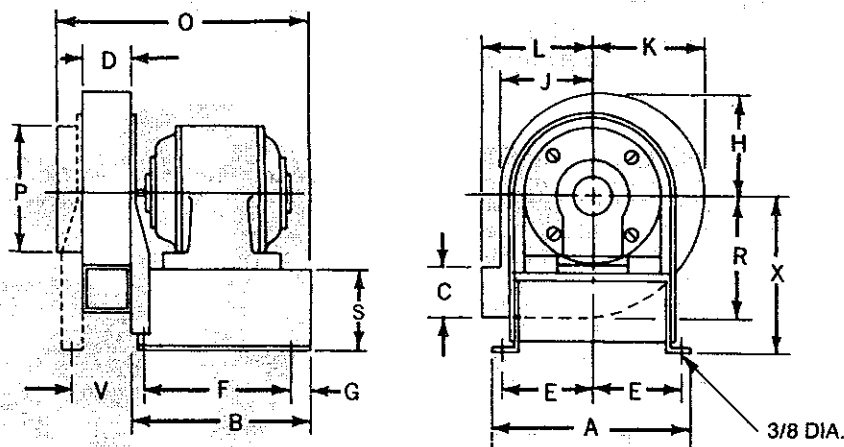


Figure 3

Performance

MODEL	HP REQ'D.	MOTOR FRAME	VOLTS	MOTOR TYPE	CFM AIR DELIVERY AT 3450 RPM								SHPG. WT.
					1" SP	2" SP	3" SP	4" SP	5" SP	6" SP	7" SP	8" SP	
2C940	1/3	48	115	Split	290	230	160	—	—	—	—	—	13
2C820	1/3	48	115	Split	530	470	415	335	165	—	—	—	17
4C108	1	56	115/230	Cap. (†)	800	745	680	610	510	375	225	—	25
4C329	3	145T	230/460	3-Ph.	1200	1140	1070	1010	940	870	790	695	37
4C330	5	182T	230/460	3-Ph.	2140	2030	1930	1820	1710	1615	1500	1375	64

(†) Also available in 208-230/460, 60Hz, 3-Phase.

Based on standard test codes of (AMCA) Air Moving and Conditioning Association

⚠ CAUTION

Must not be used where static pressure is less than shown in table. Severe motor overload will result. Motor overload protection, closely matched to motor full-load current, is highly recommended.

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. High pressure direct drive blowers, Models 2C940, 2C820, 4C108, 4C329, & 4C330, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specified legal rights which vary from state to state.

LIMITATION OF LIABILITY. To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to, and shall not exceed, the purchase price paid.

WARRANTY DISCLAIMER. Dayton has made a diligent effort to illustrate and describe the products in this literature accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the products are merchantable, or fit for a particular purpose, or that the products will necessarily conform to the illustrations or descriptions.

Except as provided below, no warranty or affirmation of fact, expressed or implied, other than as stated in "LIMITED WARRANTY" above is made or authorized by Dayton.

PRODUCT SUITABILITY. Many states and localities have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, please review the product application, and national and local codes and regulations, and be sure that the product, installation, and use will comply with them.

Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of the Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Chicago, IL 60648

Assembly

1. Attach base upright to the motor mounting base as shown in the exploded view. Hand tighten (4) 1/4-20 x 1/2" bolts, washers, and nuts through slotted holes in base upright. Place motor on motor base and align the center hole of the base upright with the motor shaft. Secure the four 1/4-20 bolts. Models 4C329 and 4C330 have a welded motor base assembly.
2. Bolt the housing to the base upright in the desired discharge position using #10 x 3/8 or 5/16-18 x 3/4" self tapping bolts. Blower is clockwise rotation. Refer to exploded view showing clockwise bottom horizontal discharge.
3. With the motor shaft through the center hole of the base upright, align the mounting holes of the motor to the pre-drilled holes in the motor base. Install two bolts to retain proper motor alignment but do not tighten. Mount the wheel to the motor shaft. Refer to exploded view drawing.
4. Mount the inlet ring to the housing and secure with #10 x 3/8" or 5/16-18 x 3/4" self tapping bolts.
5. Slide the wheel toward the inlet ring so there is at least 1/4" clearance between the wheel and cone. The motor shaft should extend through the hub of the wheel so when the setscrews are securely tightened, they will make contact with the motor shafts.
6. Install the remaining nuts, bolts, and washers (not provided) to the motor mounting holes of the motor and secure to the blower motor base.

Installation

1. Make sure all bolts and screws are tightened before mounting on a rigid, flat, level foundation. Bolt the blower securely into position.
2. Check the interior of the fan housing to be sure it is free of debris. Rotate the wheel to insure that it is not rubbing or binding. Check the clearance of the

wheel and the inlet ring. If rubbing exists, loosen the bolts on the ring and shift the ring until clearance is obtained. If still rubbing, loosen the set screw on the wheel and shift the wheel rearward to obtain clearance. Retighten the set screw.

Operation

1. Before connecting the motor to the electric supply, check the electrical characteristics as indicated on the motor nameplate to insure proper voltage and phase.

⚠ CAUTION

A ground wire must run from the blower motor housing to a suitable electrical ground such as a properly grounded metallic raceway or a ground wire system.

2. After electrical connections are completed, apply just enough power to start the unit. Be sure that the rotation of the wheel is correct as indicated by directional arrows on the unit. If proper rotation, apply full electrical power.
3. With the air system in full operation and all ducts attached, measure current input to the motor and compare with the nameplate rating to determine if the motor is operating under safe load conditions.

Maintenance**⚠ CAUTION**

Before attempting any repair work, be certain that all power to the motor and electrical accessories are turned off and locked in the off position.

- A. Periodically remove dirt from blower wheel and housing.
- B. Check tightness of wheel setscrews.
- C. After disconnecting the power source, check the wiring to see if insulation is damaged or frayed.
- D. Relubricate motor per manufacturer's instructions. Remove any excess lubricants.

Troubleshooting Chart

SYMPTOM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
Noise.	1. Foreign objects in housing. 2. Loose setscrew on wheel. 3. Incorrect wheel rotation.	1. Remove. 2. Tighten. 3. Reverse rotation.
Motor bearing noise.	Lack of bearing lubrication.	Lubricate.
Excessive vibration.	1. Loose wheel on shaft. 2. Loose mounting bolts. 3. Motor out of balance. 4. Wheel out of balance. 5. Accumulation of material on wheel.	1. Tighten setscrews. 2. Tighten. 3. Replace. 4. Replace or rebalance. 5. Clean.
Motor overloaded.	System static pressure less than .1" water column.	Increase system static pressure.

**ORDER REPLACEMENT PARTS
BY CALLING TOLL FREE**

1-800-323-0620

Please provide the following information:

- Model Number
- Serial Number (if any)
- Parts Description and Number as shown in Parts List

Address parts correspondence to:

Parts Company of America
1657 Shermer Road
Northbrook, IL 60062-5362

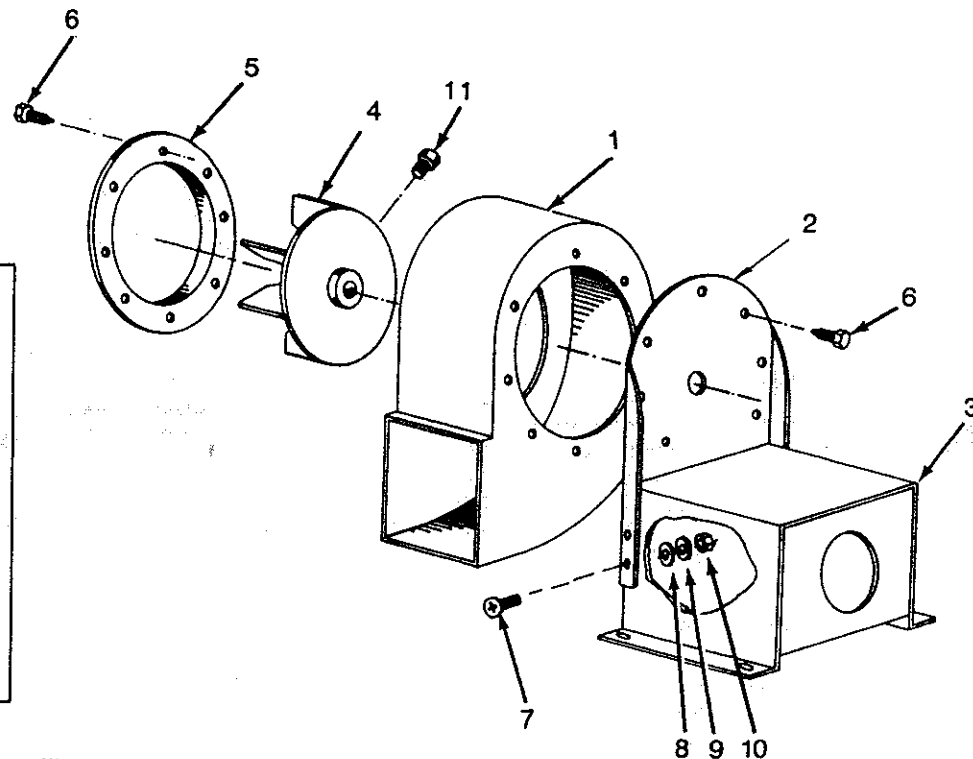


Figure 4 — Replacement Parts Illustration

Replacement Parts List

REF. NO.	DESCRIPTION	PART NO. FOR MODEL:				
		2C940	2C820	4C108	4C329	4C330 (†)
1	Housing scroll	201-08-4005-5	201-09-4003-5	201-11-4005-5	201-12-4004-5	201-14-4005-5
2	Base upright	618-08-7001-5	618-09-7001-5	618-11-7002-5	—	—
3	Motor base assembly	203-08-7001-5	203-09-7001-5	203-11-7005-5	203-12-4016-5	203-14-4011-5
4	Wheel	602-08-4001-5	602-09-4001-5	602-11-4002-5	602-12-4004-5	602-14-4003-5
5	Inlet ring	609-08-4002-5	609-09-4001-5	609-11-4003-5	602-12-4003-5	609-14-4001-5
6	Hex hd. screw	#10 x 3/8" 8 Req'd.	#10 x 3/8" 14 Req'd.	#10 x 3/8" 14 Req'd.	5/16-18 x 3/4" 16 Req'd.	5/16-18 x 3/4" 16 Req'd.
7	Slotted machine screw*	1/4-20 x 1/2" 4 Req'd.	1/4-20 x 1/2" 4 Req'd.	1/4-20 x 1/2" 4 Req'd.	—	—
8	Flat washer*	1/4 4 Req'd.	1/4 4 Req'd.	1/4 4 Req'd.	—	—
9	Split washer*	1/4 4 Req'd.	1/4 4 Req'd.	1/4 4 Req'd.	5/16 16 Req'd.	5/16 16 Req'd.
10	Hex nut*	1/4"-20 4 Req'd.	1/4"-20 4 Req'd.	1/4"-20 4 Req'd.	—	—
11	Setscrew	†	†	†	†	†

NOTE — Models 4C329 and 4C330 have welded 1 piece motor base & upright assembly.

(†) Model 4C330 has inlet upright supports (not shown) to support housing. Order by P/N 617-13-7002-5.

(*) Standard hardware item, available locally.

(†) Available with wheel.

Inspection Checklist for Supervisors

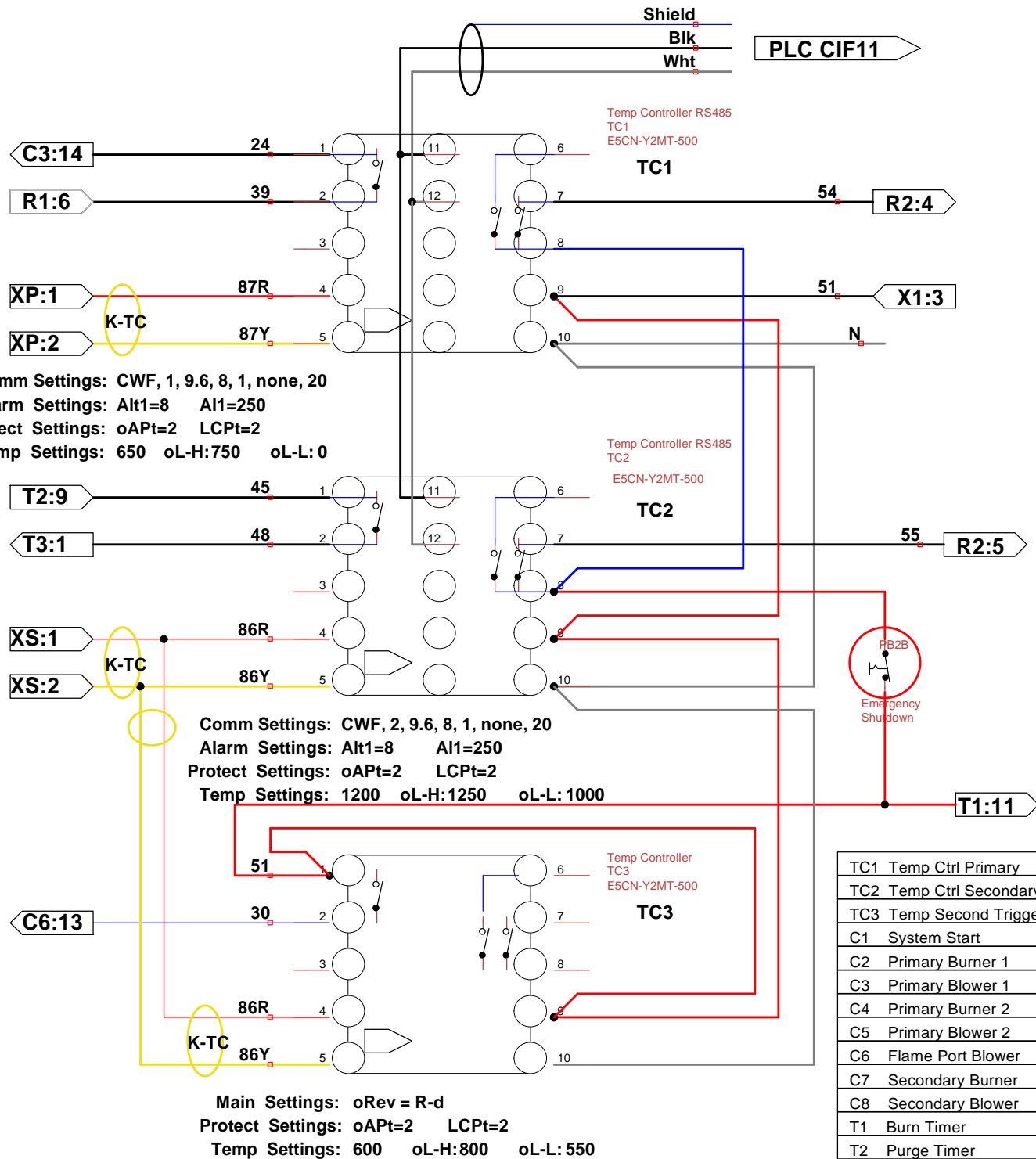
Facility:			Date:	
	Activity	Yes	No	Remarks
A.	Safety			
1.	Is there adequate personal protective equipment (PPE)?			
2.	Is the PPE being used?			
3.	Is the PPE in good condition?			
4.	Is there restricted entry to the waste incineration/ash disposal site?			
5.	Is there functional fire safety equipment?			
6.	Do the operators know how to use the equipment?			
7.	Is there adequate first aid kit?			
8.	Are the operators conversant with use of the kit?			
9.	Is flammable material stored away from the incinerator?			
10.	Are warning signs distinctly displayed?			
Additional Comments on Safety:				

Inspection Checklist for Supervisors

B.	Operation	Yes	No	Remarks
1.	Is there a sufficient supply of fuel?			
2.	Is the procedure for preparation of waste for incineration being followed?			
3..	Is the incinerator cleaned daily?			
4.	Is the waste weighed upon reception?			
5.	Is the waste temporarily stored neatly?			
6.	Is the loading of incinerator done in the right way?			
7.	Is the temperature regulated adequately during the burn?			
8.	IS the incinerator allowed to burn down and cool before cleaned?			
9.	Is the ash properly disposed as specified by compliance procedures?			
10.	Are the following tools and equipment available?			
a.	Ash Rake			
b.	Shovel			
c.	Hand brush/Dustpan			
d.	Hard broom			
e.	Non-Combustible Ash Disposal Drums			
f.	Weighing Scale			
g.	Fire Extinguisher			
h.	Fire Retardant Gloves			
i.	Eye Protection/ Face Mask			
j.	Fire Retardant Coveralls or suitable clothing to cover the upper body, including the lower arms			
k.	Safety First Aid Kit			
Additional Comments on Operation:				

Inspection Checklist for Supervisors

C.	Maintenance			
	Activity	Yes	No	Remarks
1.	Is there evidence of cracks in the refractor? (Do not include heat expansion cracks)			
2.	Is there good housekeeping?			
3.	Is the status of the ash handling and disposal system good?			
Additional Comments on Maintenance:				
D.	Records			
	Activity	Yes	No	Remarks
1.	Are the relevant forms available?			
2.	Are the forms filled accurately and completely?			
3.	Are incidents recorded?			
4.	Are reports of the waste incinerated done on time?			
Additional Comments on Records:				
Name of Supervisor:		Signature:		Designation:

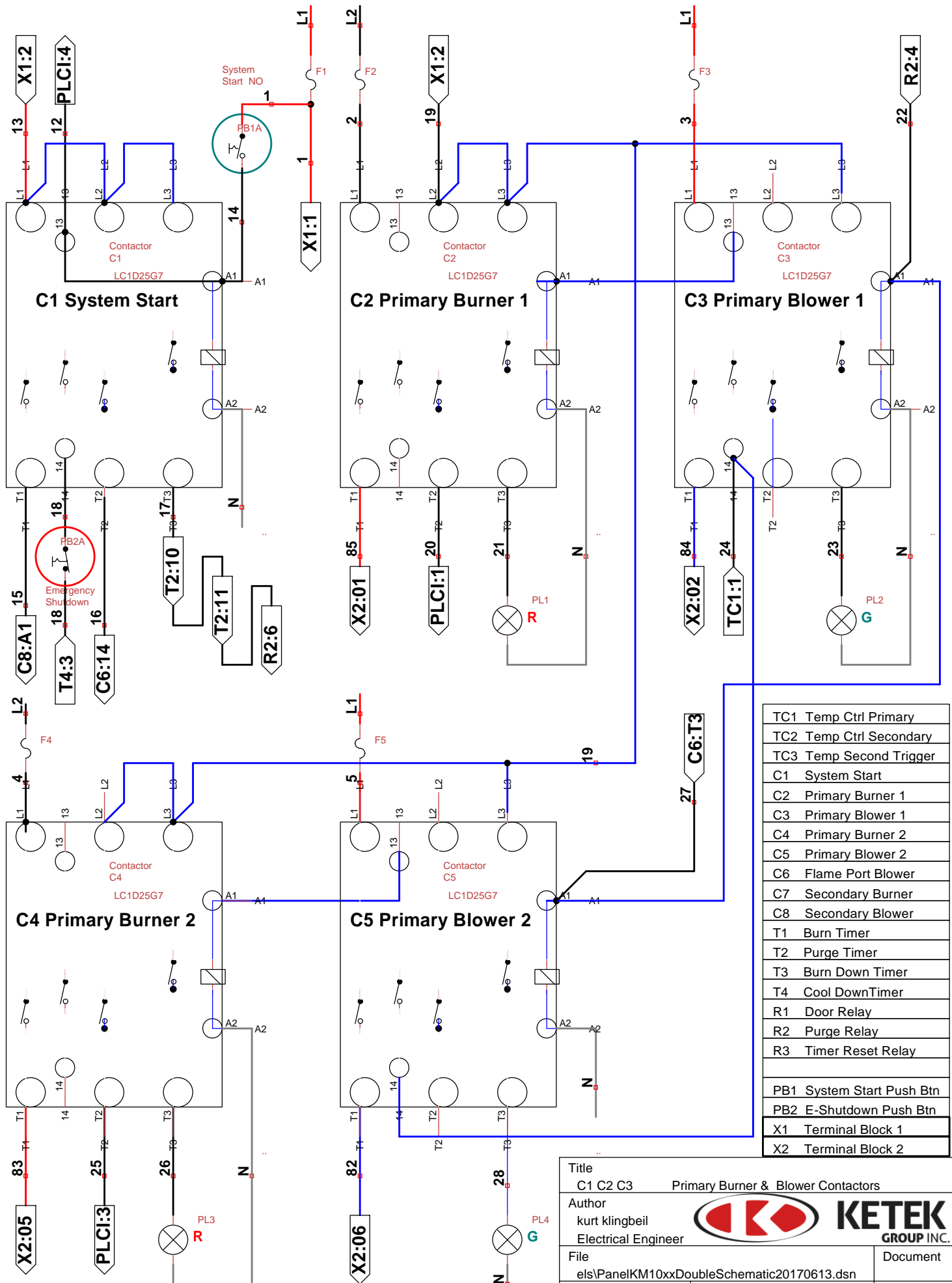


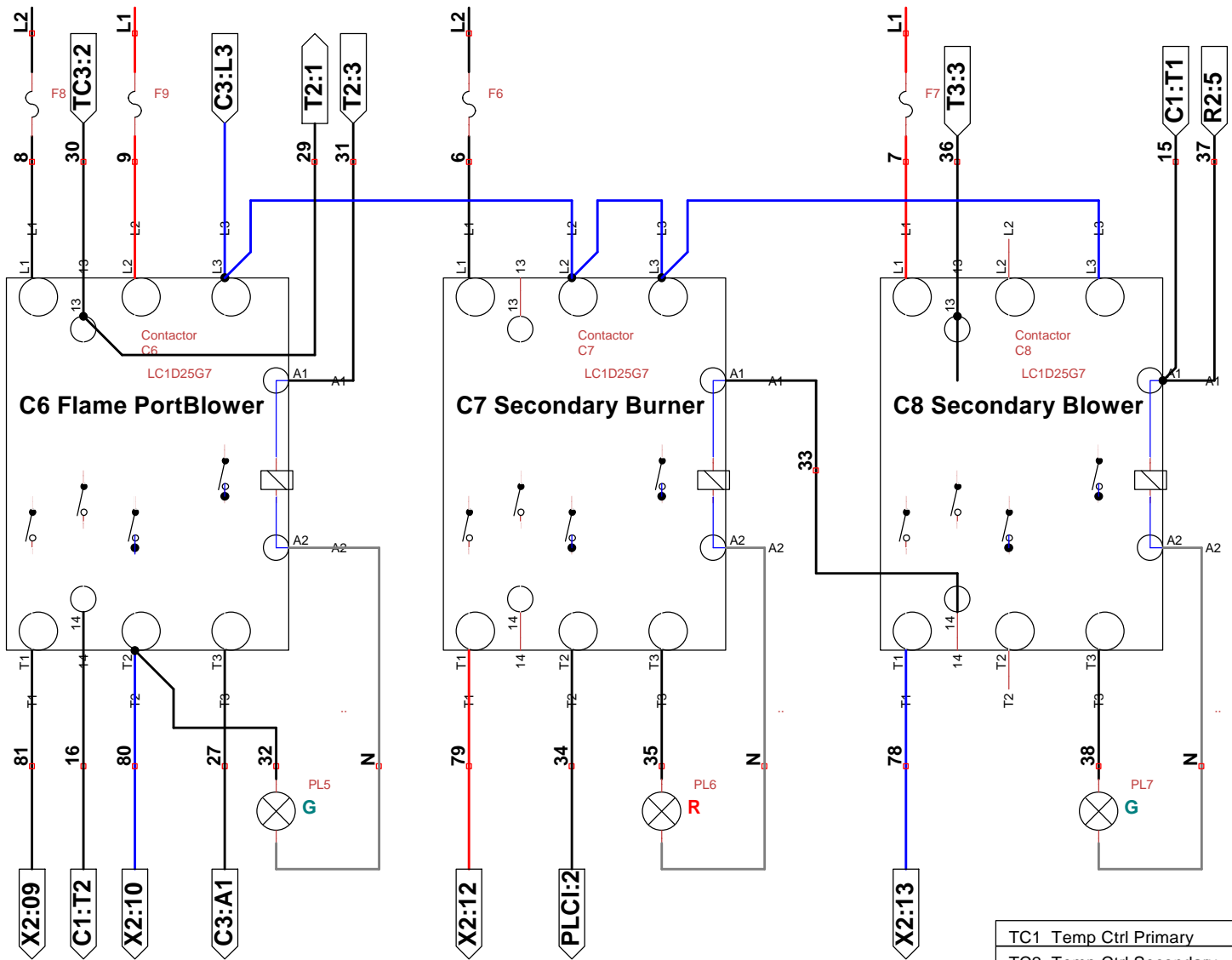
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Title		
TC1 TC2 TC3 Temperature Controllers		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.37	2017-01-05	1 of 7

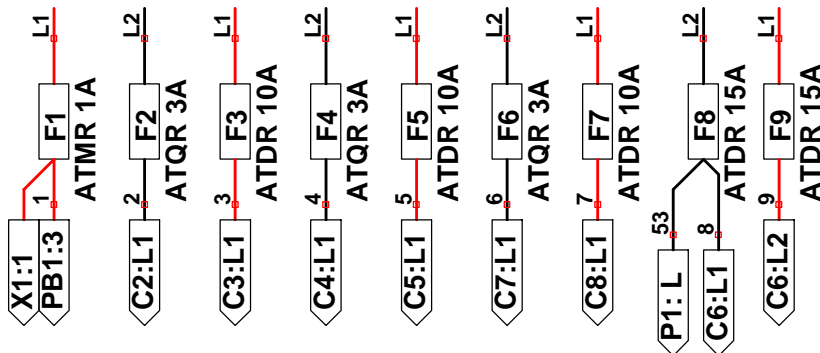






TC1	Temp Ctrl Primary
TC2	Temp Ctrl Secondary
TC3	Temp Second Trigger
C1	System Start
C2	Primary Burner 1
C3	Primary Blower 1
C4	Primary Burner 2
C5	Primary Blower 2
C6	Flame Port Blower
C7	Secondary Burner
C8	Secondary Blower
T1	Burn Timer
T2	Purge Timer
T3	Burn Down Timer
T4	Cool DownTimer
R1	Door Relay
R2	Purge Relay
R3	Timer Reset Relay
P1	Instrument Plug
PB1	System Start Push Btn
PB2	E-Shutdown Push Btn
X1	Terminal Block 1
X2	Terminal Block 2

FUSES - SUMMARY



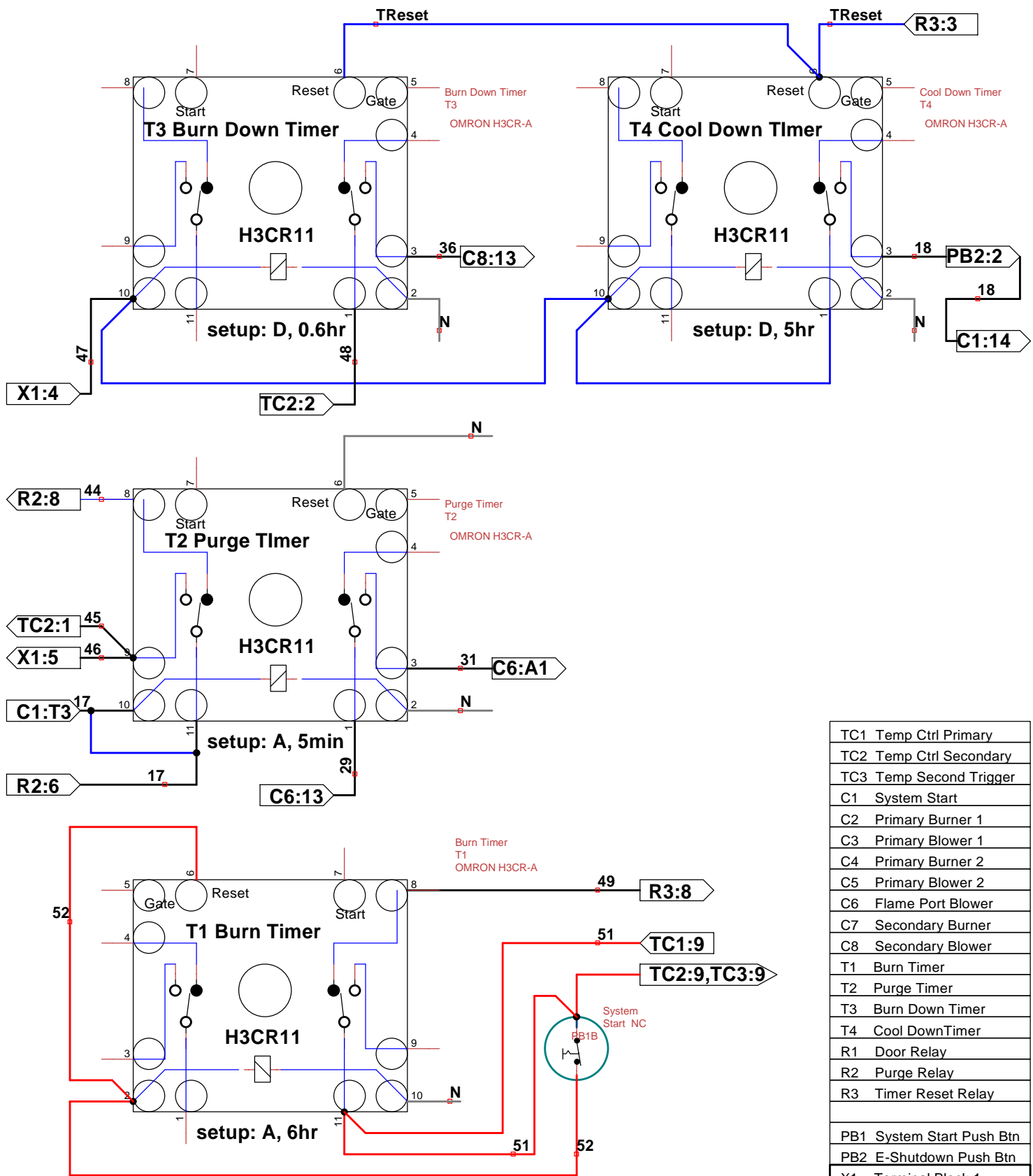
Fuse sizes could change based on model of Burners/Blowers

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Title		
C6 C7 C8 Secondary Burner & Blower Contactors		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.36	2017-01-05	3 of 7





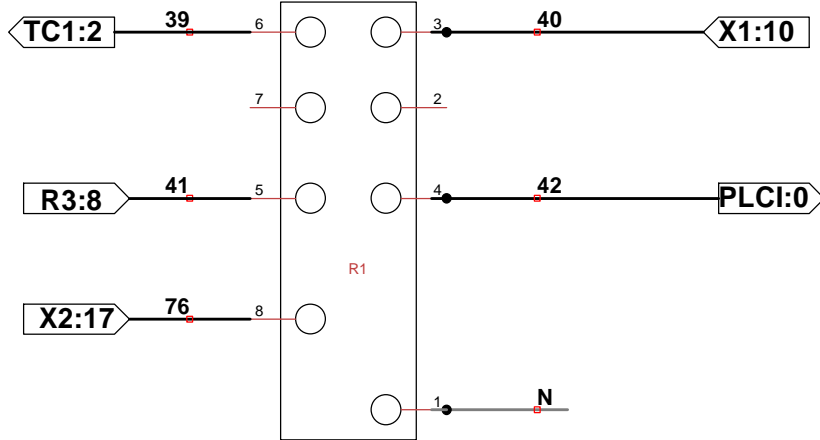
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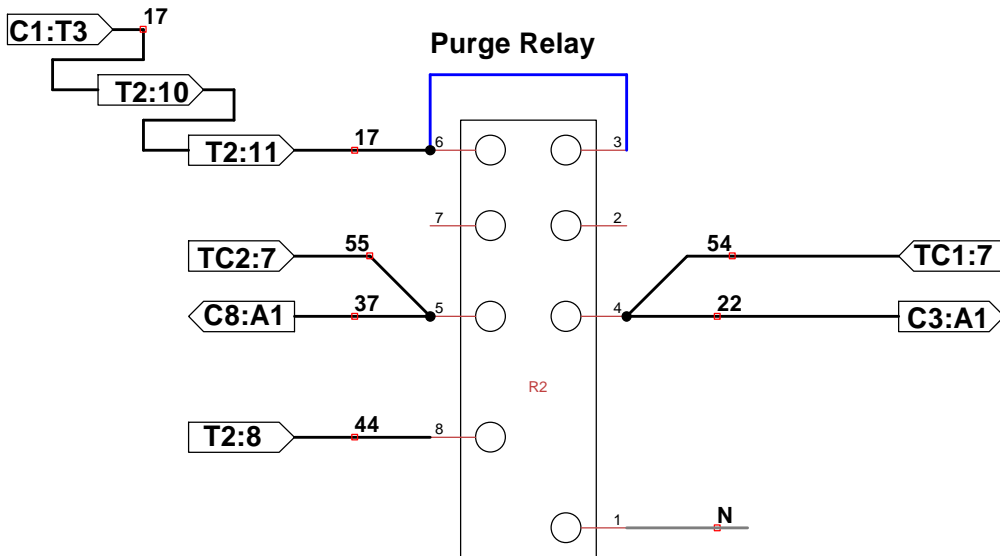
Title		
Timers: T1-Burn, T2-Purge, T3-BurnDown, T4 -CoolDown		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.36	2017-01-05	4 of 7



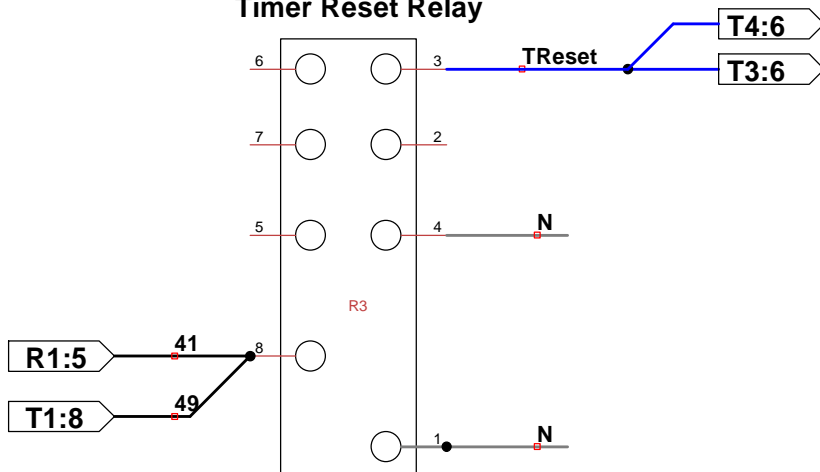
Door Relay



Purge Relay



Timer Reset Relay



TC1	Temp Ctrl Primary
TC2	Temp Ctrl Secondary
TC3	Temp Second Trigger
C1	System Start
C2	Primary Burner 1
C3	Primary Blower 1
C4	Primary Burner 2
C5	Primary Blower 2
C6	Flame Port Blower
C7	Secondary Burner
C8	Secondary Blower
T1	Burn Timer
T2	Purge Timer
T3	Burn Down Timer
T4	Cool DownTimer
R1	Door Relay
R2	Purge Relay
R3	Timer Reset Relay
PB1	System Start Push Btn
PB2	E-Shutdown Push Btn
X1	Terminal Block 1
X2	Terminal Block 2

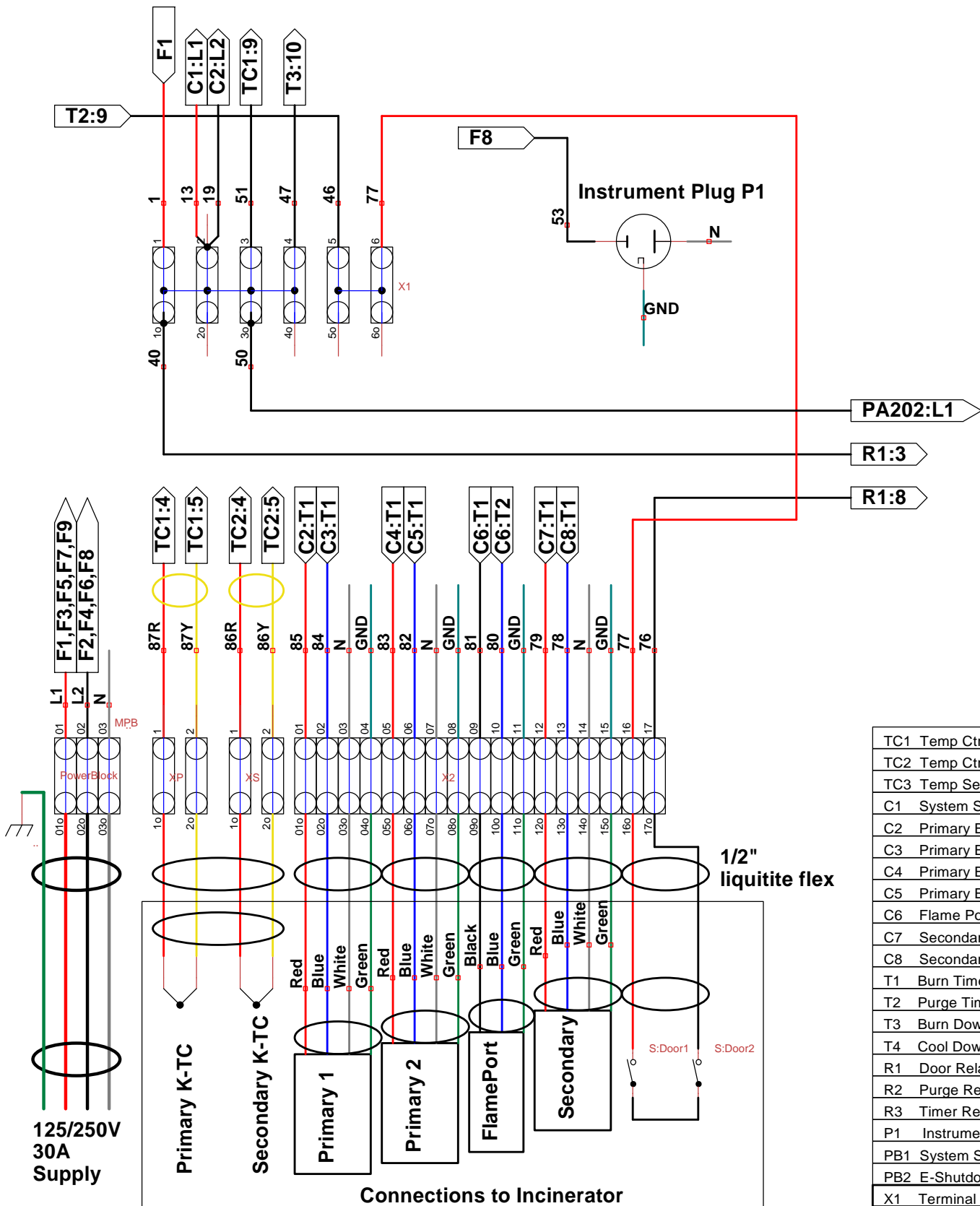
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Title		
Relays: R1-Door Switch, R2 Timer Reset, R3 Purge1, R4 Purge 2		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.36	2017-01-05	5 of 7



KETEK
GROUP INC.



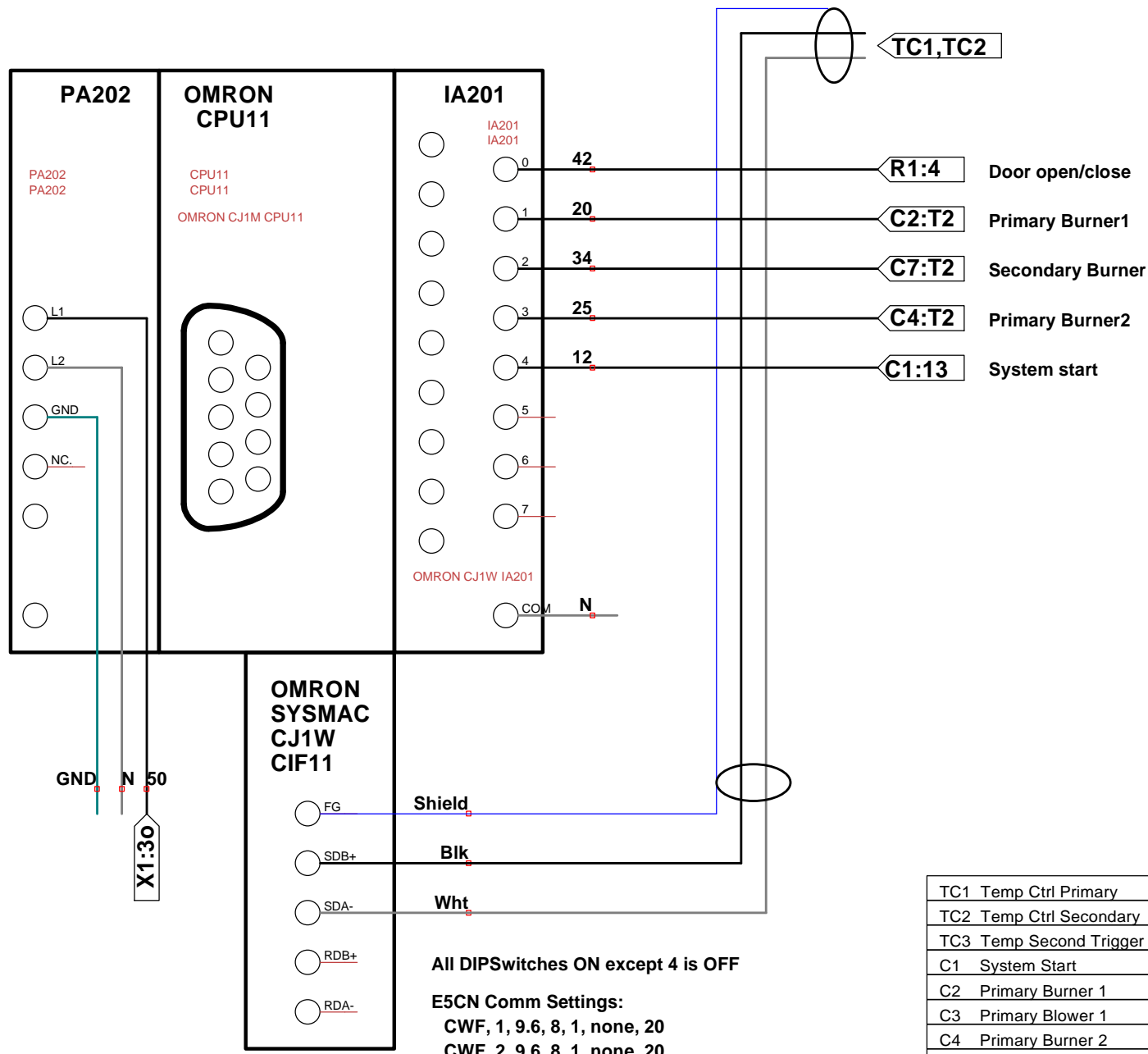
TC1	Temp Ctrl Primary
TC2	Temp Ctrl Secondary
TC3	Temp Second Trigger
C1	System Start
C2	Primary Burner 1
C3	Primary Burner 2
C4	Primary Burner 2
C6	Flame Port Blower
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Title		
Terminal Strips		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.36	2017-01-05	6 of 7






All DIPSwitches ON except 4 is OFF

E5CN Comm Settings:
 CWF, 1, 9.6, 8, 1, none, 20
 CWF, 2, 9.6, 8, 1, none, 20

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Title PLC and Data collection Hardware		
Author kurt klingbeil Electrical Engineer		 KETEK GROUP INC
File els\PanelKM10xxDoubleSchematic20170613.dsn		Document
Revision 1.36	Date 2017-01-05	Sheets 7 of 7



CERTIFICATE OF REGISTRATION

This is to certify that

Ketek Group Inc.

Main Site

20204 110 Avenue NW, Edmonton, Alberta T5S 1X8 Canada

operates a

Quality Management System

which complies with the requirements of

ISO 9001:2008

for the following scope of certification

Design, manufacture, sales and service of air, water and solid waste treatment equipment and their components.

This registration is supported by the following site(s) at:

11004 205 Street NW Edmonton, Alberta T5S 1Z4 Canada

Certificate No.: CERT-0097513
File No.: 1647520
Issue Date: August 8, 2016

Original Certification Date: July 17, 2013
Certification Effective Date: August 25, 2016
Certificate Expiry Date: September 14, 2018

Paul Simpson
Global Head of Policy, Risk and Compliance



ISO 9001



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KETEK GROUP INC.

Warranty - New

1. Ketek Group Inc. hereby warrants to the Purchaser, for a one (1) year period of time from the date of acceptance and upon the conditions hereinafter set forth, each new product sold by it, to be free from defects in material and workmanship (specifically excluding there from component parts and accessories manufactured, furnished, and supplied by others) under normal use, maintenance and service. Except for the above Warranty, it is agreed and understood that no other WARRANTY or CONDITION whether express, implied, or statutory is made by Ketek Group Inc.
2. The obligation of Ketek Group Inc. under this Warranty shall be limited to the repair or replacement (**not in excess of its factory labour rate**) of its units; which, upon examination by Ketek Group Inc., shall disclose to their satisfaction to have been defective in material and/or workmanship under normal use, maintenance, and service.
3. The foregoing shall be the Purchaser's sole and exclusive remedy whether in contract, tort, or otherwise; and Ketek Group Inc. shall not be liable for injuries to persons, for damage to property or for loss of any kind which results (whether directly or indirectly) from such defects in material or workmanship, or for any other reason; and, it is agreed and understood that the Purchaser shall keep Ketek Group Inc. indemnified against any such claim. In no event shall Ketek Group Inc. be liable for incidental or consequential damages, or commercial losses, or for any loss or damage except as set forth in paragraph 2 herein.
4. This Warranty does not apply to, and no warranty or condition is made by Ketek Group Inc. regarding any purchased components, parts, and accessories; manufactured, supplied and/or furnished by others, or any non-standard features or items specified by the Purchaser; nor does this Warranty expand, enlarge upon, or alter in any way, the warranties provided by the makers and suppliers of such component parts and accessories.
5. The liability of Ketek Group Inc. under this Warranty shall cease and determine if:
 - (a) The Purchaser shall not have paid in full all invoices as submitted by Ketek Group Inc., or affiliated companies on or before their due dates:
 - (b) Representatives of Ketek Group Inc., are denied full and free right of access to the units:
 - (c) The Purchaser permits persons other than the agents of Ketek Group Inc. or those approved or authorized by Ketek Group Inc. to effect any replacement of parts, maintenance, adjustments, or repairs to the units:
 - (d) The Purchaser has not properly maintained the units in accordance with instructions, pamphlets or directions given or issued by Ketek Group Inc. at the time of the sale and/or from time to time thereafter:
 - (e) The Purchaser uses any spare parts or replacements not manufactured by or on behalf of Ketek Group Inc. and supplied by it, or by someone authorized by it, or fails to follow the instructions for the use of the same:
 - (f) The Purchaser misuses, or uses this unit for any purpose other than that for which it was intended or manufactured:
 - (g) The defective parts are not returned to Ketek Group Inc. within 15 days of repair.
6. No condition is made or is to be implied, nor is any Warranty given or to be implied as to the life or wear of the units supplied; or that they will be suitable for use under any specific conditions; notwithstanding that such conditions may be known or made known to the seller.
7. Defects in material and/or workmanship must be brought to the attention of Ketek Group Inc. by written notification within ten (10) days of discovery, and repairs must be commenced within forty-five (45) days thereafter.
8. It is agreed and understood that the Purchaser is responsible for and must pay for the transporting of the defective goods or of the replacement parts to the place of repair. Premium freight charges (such as air express or air fare charges for transportation of personnel, tools and for replacement parts) and other expenses, apart from servicemen's regular straight time travel, mileage, and regular straight time labour required to repair or replace defective parts and the cost of the parts, will be paid for by the customer at Ketek Group Inc. regular billing rates on usual credit terms.
9. The liability of Ketek Group Inc. under this Warranty is limited to the purchase price of the unit and in no case shall a claim be advanced for more than such amount.
10. All repairs and replacements are made and furnished subject to the same terms, conditions, warranties, disclaimer or warranty and limitations of liability and remedy as applied to each new unit sold.
11. This warranty and the Purchaser's rights under it, is not transferable, or is it assignable.

DATE IN SERVICE: _____

PURCHASED BY: _____

MODEL NUMBER: _____

SELLING BRANCH: _____

SERIAL NUMBER: _____

Appendix B. Ketek CY-50-CA Incinerator



**KETEK
MANUFACTURING**
MEMBER OF KETEK GROUP INC.

ketek.ca

OPERATING & MAINTENANCE

MANUAL



CY-50-CA

Phone: (780) 447-5052
Fax: (780) 447-4912
info@ketek.ca



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2.2.	Why incinerate waste?	4
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Thank you for selecting **KETEK MANUFACTURING** 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 2 and 3 contain the most relevant information.

TABLE 1 ORGANIZATION OF MANUAL

Chapter Number	Title Brief Description
2	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.
3	System Description List and photographs of the components of the system and their functions.
4	Operation and Maintenance How to operate and maintain the system, including discussion on safety aspects
5	Warranty Terms of the warranty



2.1. 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 temperature¹ 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.

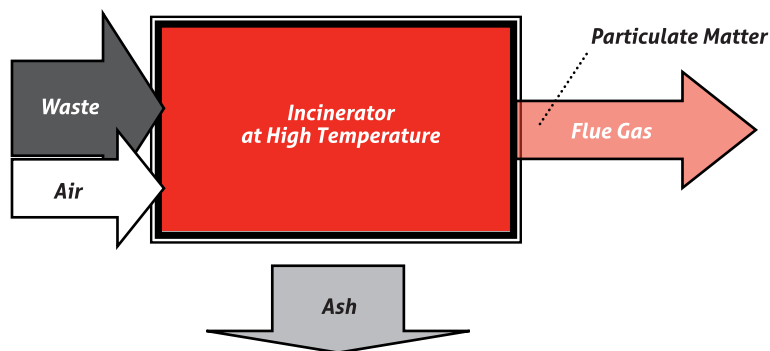


FIGURE 1 SCHEMATIC DIAGRAM OF INCINERATION PROCESS

2.2. 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.

2.3. 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.

2.4. 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.

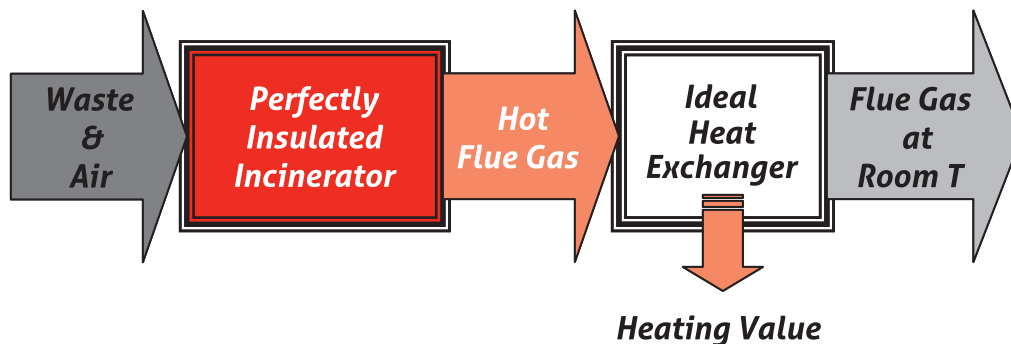


FIGURE 2 THE CONCEPT OF HEATING VALUE

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.



2.5. 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".

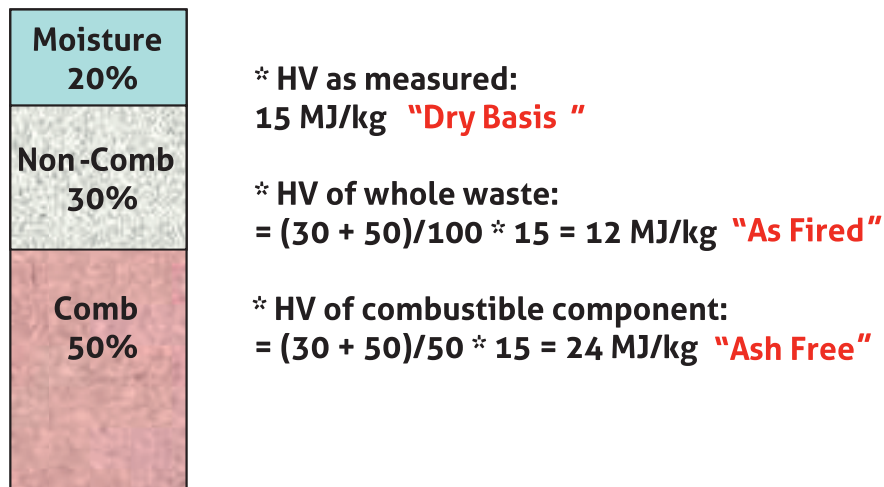


FIGURE 3 DIFFERENT BASES FOR EXPRESSING HEATING VALUE (HV)



2.6. 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 HHV (A/F)
			Moist	Comb	Non-C	
0	Trash	Paper, cardboard, cartons wood boxes and combustible floor sweepings from commercial 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 sources	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



2.7. 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.



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

2.8. Dual-Chamber Design and Starved-Air Operation

The mechanisms of solid waste combustion consist of the following stages:

- Evaporation of water or drying,
- Devolatilization, involving pyrolysis and gasification, generating "volatile" combustible gas and in some cases, soot ; ⁶
- Combustion of the devolatilization products in the gas phase, and
- Char oxidation, where the "fixed carbon" is oxidized, leaving the ash residue.

With a dual chamber design operated under a starved air condition, stages (a), (b) and (d) take place in the primary chamber, and (d) in the secondary chamber. The initial stages (a) and (b) occur under starved-air (sub-stoichiometric) condition, meaning that there is not sufficient air for complete combustion. Stage (c) occurs in the secondary chamber following the addition of flameport air, introduced into the flameport which connects the primary and secondary chambers. The final stage (d) occurs in the primary chamber.

The low flow rate in the primary chamber reduces the entrainment of particulate matter (dust) and hence its emission. The flameport can be designed to promote good mixing ("turbulence") between flameport air and the "volatiles" generated in the primary chamber, which promotes complete combustion.

⁶ Pyrolysis: thermal break-down in the absence of O₂; gasification: partial oxidation with sub-stoichiometric O₂; soot: fine carbonaceous particles.



A schematic diagram of the system is shown in [Figure 4](#).

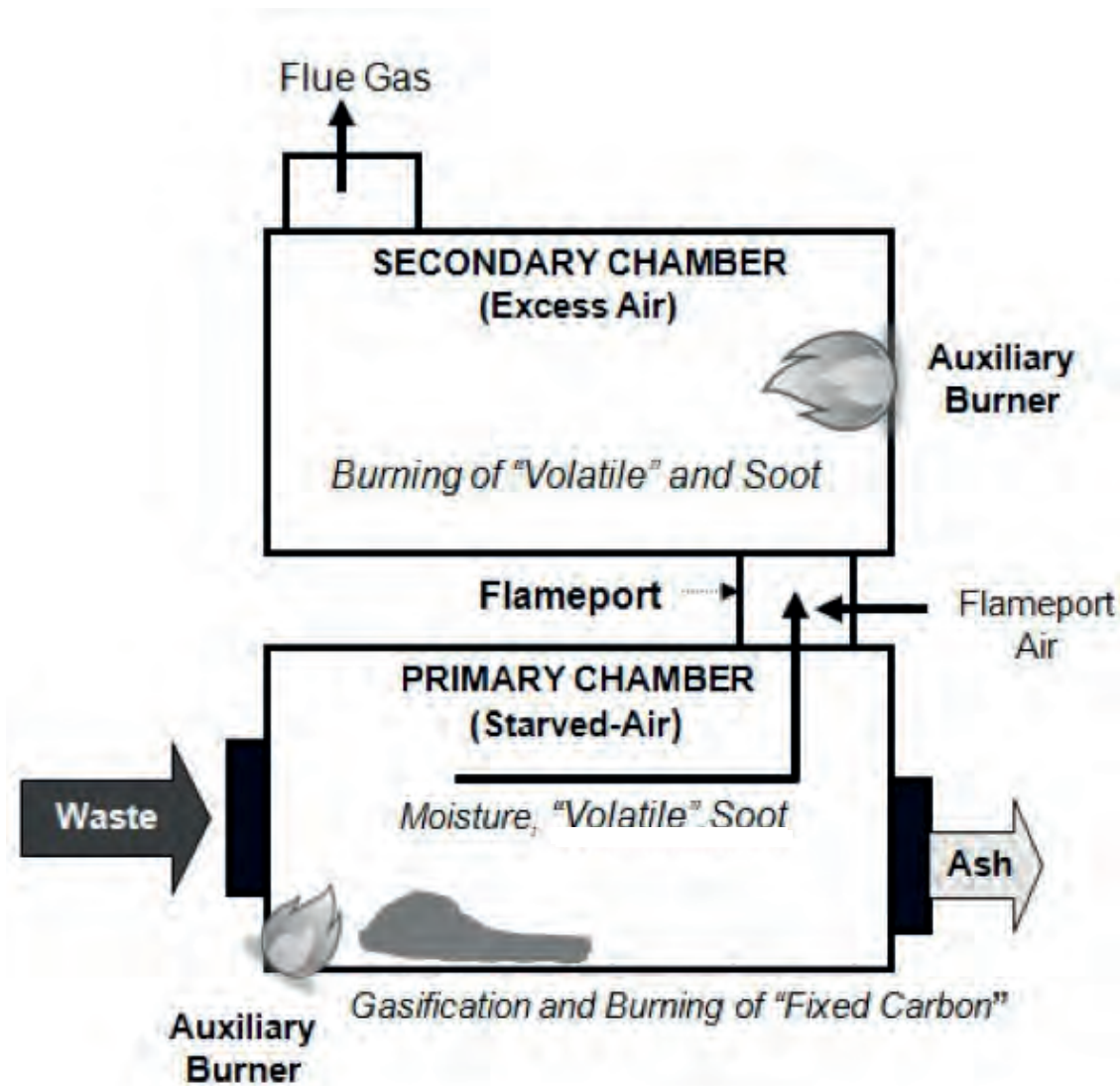


FIGURE 4. SCHEMATIC A DIAGRAM OF DUAL-CHAMBER, STARVED-AIR INCINERATOR



A photograph of the system is shown in Figure 5, identifying its major components:

- Primary Chamber
- Secondary Chamber
- Flameport
- Control Panel
- Stack

The components are shown in more detail in Figure 6 to Figure 8, and their functions are summarized in the next Section in Table 5.

Notes on design simplification. (i) No underfire air blower is used. The underfire air is supplied by the excess air in the auxiliary burner in the primary chamber. (ii) Ash removal is done via the waste loading door



FIGURE 5. OVERALL VIEW OF SYSTEM AND ITS MAJOR COMPONENTS

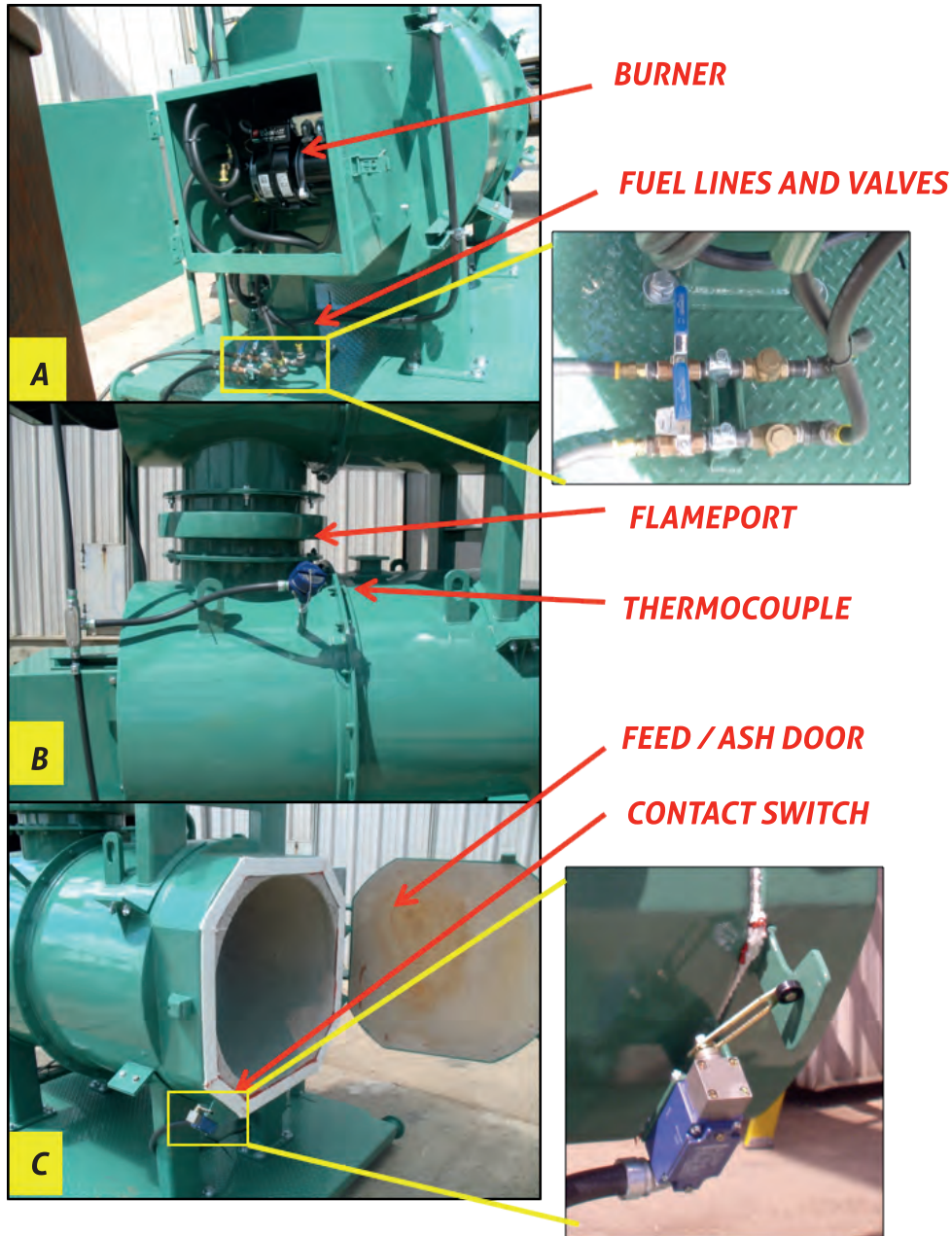


FIGURE 6. PRIMARY CHAMBER

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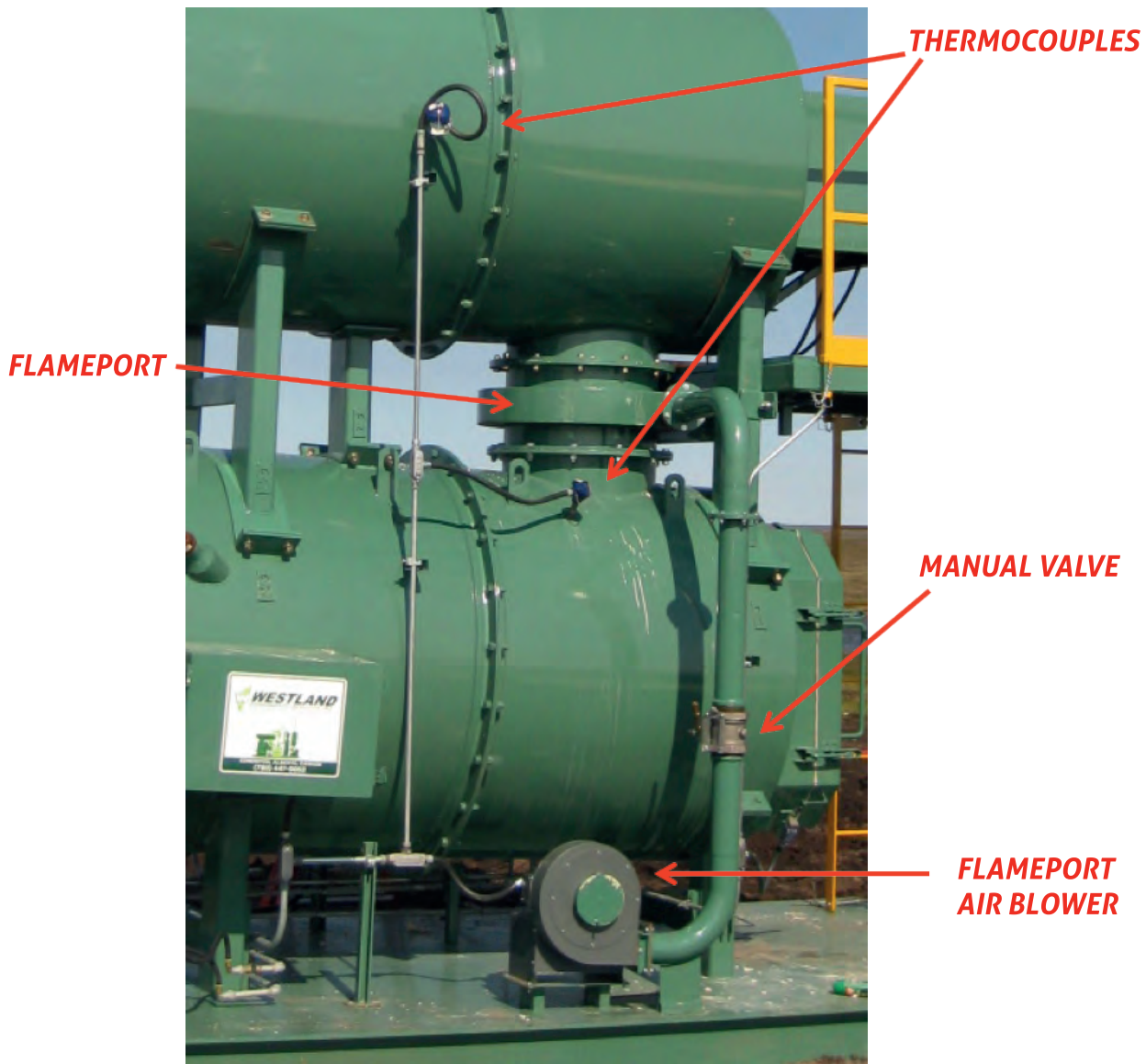


FIGURE 7. SECONDARY CHAMBER AND OTHER COMPONENTS

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3. SYSTEM DESCRIPTION

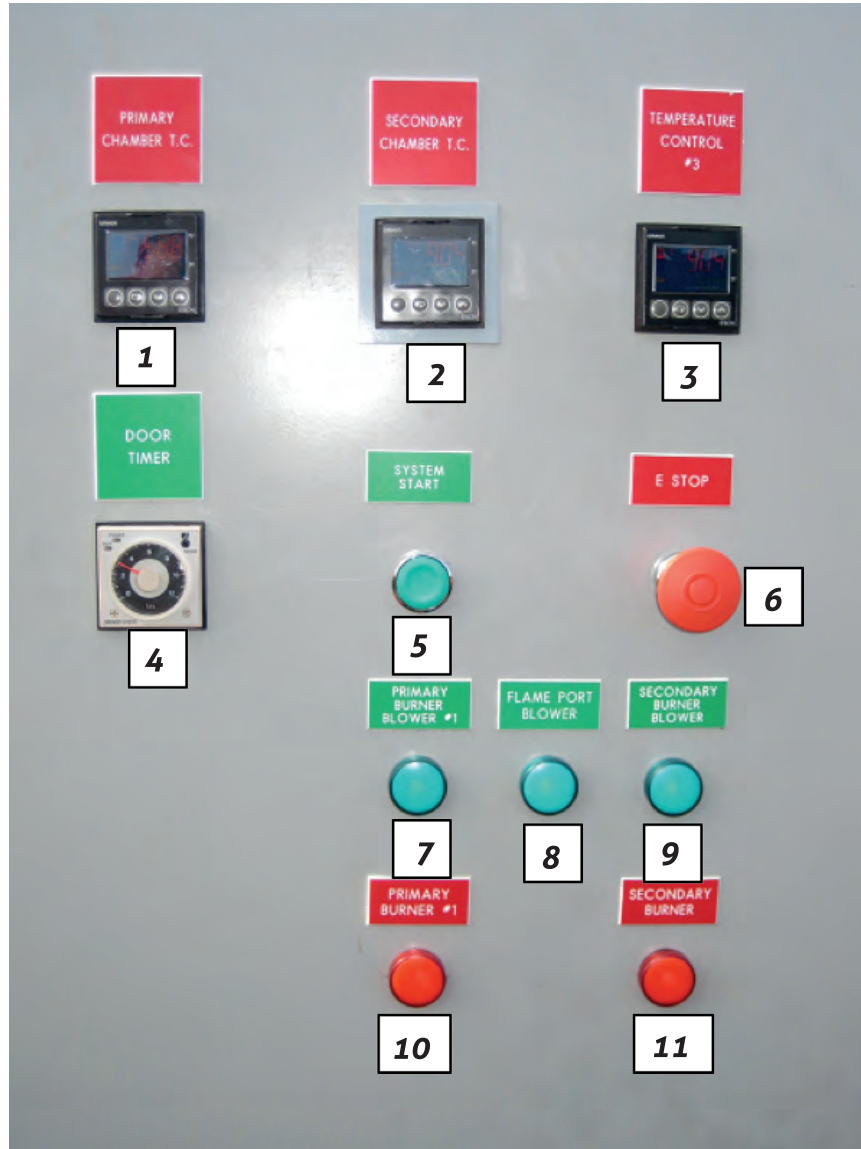


FIGURE 8. CONTROL PANEL

LEGEND. 1. Primary Chamber Temperature Indicator and Controller (TIC); 2. Secondary Chamber TIC; 3. Controller for set point of secondary chamber temperature to trigger Primary Chamber Burner during pre-heating; 4. Timer for Burn Time; 5. Start Button; 6. Emergency Stop Button 7 to 9: Light Indicators for Blowers; 10 and 11: Light Indicators for Burners (Flame ON).



3.1. System components

The components are listed in Table 5, together brief descriptions of their functions and reference photographs.

TABLE 5 COMPONENTS AND THEIR FUNCTIONS

COMPONENT	FUNCTION	Reference
Primary Chamber	Water evaporation, pyrolysis and gasification, generating combustible gases (volatiles) and soot	Figure 6
1 Burner	Supply heat to maintain a minimum pre-set (variable) temperature	Figure 6 A
2 Fuel line and valve	Connection to fuel supply	Figure 6 A
3 Thermocouple	Measure, display and input to ON-OFF controller	Figure 6 B
4 Feed/ash door	Access to primary chamber for waste loading and ash removal	Figure 6 C
5 Contact switch	Input to safety interlock to shut-off burner when door is open.	Figure 6 C
Secondary Chamber	Complete combustion of gases and soot generated in the primary chamber	Figure 7
6 Burner	Supply heat to maintain a minimum pre-set (variable) temperature	Figure 7
7 Fuel line and valve	Connection to fuel supply	Figure 6 A
8 Thermocouple	Measure, display and input to ON-OFF controller	Figure 7
Flameport	Mixing of combustible gas and air, promoting "turbulence"	Figure 6 B Figure 7
9 Blower	Supply air (oxygen) for combustion	Figure 7
10 Manual valve	Control flameport air flow rate	Figure 7
Control Panel	Automation of operation	Figure 8
Stack	Disperse hot flue gas	Figure 5
(Fuel Supply Tank)	Supply of auxiliary fuel	Not shown

The controllers and indicators of in the Control Panel are described below (see Figure 8):



TABLE 6. CONTROL PANEL (FIGURE 8)

LEGEND	FUNCTION
1	<ul style="list-style-type: none">Displays Primary Chamber temperatureSet-point for minimum temperature in the Primary Chamber
2	<ul style="list-style-type: none">Displays Secondary Chamber temperatureSet-point for minimum temperature in the Secondary Chamber
3	Set-point for Secondary Chamber temperature to trigger Primary Chamber Burner during pre-heating (Factory pre-set)
4	START-UP BUTTON to initiate pre-heating and execute complete burning cycle after waste loading
5	Burn TIMER to pre-set period of burning time in the Primary Chamber
6	(Spare)
7, 8, 9	Indicator lights showing BLOWER ON for flameport, primary and secondary chamber burners.
10, 11	Indicator lights showing BURNER (fuel/flame) ON for primary and secondary burners.



The operation of the system is cyclic, as shown in Figure 9 and each step is described in the following sections.

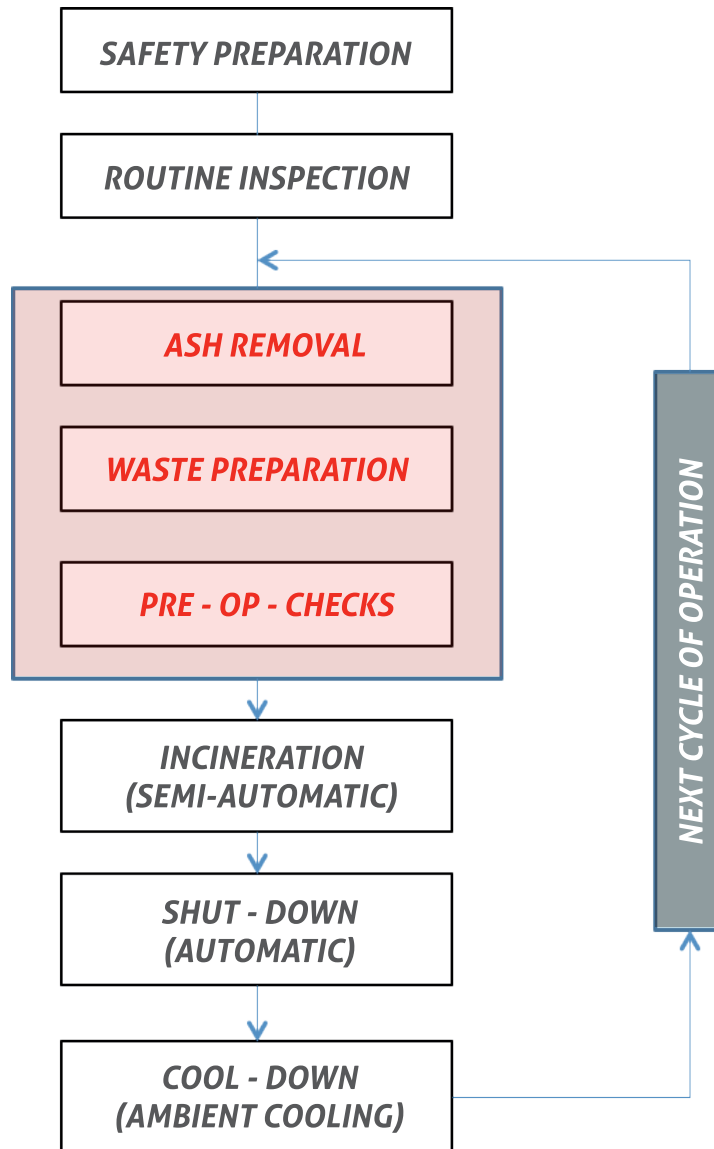


FIGURE 9. SCHEMATIC OF OPERATIONAL STEPS



4.1. 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 N85 respirator
- [See Chapter 4.7: Intermittent feeding and raking : (i) heat protective clothing and gloves, and (2) CSA/ANSI approved full face shield. Note: This is NOT required under batch operation.]

4.2. 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):
 - o Inspect refractory for large cracks (not expansion cracks)
 - o Inspect door gaskets for damages

4.3. 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 plugging the combustion air holes and 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
- Dispose of ash as specified in the guidelines or regulations

4.4. Waste batch preparation

As previously mentioned incinerator capacity in kg/h is dependent on the heating value of the waste, which is normally not known. This system can generally be loaded with 200 kg of Type 3 waste (Table 2). In general, the higher the heating value, the smaller batch should be loaded. The proper size should be determined from experience.

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.



4.5. Pre-operational checks

- Check fuel tank to make sure enough fuel.
- Open fuel valves.
- (Connect electrical plug and turn power ON)).
- Prime burner pumps if necessary.

4.6. Incineration (Batch Operation)

1. [Check and reset if necessary set points in primary chamber (650 C) and secondary chamber (900 C)]
2. Open feed/ash door and load waste to Primary Chamber (For Type 3 waste, about 80% of the chamber volume).
3. Close feed/ash door.
4. Set burner timer according to the size of the load
5. Press "Start" button.

4.7. Notes on Intermittent Feeding Operation

In intermittent feeding operation, waste is loaded **while incineration process is occurring**. This mode of operation increases incinerator capacity, especially when "raking" is also practiced. But it has the following drawbacks:

- Disturbance and cooling in the primary chamber will increase emission of particulate matter and generates "spikes" of carbon monoxide, and potentially also dioxin emission;
- Particular attention should be paid with respect to safety, including the need for additional PPE as mentioned in *Chapter 4.1*.
- Increased in man-power requirement.

The protocol for intermittent feeding consists of undertaking Steps (2) to (5) described in previous Chapter 4.6. Note that the size of the batch loaded is much smaller, a maximum of about 20 kg for Type 3 waste. Otherwise, black smoke could be generated. Raking is done in the same way, except that no waste is loaded, but instead, the waste in primary chamber is "raked" to expose un-burnt components, thereby increasing the burn rate, and hence the incinerator capacity.

4.8. Shut-down and Cool-down

- Automatically done.

4.9. Burner and blower maintenance

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 supplied.



4.10. Diesel Requirement

Figure 10 shows the requirement for diesel as a function of running time and total capacity, expressed in USG/h. Note that: 1 USG/h ~ 140,000 Btu/h or 0.15 GJ/h.

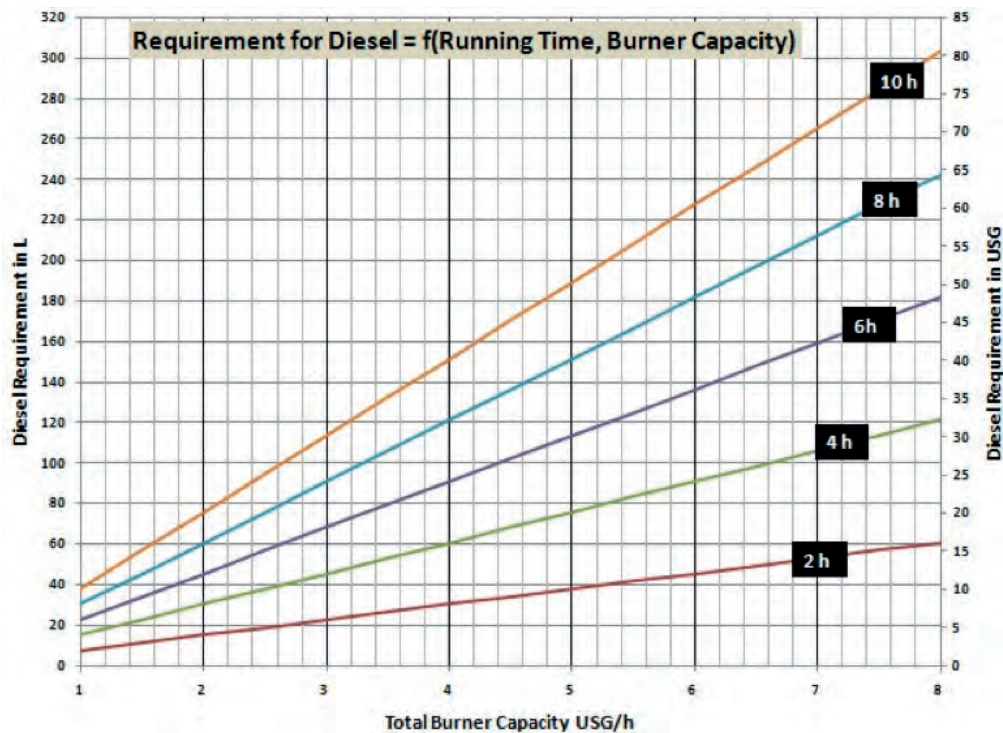


FIGURE 10. REQUIREMENT FOR DIESEL



1. **KETEK MANUFACTURING** hereby warrants to the Purchaser, for a one (1) year period of time from the date of acceptance and upon the conditions hereinafter set forth, each new product sold by it, to be free from defects in material and workmanship (specifically excluding therefrom component parts and accessories manufactured, furnished, and supplied by others) under normal use, maintenance and service. Except for the above Warranty, it is agreed and understood that no other WARRANTY or CONDITION whether express, implied, or statutory is made by KETEK MANUFACTURING.
2. The obligation of KETEK MANUFACTURING under this Warranty shall be limited to the repair or replacement (**not in excess of its factory labour rate**) of its units; which, upon examination by Westland Environmental Services Inc., shall disclose to their satisfaction to have been defective in material and/or workmanship under normal use, maintenance, and service.
3. The foregoing shall be the Purchaser's sole and exclusive remedy whether in contract, tort, or otherwise; and KETEK MANUFACTURING shall not be liable for injuries to persons, for damage to property or for loss of any kind which results (whether directly or indirectly) from such defects in material or workmanship, or for any other reason; and, it is agreed and understood that the Purchaser shall keep KETEK MANUFACTURING indemnified against any such claim. In no event shall KETEK MANUFACTURING be liable for incidental or consequential damages, or commercial losses, or for any loss or damage except as set forth in paragraph 2 herein.
4. This Warranty does not apply to, and no warranty or condition is made by KETEK MANUFACTURING regarding any purchased components, parts, and accessories; manufactured, supplied and/or furnished by others, or any non-standard features or items specified by the Purchaser; nor does this Warranty expand, enlarge upon, or alter in any way, the warranties provided by the makers and suppliers of such component parts and accessories.
5. The liability of KETEK MANUFACTURING under this Warranty shall cease and determine if:
 - (a) The Purchaser shall not have paid in full all invoices as submitted by KETEK MANUFACTURING, or affiliated companies on or before their due dates:
 - (b) Representatives of KETEK MANUFACTURING, are denied full and free right of access to the units:
 - (c) The Purchaser permits persons other than the agents of KETEK MANUFACTURING or those approved or authorized by KETEK MANUFACTURING to effect any replacement of parts, maintenance, adjustments, or repairs to the units:
 - (d) The Purchaser has not properly operated and maintained the units in accordance with instructions, pamphlets or directions given or issued by KETEK MANUFACTURING at the time of the sale and/or from time to time thereafter:
 - (e) The Purchaser uses any spare parts or replacements not manufactured by or on behalf of KETEK MANUFACTURING and supplied by it, or by someone authorized by it, or fails to follow the instructions for the use of the same:
 - (f) The Purchaser misuses, or uses this unit for any purpose other than that for which it was intended or manufactured:
 - (g) The defective parts are not returned to KETEK MANUFACTURING within 15 days of repair.
6. No condition is made or is to be implied, nor is any Warranty given or to be implied as to the life or wear of the units supplied; or that they will be suitable for use under any specific conditions; notwithstanding that such conditions may be known or made known to the seller.
7. Defects in material and/or workmanship must be brought to the attention of KETEK MANUFACTURING by written notification within ten (10) days of discovery, and repairs must be commenced within forty-five (45) days thereafter.
8. It is agreed and understood that the Purchaser is responsible for and must pay for the transporting of the defective goods or of the replacement parts to the place of repair. Premium freight charges (such as air express or air fare charges for transportation of personnel, tools and for replacement parts) and other expenses, apart from servicemen's regular straight time travel, mileage, and regular straight time labour required to repair or replace defective parts and the cost of the parts, will be paid for by the customer at KETEK MANUFACTURING regular billing rates on usual credit terms.
9. The liability of KETEK MANUFACTURING under this Warranty is limited to the purchase price of the unit and in no case shall a claim be advanced for more than such amount.
10. All repairs and replacements are made and furnished subject to the same terms, conditions, warranties, disclaimer or warranty and limitations of liability and remedy as applied to each new unit sold.
11. This warranty and the Purchaser's rights under it, is not transferable, or is it assignable.

DATE IN SERVICE: _____ MODEL NUMBER: _____

SERIAL NUMBER: _____

