# Appendix

Fuel Use Summary
Bin Energy Analysis
Site Plan
Boiler Plant Concept Drawings
Estimates of Probable Cost
ACT Boiler Maintenance Information

**Haines School**
**Monthly Fuel Oil Use Summary**

| | Month | 2011-12 Gallon | 2012-13 Gallon | 2013-14 Gallon | 2014-15 Gallon | 2015-16 Gallon |
|---|---|---|---|---|---|---|
| | July | 1406 | 1457 | 1108 | 1671 | 1300 |
| | Aug | 1705 | 1515 | 1510 | 1530 | 1291 |
| | Sept | 2052 | 1771 | 1758 | 1876 | 1625 |
| | Oct | 2826 | 2964 | 2687 | 3048 | 2192 |
| | Nov | 4618 | 4652 | 4310 | 3565 | |
| | Dec | 4385 | 5402 | 4928 | 4335 | |
| | Jan | 5545 | 4129 | 3811 | 4533 | |
| | Feb | 4168 | 3384 | 4644 | 4193 | |
| | Mar | 3954 | 3995 | 4158 | 3260 | |
| | Apr | 2455 | 2940 | 2812 | 2568 | |
| | May | 2428 | 1963 | 1816 | 1422 | |
| | Jun | 1589 | 1175 | 1870 | 1228 | Average |
| | Totals | 37,131 | 35,347 | 35,412 | 33,229 | 35,280 |
| Gross | Btu | 5,142,643,500 | 4,895,559,500 | 4,904,562,000 | 4,602,216,500 | 4,886,245,375 |
| Net | Btu | 4,371,246,975 | 4,161,225,575 | 4,168,877,700 | 3,911,884,025 | 4,153,308,569 |

Note: Fuel meter malfunctioned in July and August of 2013, so average data was used.

Energy Conversion:

| | | |
|---|---|---|
| Fuel Oil: | 138500 | Btu/gal |
| Boiler Eff: | 0.85 | |

**Haines School**
**Daily Fuel Oil Use Summary**

| Peak Day Use Gals | Energy Btu | Gross 24 hr Avg Btu/hr | Net 24 hr Avg Btu/hr | |
|---|---|---|---|---|
| 310 | 42,935,000 | 1,788,958 | 1,520,615 | |
| 300 | 41,550,000 | 1,731,250 | 1,471,563 | |
| 295 | 40,857,500 | 1,702,396 | 1,447,036 | |
| 250 | 34,625,000 | 1,442,708 | 1,226,302 | |
| 200 | 27,700,000 | 1,154,167 | 981,042 | |
| 175 | 24,237,500 | 1,009,896 | 858,411 | |
| 150 | 20,775,000 | 865,625 | 735,781 | |
| 100 | 13,850,000 | 577,083 | 490,521 | |
| 45 | 6,232,500 | 259,688 | 220,734 | (Typical for July) |

**Wood Fuel Storage Estimate**

| From Fuel Data | Fuel Oil Gal | Gross Btu | Pellets tons | 30% MC Chip tons | Bulk Den. Chip lb/cu ft | Volume Chip cu ft | Bin Size width (ft) | length (ft) | depth (ft) |
|---|---|---|---|---|---|---|---|---|---|
| 1 day peak | 310 | 42,935,000 | 3.3 | 5.4 | 15 | 715.6 | 10 | 10 | 7.2 |
| 1 week peak | 1,250 | 173,125,000 | 13.2 | 21.6 | 15 | 2885.4 | 18 | 18 | 8.9 |
| 1 month peak | 5,000 | 692,500,000 | 52.8 | 86.6 | 15 | 11541.7 | 24 | 42 | 11.5 |
| 2 month peak | 9,000 | 1,246,500,000 | 95.0 | 155.8 | 15 | 20775.0 | 24 | 72 | 12.0 |
| Average Annual Use | 35,300 | 4,889,050,000 | 372.6 | 611.1 | 15 | 81484.2 | 90 | 90 | 10.1 |

Assumes fuel oil boilers and wood boilers have similar combustion efficiencies.

**Unit Fuel Costs Equalized to $/MMBtu**

| Fuel Type | Units | Gross Btu/unit | System Effeciency | Net System Btu/unit | $/unit | Delivered $/MMBtu | Gross $/MMBtu |
|---|---|---|---|---|---|---|---|
| Fuel Oil | gal | 134500 | 0.8 | 107600 | $3.00 | $27.88 | $22.30 |
| | | | | | $3.50 | $32.53 | $26.02 |
| | | | | | $4.00 | $37.17 | $29.74 |
| | | | | | $4.50 | $41.82 | $33.46 |
| Cord Wood | cords | 16173800 | 0.7 | 11321660 | $300.00 | $26.50 | $18.55 |
| | | | | | $400.00 | $35.33 | $24.73 |
| | | | | | $500.00 | $44.16 | $30.91 |
| Pellets | tons | 16400000 | 0.8 | 13120000 | $300.00 | $22.87 | $18.29 |
| | | | | | $400.00 | $30.49 | $24.39 |
| | | | | | $500.00 | $38.11 | $30.49 |
| Chips | tons | 10000000 | 0.8 | 8000000 | $50.00 | $6.25 | $5.00 |
| | | | | | $75.00 | $9.38 | $7.50 |
| | | | | | $100.00 | $12.50 | $10.00 |
| | | | | | $125.00 | $15.63 | $12.50 |
| | | | | | $150.00 | $18.75 | $15.00 |

Haines School
Haines, Alaska
March 14, 2016
By: N. Ratz
Bin data based on Juneau Intl Airport Data

Ventilation Air

7500 CFM
78 dT

Estimated Peak Heating Load:

| | | |
|---|---|---|
| 631800 | Btu/hr | Ventilation Air |
| 1150000 | Btu/hr | Envelope |
| 1781800 | Btu/hr | Total |

Indoor Design Temp: 70 °F
ASHRAE 99% Htg DB: 9 °F
Building Area: 96,560 SF

| Low Temp | Upper Temp | Avg Temp | Total Hours Hour Group 01 - 08 | 09 - 16 | 17 - 00 | Total Hours | Percentage of Total By Group Hour Group 01 - 08 | 09 - 16 | 17 - 00 | Total Hours | Base 69 Heating Hours | % of Total | Cumm % from 69 | Base 70 Heating dT | % Peak Heating dT | Envelope Est. Htg Ld Btu/hr | Ventil. Air Est. Htg Ld Btu/hr | Total Est. Htg Ld Btu/hr | Sep- May Hours 09 - 16 Base 69 Heating Hours | % of Total | Total Cumm % from 69 | Sep- May Hours 09 - 16 Base 69 % of Total | Sep- May Hours 09 - 16 Total Cumm % from 69 | Estimated Envelope Energy Btu | Sep - May 09 - 16 Estimated Vent Air Energy Btu | Estimated Total Energy Btu | % of Total Energy | Total Cumm % from 69 Ttl Energy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95 | 99 | 97 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 90 | 94 | 92 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 85 | 89 | 87 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | |
| 80 | 84 | 82 | 0 | 2 | 0 | 2 | 0 | 0.0006842 | 0 | 0.0002282 | | | | | | | | | | | | | | | | | | |
| 75 | 79 | 77 | 0 | 15 | 5 | 20 | 0 | 0.0051317 | 0.0017129 | 0.0022823 | | | | | | | | | | | | | | | | | | |
| 70 | 74 | 72 | 0 | 45 | 20 | 65 | 0 | 0.0153951 | 0.0068517 | 0.0074176 | | | | | | | | | | | | | | | | | | |
| 65 | 69 | 67 | 2 | 105 | 41 | 148 | 0.0006847 | 0.035922 | 0.0140459 | 0.0168892 | 148 | 0.0170586 | 0.0170586 | 3 | 0.0384615 | 44231 | 24300 | 68531 | 16 | 0.0018442 | 0.0018442 | 0.0073294 | 0.0073294 | 6546153.8 | 388800 | 6934953.8 | 0.00164627 | 0.001646 |
| 60 | 64 | 62 | 20 | 211 | 100 | 331 | 0.006847 | 0.0721861 | 0.0342583 | 0.0377725 | 331 | 0.0381512 | 0.0552098 | 8 | 0.1025641 | 117949 | 64800 | 182749 | 50 | 0.005763 | 0.0076072 | 0.0229043 | 0.0302336 | 39041026 | 3240000 | 42281026 | 0.01003699 | 0.011683 |
| 55 | 59 | 57 | 127 | 369 | 248 | 744 | 0.0434783 | 0.1262402 | 0.0849606 | 0.0849024 | 744 | 0.0857538 | 0.1409636 | 13 | 0.1666667 | 191667 | 105300 | 296967 | 119 | 0.013716 | 0.0213232 | 0.0545121 | 0.0847458 | 142600000 | 12530700 | 155130700 | 0.03682611 | 0.048509 |
| 50 | 54 | 52 | 456 | 414 | 469 | 1339 | 0.1561109 | 0.1416353 | 0.1606715 | 0.1528016 | 1339 | 0.1543338 | 0.2952974 | 18 | 0.2307692 | 265385 | 145800 | 411185 | 258 | 0.0297372 | 0.0510604 | 0.118186 | 0.2029317 | 355350000 | 37616400 | 392966400 | 0.09328537 | 0.141795 |
| 45 | 49 | 47 | 462 | 331 | 393 | 1186 | 0.158165 | 0.1132398 | 0.1346351 | 0.1353418 | 1186 | 0.1366989 | 0.4319963 | 23 | 0.2948718 | 339103 | 186300 | 525403 | 310 | 0.0357308 | 0.0867911 | 0.1420064 | 0.3449382 | 402175641 | 57753000 | 459928641 | 0.10918138 | 0.250976 |
| 40 | 44 | 42 | 438 | 384 | 401 | 1223 | 0.1499486 | 0.1313719 | 0.1373758 | 0.1395641 | 1223 | 0.1409636 | 0.5729599 | 28 | 0.3589744 | 412821 | 226800 | 639621 | 383 | 0.0441448 | 0.1309359 | 0.1754466 | 0.5203848 | 504879487 | 86864400 | 591743887 | 0.1404727 | 0.391449 |
| 35 | 39 | 37 | 492 | 411 | 450 | 1353 | 0.1684355 | 0.140609 | 0.1541624 | 0.1543992 | 1353 | 0.1559474 | 0.7289073 | 33 | 0.4230769 | 486538 | 267300 | 753838 | 411 | 0.0473721 | 0.178308 | 0.188273 | 0.7086578 | 658286538 | 109860300 | 768146838 | 0.18234858 | 0.573797 |
| 30 | 34 | 32 | 393 | 273 | 353 | 1019 | 0.134543 | 0.0933972 | 0.1209318 | 0.1162844 | 1019 | 0.1174504 | 0.8463578 | 38 | 0.4871795 | 560256 | 307800 | 868056 | 273 | 0.0314661 | 0.2097741 | 0.1250573 | 0.8337151 | 570901282 | 84029400 | 654930682 | 0.15547246 | 0.72927 |
| 25 | 29 | 27 | 190 | 128 | 158 | 476 | 0.0650462 | 0.0437906 | 0.0541281 | 0.0543193 | 476 | 0.054864 | 0.9012218 | 43 | 0.5512821 | 633974 | 348300 | 982274 | 128 | 0.0147533 | 0.2245274 | 0.0586349 | 0.89235 | 301771795 | 44582400 | 346354195 | 0.08222021 | 0.81149 |
| 20 | 24 | 22 | 121 | 95 | 101 | 317 | 0.0414242 | 0.0325009 | 0.0346009 | 0.0361748 | 317 | 0.0365376 | 0.9377593 | 48 | 0.6153846 | 707692 | 388800 | 1096492 | 95 | 0.0109497 | 0.2354772 | 0.0435181 | 0.9358681 | 224338462 | 36936000 | 261274462 | 0.06202333 | 0.873513 |
| 15 | 19 | 17 | 80 | 60 | 68 | 208 | 0.0273879 | 0.0205269 | 0.0232956 | 0.0237362 | 208 | 0.0239742 | 0.9617335 | 53 | 0.6794872 | 781410 | 429300 | 1210710 | 60 | 0.0069156 | 0.2423928 | 0.0274851 | 0.9633532 | 162533333 | 25758000 | 188291333 | 0.04469804 | 0.918211 |
| 10 | 14 | 12 | 57 | 42 | 54 | 153 | 0.0195139 | 0.0143688 | 0.0184995 | 0.0174598 | 153 | 0.0176349 | 0.9793684 | 58 | 0.7435897 | 855128 | 469800 | 1324928 | 42 | 0.0048409 | 0.2472337 | 0.0192396 | 0.9825928 | 130834615 | 19731600 | 150566215 | 0.03574256 | 0.953954 |
| 5 | 9 | 7 | 42 | 24 | 34 | 100 | 0.0143786 | 0.0082107 | 0.0116478 | 0.0114116 | 100 | 0.011526 | 0.9908944 | 63 | 0.8076923 | 928846 | 510300 | 1439146 | 24 | 0.0027663 | 0.25 | 0.010994 | 0.9935868 | 92884615 | 12247200 | 105131815 | 0.024957 | 0.978911 |
| 0 | 4 | 2 | 28 | 12 | 18 | 58 | 0.0095858 | 0.0041054 | 0.0061665 | 0.0066187 | 58 | 0.0066851 | 0.9975795 | 68 | 0.8717949 | 1002564 | 550800 | 1553364 | 12 | 0.0013831 | 0.2513831 | 0.005497 | 0.9990838 | 58148718 | 6609600 | 64758318 | 0.01537283 | 0.994284 |
| -5 | -1 | -3 | 10 | 2 | 5 | 17 | 0.0034235 | 0.0006842 | 0.0017129 | 0.00194 | 17 | 0.0019594 | 0.999539 | 73 | 0.9358974 | 1076282 | 591300 | 1667582 | 2 | 0.0002305 | 0.2516136 | 0.0009162 | 1 | 18296795 | 1182600 | 19479395 | 0.00462417 | 0.998908 |
| -10 | -6 | -8 | 3 | 0 | 1 | 4 | 0.001027 | 0 | 0.0003426 | 0.0004565 | 4 | 0.000461 | 1 | 78 | 1 | 1150000 | 631800 | 1781800 | 0 | 0 | 0.2516136 | 0 | 1 | 4600000 | 0 | 4600000 | 0.00109198 | 1 |
| -15 | -11 | -13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 83 | 1.0641026 | 1223718 | 672300 | 1896018 | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -20 | -16 | -18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 88 | 1.1282051 | 1297436 | 712800 | 2010236 | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -25 | -21 | -23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 93 | 1.1923077 | 1371154 | 753300 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -30 | -26 | -28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 98 | 1.2564103 | 1444872 | 793800 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -35 | -31 | -33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 103 | 1.3205128 | 1518590 | 834300 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -40 | -36 | -38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 108 | 1.3846154 | 1592308 | 874800 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -45 | -41 | -43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 113 | 1.4487179 | 1666026 | 915300 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -50 | -46 | -48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 118 | 1.5128205 | 1739744 | 955800 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -55 | -51 | -53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 123 | 1.5769231 | 1813462 | 996300 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -60 | -56 | -58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 128 | 1.6410256 | 1887179 | 1036800 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -65 | -61 | -63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 133 | 1.7051282 | 1960897 | 1077300 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -70 | -66 | -68 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 138 | 1.7692308 | 2034615.4 | 1117800 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -75 | -71 | -73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 143 | 1.8333333 | 2108333.3 | 1158300 | | 0 | 0 | 0.2516136 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Totals | | | 2921 | 2923 | 2919 | 8763 | | | | | 8676 | | | | | | | | 2183 | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | 0.2516136 | | | | | | | | | |

| | | | | |
|---|---|---|---|---|
| | Btu | 3.673E+09 | 539330400 | 4.213E+09 |
| | % Total | 0.872 | 0.128 | 1.000 |
| | kBtu/SF | 38.04 | 5.59 | 43.63 |
| | Boiler Eff: | 0.85 | 0.85 | |
| | Btu | 4.321E+09 | 634506353 | |
| | kBtu/SF | 44.75 | 6.57 | 51.32 |
| | Btu/Gal | 138500 | 138500 | |
| Net | Gallons | 26521 | 3894 | 30415 |
| Gross | Gallons | 31201.431 | 4581.2733 | 35783 |

SCALE 1"=50'-0"

0 25 75 175

NORTH REF

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CTA

HAINES SCHOOL BIOMASS PROJECT
HAINES, ALASKA

# BOILER PLANT CONCEPTS

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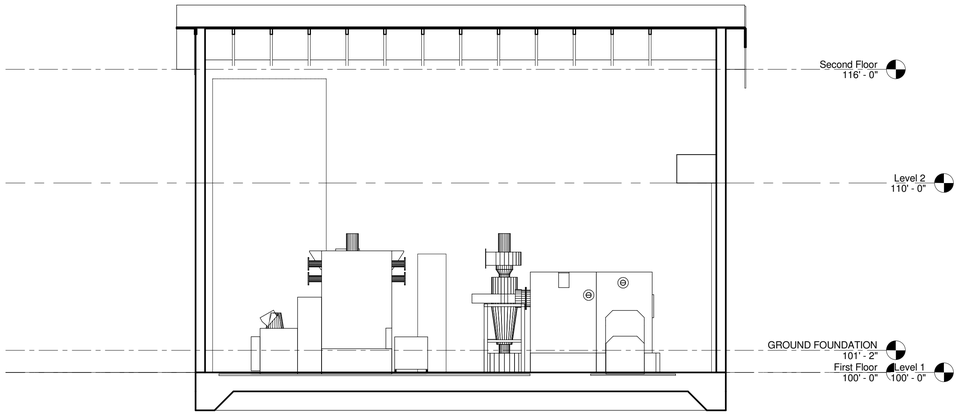
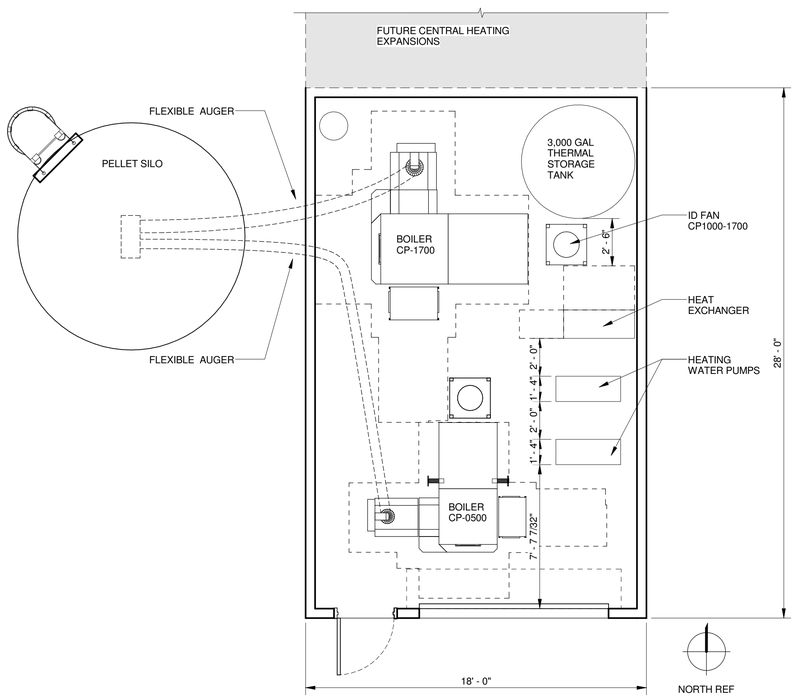
SITE PLAN

A001




2 A101 Section 1

1/4" = 1'-0"




1 A101 FIRST FLOOR PLAN SILO PELLET

1/4" = 1'-0"

## PLAN LEGEND

- WALL TYPE (SEE SHEET A101) / WALL TYPE NOTE
- 101 — ROOM NUMBER
- WINDOW TYPE (SEE SHEET A601)
- PLAN NOTE
- SIM / 1 / A101 — DETAIL OR SECTION NUMBER / SHEET WHERE DRAWN
- 101-1 — DOOR NUMBER (SEE SHEET A601)
- DIMENSION TO FACE OF STUD
- DIMENSION TO GRID LINE
- SLOPE X:X — INDICATES ROOF SLOPE
  - IF NO SLOPE IS LISTED ASSUME 1/4" PER 12" MIN - SLOPE ALL CRICKETS TO DRAIN - ROOF DRAIN SUMPS SLOPE 1/2" PER 12"

## WALL TYPE LEGEND

SCALE: 1" = 1'-0"

**GENERAL WALL TYPE NOTES:**

A. SEE INTERIOR ELEVATIONS (SHEET A801) AND FINISH SCHEDULE (SHEET A501) FOR WALL FINISHES.
B. PROVIDE BLOCKING AS REQUIRED TO SECURE WALL HUNG COMPONENTS.
C. EXTEND ALL COMPONENTS TO UNDERSIDE OF DECK, UNLESS NOTED OTHERWISE.

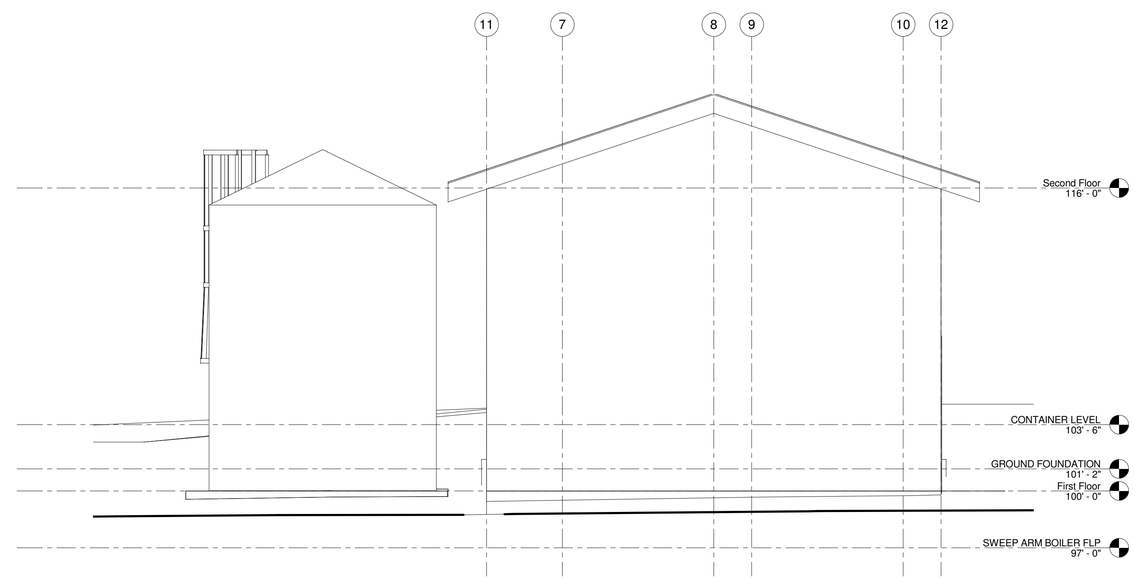
**KEYNOTES:**

1. NOT USED.

A INTERIOR WALL

## # SHEET WORK NOTES

1. NOT USED.
2. NOT USED.




3 A101 SOUTH ELEVATION

1/4" = 1'-0"

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HAINES SCHOOL BIOMASS PROJECT
HAINES, ALASKA

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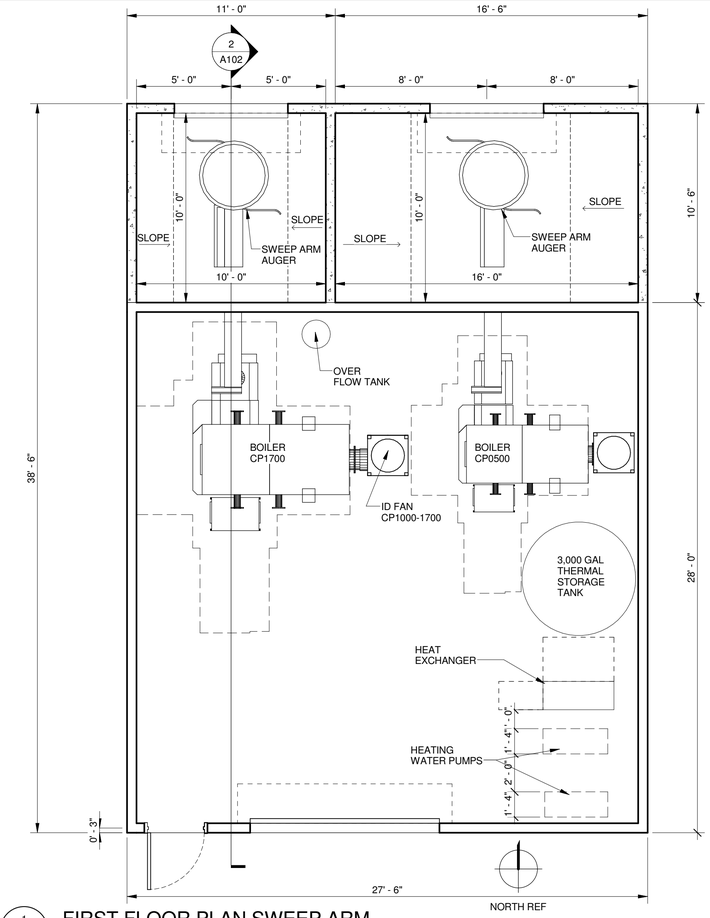
FLOOR PLAN SILO PELLET

A101




1 A102 FIRST FLOOR PLAN SWEEP ARM

1/4" = 1'-0"

## PLAN LEGEND

- X / XX — WALL TYPE (SEE SHEET A101) / WALL TYPE NOTE
- 101 — ROOM NUMBER
- X — WINDOW TYPE (SEE SHEET A601)
- X — PLAN NOTE
- 1 / A101 (SIM) — DETAIL OR SECTION NUMBER / SHEET WHERE DRAWN
- 101 — DOOR NUMBER (SEE SHEET A601)
- DIMENSION TO FACE OF STUD
- DIMENSION TO GRID LINE
- SLOPE X:X — INDICATES ROOF SLOPE
  - IF NO SLOPE IS LISTED ASSUME 1/4" PER 12" MIN - SLOPE ALL CRICKETS TO DRAIN - ROOF DRAIN SUMPS SLOPE 1/2" PER 12"

## WALL TYPE LEGEND

SCALE: 1" = 1'-0"

**GENERAL WALL TYPE NOTES:**

A. SEE INTERIOR ELEVATIONS (SHEET A801) AND FINISH SCHEDULE (SHEET A501) FOR WALL FINISHES.
B. PROVIDE BLOCKING AS REQUIRED TO SECURE WALL HUNG COMPONENTS.
C. EXTEND ALL COMPONENTS TO UNDERSIDE OF DECK, UNLESS NOTED OTHERWISE.

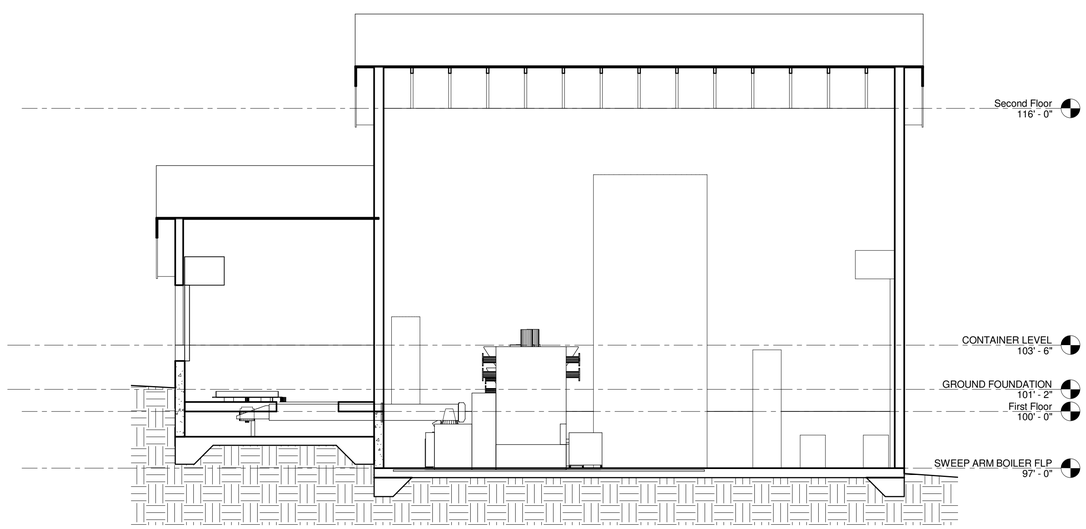
**KEYNOTES:**

1. NOT USED.

A INTERIOR WALL

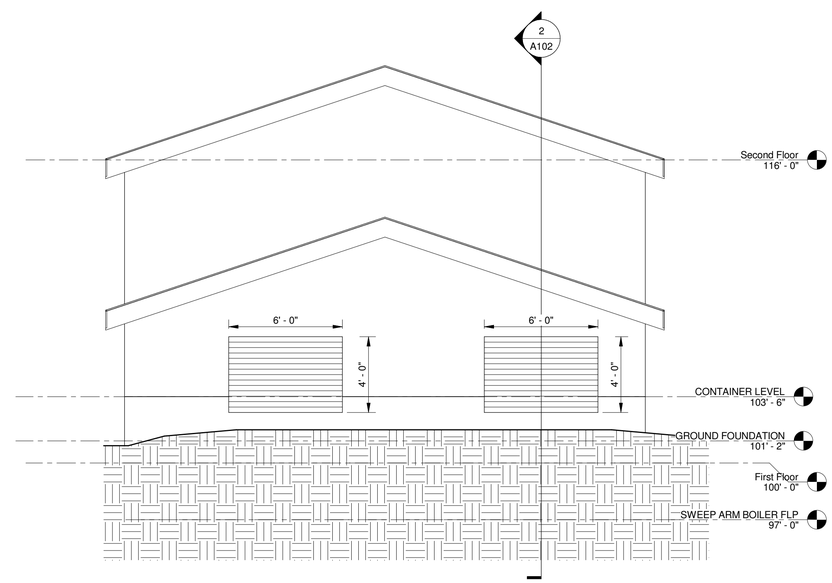
## # SHEET WORK NOTES

1. NOT USED.
2. NOT USED.




2 A102 SWEEP ARM LONG. SECTION

1/4" = 1'-0"




3 A102 NORTH ELEVATION

1/4" = 1'-0"

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HAINES SCHOOL BIOMASS PROJECT
HAINES, ALASKA

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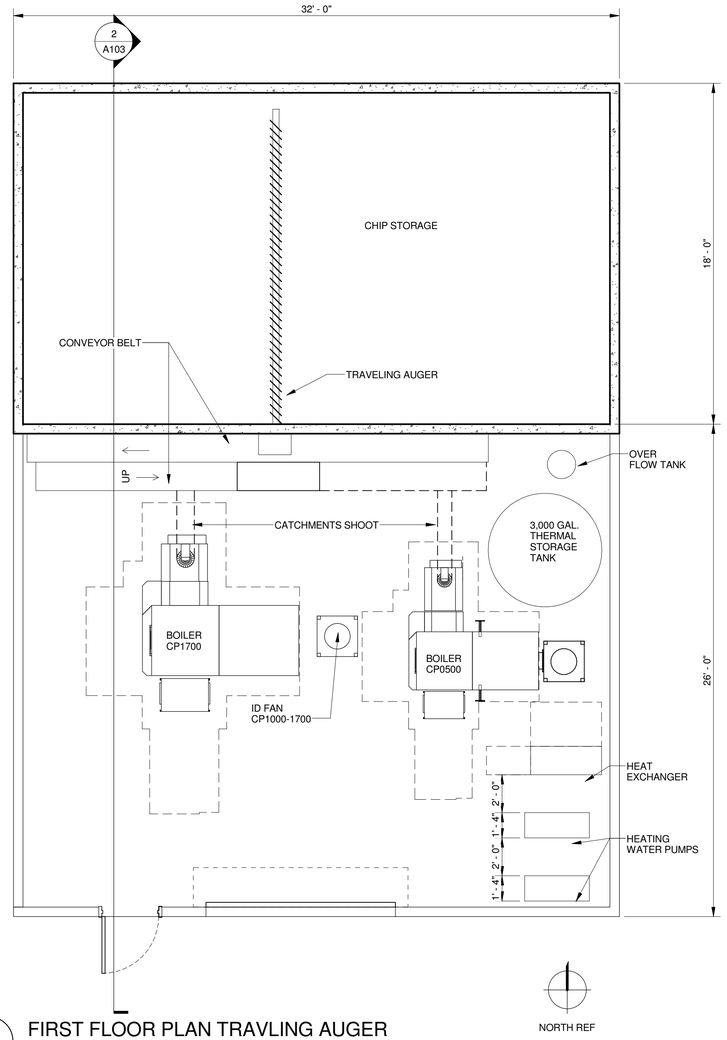
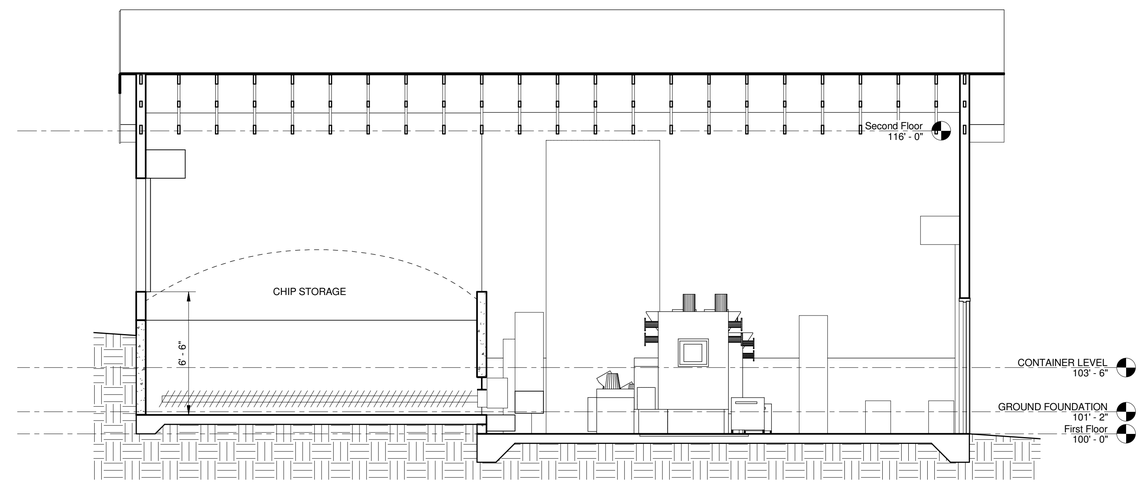
FLOOR PLAN SWEEP ARM

A102



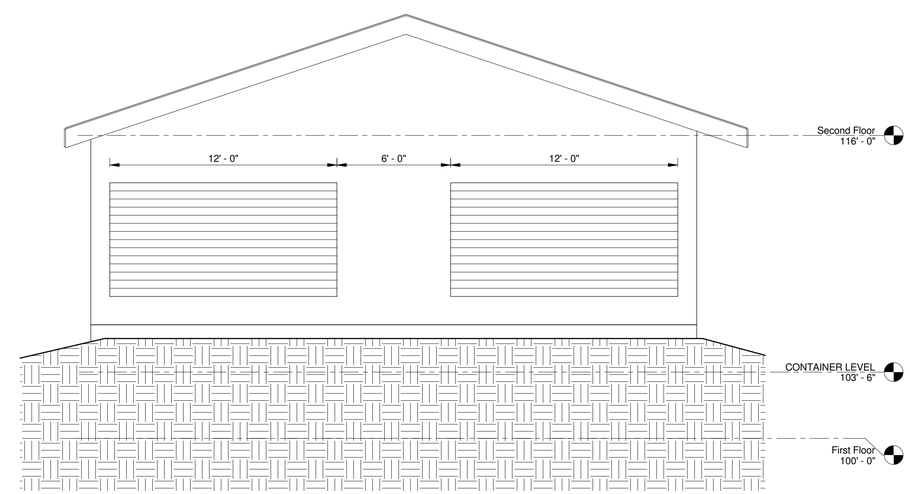

1 A103 FIRST FLOOR PLAN TRAVLING AUGER

1/4" = 1'-0"




2 A103 TRAVELING AUGER LONG. SECTION

1/4" = 1'-0"




4 A103 NORTH ELEVATION TRAV.

1/4" = 1'-0"

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HAINES, ALASKA

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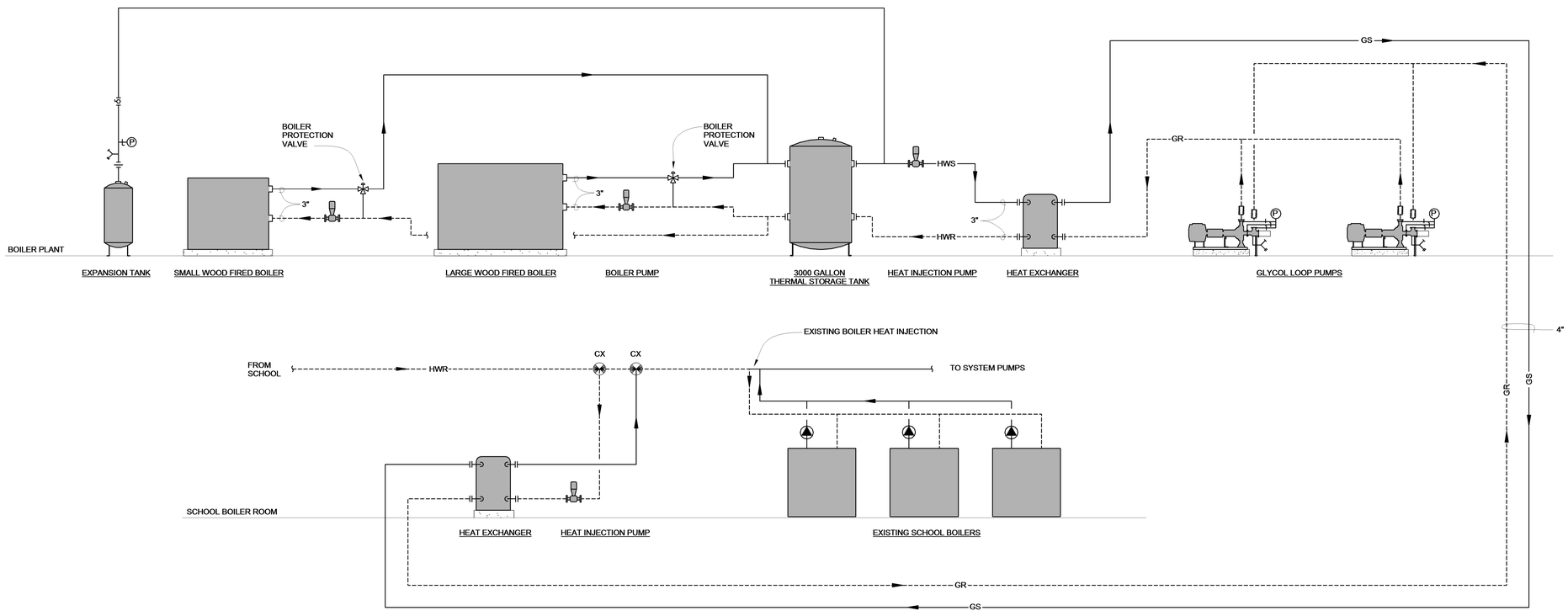
FLOOR PLAN
TRAVELING AUGER

A103




1
M400

## BOILER PLANT FLOW DIAGRAM CONCEPT

NOT TO SCALE

NOT FOR CONSTRUCTION - PRELIMINARY DESIGN

HAINES SCHOOL BIOMASS PROJECT
HAINES, ALASKA

# BOILER PLANT CONCEPTS

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NOT FOR CONSTRUCTION

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DRAWN BY | MFD
REVISIONS

BOILER PLANT FLOW DIAGRAM

M400

**Preliminary Estimate of Probable Cost**
**Biomass Heating System**
**Haines School**
**Haines, AK**

| | |
|---|---|
| **Base Boiler Plant Building** | |
| Boiler Building: | $75,000 |
| Site Development: | $75,000 |
| Installation of ACT Boiler and Components | $32,000 |
| ACT Startup | $10,000 |
| Mechanical/Electrical within Boiler Building: | $100,000 |
| Subtotal: | $292,000 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $43,800 |
| Subtotal: | $335,800 |
| 25% Location Factor: | $83,950 |
| Subtotal: | $419,750 |
| 10% Contingency: | $41,975 |
| **Total Project Costs** | **$ 461,725** |

| | |
|---|---|
| **Elks Lot Location Integration** | |
| Distribution & Underground Piping | $20,000 |
| Integration in High School | $25,000 |
| Subtotal: | $45,000 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $6,750 |
| Subtotal: | $51,750 |
| 25% Location Factor | $12,938 |
| Subtotal: | $64,688 |
| 10% Contingency: | $6,469 |
| **Total Project Costs** | **$ 71,156** |

| | |
|---|---|
| **5th Ave Location Integration - North Route** | |
| Distribution & Underground Piping | $80,000 |
| Integration in High School | $35,000 |
| Subtotal: | $115,000 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $17,250 |
| Subtotal: | $132,250 |
| 25% Location Factor | $33,063 |
| Subtotal: | $165,313 |
| 10% Contingency: | $16,531 |
| **Total Project Costs** | **$ 181,844** |

**Preliminary Estimate of Probable Cost**
**Biomass Heating System**
**Haines School**
**Haines, AK**

| | |
|---|---|
| **5th Ave Location Integration - Access Road** | |
| Distribution & Underground Piping | $100,000 |
| Integration in High School | $35,000 |
| Subtotal: | $135,000 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $20,250 |
| Subtotal: | $155,250 |
| 25% Location Factor | $38,813 |
| Subtotal: | $194,063 |
| 10% Contingency: | $19,406 |
| **Total Project Costs** | **$ 213,469** |

| | |
|---|---|
| **5th Ave Location Integration - Through School** | |
| Distribution & Underground Piping | $72,500 |
| Integration in High School | $35,000 |
| Subtotal: | $107,500 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $16,125 |
| Subtotal: | $123,625 |
| 25% Location Factor | $30,906 |
| Subtotal: | $154,531 |
| 10% Contingency: | $15,453 |
| **Total Project Costs** | **$ 169,984** |

| | |
|---|---|
| **Voc Ed Integration** | |
| Integration in Main School Fan Room | $9,500 |
| Distribution Piping through Main School | $12,000 |
| Underground Piping | $12,000 |
| Integration in Voc Ed Building | $9,500 |
| Subtotal: | $43,000 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $6,450 |
| Subtotal: | $49,450 |
| 25% Location Factor: | $12,363 |
| Subtotal: | $61,813 |
| 10% Contingency: | $6,181 |
| **Total Project Costs** | **$ 67,994** |

**Preliminary Estimate of Probable Cost**
**Biomass Heating System**
**Haines School**
**Haines, AK**

| | |
|---|---|
| **Sweeper Arm Fuel Handling Additional Cost to Base** | |
| Building | $24,000 |
| Fuel Handling Equipment | $25,000 |
| Subtotal: | $49,000 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $7,350 |
| Subtotal: | $56,350 |
| 25% Location Factor | $14,088 |
| Subtotal: | $70,438 |
| 10% Contingency: | $7,044 |
| **Total Project Costs** | **$ 77,481** |
| | |
| **Traveling Auger Fuel Handling Additional Cost to Base** | |
| Building | $100,000 |
| Fuel Handling Equipment | $140,000 |
| Subtotal: | $240,000 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $36,000 |
| Subtotal: | $276,000 |
| 25% Location Factor | $69,000 |
| Subtotal: | $345,000 |
| 10% Contingency: | $34,500 |
| **Total Project Costs** | **$ 379,500** |
| | |
| **Hybrid Roll Off Bin System Additional Cost to Base** | |
| Building | $24,000 |
| Fuel Handling Equipment (3 Roll Off Live Bottom Bins) | $100,000 |
| Subtotal: | $124,000 |
| Design Fees, Building Permit, Miscellaneous Expenses 15%: | $18,600 |
| Subtotal: | $142,600 |
| 25% Location Factor | $35,650 |
| Subtotal: | $178,250 |
| 10% Contingency: | $17,825 |
| **Total Project Costs** | **$ 196,075** |

**Preliminary Estimate of Probable Cost**
**Biomass Heating System**
**Haines School**
**Haines, AK**

**Option Summaries**

| | Elks | 5th North | 5th Road | 5th School |
|---|---|---|---|---|
| Base | $ 461,725 | $ 461,725 | $ 461,725 | $ 461,725 |
| Integration | $ 71,156 | $ 181,844 | $ 213,469 | $ 169,984 |
| **Total** | **$ 532,881** | **$ 643,569** | **$ 675,194** | **$ 631,709** |
| | | | | |
| Sweeper | $ 77,481 | $ 77,481 | $ 77,481 | $ 77,481 |
| **Total** | **$ 610,363** | **$ 721,050** | **$ 752,675** | **$ 709,191** |
| | | | | |
| Auger | $ 379,500 | $ 379,500 | $ 379,500 | $ 379,500 |
| **Total** | **$ 912,381** | **$ 1,023,069** | **$ 1,054,694** | **$ 1,011,209** |
| | | | | |
| Roll Off Bin | $ 196,075 | $ 196,075 | $ 196,075 | $ 196,075 |
| **Total** | **$ 806,438** | **$ 917,125** | **$ 948,750** | **$ 905,266** |

# 6 Maintenance

## 6.1 Maintenance Logbook

A history of inspections and maintenance should be recorded in a logbook. A sample logbook page is attached in section 8 of this manual. This logbook will also be important if there are any warranty claims.

## 6.2 Regular maintenance

**WARNING: Always confirm that the Emergency Stop is pressed and latched during service and maintenance and fresh air ventilation is occurring to the workspace.**

Carbon monoxide poisoning can occur in an enclosed space without adequate ventilation. Always take appropriate precautions before entering the main fuel storage or any other enclosed space where carbon monoxide may be present.

### 6.2.1 Weekly checks

Visually inspect the complete heating unit including the main fuel storage. Any defects discovered during inspections must be immediately corrected. Record weekly checks in the Maintenance Log Book.

- Open the boiler inspection door to view the flame color and dimensions in the combustion chamber and inspect the grate and burn rings for excessive ash build-up.
- Confirm the return water temperature is above the required 140F (60C).
- Confirm the water levels and pressures in the system are within their normal range
- Inspect for and rectify immediately the source of any leaks, corrosion or unusual noise.
- Check the stack temperature and ensure it is within normal range, raised stack temperature may indicates soot or ash build-up on the boiler's interior surfaces and reduced heat transfer.
- Open the main ash collection bin, the heat exchanger clean-out door and the cyclone clean-out door and remove excess ash.
- Disposal of Ashes – Ashes should be placed in a metal container with a tight fitting lid. The closed container of ashes should be placed on a non-combustible floor or on the ground, well away from all combustible materials, pending final disposal. If ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have thoroughly cooled.

### 6.2.2 Monthly checks

Perform the following monthly checks and record in the Maintenance Log Book.

- Confirm the functioning of the boiler control panel to shut the boiler down in a controlled manner.
- Open and inspect the clean out ports in the flue and chimney, remove excessive build-up.

- Creosote – Formation and Need for Removal – When wood is burned slowly, it produces tar and other organic vapors, which combine with expelled moisture to form creosote. The creosote vapors condense in the relatively cool chimney flue of a slow-burning fire. As a result, creosote residue accumulates on the flue lining. When ignited this creosote makes an extremely hot fire. When burning wood, the chimney should be inspected at least once every two months during the heating season to determine if creosote build up has occurred. If creosote has accumulated, it should be removed to reduce the risk of a chimney fire.

- Check daily for creosote build up until experience shows how often cleaning is necessary.

- Remove the ultrasonic probe from the intermediate storage bin and clean dust from the probe using a soft cloth or compressed air.

- Remove the cover on the rigid feed auger (if so equipped) and check that an error message is triggered. Visually inspect the seal of the back-burning actuator flap. Open the actuator (back-burning prevention flap) and allow it to release fully confirming that it makes a tight seal. The seal can be confirmed by shining a light from under the closed seal and checking for light leakage. The back-burning flap valve seal can also be inspected through the round inspection port on the side of the auger mounting collar on top of the intermediate storage bin.

- Confirm the functionality of the emergency fire extinguisher water tank. Push the red button on the extinguisher valve to confirm water is released by viewing air bubbles rising in the extinguisher tube. After releasing the button, the valve should reseal.

- Confirm the function of all boiler motors. Run all motors in the “manual” mode to confirm their functionality. Confirm that the main circulation pump turns on at the pre-set temperature and that the shorting pump or 3-way valve turns on when the set temperature differential between input and output water is reached. Confirm the cycle of fuel feeding and confirm that the ultrasonic probe triggers the filling of the intermediate storage bin.

- Check the operation of the combustion and exhaust fans, by switching-over into the “Manual mode”, and by turning-on each fan.

- Confirm the function of external failure alarms linked to the boiler.

- Inspect the combustion chamber for damage or deformation

- Confirm that an operable hand fire extinguisher is present

- Confirm that any ash is safely stored

- Confirm no combustible materials are stored in the boiler room

- Confirm that chimney exhaust is clean and that there are no combustible deposits on the roof outside of the boiler room.

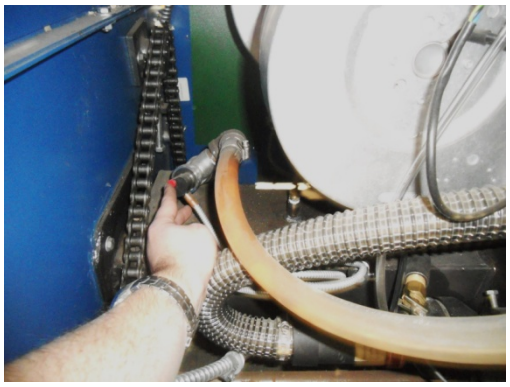
- Check and lubricate as required the turbulator bearings and bearing located next to the boiler with high temperature grease (Minimum 750°F (400°C)). Suggested- CRC Industries Permatherm Synthetic Hi-Temp Grease

### 6.2.3 Half-year checks

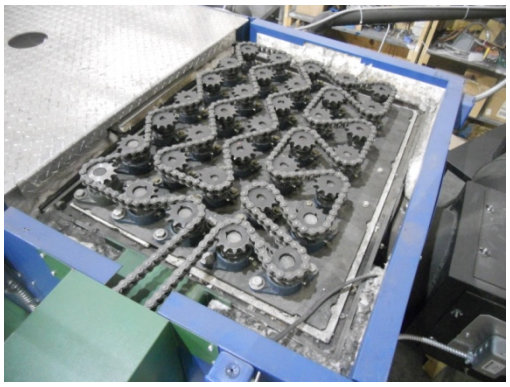
Perform a biannual general inspection of the boiler, lubricate all the bearings and complete all required maintenance monthly maintenance. At least once a year this inspection should be performed by ACT's Service Department or by a qualified service company.

Open the chimney inspection cover and remove any built-up fly-ash. Inspect the cyclone draft fan for any build-up on the ban blades of the fan motor.

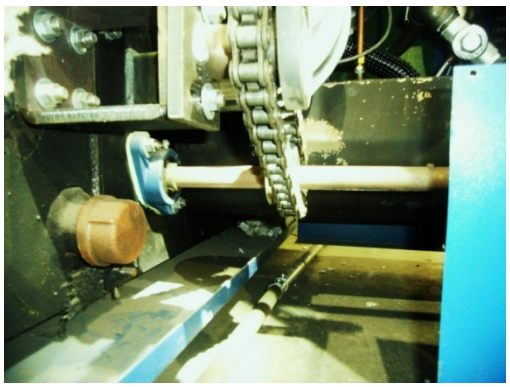
Open the combustion chamber access door and remove the accumulated fly-ash. Pull out the secondary and tertiary burner rings and inspect for damage. Completely remove from the burner surfaces any ash clinkers. If the vent holes are clogged, use a metal point to clean the holes. If you have to remove the primary air burner ring (it is fastened down with three spring pins), ensure that it fits back snugly when remounted. When remounting the secondary and tertiary air rings ensure that they are free from ash and that the air channels are aligned. When remounting the burner rings ensure that the rings sit tightly against the fan ducts by tightening the positioning bolts located on the ash bin side of the combustion chamber. Once the rings are securely in place, the bolts must be loosened to allow for expansion of the burner rings during combustion.



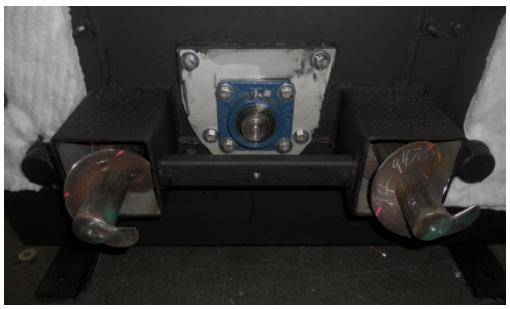
Confirm the emergency fire extinguisher's function. The valve should open with pressure on the red release button. Press the button for an instant and observe if water flows. After releasing the button, the valve should reclose tightly.



Remove the aluminium top cover of the boiler and lubricate the bearings and the chain. Confirm the chain tension. The chain tension is adjusted by moving the engine in its mounting block. If the chain is removed, ensure that the chain routing does not change when the chain is remounted.

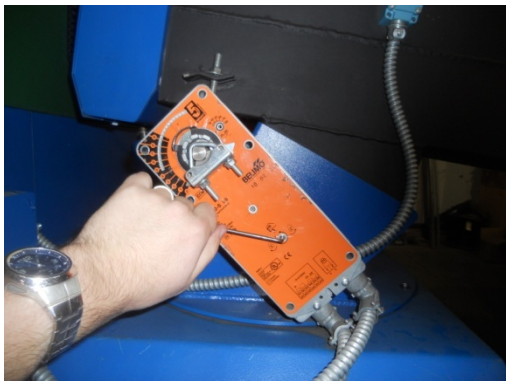


Remove the cover under the control unit and the cover at the end of the intermediate fuel bin and lubricate the bearings and chains for fuel feeding and ash removal.

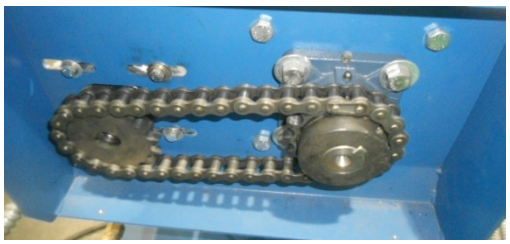


Remove the ash storage bin and then lubricate the visible bearing of the feeding auger with heat resistant bearing grease. This bearing may have to be greased more frequently if it is subject to high thermal load. Check the gasket on the ash storage bin for damage.

Lift the cover of the main auger and check whether the equipment reports a failure. Open the cover fully and with a flashlight inspect the tightness of the flap for burn-back protection. Open the actuator manually with a hex wrench. Secure the flap in an open position by rotating the wrench counter–clockwise and inspect the seal for damage. Observe that it closes quickly and tightly when the actuator is released.



Ensure that the back-burn flap is left in an unlocked position.



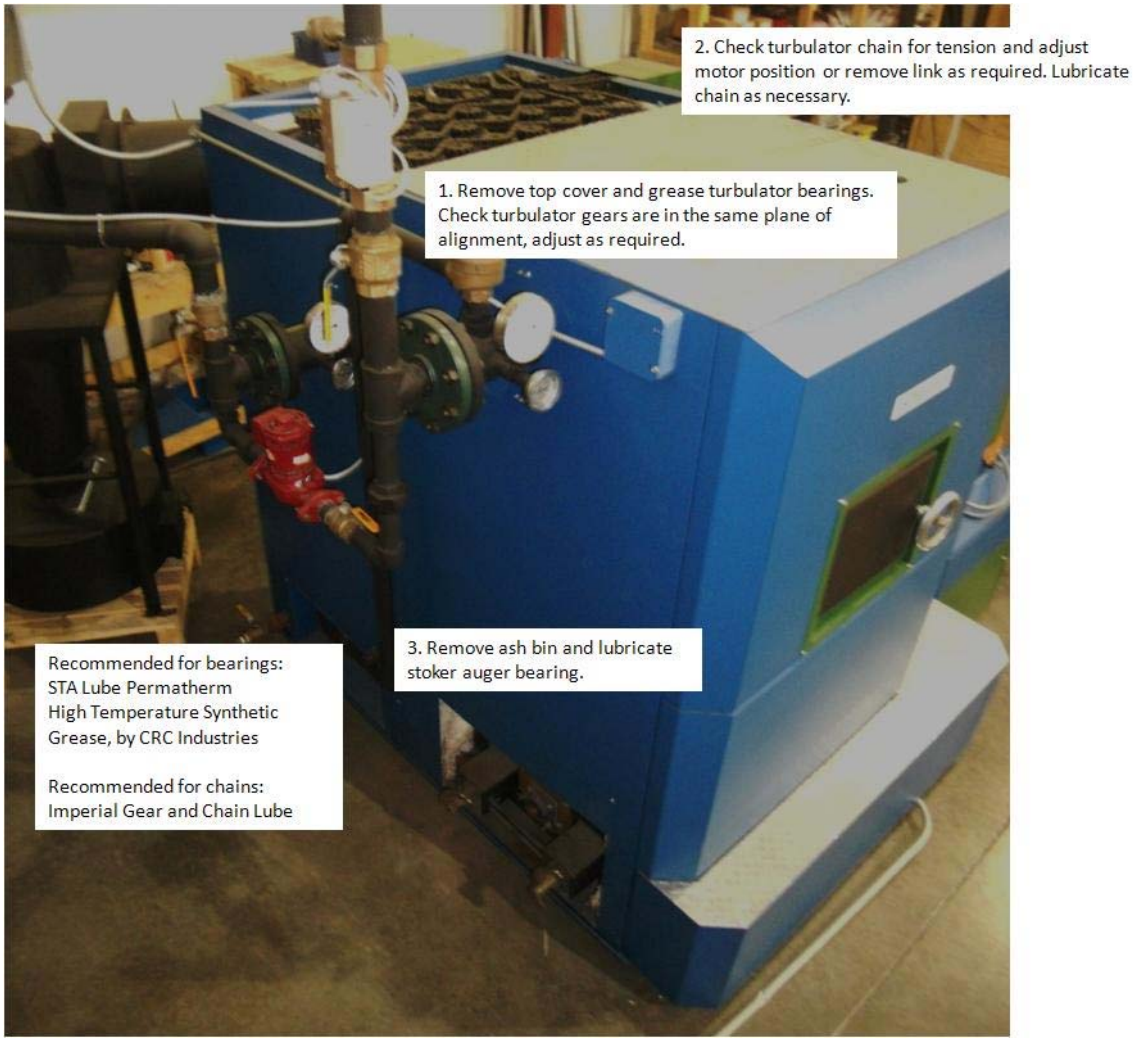
Remove the cover of the main auger drive and lubricate the bearings and the chain. Confirm the tension of the drive chain.

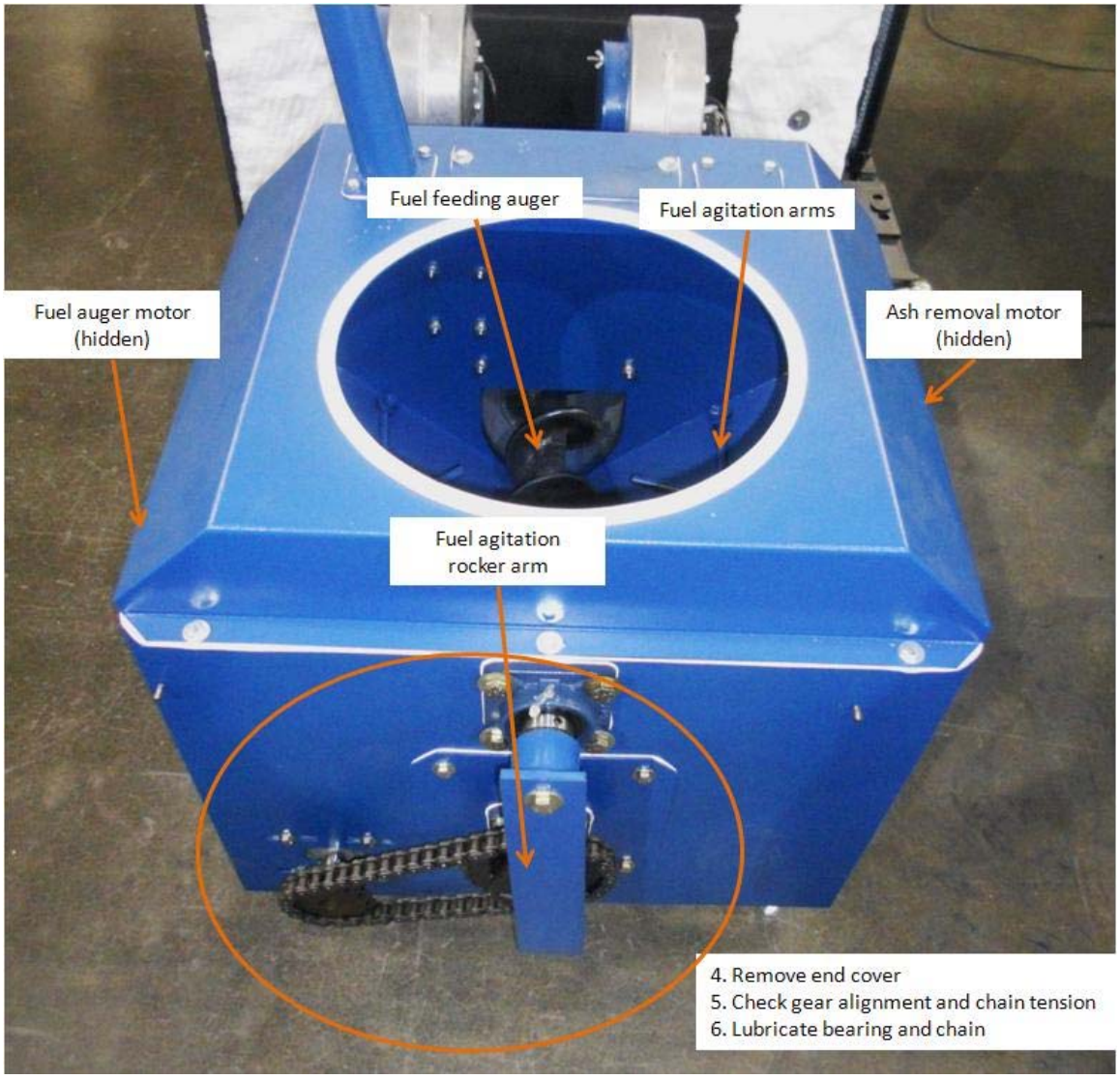
Open the doors underneath the heat exchanger and underneath the cyclone and remove any accumulated ash. Ensure that the doors reseal tightly.

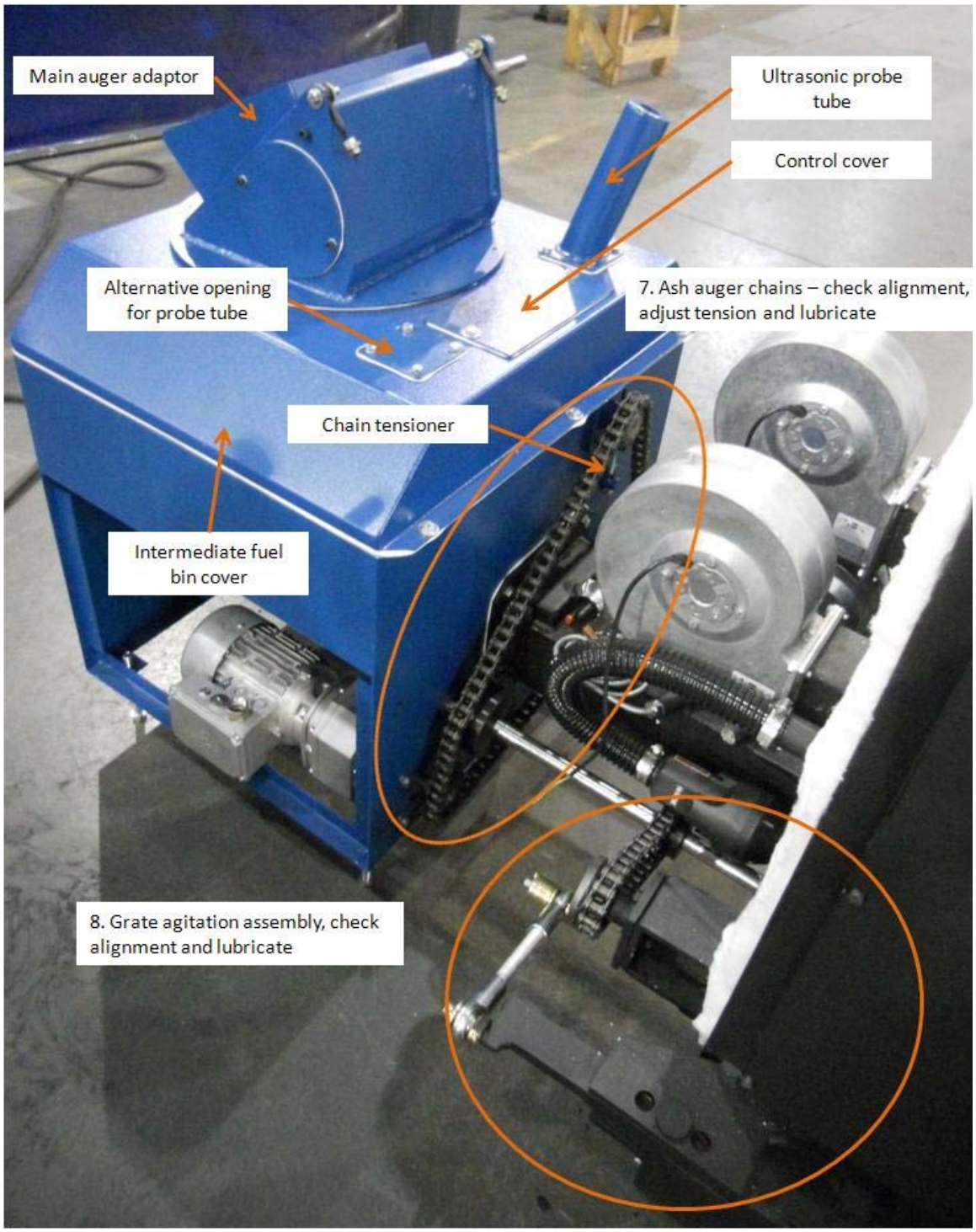
## 6.3 List of Recommended Service Items and Replacement Parts

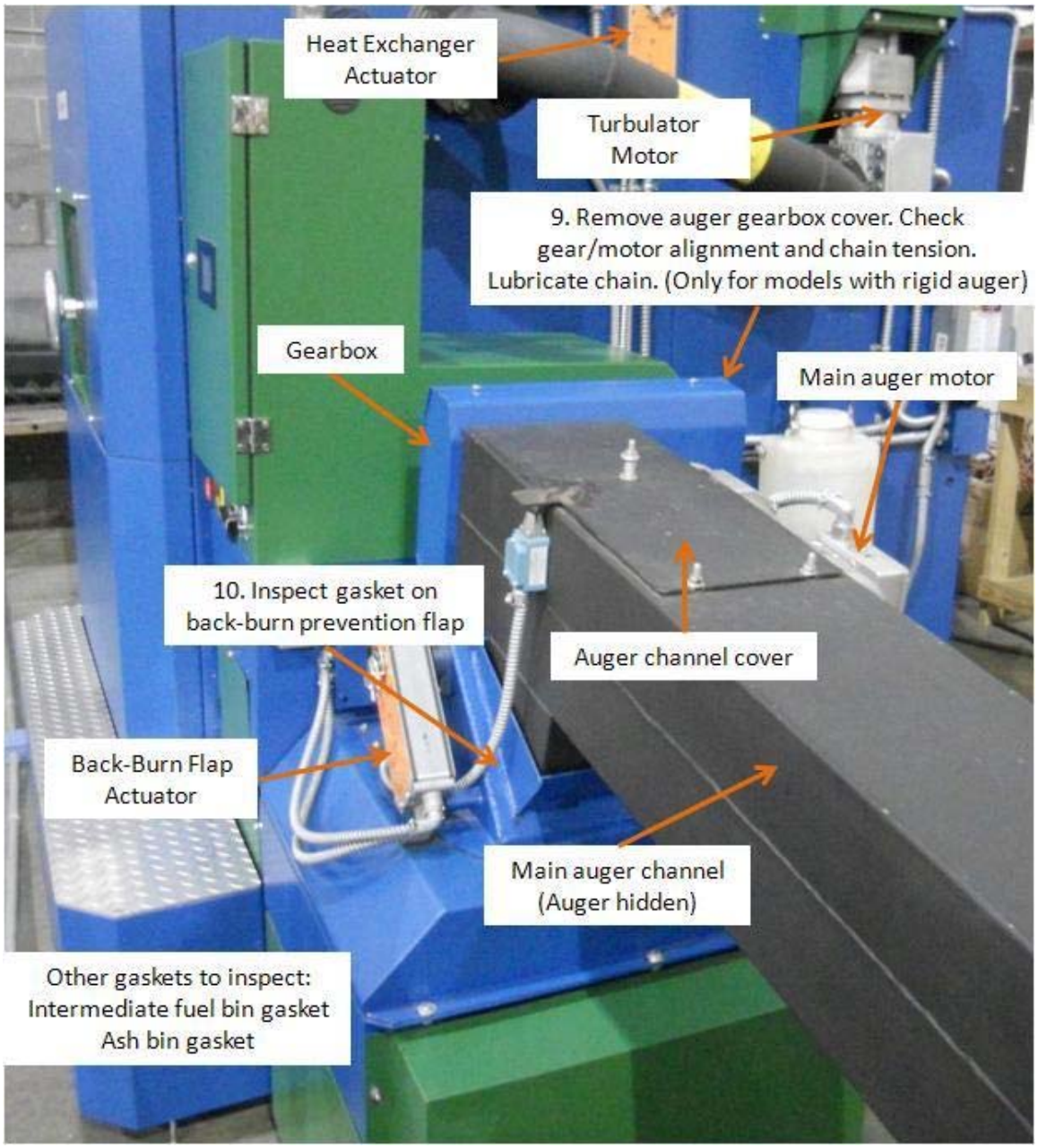
| Item | Manufacturer | Part # |
|---|---|---|
| Gasket material | Thermoseal Inc. | SEALEX, PTFE Tape 1/4”, 3/8”, 1/2” width |
| High Temperature Grease | CRC | Sta-lube Permatherm #SL3580 |
| High Temperature Chain oil | Sprayon | LU 201 - Open Gear &, Wire and Rope Lubricant, Heavy Duty |
| High temperature sealant | Loctite | Superflex Red High Temp RTV #59675 |
| Motors | Nord | SK373.1F-80S/4 |
| Oxygen sensor | Bosch | LS17025 |
| Ignitor Blower | Leister | BM4 230V, 1600 W |
| Actuators – Spring return 120V | Belimo | AFBUP-S |
| Temperature Safety Relief Valve for extinguisher tank | Caleffi | 543513 – ¾” |

## *6.4 Lubrication and Inspection Diagram*




Fuel feeding auger
Fuel agitation arms
Fuel auger motor (hidden)
Ash removal motor (hidden)
Fuel agitation rocker arm
4. Remove end cover
5. Check gear alignment and chain tension
6. Lubricate bearing and chain


Main auger adaptor
Ultrasonic probe tube
Control cover
Alternative opening for probe tube
7. Ash auger chains – check alignment, adjust tension and lubricate
Chain tensioner
Intermediate fuel bin cover
8. Grate agitation assembly, check alignment and lubricate


Heat Exchanger Actuator
Turbulator Motor
9. Remove auger gearbox cover. Check gear/motor alignment and chain tension. Lubricate chain. (Only for models with rigid auger)
Gearbox
Main auger motor
10. Inspect gasket on back-burn prevention flap
Auger channel cover
Back-Burn Flap Actuator
Main auger channel (Auger hidden)
Other gaskets to inspect:
Intermediate fuel bin gasket
Ash bin gasket

## 6.5 Water Treatment

Water treatment is required for satisfactory operation of a boiler to prevent depositing of scale and to prevent corrosion from acids, oxygen and other harmful elements that may be in the water supply. A qualified water treatment specialist should be consulted and the water treated as appropriate.

The basic aims and objectives of boiler water conditioning are:

- Prevent the accumulation of scale and deposits in the boiler.
- Remove dissolved gases from the water.
- Protect the boiler against corrosion.
- Maintain the highest possible boiler efficiency.
- Decrease the amount of boiler down time for cleaning.

Water treatment should be checked and maintained on a regular basis. The end user should be sure that the boiler is not operated for long periods for approval tests or any other operation of firing without water treatment. It should also be noted that water boilers may well need chemical treatment for the first filling of water and additional periodic chemical treatment, depending on the system losses and the make-up requirements. Water treatment may vary from season to season or over a period of time; therefore, there should be a requirement that a water treatment procedure is checked no less than four times a year and possibly more frequently as the local water conditions may require. When the system is drained and then refilled, chemical treatment is required, for the new water will again be necessary.

### 6.6 Extended Boiler Layup

If the boiler is to be placed into an extended lay-up the following items need to be accomplished.

Use the burner controls to safely shut the burner off

The electric power to the control panel should be disconnected to insure no accidental restart of the boiler

Once shut-off isolate the boiler from the system and allow the boiler to cool slowly.

- Close all isolation valves supplying water through the boiler
- The flue gas isolation damper (if installed) should be closed to minimize air flow through the boiler
- Once cool, slowly open the vents to allow pressure to be safely bled off

Wet lay-up

- If the lay-up is to be of a short-term then the unit may be kept in a wet lay-up
- Insure that the boiler is not exposed to a freezing condition
- Once pressure is equalized close all vents to insure no additional fresh air is allowed to enter the system

Dry lay-up

- If the boiler is to be kept off-line for an extended period of time the unit can be placed into a dry lay-up
- The boiler should be drained and a desiccant placed into the boiler

- After installation of the desiccant all pressure side openings should be closed to keep fresh air and oxygen out of the boiler
- Upon restarting of the boiler, a complete waterside and fireside inspection should be accomplished

For either lay-up insure that the safety relief valve is free of standing water and is dry to avoid corrosion of the assembly

# 7 ACT Boiler Operation Settings Record

Job Name: Model: Serial #:
Date: Recorded by:

| | |
|---|---|
| **Actual temperature of the outlet water** | |
| **Oxygen level** | |
| **Temperature of return water** | |
| **Temperature of flue gases** | |
| **Negative pressure (under-pressure) in the furnace** | |
| **Type of the fuel** | |
| | |
| **Ignition cycle** | |
| **Ignition feed time** | |
| | |
| **Normal feed gain** | |
| **Normal feed cycle** | |
| **Normal feed time** | |
| | |
| **Target temperature** | |
| **Minimum supply temperature** | |
| **Maximum supply temperature** | |
| **Minimum return water temperature** | |
| | |
| **Maximum stack temperature** | |
| **Minimum pressure** | |
| | |
| **Turbulator cycle** | |
| **Turbulator run time** | |
| **Agitation cycle** | |
| **Agitation time** | |
| **Ash removal cycle** | |
| **Ash removal time** | |

# 8 ACT Boiler Service Record

| Year | Equipment operator: | | | | | Administrator: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Check | Month: | | | | Month: | | | | Month: | | | | |
| Week | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | Notes |
| Confirm seal of back-burning prevention flap | | | | | | | | | | | | | |
| Review boiler error messages from archives. | | | | | | | | | | | | | |
| Confirm smoke flue cleanliness | | | | | | | | | | | | | |
| Confirm condition chains and drives | | | | | | | | | | | | | |
| Confirm control system function | | | | | | | | | | | | | |
| Test external alarms/failure messages | | | | | | | | | | | | | |
| Function of extinguisher tank | | | | | | | | | | | | | |
| Confirm combustion and exhaust fan function and modulation | | | | | | | | | | | | | |
| Check combustion chamber condition flame/ash condition | | | | | | | | | | | | | |
| Confirm no ash/staining on the roof from the chimney | | | | | | | | | | | | | |
| Confirm boiler shut-down function | | | | | | | | | | | | | |
| Confirm boiler room safe operating condition | | | | | | | | | | | | | |
| Locate/check hand fire extinguisher | | | | | | | | | | | | | |
| **Initials of Technician** | | | | | | | | | | | | | |

Comments: