SHA Trans – September 2022

Experiments using the single-hole atomizer (SHA) injector with various fuels related to SAF. The objective of this campaigns is to perform measurements using long-distance microscopy to visualize droplets generated during the atomization process of the fuel flow coming out of the injector under a wide range of pressure and temperature conditions to assess the evaporation regime: classical, transitional and diffusive.

Experimental participants: Julien, Rafa, Tyler and Francesco

# Experimental Setup (typical)

## Injection

Injector: SHA

Injection duration: around 1 ms (ET 320us ramp + 650 us hold)

Injection pressure: 1.0 MPa pressure difference

Fuel: n-C12, A-2, C-1, C-4 and bicyclohexyl

## Diagnostics and Equipment

Long-distance microscopy with K2 DistaMax and iX i727 camera.

### Optical diagnostics

#### Long-distance microscopy

### Imaging

Camera: iX i-Speed 727

Settings: 5 kHz, 2 us exposure, Internal sync

Lens: Infinity K2-DistaMax with CF-2 objective and NTX 2X magnifier

Digital resolution: 3.77 um/pix

Injector location (x, y) = (366, 96) @ 384x192, pre-flip

ScaleFile: Scale\_3.77um

Delayed by 1us w.r.t laser pulse

**Illumination**

Type: LED

Emitter: LEDengin LZP custom (450 nm)

Voltage: 39 VDC

Pulse duration (SRS): 250 ns

Delay (SRS): 1 us

Burst duration: 15 ms (PreTrig)

# Data storage

D-Files/DBI: SC3 (D:\xdata\202209\_SHA\_Trans\d)

LDM: HP laptop (C:\xdata\202209\_SHA\_Trans\LDM)

# Conditions

Ambient pressures: 2.0, 4.0 and 6.0 MPa

Oxygen: Inert and reacting (recirculation zone; 15% O2)

Injection pressure: 10 bar delta P (good match for droplet size distribution)

Temperatures: 800 – 1700 K

*Targets:*

*800 K – 2.0 MPa – 21% O2 & 1200 K – 2.0 MPa –15% O2 (Cruise)*

*900 K – 6.0 MPa – 21% O2 & 1200 K – 6.0 MPa –15% O2 (Take-off)*

### Pressure conditions:

60 bar

T: 900K; rho: 22.8 kg/m3

T: 1000K; rho: 20.5 kg/m3

T: 1100K; rho: 18.7 kg/m3

T: 1200K; rho: 17.1 kg/m3

T: 1300K; rho: 15.8 kg/m3

T: 1400K; rho: 14.7 kg/m3

T: 1500K; rho: 13.7 kg/m3

T: 1600K; rho: 12.8 kg/m3

T: 1700K; rho: 12.1 kg/m3

40 bar

T: 900K; rho: 15.2 kg/m3

T: 1000K; rho: 13.7 kg/m3

T: 1100K; rho: 12.4 kg/m3

T: 1200K; rho: 11.4 kg/m3

T: 1300K; rho: 10.5 kg/m3

T: 1400K; rho: 9.8 kg/m3

T: 1500K; rho: 9.1 kg/m3

T: 1600K; rho: 8.6 kg/m3

T: 1700K; rho: 8.0 kg/m3

20 bar

T: 900K; rho: 7.6 kg/m3

T: 1000K; rho: 6.9 kg/m3

T: 1100K; rho: 6.2 kg/m3

T: 1200K; rho: 5.7 kg/m3

T: 1300K; rho: 5.3 kg/m3

T: 1400K; rho: 4.9 kg/m3

T: 1500K; rho: 4.6 kg/m3

T: 1600K; rho: 4.3 kg/m3

T: 1700K; rho: 4.0 kg/m3

# Experiments log

## 2 September 2022

(Julien and Tyler)

Setting up long distance microscope.

The special window extension got damaged while being installed, so there is a small part that is chipped, but it is unlikely to fall within the solid collection angle of the K2 system.

The setup is not optimized for the SHA with the current injector port design and the special window extension does not line up too well with the injector outlet (nozzle). The installation needs to be redesigned to accommodate this, by either modifying the window insert and extension or by modifying the SHA injector port to make it protrude a little more into the chamber.

## 6 September 2022

(Julien and Tyler)

Finalized setup.

As mentioned yesterday, the system has to be angled a few degrees to accommodate the design constraints.

Let’s try a few tests to see if the image quality suffers from the slight out-of-alignment of the system. If the images look good, we will keep going with the current configuration. If not, we’ll take measures, which might include going back to the previous window and extension design.

Try test at 20 bar ambient, but in N2, so at chamber temperature (188 C).

188C\_20b\_001

Going to high temperatures and high pressures, starting with 60 bar, 900 K and moving up.

ABKCWS003 – 901 K

ABKCWS004 – 903 K

ABICWS001 – 981 K

Cooldown written with ABICWS001

ABICWS002 – 997 K

ABGCWS001 – 1082 K

Cooldown written with ABGCWS001

ABGCWS002 – 1102 K

ABECWS001 – 1192 K

Cooldown written with ABECWS001

ABECWS002 – 1202 K

ABECWS003 – 1189 K

ABCCWS001 – 1285 K

Cooldown written with ABCCWS001

ABCCWS002 – 1320 K

This temperature appears to be transitional to diffusive

ABTCWS001 – 1414 K

Cooldown written with ABTCWS001

ABTCWS002 – 1397 K

ABTCWS003 – 1397 K

ABVCWS001 – 1468 K

Cooldown written with ABVCWS001

ABVCWS002 – 1507 K

Diffusive, soot forms very late

ABXCWS001 – 1614 K

Cooldown written with ABXCWS001

ABXCWS002 – 1586 K

ABZCWS001 – 1662 K

Cooldown written with ABZCWS001

New 0% O2 mix transferred to mixer B

ABZCWS002 – 1700 K

ABZCWS003 – 1695 K

Moving down in ambient pressure, to 40 bar; also starting with 900 K, and going up.

ABKDWS001 – 1261 K

Wrong density, so Cooldown written with ABKDWS001

ABKDWS002 – 990 K

Cooldown written with ABKDWS002

ABKDWS003 – 911 K

Going all the way to 1700 K first, to see what happens up there…

ABZBWS001 – 1658 K

Cooldown written with ABZBWS001

ABZBWS002 – 1685 K

Appears to be classical evaporation at 40 bar, even at 1700 K.

## 7 September 2022

(Julien and Tyler)

Keep going with 40 bar ambient pressure. One more at 1700 K to start the day, then down to 1200 and 1500 K.

ABZBWS003 – 1707 K

ABEBWS001 – 1174 K

Cooldown written with ABEBWS001

ABEBWS002 – 461 K; Spark did not ignite the mixture… Trying again

ABEBWS003 – 1194 K

ABVBWS001 – 1434 K

Cooldown written with ABVBWS001

ABVBWS001 – 1520 K

Going down in pressure to 20 bar ambient, similar temperature targets as 40 bar ambient pressure.

ABKAVS001 – 1212 K

Cooldown written with ABVBWS001

ABKAVS002 – 979 K

Cooldown written with ABVBWS002

ABKAVS003 – 915 K

ABEAVS001 – 1146 K

Cooldown written with ABEAVS001

ABEAVS001 – 1213 K

ABVAVS001 – 1472 K

Cooldown written with ABVAVS001

ABVAVS002 – 461 K; Spark did not ignite the mixture… Trying again

ABVAVS003 – 1491 K

ABZAVS001 – 1682 K

Cooldown written with ABZAVS001

ABZAVS002 – 1690 K

We’re going back up to 60 bar and high temperature points to finish the mix with 0 % O2. Next mix is with 15 % O2 for reacting conditions.

ABZCWS004 – 1724 K

ABVCWS003 – 1520 K

ABVCWS004 – 1489 K

ABCCWS003 – 1284 K

ABTCWS004 – 1406 K

## 8 September 2022

(Francesco, Tyler, and Julien)

60 bar 15%O2 1200 K

AJECWS001 1246 K dp 8 bar

AJECWS002 1199 K dp 12 bar

AJECWS003 1185 K dp 14 bar

AJECWS004 1199 K dp 8 bar

AJECWS005 1193 K dp 10 bar

60 bar 15%O2 900 K

AJKLWS001 1072 K dp 10 bar

AJKLWS002 911 K dp 10 bar

AJKLWS003 896 K dp 11 bar

AJKLWS004 896 K dp 8 bar

20 bar 15%O2 1200 K

AJECVS001 1069 K dp 14 bar

AJECVS002 1200 K dp 11 bar

AJECVS003 1203 K dp 9 bar

AJECVS004 1196 K dp 12 bar

20 bar 15%O2 800 K

AJMCVS001 948 K dp 6 bar

AJMCVS002 822 K dp 9 bar

AJMCVS003 798 K dp 9 bar

AJMCVS004 801 K dp 9 bar

AJMCVS005 801 K dp 10 bar

60 bar 15%O2 1500 K

AJVCWS001 1444 K dp 11 bar

AJVCWS002 1495 K dp 8 bar

AJVCWS003 1500 K dp 9 bar

40 bar 15%O2 900 K

AJKDWS001 876 K dp NA

AJKDWS002 898 K dp 9 bar

AJKDWS003 893 K dp 13 bar

40 bar 15%O2 1200 K

AJEBWS001 1219 K dp 8 bar

Changed fuel to Jet A (A-2).

Mix with 0% O2.

Going to high temperatures and high pressures, starting with 60 bar, 900 K and moving up.

Leak check did not pass. We removed the South window and changed the seal, as it appeared to be a little damaged.

Leak rate is good now.

JBKLWS001 – 908 K

JBKLWS002 – 908 K

JBKLWS003 – 905 K dp 8 bar

1000 K

JBICWS001 – 974 k dp 9 bar

JBICWS002 – 1013 K dp 6 bar

JBICWS003 – 1000 K dp 8

1100 K

JBGCWS001 – 1083 dp 7 bar

JBGCWS002 – 1097 K dp 8 bar

JBGCWS003 – 1102 dp 10 bar

1200 K

JBECWS001 – 1170 K dp 11 bar

JBECWS002 – 1209 K dp 8 bar

JBECWS003 – 1203 K dp 10 bar

1300 K

JBCCWS001 – 1288 K dp 11 bar

JBCCWS002 – 1318 K dp 10 bar

JBCCWS003 – 1295 K dp 10 bar

1700 K

JBZCWS001 – 1670 K dp 11 bar

JBZCWS002 – 1698 K dp 10 bar

JBZCWS003 – N/A

JBZCWS004 – 1710 K dp 9 bar

New 0% O2 mix

## 13 September 2022

1400 K

JBTCWS001 1395 K 9 bar dp

JBTCWS002 1385 K 12 bar dp

JBTCWS003 1388 K 9 bar dp

1500 K

JBVCWS001 1466 K 11 bar dp

JBVCWS002 N/A

JBVCWS003 1493 K 8 bar dp

JBVCWS004 1504 k 9 bar dp

1600 K

JBXCWS001 1564 K 11 bar dp

JBXCWS002 1588 K 10 br dp

JBXCWS003 1584 K 10 bar dp

Move to 40 bar 0% O2

900 K

JBKDVS001 1017 K 6 bar dp

JBKDVS002 919 K 9 bar dp

JBKDVS003 893 K a0 bar dp

1000 K

JBIDVS001 976 K 10 bar dp

JBIDVS002 968 K 10 bar dp

JBIDVS003 996 K 10 bar dp

JBIDVS004 999 K 10 bar dp

1100 K

JBGDVS001 1084 K 10 bar dp

JBGDVS002 1087 K 10 bar dp

JBGDVS003 1092 K 10 bar dp

1200 K

JBEDVS001 N/A

JBEDVS002 1285 K 8 bar dp

JBEDVS003 1202 K 10 bar dp

JBEDVS004 1214 K 9 bar dp

1300 K

JBCDVS001 1283 10 bar dp

JBCDVS002 1294 K 10 bar dp

JBCDVS003 1292 K 10 bar dp

1400 K

JBTDVS001 1395 K 10 bar dp

New 0% O2 mix

JBTDVS002 1357 K 11 bar dp

JBTDVS003 1436 K 9 bar dp

JBTDVS004 1399 K 10 bar dp

1500 K

JBVDVS001 1545 K 9 bar dp

JBVDVS002 1498 K 10 bar dp

JBVDVS003 1498 K 10 bar dp

1600 K

JBXDVS001 1589 K 10 bar dp

JBXDVS002 1597 k 10 bar dp

1700 K

JBZBVS001 1642 K 11 bar dp

JBZBVS002 1707 K 10 bar dp

JBZBVS003 1694 K 10 bar dp

## 14 September 2022

20 bar 0% O2

900

JBKAVS001 858 K 11 bar dp

JBKAVS002 919 K 9 bar dp

JBKAVS003 898 K 10 bar dp

1000 K

JBICVS001 988 K 10 bar dp

JBICVS002 980 K 10 bar dp

JBICVS003 1012 K 10 bar dp

Move to 200 K step to save mix

1200 K

JBECVS001 1143 K 10 bar dp

JBECVS002 1203 K 10 bar dp

JBECVS003 1199 K 10 bar dp

1500 K

JBVCVS001 1412 K 10 bar dp

JBVCVS002 1541 K 9 bar dp

JBVCVS003 1502 K 10 bar dp

JBVCVS004 1500 K 10 bar dp

1600 K

JBXCVS001 1586 K 10 bar dp

JBXCVS002 1609 K 10 bar dp

1700 K

JBZCVS001 1688 K 10 bar dp

JBZCVS002 1683 K dp 10 bar

JBZCVS003 1651 K dp 11 bar

Move to 15% O2 for reactive cases

20 bar 15%O2 1200 K

JJECVS001 1229 K 10 bar dp

JJECVS002 1185 K 10 bar dp

JJECVS003 1203 K dp 10 bar

20 bar 15%O2 800 K

JJMCVS001 803 10 bar dp

JJMCVS002 804 10 bar dp

60 bar 15%O2 900 K

JJKLWS001 910 K 10 bar dp

JJKLWS002 895 K 11 bar dp

60 bar 15%O2 1200 K

JJECWS001 1486 K no injection; vessel pressure was wrong

JJECWS002 1253 K 9 bar dp

JJECWS003 1194 K 11 bar dp

JJECWS004 1194 K 11 bar dp

## 16 September 2022

New fuel C-1

60 bar 15%O2 1200 K

SJECWS001 1207 K 10 bar dp

SJECWS002 1198 K 11 bar dp

60 bar 15%O2 900 K

SJKLWS001 895 K 11 bar dp NO video

SJKLWS002 894 K 11 bar dp

SJKLWS003 891 K 11 bar dp

20 bar 15%O2 800 K

SJMCVS001 794 K 10 bar dp

SJMCVS002 796 K 11 bar dp

20 bar 15%O2 1200 K

SJECVS001 1192 K 11 bar dp

SJECVS002 1185 K 10 bar dp

## 19 September 2022

0% O2 60 bar

Mixture changed to 0% O2

900 K

SBKLWS001 892 K 10 bar dp

SBKLWS002 891 K 10 bar dp

1000 K

SBICWS001 987 K 10 bar dp

SBICWS002 996 K 10 bar dp

1100 K

SBGCWS001 1077 K 11 bar dp

SBGCWS002 1097 K 10 bar dp

SBGCWS003 1099 K 10 bar dp

1200 K

SBECWS001 1184 K 11 bar dp

SBECWS002 1172 K 11 bar dp

SBECWS003 1203 K 10 bar dp

SBECWS004 1202 K 10 bar dp

1300 K

SBCCWS001 1257 K 12 bar dp

SBCCWS002 1304 K 10 bar dp

SBCCWS003 1305 K 10 bar dp

1400 K

SBTCWS001 1361 K 11 bar dp

SBTCWS002 1395 K 10 bar dp

SBTCWS003 1399 K 10 bar dp

1500 K

SBVCWS001 1480 K 11 bar dp

SBVCWS002 1493 K 11 bar dp

SBVCWS003 1492 K 10 bar dp

1600 K

SBXCWS001 1582 K 11 bar dp

SBXCWS002 1579 K 11 bar dp

New 0% O2 mix

SBXCWS003 1613 K 10 bar dp

1700 K

SBZCWS001 1587 K 13 bar dp

SBZCWS002 1678 K 11 bar dp

SBZCWS003 1715 K 10 bar dp

40 bar 0% O2

900 K

SBKDVS001 908 K 9 bar dp

SBKDVS002 898 K 10 bar dp

1200 K

SBEDVS001 1187 K 11 bar dp

SBEDVS002 1212 K 10 bar dp

1500 K

SBVDVS001 1503 K 11 bar dp

SBVDVS002 1493 K 10 bar dp

1700 K

SBZBVS001 1675 K 11 bar dp

SBZBVS002 1697 K 10 bar dp

SBZBVS003 1698 K 11 bar dp

20 bar 0% O2

900 K

SBKAVS001 884 K 10 bar dp

SBKAVS002 920 K 9 bar dp

SBKAVS003 895 K 10 bar dp

1200 K

SBECVS001 1183 K 10 bar dp

SBECVS002 1197 K 10 bar dp

SBECVS003 1199 K 10 bar dp

1500 K

SBVCVS001 1468 K 11 bar dp

SBVCVS002 1503 K 9 bar dp

SBVCVS003 1480 K 10 bar dp

1700 K

SBZCVS001 1620 K 11 bar dp

SBZCVS002 N/A

SBZCVS003 1686 K 10 bar dp

SBZCVS004 1690 K 11 bar dp

## 22 September 2022

New fuel C-4

60 bar 0% O2

900 K

FBKLWS001 N/A

FBKLWS002 901 K 11 bar dp

FBKLWS003 897 K 12 bar dp

1000 K

FBICWS001 1014 K 11 bar dp

New 0% O2 mix

FBICWS002 994 K 12 bar dp

Reduce injection pressure to 70 bar instead of 70.5

1100 K

FBGCWS001 1140 K 9 bar dp

FBGCWS002 1106 11 bar dp

Reduce injection pressure to 69.5 bar instead of 70

FBGCWS003 1108 K 10 bar dp

1200 K

FBECWS001 1207 K 10 bar dp

FBECWS002 1204 K 11 bar dp

1300 K

FBCCWS001 1300 K 11 bar dp

FBCCWS002 1309 K 10 bar dp

1400 K

FBTCWS001 1389 K 11 bar dp

FBTCWS002 1409 K 11 bar dp

1500 K

FBVCWS001 1501 K 11 bar dp

FBVCWS002 1506 K 11 bar dp

1600 K

FBXCWS001 1608 K 11 bar dp

Reduce injection pressure to 69 bar instead of 69.5

FBXCWS002 1603 K 11 bar dp

1700 K

FBZCWS001 1699 K 11 bar dp

FBZCWS002 1719 K 10 bar dp

40 bar 0% O2

900 K

FBKDVS001 914 K 10 bar dp

FBKDVS002 899 K 10 bar dp

1200 K

FBECVS001 1204 K 10 bar do

FBEDVS001 1200 K 10 bar dp

1500 K

FBVDVS001 1504 K 11 bar dp

FBVDVS002 1485 K 11 bar dp

1700 K

FBZBVS001 1699 K 11 bar dp

FBZBVS002 1700 K 11 bar dp

20 bar 0% O2

900 K

FBKAVS001 892 K 11 bar dp

FBKAVS002 903 K 10 bar dp

1200 K

FBECVS002 1182 K 11 bar dp

FBECVS003 1207 K 10 bar dp

FBECVS004 1217 K 10 bar dp

1500 K

FBVCVS001 1469 K 11 bar dp

FBVCVS002 1493 K 10 bar dp

FBVCVS003 1508 K 10 bar dp

1700 K

FBZCVS001 NA

FBZCVS002 1671 K 11 bar dp

FBZCVS003 1684 K 11 bar dp

FBZCVS004 1701 K 11 bar dp

20 15% O2

800 K

FJMCVS001 845 K 10 bar dp

FJMCVS002 807 11 bar dp

FJMCVS003 806 K 11 bar dp

1200 K

FJECVS001 1298 K 10 bar dp

FJECVS002 1208 K 11 bar dp

FJECVS003 1204 K 11 bar dp

60 bar 15% O2

1200 K

FJECWS001 1237 K 10 bar dp

FJECWS002 1214 K 11 bar dp

FJECWS003 1191 K 12 bar dp

900 K

FJKLWS001 904 K 11 bar dp

FJKLWS002 907 K 11 bar dp

## 28 September 2022

New fuel bicycloexyl

60 bar 15% 02

900 K

BJKLWS001 NA

BJKLWS002 920 K 11 bar dp

BJKLWS003 889 K 13 bar dp

BJKLWS004 898 K 12 bar dp

Pressure reduced to 68 bar

1200 K

BJECWS001 1177 K 12 bar dp

Reduce the pressure to 67 bar

BJECWS002 1206 K 10 bar dp

BJECWS003 1208 K 10 bar dp

20 bar 15% O2

800 K

BJMCVS001 787 K 10 bar dp

BJMCVS002 799 K 9 bar dp

1200 K

BJECVS001 1192 K 10 bar dp

BJECVS002 1194 K 10 bar dp

20 bar 0% O2

900 K

BBKAVS001 893 K 10 bar dp

BBKAVS002 898 K 10 bar dp

1200 K

BBECVS001 N/A

BBECVS002 1193 K 10 bar dp

BBECVS003 1209 K 9 bar dp

1500 K

BBVCVS001 1512 K 9 bar dp

BBVCVS002 1522 K 9 bar dp

Increased the pressure to 28

BBVCVS003 N/A

BBVCVS004 1501 K 10 bar dp

1700 K

BBZCVS001 NA

BBZCVS002 1647 K 11 bar dp

BBZCVS003 N/A

BBZCVS004 1722 K 10 bar dp

40 bar 0% O2

900 K

BBKDDS001 887 K 11 bar dp

BBKDDS002 899 K 11 bar dp

1200 K

BBECDS001 1183 K 11 bar dp

Reduced pressure to 47 bar

BBECDS002 1200 K 9 bar dp

Adjust pressure to 47.5

BBECDS003 1195 K 10 bar dp

1500 K

BBVCDS001 1473 K 11 bar dp

BBVCDS002 1496 K 10 bar dp

BBVCDS003 1503 K 10 bar dp

## 29 September 2022

1700 K

BBZBDS001 1676 K 11 bar dp

BBZBDS002 1734 K 9 bar dp

BBZBDS003 1716 K 10 bar dp

60 bar 0% O2

900 K

BBKLWS001 890 K 10 bar dp

BBKLWS002 903 K 9 bar dp

1000 K

BBICWS001 988 K 10 bar dp

BBICWS002 993 K 10 bar dp

1100 K

BBGCWS001 1091 K 10 bar dp

BBGCWS002 1088 K 10 bar dp

New 0% O2 mix

1200 K

BBECWS001 1180 K 11 bar dp

BBECWS002 1203 K 10 bar dp

BBECWS003 1202 K 10 bar dp

1300 K

BBCCWS001 1294 K 10 bar dp

BBCCWS002 1298 K 10 bar dp

1400 K

BBTCWS001 1392 K 10 bar dp

BBTCWS002 1376 K 11 bar dp

BBTCWS0023 1418 K 9 bar dp

1500 K

BBVCWS001 1489 K 10 bar dp

BBVCWS002 1503 K 10 bar dp

1600 K

BBXCWS001 1566 K 11 bar dp

BBXCWS002 1607 K 10 bar dp

BBXCWS003 1596 K 10 bar dp

1700 K

BBZCWS001 1685 K 10 bar dp

BBZCWS002 1686 K 10 bar dp

BBZCWS003 1708 K 9 bar dp

Remaining mix in mix B is 0% O2

# Summary test table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Case name | Run Nbs. | Ambient Press. (bar) | Amb. Temp. [K] | Inj. Press. [bar] | O2 conc. [%] | Notes |
| n-dodecane | | | | | | |
| ABKCWS | 003-004 | 60 | 900 | 70 | 0 |  |
| ABICWS | 001-002 | 60 | 1000 | 70 | 0 |  |
| ABGCWS | 001-002 | 60 | 1100 | 70 | 0 |  |
| ABECWS | 001-003 | 60 | 1200 | 70 | 0 |  |
| ABCCWS | 001-003 | 60 | 1300 | 70 | 0 | Transitional to diffusive |
| ABTCWS | 001-004 | 60 | 1400 | 70 | 0 |  |
| ABVCWS | 002-004 | 60 | 1500 | 70 | 0 |  |
| ABXCWS | 001-002 | 60 | 1600 | 70 | 0 |  |
| ABZCWS | 002-004 | 60 | 1700 | 70 | 0 |  |
| ABKDWS | 003 | 40 | 900 | 50 | 0 |  |
| ABEBWS | 001; 003 | 40 | 1200 | 50 | 0 |  |
| ABVBWS | 002 | 40 | 1500 | 50 | 0 |  |
| ABZBWS | 002-003 | 40 | 1700 | 50 | 0 |  |
| ABKAVS | 003 | 20 | 900 | 30 | 0 |  |
| ABEAVS | 002 | 20 | 1200 | 30 | 0 |  |
| ABVAVS | 003 | 20 | 1500 | 30 | 0 |  |
| ABZAVS | 001-002 | 20 | 1700 | 30 | 0 |  |
| AJKLWS |  | 60 | 900 | 70 | 15 |  |
| AJECWS | 002-005 | 60 | 1200 | 70 | 15 |  |
| AJVCWS | 002-003 | 60 | 1500 | 70 | 15 |  |
| AJKDWS | 002-003 | 40 | 900 | 50 | 15 |  |
| AJEBWS | 001 | 40 | 1200 | 50 | 15 |  |
| AJMCVS | 003-005 | 20 | 800 | 30 | 15 |  |
| AJECVS | 002-004 | 20 | 1200 | 30 | 15 |  |
| A-2 (Jet A) | | | | | | |
| JBKLWS | 001-003 | 60 | 900 | 70 | 0 |  |
| JBICWS | 002-003 | 60 | 1000 | 70 | 0 |  |
| JBGCWS | 001-003 | 60 | 1100 | 70 | 0 |  |
| JBECWS | 002-003 | 60 | 1200 | 70 | 0 |  |
| JBCCWS | 001-003 | 60 | 1300 | 70 | 0 |  |
| JBTCWS | 001-003 | 60 | 1400 | 70 | 0 |  |
| JBVCWS | 003-004 | 60 | 1500 | 70 | 0 |  |
| JBXCWS | 002-003 | 60 | 1600 | 70 | 0 |  |
| JBZCWS | 002; 004 | 60 | 1700 | 70 | 0 |  |
| JBKDVS | 002-003 | 40 | 900 | 50 | 0 |  |
| JBIDVS | 003-004 | 40 | 1000 | 50 | 0 |  |
| JBGDVS | 001-003 | 40 | 1100 | 50 | 0 |  |
| JBEDVS | 003-004 | 40 | 1200 | 50 | 0 |  |
| JBCDVS | 001-003 | 40 | 1300 | 50 | 0 |  |
| JBTDVS | 001; 003-004 | 40 | 1400 | 50 | 0 |  |
| JBVDVS | 002-003 | 40 | 1500 | 50 | 0 |  |
| JBXDVS | 001-002 | 40 | 1600 | 50 | 0 |  |
| JBZBVS | 002-003 | 40 | 1700 | 50 | 0 |  |
| JBKAVS | 002-003 | 20 | 900 | 30 | 0 |  |
| JBICVS | 001-003 | 20 | 1000 | 30 | 0 |  |
| JBECVS | 002-003 | 20 | 1200 | 30 | 0 |  |
| JBVCVS | 003-004 | 20 | 1500 | 30 | 0 |  |
| JBXCVS | 001-002 | 20 | 1600 | 30 | 0 |  |
| JBZCVS | 001-002 | 20 | 1700 | 30 | 0 |  |
| JJKLWS | 001-002 | 60 | 900 | 70 | 15 |  |
| JJECWS | 003-004 | 60 | 1200 | 70 | 15 |  |
| JJMCVS | 001-002 | 20 | 800 | 30 | 15 |  |
| JJECVS | 002-003 | 20 | 1200 | 30 | 15 |  |
| C-1 | | | | | | |
| SBKLWS | 001-002 | 60 | 900 | 70 | 0 |  |
| SBICWS | 001-002 | 60 | 1000 | 70 | 0 |  |
| SBGCWS | 002-003 | 60 | 1100 | 70 | 0 |  |
| SBECWS | 001; 003-004 | 60 | 1200 | 70 | 0 |  |
| SBCCWS | 002-003 | 60 | 1300 | 70 | 0 |  |
| SBTCWS | 002-003 | 60 | 1400 | 70 | 0 |  |
| SBVCWS | 001-003 | 60 | 1500 | 70 | 0 |  |
| SBXCWS | 001; 003 | 60 | 1600 | 70 | 0 |  |
| SBZCWS | 002-003 | 60 | 1700 | 70 | 0 |  |
| SBKDVS | 001-002 | 40 | 900 | 50 | 0 |  |
| SBEDVS | 001-002 | 40 | 1200 | 50 | 0 |  |
| SBVDVS | 001-002 | 40 | 1500 | 50 | 0 |  |
| SBZBVS | 002-003 | 40 | 1700 | 50 | 0 |  |
| SBKAVS | 001-003 | 20 | 900 | 30 | 0 |  |
| SBECVS | 001-003 | 20 | 1200 | 30 | 0 |  |
| SBVCVS | 002-003 | 20 | 1500 | 30 | 0 |  |
| SBZCVS | 003-004 | 20 | 1700 | 30 | 0 |  |
| SJMCVS | 001-002 | 60 | 800 | 70 | 15 |  |
| SJKLWS | 001-003 | 60 | 900 | 70 | 15 |  |
| SJECWS | 001-002 | 60 | 1200 | 70 | 15 |  |
| SJMCVS | 001-002 | 20 | 800 | 30 | 15 |  |
| SJECVS | 001-002 | 20 | 1200 | 30 | 15 |  |
| C-4 | | | | | | |
| FBKLWS | 002-003 | 60 | 900 | 70 | 0 |  |
| FBICWS | 001-002 | 60 | 1000 | 70 | 0 |  |
| FBGCWS | 002-003 | 60 | 1100 | 70 | 0 |  |
| FBECWS | 001-002 | 60 | 1200 | 70 | 0 |  |
| FBCCWS | 001-002 | 60 | 1300 | 70 | 0 |  |
| FBTCWS | 001-002 | 60 | 1400 | 70 | 0 |  |
| FBVCWS | 001-002 | 60 | 1500 | 70 | 0 |  |
| FBXCWS | 001-002 | 60 | 1600 | 70 | 0 |  |
| FBZCWS | 001-002 | 60 | 1700 | 70 | 0 |  |
| FBKDVS | 001-002 | 40 | 900 | 50 | 0 |  |
| FBEDVS | 001-002 | 40 | 1200 | 50 | 0 | FBECVS001 may be the same condition |
| FBVDVS | 001-002 | 40 | 1500 | 50 | 0 |  |
| FBZBVS | 001-002 | 40 | 1700 | 50 | 0 |  |
| FBKAVS | 001-002 | 20 | 900 | 30 | 0 |  |
| FBECVS | 001-003 | 20 | 1200 | 30 | 0 |  |
| FBVCVS | 002-003 | 20 | 1500 | 30 | 0 |  |
| FBZCVS | 003-004 | 20 | 1700 | 30 | 0 |  |
| FJKLWS | 001-002 | 60 | 900 | 70 | 15 |  |
| FJECWS | 002-003 | 60 | 1200 | 70 | 15 |  |
| FJMCVS | 002-003 | 20 | 800 | 30 | 15 |  |
| FJECVS | 002-003 | 20 | 1200 | 30 | 15 |  |
| Bicyclohexyl | | | | | | |
| BBKLWS | 001-002 | 60 | 900 | 70 | 0 |  |
| BBICWS | 001-002 | 60 | 1000 | 70 | 0 |  |
| BBGCWS | 001-002 | 60 | 1100 | 70 | 0 |  |
| BBECWS | 001-003 | 60 | 1200 | 70 | 0 |  |
| BBCCWS | 001-002 | 60 | 1300 | 70 | 0 |  |
| BBTCWS | 001; 003 | 60 | 1400 | 70 | 0 |  |
| BBVCWS | 001-002 | 60 | 1500 | 70 | 0 |  |
| BBXCWS | 002-003 | 60 | 1600 | 70 | 0 |  |
| BBZCWS | 001-003 | 60 | 1700 | 70 | 0 |  |
| BBKDDS | 001-002 | 40 | 900 | 50 | 0 |  |
| BBECDS | 001-003 | 40 | 1200 | 50 | 0 |  |
| BBVCDS | 002-003 | 40 | 1500 | 50 | 0 |  |
| BBZBDS | 003 | 40 | 1700 | 50 | 0 |  |
| BBKAVS | 001-002 | 20 | 900 | 30 | 0 |  |
| BBECVS | 002-003 | 20 | 1200 | 30 | 0 |  |
| BBVCVS | 001; 004 | 20 | 1500 | 30 | 0 |  |
| BBZCVS | 004 | 20 | 1700 | 30 | 0 | 22 K higher than target |
| BJKLWS | 002-004 | 60 | 900 | 70 | 15 |  |
| BJECWS | 002-003 | 60 | 1200 | 70 | 15 |  |
| BJMCVS | 001-002 | 20 | 800 | 30 | 15 |  |
| BJECVS | 001-002 | 20 | 1200 | 30 | 15 |  |