

# **DSD SmartCAFS**

Clutch/Gearbox Temperature  
Testing for CCC Certification

**Company:**

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**Title:** Product Engineer

**Date:** 25-April-2014

**Document No.:**

| DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification |      |                                       |       |         |      |         |
|------------------------------------------------------------------------|------|---------------------------------------|-------|---------|------|---------|
|                                                                        | UNIT | DSD150-23LC with Integrated SmartCAFS | ECN   | CFL3194 | PAGE | 2 OF 12 |
|                                                                        | TYPE | Single Stage Midship Pump             | DOC # |         | REV  | A       |

## Abstract

The purpose of this report is to summarize the temperature testing results of the DSD150-23 SmartCAFS pump for CCC certification. The pump was originally built as a prototype in early 2013 but it suffered issues with overheating in the clutch housing during CAFS operational testing. The pump shaft was redesigned to fix an interference issue once discovered and the unit was tested in multiple configurations to prove out the new shaft design.

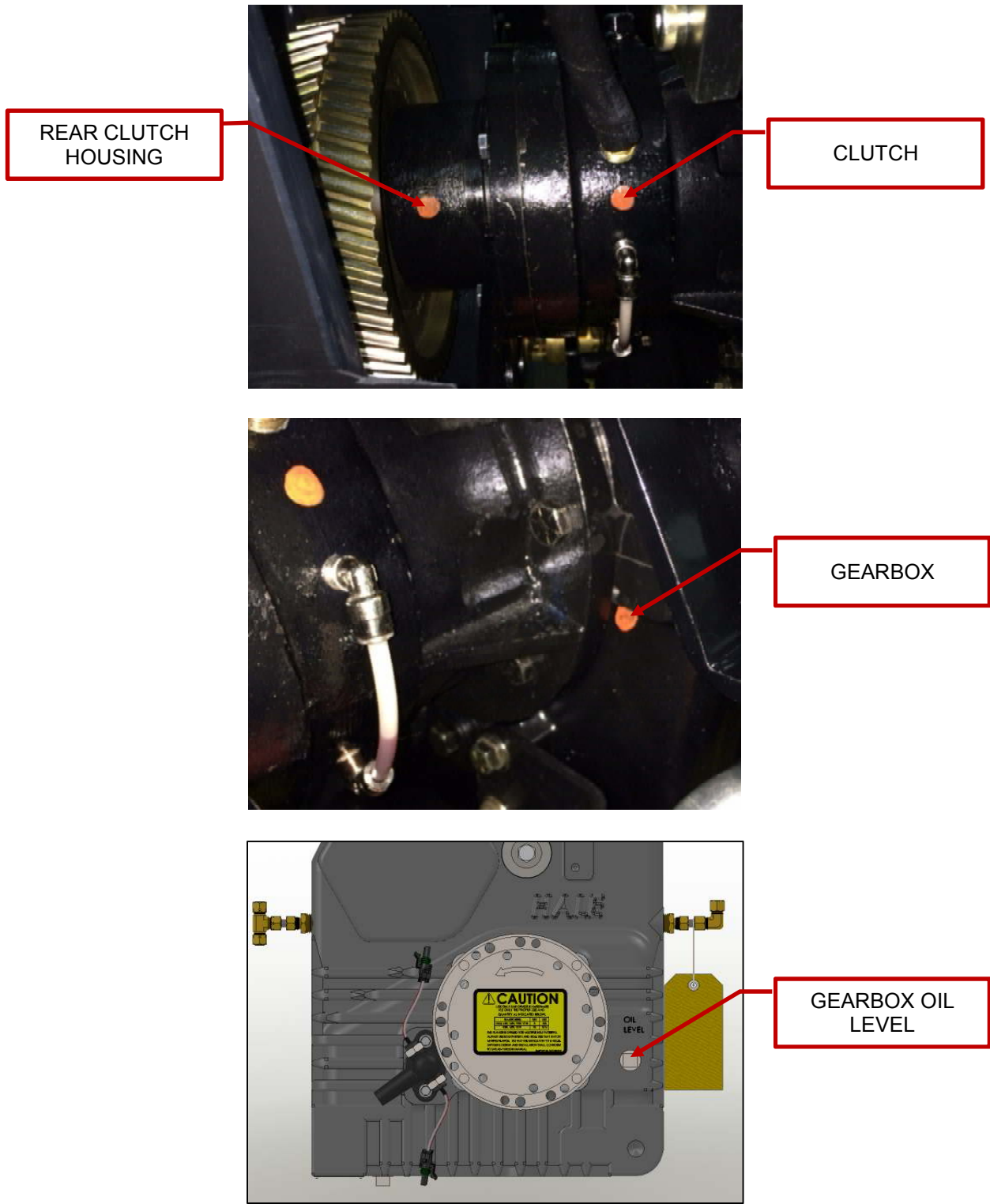
During CAFS testing it was discovered the clutch housing sees significant heat when the clutch is rotating in the housing and the clutch is not engaged. This heat is due to friction generated between the clutch plates and causes the temperature of the clutch housing to rise above 212°F (100°C) in less than 50 minutes of run time. 212°F (100°C) is the limit for the Chinese CCC certification.

To combat this excessive heat generation, a clutch cooler was added to the clutch housing and the gearbox cooler and cooling lines were changed to remove additional heat from the assembly. The test data that follows documents all of the testing with and without clutch coolers and with and without the CAFS system engaged in order to obtain the best sampling of data possible. A QMAX CAFS pump was tested in between DSD testing to create some baseline data since QMAX CAFS pumps have been built and tested successfully for 12+ years.

## DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification

|      |                                       |       |         |      |         |
|------|---------------------------------------|-------|---------|------|---------|
| UNIT | DSD150-23LC with Integrated SmartCAFS | ECN   | CFL3194 | PAGE | 3 OF 12 |
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### Location of Temperature Test Points



| DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification |                                       |  |       |         |      |         |
|------------------------------------------------------------------------|---------------------------------------|--|-------|---------|------|---------|
| UNIT                                                                   | DSD150-23LC with Integrated SmartCAFS |  | ECN   | CFL3194 | PAGE | 4 OF 12 |
| TYPE                                                                   | Single Stage Midship Pump             |  | DOC # |         | REV  | A       |

**Date:** 01-15-2014

**Pump:** DSD150-23 SmartCAFS

**Serial No:** H01183-003

**Conditions:** New pump shaft design, no clutch cooler, 007-0100-00-0 1/2 inch gearbox cooling tube.

Clutch engaged, no compressor load, no belt.

116 HP, 1391 RPM, 147 PSI, 880 GPM.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|----------|
| 8:35 AM     | 0              | 72           | 72          | 72            | 76       |
| 8:45 AM     | 10             | 103          | 117         | 112           | 78       |
| 8:55 AM     | 20             | 128          | 141         | 135           | 78       |
| 9:05 AM     | 30             | 141          | 153         | 149           | 79       |
| 9:15 AM     | 40             | 150          | 161         | 155           | 79       |
| 9:25 AM     | 50             | 156          | 167         | 161           | 80       |
| 9:35 AM     | 60             | 160          | 170         | 165           | 80       |
| 9:45 AM     | 70             | 163          | 172         | 168           | 80       |
| 9:55 AM     | 80             | 167          | 175         | 169           | 80       |

**Date:** 01-15-2014

**Pump:** DSD150-23 SmartCAFS

**Serial No:** H01183-003

**Conditions:** New pump shaft design, no clutch cooler, 007-0100-00-0 1/2 inch gearbox cooling tube.

Clutch engaged with compressor load, belt tightened to 19 LBF.

173 HP, 1388 RPM, 148 PSI, CAFS.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|----------|
| 10:45 AM    | 0              | 124          | 133         | 136           | 78       |
| 10:55 AM    | 10             | 152          | 158         | 157           | 77       |
| 11:05 AM    | 20             | 170          | 173         | 173           | 79       |
| 11:15 AM    | 30             | 181          | 182         | 178           | 79       |
| 11:25 AM    | 40             | 189          | 188         | 184           | 79       |
| 11:35 AM    | 50             | 194          | 192         | 189           | 78       |
| 11:45 AM    | 60             | 196          | 195         | 192           | 79       |
| 11:55 AM    | 70             | 199          | 198         | 195           | 79       |
| 12:05 PM    | 80             | 200          | 198         | 195           | 79       |
| 12:15 PM    | 90             | 200          | 199         | 199           | 79       |
| 12:25 PM    | 100            | 202          | 201         | 197           | 79       |
| 12:35 PM    | 110            | 203          | 200         | 197           | 77       |
| 12:45 PM    | 120            | 202          | 202         | 198           | 78       |

| DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification |                                       |       |         |      |         |
|------------------------------------------------------------------------|---------------------------------------|-------|---------|------|---------|
| UNIT                                                                   | DSD150-23LC with Integrated SmartCAFS | ECN   | CFL3194 | PAGE | 5 OF 12 |
| TYPE                                                                   | Single Stage Midship Pump             | DOC # |         | REV  | A       |

**Date:** 01-16-2014

**Pump:** DSD150-23 SmartCAFS

**Serial No:** H01183-003

**Dyno No:** 3

**Conditions:** New pump shaft design, no clutch cooler, 007-0100-00-0 1/2 inch gearbox cooling tube.

Clutch engaged with compressor load.

125 HP, 1265 RPM, 125 PSI, 300-400 GPM CAFS.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|----------|
| 2:00 PM     | 20             | 143          | 158         | 164           | 76       |
| 2:10 PM     | 30             | 155          | 166         | 174           | 79       |
| 2:20 PM     | 40             | 163          | 174         | 178           | 77       |
| 2:30 PM     | 50             | 169          | 179         | 181           | 78       |
| 2:40 PM     | 60             | 172          | 182         | 182           | 77       |
| 2:50 PM     | 70             | 175          | 184         | 185           | 77       |
| 3:00 PM     | 80             | 177          | 186         | 187           | 78       |
| 3:10 PM     | 90             | 179          | 186         | 188           | 78       |
| 3:20 PM     | 100            | 180          | 188         | 189           | 79       |
| 3:30 PM     | 110            | 182          | 189         | 190           | 79       |
| 3:40 PM     | 120            | 182          | 189         | 190           | 79       |

**Conditions:** 173 HP, 1390 RPM, 150 PSI, 1000 GPM CAFS.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|----------|
| 3:50 PM     | 130            | 188          | 190         | 192           | 80       |
| 4:00 PM     | 140            | 192          | 194         | 195           | 80       |
| 4:10 PM     | 150            | 195          | 194         | 196           | 81       |
| 4:20 PM     | 160            | 197          | 198         | 197           | 81       |
| 4:30 PM     | 170            | 199          | 198         | 198           | 82       |
| 4:40 PM     | 180            | 198          | 198         | 197           | 80       |

**DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification**

|      |                                       |       |         |      |         |
|------|---------------------------------------|-------|---------|------|---------|
| UNIT | DSD150-23LC with Integrated SmartCAFS | ECN   | CFL3194 | PAGE | 6 OF 12 |
| TYPE | Single Stage Midship Pump             | DOC # |         | REV  | A       |

**Date:** 01-22-2014

**Pump:** DSD150-23 SmartCAFS

**Serial No:** H01183-003

**Dyno No:** 3

**Conditions:** New pump shaft design, no clutch cooler, 007-0100-00-0 1/2 inch gearbox cooling tube.

Clutch disengaged but spinning to create heat in clutch housing.

230 HP, 1750 RPM, 150 PSI, 1480 GPM, no CAFS, deck gun valve.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|----------|
| 11:55 AM    | 0              | 70           | 70          | 70            | 74       |
| 12:05 PM    | 10             | 119          | 118         | 85            | 75       |
| 12:15 PM    | 20             | 160          | 156         | 100           | 75       |
| 12:25 PM    | 30             | 182          | 185         | 146           | 76       |
| 12:35 PM    | 40             | 198          | 201         | 169           | 75       |
| 12:40 PM    | 45             | 204          | 211         | 186           | 75       |
| 12:45 PM    | 50             | 208          | 217         | 193           | 75       |
| 12:50 PM    | 55             | 214          | 221         | 197           | 75       |
| 12:55 PM    | 60             | 215          | 225         | 200           | 75       |

**Conditions:** 135 HP, 1400 RPM, 120 PSI, 1315 GPM, no CAFS.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|----------|
| 1:00 PM     | 65             | 213          | 228         | 205           | 75       |
| 1:05 PM     | 70             | 211          | 228         | 210           | 75       |
| 1:10 PM     | 75             | 208          | 227         | 210           | 75       |
| 1:15 PM     | 80             | 206          | 225         | 209           | 75       |

**Conditions:** 115 HP, 1400 RPM, 150 PSI, 850 GPM, no CAFS.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|----------|
| 1:25 PM     | 90             | 203          | 225         | 207           | 75       |
| 1:35 PM     | 100            | 199          | 225         | 210           | 75       |
| 1:45 PM     | 110            | 196          | 221         | 204           | 75       |
| 1:55 PM     | 120            | 195          | 220         | 206           | 76       |

**Conditions:** 65 HP, 1200 RPM, 110 PSI, 530 GPM, no CAFS.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|----------|
| 2:05 PM     | 130            | 188          | 217         | 205           | 76       |
| 2:15 PM     | 140            | 183          | 212         | 201           | 75       |
| 2:25 PM     | 150            | 179          | 209         | 198           | 75       |
| 2:35 PM     | 160            | 176          | 206         | 195           | 75       |
| 2:45 PM     | 170            | 174          | 205         | 193           | 76       |

| DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification |                                       |  |       |         |      |         |
|------------------------------------------------------------------------|---------------------------------------|--|-------|---------|------|---------|
| UNIT                                                                   | DSD150-23LC with Integrated SmartCAFS |  | ECN   | CFL3194 | PAGE | 7 OF 12 |
| TYPE                                                                   | Single Stage Midship Pump             |  | DOC # |         | REV  | A       |

**Date:** 01-23-2014

**Pump:** QMAX150-23 CAFSPro

**Serial No:** H03569-001

**Dyno No:** 3

**Conditions:** No clutch cooler, 007-0100-00-0 1/2 inch gearbox cooling tube.  
Clutch disengaged but spinning to create heat in clutch housing.  
197 HP, 1507 RPM, 150 PSI, 1460 GPM, no CAFS, H-port.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Gearbox Level (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|--------------------|----------|
| 10:35 AM    | 0              | 70           | 70          | 70            | 70                 | 76       |
| 10:55 AM    | 20             | 134          | 139         | 111           | 119                | 76       |
| 11:05 AM    | 30             | 159          | 163         | 130           | 140                | 76       |
| 11:15 AM    | 40             | 175          | 183         | 148           | 156                | 76       |
| 11:25 AM    | 50             | 187          | 198         | 164           | 167                | 76       |
| 11:35 AM    | 60             | 195          | 211         | 176           | 176                | 76       |
| 11:45 AM    | 70             | 203          | 220         | 187           | 183                | 76       |
| 11:55 AM    | 80             | 209          | 223         | 194           | 187                | 76       |
| 12:05 PM    | 90             | 210          | 230         | 199           | 189                | 76       |

| DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification |                                       |       |         |      |         |
|------------------------------------------------------------------------|---------------------------------------|-------|---------|------|---------|
| UNIT                                                                   | DSD150-23LC with Integrated SmartCAFS | ECN   | CFL3194 | PAGE | 8 OF 12 |
| TYPE                                                                   | Single Stage Midship Pump             | DOC # |         | REV  | A       |

**Date:** 01-24-2014

**Pump:** DSD150-23 SmartCAFS

**Serial No:** H01183-003

**Dyno No:** 3

**Conditions:** No clutch cooler, 007-3610-00-0 3/8 wrapped gearbox cooling tube, reduced clutch oil level to 27MM on sight tube.

Clutch disengaged but spinning to create heat in clutch housing.

215 HP, 1600 RPM, 153 PSI, 1500 GPM, no CAFS, deck gun valve.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Gearbox Level (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|--------------------|----------|
| 3:25 PM     | 5              | 99           | 102         | 88            | 86                 | 75       |
| 3:35 PM     | 15             | 136          | 131         | 107           | 110                | 75       |
| 3:45 PM     | 25             | 161          | 158         | 127           | 130                | 74       |
| 3:55 PM     | 35             | 175          | 177         | 148           | 150                | 75       |
| 4:05 PM     | 45             | 187          | 192         | 165           | 159                | 75       |
| 4:15 PM     | 55             | 194          | 204         | 177           | 160                | 75       |
| 4:25 PM     | 65             | 199          | 212         | 188           | 163                | 75       |
| 4:35 PM     | 75             | 203          | 220         | 195           | 165                | 75       |
| 4:40 PM     | 80             | 204          | 222         | 196           | 167                | 75       |
| 4:45 PM     | 85             | 206          | 224         | 196           | 168                | 75       |
| 4:50 PM     | 90             | 208          | 227         | 195           | 170                | 75       |
| 4:55 PM     | 95             | 208          | 229         | 193           | 173                | 75       |



**DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification**

|      |                                       |       |         |      |         |
|------|---------------------------------------|-------|---------|------|---------|
| UNIT | DSD150-23LC with Integrated SmartCAFS | ECN   | CFL3194 | PAGE | 9 OF 12 |
| TYPE | Single Stage Midship Pump             | DOC # |         | REV  | A       |

**Date:** 01-27-2014

**Pump:** DSD150-23 SmartCAFS

**Serial No:** H01183-003

**Dyno No:** 3

**Conditions:** First clutch cooling tube design, 007-3610-00-0 3/8 wrapped gearbox cooling tube, reduced clutch oil level to 27MM on sight tube.  
Clutch disengaged but spinning to create heat in clutch housing.  
220 HP, 1620 RPM, 152 PSI, 1510 GPM, no CAFS, deck gun valve.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Gearbox Level (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|--------------------|----------|
| 11:55 AM    | 5              | 90           | 76          | 72            | 79                 | 76       |
| 12:05 PM    | 15             | 140          | 84          | 76            | 101                | 76       |
| 12:15 PM    | 25             | 174          | 98          | 89            | 130                | 76       |
| 12:25 PM    | 35             | 191          | 120         | 112           | 149                | 76       |
| 12:35 PM    | 45             | 200          | 132         | 134           | 165                | 76       |
| 12:45 PM    | 55             | 206          | 141         | 149           | 172                | 76       |
| 12:55 PM    | 65             | 211          | 147         | 162           | 180                | 76       |

**Stop and fill 2 oz. oil in clutch housing. Check gearbox oil level.**

**Conditions:** 212 HP, 1610 RPM, 150 PSI, 1505 GPM, no CAFS, deck gun valve.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Gearbox Level (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|--------------------|----------|
| 1:10 PM     | 80             | 197          | 147         | 168           | 170                | 76       |
| 1:20 PM     | 90             | 206          | 153         | 180           | 176                | 76       |
| 1:30 PM     | 100            | 210          | 160         | 191           | 178                | 77       |
| 1:40 PM     | 110            | 212          | 161         | 199           | 182                | 77       |
| 1:50 PM     | 120            | 214          | 168         | 205           | 183                | 78       |
| 2:00 PM     | 130            | 216          | 170         | 209           | 183                | 78       |
| 2:10 PM     | 140            | 217          | 170         | 212           | 185                | 78       |
| 2:20 PM     | 150            | 217          | 170         | 214           | 187                | 78       |
| 2:30 PM     | 160            | 218          | 173         | 216           | 187                | 78       |
| 2:40 PM     | 170            | 218          | 168         | 217           | 187                | 79       |

| DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification |                                       |       |         |      |          |
|------------------------------------------------------------------------|---------------------------------------|-------|---------|------|----------|
| UNIT                                                                   | DSD150-23LC with Integrated SmartCAFS | ECN   | CFL3194 | PAGE | 10 OF 12 |
| TYPE                                                                   | Single Stage Midship Pump             | DOC # |         | REV  | A        |

**Date:** 01-28-2014

**Pump:** DSD150-23 SmartCAFS

**Serial No:** H01183-003

**Dyno No:** 1

**Conditions:** First clutch cooling tube design, 007-3610-00-0 3/8 wrapped gearbox cooling tube not connected to CAFS cooler, clutch oil level at half full. Clutch disengaged but spinning to create heat in clutch housing. 220 HP, 1620 RPM, 147 PSI, 1500 GPM, no CAFS, deck gun valve.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Gearbox Level (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|--------------------|----------|
| 11:05 AM    | 5              | 113          | 93          | 93            | 95                 | 79       |
| 11:15 AM    | 15             | 149          | 110         | 111           | 116                | 79       |
| 11:25 AM    | 25             | 172          | 124         | 130           | 136                | 79       |
| 11:35 AM    | 35             | 187          | 134         | 150           | 151                | 79       |
| 11:45 AM    | 45             | 195          | 143         | 168           | 162                | 79       |
| 11:55 AM    | 55             | 202          | 150         | 183           | 167                | 79       |
| 12:05 PM    | 65             | 204          | 153         | 186           | 172                | 80       |
| 12:15 PM    | 75             | 207          | 155         | 192           | 176                | 80       |
| 12:25 PM    | 85             | 210          | 159         | 199           | 178                | 80       |
| 12:35 PM    | 95             | 212          | 188         | 202           | 178                | 81       |
| 12:45 PM    | 105            | 215          | 188         | 215           | 181                | 81       |
| 12:55 PM    | 115            | 218          | 190         | 216           | 181                | 81       |
| 1:05 PM     | 125            | 217          | 191         | 218           | 183                | 81       |

# DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification

|      |                                       |       |         |      |          |
|------|---------------------------------------|-------|---------|------|----------|
| UNIT | DSD150-23LC with Integrated SmartCAFS | ECN   | CFL3194 | PAGE | 11 OF 12 |
| TYPE | Single Stage Midship Pump             | DOC # |         | REV  | A        |

**Date:** 01-29-2014

**Pump:** DSD150-23 SmartCAFS

**Serial No:** H01183-003

**Dyno No:** 1

**Conditions:** First clutch cooling tube design, 007-3610-00-0 3/8 wrapped gearbox cooling tube not connected to CAFS cooler, clutch oil level at half full. Clutch disengaged but spinning to create heat in clutch housing. 220 HP, 1620 RPM, 150 PSI, 1510 GPM, no CAFS, deck gun valve. Test was re-run in the morning after chillers had been actively cooling the pit water.

| Actual Time | Run Time (Min) | Gearbox (°F) | Clutch (°F) | Rear Hsg (°F) | Gearbox Level (°F) | Pit (°F) |
|-------------|----------------|--------------|-------------|---------------|--------------------|----------|
| 9:25 AM     | 5              | 93           | 94          | 77            | 82                 | 66       |
| 9:35 AM     | 15             | 152          | 129         | 110           | 115                | 65       |
| 9:45 AM     | 25             | 175          | 145         | 139           | 138                | 65       |
| 9:55 AM     | 35             | 187          | 162         | 158           | 153                | 65       |
| 10:05 AM    | 45             | 195          | 168         | 172           | 162                | 65       |
| 10:15 AM    | 55             | 200          | 180         | 184           | 167                | 65       |
| 10:25 AM    | 65             | 206          | 185         | 194           | 173                | 65       |
| 10:35 AM    | 75             | 209          | 189         | 201           | 173                | 65       |
| 10:45 AM    | 85             | 210          | 191         | 205           | 178                | 65       |
| 10:55 AM    | 95             | 212          | 189         | 208           | 180                | 65       |
| 11:05 AM    | 105            | 214          | 198         | 210           | 180                | 65       |
| 11:15 AM    | 115            | 214          | 200         | 212           | 181                | 66       |
| 11:25 AM    | 125            | 214          | 201         | 214           | 181                | 66       |
| 11:35 AM    | 135            | 215          | 202         | 215           | 182                | 66       |

| DSD SmartCAFS Clutch/Gearbox Temperature Testing for CCC Certification |                                       |  |       |         |      |          |
|------------------------------------------------------------------------|---------------------------------------|--|-------|---------|------|----------|
| UNIT                                                                   | DSD150-23LC with Integrated SmartCAFS |  | ECN   | CFL3194 | PAGE | 12 OF 12 |
| TYPE                                                                   | Single Stage Midship Pump             |  | DOC # |         | REV  | A        |

## Summary of Outcome

Based on the testing performed 15-Jan-2014 thru 16-Jan-2014, the problem with the original DSD shaft causing the clutch to overheat within 20 minutes has been corrected. When running CAFS, the new shaft design allows the unit to stabilize around 200°F (93°C) even after running for 3 hours. During a regular run test of 40 minutes (standard CAFS operational test) the clutch housing remains under 180°F (82°C) which is below the original maximum allowable temperature from FSG-TC-00100. Given these conditions, the DSD SmartCAFS pump assembly is capable of meeting the CCC certification specification in China.

Through further in-depth testing, it was discovered the clutch housings see noticeably higher temperatures when the CAFS compressor is disengaged due to the additional friction generated between the clutch plates. It has been determined the best method for eliminating the maximum amount of heat from the pump gearbox/clutch assembly is to do the following:

- Install a clutch cooling tube that is fed with water from the discharge manifold and returned to the suction manifold.
- Change the standard 007-0100-00-0 1/2 inch gearbox cooling tube to a 007-3610-00-0 3/8 inch wrapped gearbox cooling tube to gain increased surface area for additional gearbox cooling.
- Re-plumb the cooling hoses that connect the gearbox cooler and the CAFS heat exchanger so they each have their own feed and return lines as opposed to being plumbed in series (i.e. CAFS heat exchanger feeding gearbox cooling tube).
- Maintain a standard oil level in the hot shift clutch housing equal to approximately 12 oz. of Dexron III transmission fluid.

These changes allow the gearbox and clutch housing to stabilize around 215°F (102°C) after a run time of approximately 2 hours. These changes have been implemented on DSD and QMAX CAFS pumps built from January 2014 onward and the documentation updates that cover the required changes are currently in process. Information regarding these changes is covered on ECNs CFL3194, CFL3212 and CFL3229.