Calibration of the Regulating Unit on VARIAX® B & C Hub Fans

Howden has seen difficulties with the previous erection procedure for regulating units on VARIAX® B & C Hub Fans. It is very important – especially for fans operating in parallel – that the regulating units are mounted and calibrated correctly.

This procedure is implemented in all new erection and maintenance manuals edited after December 2013. The procedure is valid for fans with Howden B- and C-hubs.

Verification Document V213351-9 (see pages 7/8/9).

3.20 Blade Pitch Actuator

The movement of the actuator lever is transmitted to the external regulating arm of the fan through a connecting rod. From the external regulating arm the regulating movements are transmitted to the hydraulic regulating unit (hydraulic cylinder) through a regulating shaft and a pull fork.

The position of the actuator in relation to the regulating arm is designed so that the angular motion of the actuator and the air volume are almost linear.

1. The pedestal for the actuator on the side of the diffuser has been mounted according to the drawing in chapter 10.00 of the Fan Manuals “Actuator Arrangement”. Verify the location of the bracket is correct in verification document V213351-9.

Notice: All dimensions and angle given in this instruction are for reference only and the relevant project drawings must be used when calibrating the regulating drive assembly.
2. Verify the regulating arm bracket (see Figure 1) on the outer regulating arm is at the correct radius according to the drawing “Actuator Arrangement.”

3. Check / adjust actuator crank length “R1” (Figure 2) according to above mentioned drawings.

4. Check measurements “L1” and “L2” (Figure 2) according to the above mentioned drawings – correct if necessary. If tolerances are greater than ± 3 mm (0.12”) contact Howden for new calculation of “L3”.

5. Mount the rod ends on the external regulating arm and adjust the connecting rod length “L3 (Figure 2)” according to above mentioned drawings.

6. Adjust the actuator until the bracket on external regulating arm is in horizontal position – see Figure 2. According to above mentioned drawings.

**Checkpoint:** Check measurement of the outer regulating arrangement – check horizontal position for the bracket – see Calibration of Regulating Drive Assembly in verification document.

For electrical connections please see the actual terminal plan in Fan Manuals.

### 3.21 Calibration of the Regulating Drive Assembly (Internal and External)

Adjustment of the regulating drive assembly is very important to obtain an approximately linear control of the blade pitch. This means that the speed of the hydraulic cylinder is constant. Regulating Drive geometry is designed so that the torque from the actuator cannot "break" the external regulating arm (activating the torque switch) during normal operation.

The theoretical minimum and maximum blade angles can be found in the fan performance curve (blade angles) in chapter 2.00 in Fan Manuals. See example copy in Figure 3.

**Checkpoint:** Note actual theoretical minimum blade angle and actual maximum blade angle in document V213351-9.

Any blade angle (maximum/minimum) references in section 3.00 of the IOM manual must be verified by comparing the blade angle on the fan performance curve in chapter 2.00 of the IOM manual. Any deviations may be reported to Howden for clarification.

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**Figure 2: Extract from drawing “Actuator Arrangement”**

**Figure 3: Fan Curve – find actual curve in Fan Manual “Performance Data”**

Min blade angle = lowest mentioned angle + 1; (here 30+1=31)
Max blade angle = highest mentioned working point +1; (here 77+1=78)
The procedure below describes how to adjust the minimum and maximum mechanical blade pitch regulating range of the fan impeller, adjustment of the graduated scale at the external regulating lever, and adjustment of the torque switch mounted at the regulating lever.

Check that the maximum allowable working pressure has been reduced to an opening pressure at app. 20-35 bar (290-507 psi). The pressure reduction is required for mechanical protection of the mechanical regulating parts inside the hub when adjusting the mechanical blade pitch range and the torque switch. See chapter 3.00 in Fan Manuals “Mounting of Oil Cabinets”

Warning: When handling the blades, it is mandatory to use Howden’s hosting tool for blades. See Figure 4 and Instruction Manual for VARIAX® Blade Lifting Tool in Fan Manual.

Close the ball valve placed in the pressure line. Adjust the pressure relief valves at the control oil pumps in the oil cabinet downwards to the minimum pressure working pressure, 20 bar (290 psi). Open the ball valve and regulate the hub, if the hub does not regulate, slow increase the pressure relief valve setting until the hub moves.

Stop the Hydraulics and observe site safety regulations for working on energized equipment and fan blades.

1. Dismount one blade and mount the blade adjustment tool onto the blade pivot in the hub. See Figure 6 (Note the blade pivot number at the verification document V213351-9).
2. Start the control oil unit, for supplying oil to the hydraulic regulating unit.
3. Verify the blade angle tool position, it should be at 55°. If adjustment is required adjust the blade angle to 55° (mid-pitch) on the blade angle tool by loosening the set screws on the internal crank and rotating the internal crank manually. Exercise caution while moving the blades.
4. Stop the control oil unit.
5. Check that the blade angle is 55°. If necessary, start the control oil unit and increase or decrease the blade angle until 55° is reached when the control oil unit is stopped.
6. Adjust the push rod length of the pull fork when the blades are in the middle position (55°). The rod length should be adjusted to position the internal regulating crank arm exactly in the vertical position.
7. Start the control oil unit and check that the blade angle is 55°. If necessary, the pull fork push rod length may be adjusted until the blade angle is 55° with oil pressure.

8. Secure the crank in the vertical position by means of the two socket set screws.

9. Adjust the regulating drive external graduated scale to 55° ± 0.5°, corresponding to 55° measured on the graduated scale of the blade adjustment tool. See Figure 9.

10. Start control oil unit.

11. Close the blades carefully to mechanical minimum limit, a spike in hydraulic pressure will indicate a hard stop has been reached. Mechanical minimum is: contact of the internal parts in hub. Record the angle on the blade angle tool mounted in the hub.

12. Then open blade angle 2°, measured on the graduated scale of the blade-angle adjustment tool, and tighten the “open mechanical stop bolt” (see Figure 9) towards the stop pin.

13. To avoid mechanical contact between the blades the current minimum blade angle must be adjusted to a distance between blades ≥3 mm – see Figure 8.

14. Open the blades carefully to mechanical maximum limit, a spike in hydraulic pressure will indicate a hard stop has been reached. Mechanical maximum is: contact of the internal parts in hub. Record the angle on the blade angle tool mounted in the hub. E.g. 78° measured on the graduated scale of the blade adjustment tool and tighten the “open mechanical stop bolt” (see Figure 9) towards the stop pin.

15. Adjust blade angle to 55° measured at the blade angle measuring tool and check that external graduated scale corresponds to 55° ± 0.5°.

16. Adjust the internal end of the travel limit electronic switches and the position feedback transmitter in the actuator so that the “open and closed mechanical stop bolts” (Figure 9) avoid touching the stop pin in the extreme position. One of the internal mechanical switches can be adjusted to the position corresponding to the fan stall-cancelling angle.

17. The internal end of travel limit switches in the actuator should be adjusted according to the supplier’s instructions.

18. When adjusted, the blade angles (example) in Table 1 should be reached. (recalculate mA value for stall cancelling for actual blade angles).

19. Close the blades carefully to minimum e.g. 31° and tighten the “closed mechanical stop bolt” (see Figure 9) slightly towards the stop pin and secure with the locknut.

20. Open the blades to maximum e.g. 78° and tighten the “open adjustment set screw” (see Figure 9) slightly towards the stop pin and secure with the locknut.

21. Secure the internal crank and the external regulating arm to the regulating shaft by means of the socket set screws. Dismount one screw at a time and carefully drill a dimple (app 3 mm (0.12”)) in the shaft through the threaded hole – take care not to damage the thread. Carefully clean the hole before remounting the screw.

22. Check that the friction brake disc and friction disc are set at torque 10 Nm (7.38 lbft) by adjusting the clearance between the stop fork and the brake disk to approx. 2.3 mm (0.08”-0.12”).

23. Mount the torque switch on the external regulating arm (see drawing no in Fan Manual) and adjust it according to Figure 9. Adjust the screw (01) so that the torque/limit switch is activated, but still have a clearance of X mm (“Y”) to the bottom of the torque/limit switch movement. Lock the screw with the locknut (02).

24. Dismount the blade adjustment tool and mount the blade.

25. Mount the inspection cover in the impeller casing and seal with new “Super Seal” (PTFE) packing cord.

26. If fans are installed for parallel operation, the blade angle limits for both fans should be adjusted to the same value ± 0.5°.

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**Calculation of Set Point for Plant DCS**

Correct angle according to curve from Fan Performance Curve in the Fan Manual

**Table 1 (reference only)**

<table>
<thead>
<tr>
<th></th>
<th>min blade angle</th>
<th>max blade angle</th>
<th>stall canceling angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>mA</td>
<td>31</td>
<td>78</td>
<td>42</td>
</tr>
<tr>
<td>mA</td>
<td>4.0</td>
<td>20.0</td>
<td>7.7</td>
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</tbody>
</table>

Any deviations should be noted for further programming of the DCS – refer specially to item 14.

**Checkpoint:** Calibration of Regulating Drive Assembly in verification document V213351-9 in chapter 11.00.

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**Figure 9: Placing of Torque Limit Switch**

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**Notice:** Correct example blade angles in item 14) 19) and 20) and Table 1 according to actual Fan Curve

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**Notice:** Important: Blades are not allowed to touch each other.
3.22 Readjustment of Maximum Working Pressure

1. Stop the control oil unit.

**Warning:** Depressurize hoses/pipes containing high-pressure fluids and allow them to cool to a suitable temperature.

2. Dismount the supply and return oil hoses at the rotating oil-seal and short-circuit the two hoses with the nipple used previously, see Figure 5.

3. Close the ball valve placed in the pressure line just before the outlet flange in the oil unit and start the oil unit. Readjust the pressure relief valves at the control oil pumps at the oil unit upwards to the original pressure limit at xxx bar (yyyy psi). Check actual value in actual set point list in Fan Manual.

4. Stop the oil unit, dismount the short-circuit valve and mount the supply and return oil hoses at the rotating oil-seal.

3.23 Balancing the Counterweight at the Internal Regulating Crank Arm

All position numbers refer to drawing “Regulating Drive – Complete” in Fan Manual. See example above.

The internal regulating crank arm of the fan is equipped with an adjustable counterweight (30) mounted on a lever (29). The counterweight is mounted to balance the spring inside of the hydraulic cylinder, which acts on the pilot valve, forcing it to go out of position. If not balanced, hydraulic pressure will result in an uncontrolled movement of the hydraulic piston.

Adjustment of the counterweight balancing the hydraulic pressure is done from the inside of the inner tube of the diffuser. The external regulating arm must be disconnected from the actuator by disconnecting the connecting rod from the external regulating arm.

**Balance procedure:**

1. Disconnect the external regulating arm linkage.

2. Start the control oil unit.

3. Place the internal regulating crank arm in a position approximately in the middle of the regulating range.

4. Observe if the piston valve moves and if so observe the direction.

5. If any movement is observed, adjust the counterweight position at the lever to increase the force applied to the piston valve in the opposite direction of the movement.

6. Repeat the adjustment procedure by placing the internal regulating crank arm in different positions, including the end positions.

7. When adjusted stop the control oil unit.

**Checkpoint:** Calibration of Regulating Drive Assembly in verification document V213351-9.
Calibration of regulating drive assembly

Howden Denmark ApS

<table>
<thead>
<tr>
<th>Order number</th>
<th>Project name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan application</td>
<td>Size</td>
</tr>
<tr>
<td>Fan serial no.</td>
<td></td>
</tr>
</tbody>
</table>

Adjustment of the regulating drive assembly is of great importance to control the blade pitch approximately linear. This means that the speed of the hydraulic cylinder is constant. Regulating Drive geometry is designed so that the torque from the actuator can ‘break’ the outer control arm (activating of torque switch) when a failure of the hydraulic control unit occurs.

Installation and calibration are done according to instructions in E&C/OM-Manual chapter 3.00.

At maintenance follow instructions in O&M-Manual chapter 4.00.

Perform a calibration of each fan during erection and maintenance.

Refer to Actuator Arrangement Drawing in E&C-manual and O&M Manual Chapter 10.00.

Actual drawing number:

1. Check measure ‘R1’ and ‘R2’, ‘L1’ and ‘L2’ (Figure 1) according to above mentioned drawings – correct if needed. If tolerances are more than ± 3 mm (0.12”) contact Howden Basic Engineering for new calculation of ‘L3’.

![Figure 1](image)

Table 1

<table>
<thead>
<tr>
<th>Measurements according to drawing no.</th>
<th>Achieved measures</th>
<th>Approved</th>
<th>Rejected</th>
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<tbody>
<tr>
<td>R1</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>R2</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
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<td>☐</td>
</tr>
<tr>
<td>L2</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>L3</td>
<td>☐</td>
<td>☐</td>
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</tr>
</tbody>
</table>
Calibration of regulating drive assembly

Theoretical minimum and maximum blade angle can be found in the fan curve blade in chapter 2.00.

### Table 2

<table>
<thead>
<tr>
<th>Actual theoretical minimum blade angle</th>
<th>Actual maximum blade angle</th>
</tr>
</thead>
</table>

### Table 3

Note the blade pivot number where the blade adjustment tool is placed.

2. Regulate to blade angle 55° measured at the blade adjustment tool.
3. Check that outer regulation arm is in horizontal level and internal crank is in vertical level, at blade angle 55° (see Figure 2).

#### Figure 2

![Diagram](https://example.com/diagram.png)

Regulate length of pull fork to adjust crank to vertical at blade angle 55°.

- Vertical level checked
- Horizontal level checked

Notes:

4. To avoid mechanical contact between the blades, the actual minimum blade angle has to be adjusted to a distance between blades ≥3 mm (see Figure 3).
Calibration of regulating drive assembly

5. Once the calibration of the regulating drive has been completed, the blade pitch must be stroked through its operating range in 10% increments and the readings recorded in the table below.

Actual measured values:

<table>
<thead>
<tr>
<th>Set point</th>
<th>Blade angle</th>
<th>Feedback %</th>
<th>Feedback mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual minimum blade angle</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Stall cancelling angle</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td></td>
<td></td>
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<tr>
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<td>30</td>
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</tr>
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<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max blade angle</td>
<td>100</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

Results of measuring should be noted for further programming in the DCS

- Limit switches in actuator adjusted
- Check the friction brake disc and friction disc is set to torque 10 Nm (7.38 lbf ft)
- Travel of plunger on the torque switch adjusted according to drawing
- Adjustment mechanical step screws on the external regulating arm adjusted
- Maximum working pressure at control oil unit adjusted
- Counter weight at internal regulating arm adjusted

Date

Howden Denmark

Customer