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# CCTA Test 1: System Capabilities Test Report

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## Objective

The objective of this test is to characterize the system's capability and determine whether the desired outputs set by Boston Scientific (BSC) can be achieved at specific locations within the circulation system. Table 1 shows the target pressures and flow rates at these locations as specified by BSC.

Table : Desired System Outputs set by Boston Scientific.

|  |  |  |
| --- | --- | --- |
| Location | Flow Rate (L/min) | Pressure (mmHg) |
| Inferior Vena Cava | 1.02 | 5 |
| Common Femoral Vein | 0.91 | 10 |
| Right Atrium - IVC | 3.75 | 3 |
| Right Atrium - SVC | 2.42 | 8 |
| Left Atrium | NA | 8 |

## Equipment Needed

Table : Test Apparatus.

|  |  |
| --- | --- |
| Item | Purpose |
| CCTA | Device to be tested |
| CCTA MATLAB App | Control the system |
| Male Luer Syringe | System debubbling |
| Power Supply (0-12 V DC) | Power the system |

## Test Procedure

**1. Set Up the System**

* Set the CCTA up using the following schematic as a reference:

A diagram of a computer system

AI-generated content may be incorrect.

Figure : CCTA Test 1 setup schematic.

* Connect the power supply to the control box using the designated banana plugs.
* Connect the control box to your laptop using the USB cable.

*Note: Make sure that the pressure sensor valves are open to the system, otherwise there won’t be any pressure readings.*

**2. Open the needle valve to the Silver line (fully Open)**

*Note: This step is important to avoid creating a large back pressure which could potentially cause leaks and system failure.*

**3. Fill the system with water until the water level is just underneath the top barb in the reservoir**

**4. Run and debubble the system for 5 minutes.**

* Turn on the power supply and set it to **12 V**.
* Open the CCTA MATLAB App and click “Connect”.
* Set the Control Mode to manual.
* Set the Pump Power (duty cycle) to **50%**.
* Visually inspect the system for any bubbles, use the Luer syringe to debubble the pressure sensors. Squeeze the tubing where there are large bubbles to push the bubbles out.
* Add water to the reservoir if needed.

**5. Calibrate the pressure sensors by clicking the “Calibrate” button on the MATLAB App and following the instructions.**

**6. Adjust the pump power, needle valve throttle and the pressure regulator valve throttle to characterise the system.**

* Determine the maximum attainable flow/pressure and record the settings.
* Determine the minimum attainable flow/pressure and record the settings.
  + Close the needle valve slowly until the analog indicator on the pressure regulator valve start flickering (this means that the pressure regulator valve is engaged).
* Change the settings to achieve the desired targets as shown in Table 1.

## Test Results and Discussion

Table 3 below shows the system limits in terms of minimum and maximum flow and pressure, along with the corresponding settings. Comparing these results with the targets in Table 1, we can see that the system covers the entire range of values required by BSC.

Table : System Limits.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Flow Rate (L/min) (±SD) | Pressure (mmHg) (±SD) | Settings |
| Minimum | 0.02 (± 0.0) | 3.02 (± 0.3) | * Needle Valve **Red Line**. * Pressure Regulator Valve at **0 PSI**. * Pump Power at **30%.** |
| Maximum | 4.67 (± 0.0) | 123.66 (± 0.5) | * Needle Valve **Fully Open**. * Pressure Regulator Valve at **0 PSI**. * Pump Power at **100%.** |

The procedure outlined above was repeated to target specific values within the common femoral vein, inferior vena cava, and right atrium. This allows us to determine the required settings to achieve those targets. It should be noted that these settings may not yield the exact same results as shown above, as performance also depends on the system setup and tube lengths. Users should fine-tune the system for each test to ensure the desired flow and pressure are achieved.

Table 4 and Table 5 below show the results from these tests. With the current system schematic, most of the target values were achievable with great accuracy.

Values highlighted in orange were difficult to verify. Regarding pressures, only a single sensor is connected to the right atrial wall, so only the average atrial pressure could be measured. Regarding flow, the pump’s maximum flow rate is 4.7 L/min; given the current setup (Figure 1), the RA–IVC and RA–SVC target flows cannot be achieved simultaneously because the fluid splits into two lines before combining in the atrium (and 3.75 L/min + 2.42 L/min ≠ 4.7 L/min). However, since these target values remain within the system limits shown in Table 2, they are achievable, just **not simultaneously**.

Table : Flow Targets Test Results.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test # | Location | Target Flow Rate (L/min) | Achieved Flow Rate (L/min) (± SD) | Duty Cycle (%) | Needle Valve | PRV Backpressure (PSI) |
| 1 | Inferior Vena Cava | 1.02 | 1.02 (±0.0) | 65 | Silver Line | 0 |
| 2 | Common Femoral Vein | 0.91 | 0.92 (±0.0) | 25 | Silver Line | 0 |
| 3 | Right Atrium - IVC | 3.75 | - | - | - | - |
| 4 | Right Atrium - SVC | 2.418 | - | - | - | - |

Table : Pressure Targets Test Results.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test # | Location | Target Pressure (mmHg) | Achieved Pressure (mmHg) (± SD) | Duty Cycle | Needle Valve | PRV Backpressure  (PSI) |
| 5 | Inferior Vena Cava | 5 | 4.99 (±0.2) | 35 | Red Line | 10 |
| 6 | Common Femoral Vein | 10 | 10.51 (±0.3) | 40 | Blue Line | 8 |
| 7 | Right Atrium - IVC | 3 | - | - | - | - |
| 8 | Right Atrium - SVC | 8 | - | - | - | - |
| 9 | Left Atrium | 8 | 8.01 (±0.3) | 35 | Blue Line | 8 |

## Conclusion

Overall, the test was successful and demonstrates that the CCTA is effective at achieving the flow and pressure targets set by Boston Scientific. The system would need to be modified to reach the values highlighted in orange in the tables above. However, since these remain within the system limits, they are still achievable, just not simultaneously.