

## Data description file

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*v. 02March2002*

**1. Version Info**

<b>version #</b>	<b>Remarks</b>
<b>1.0</b>	Start-up version
<b>1.1</b>	Introduction of Sections: Set of actuator faults, Index of artificial faults.
<b>02March2002</b>	Introduction of Version Info Section. Change in f15 definition. Correction in f2, f3 names.

## 2. Tag description

Each data file contains data acquired from one day. Data are structured in a form of a matrix (86400 rows x 33 columns) of real numbers. Columns are related to the process variables while rows correspond to the time stamp. *NaN* string represents dummy data in the case of data lack. The table below contains columns and related process variables description.

Table 1. Tag description

Column	Actuator	Variable Symbol	Variable Description	Range	Units
1	1	-	Time stamp	0 – 86399 <sup>1)</sup>	s
2		P51_05	P1 – juice pressure (valve inlet)	0 – 1000	kPa
3		P51_06	P2 - juice pressure (valve outlet)	0 – 1000	kPa
4		T51_01	T - juice temperature (valve outlet)	50 – 150	°C
5		F51_01	F - juice flow (1 <sup>st</sup> evaporator inlet)	0 – 500	m <sup>3</sup> /h
6		LC51_03CV	CV – control value (controller output)	0 – 100 <sup>2)</sup>	%
7		LC51_03X	X – servomotor rod displacement	0 – 100 <sup>2)</sup>	%
8		LC51_03PV	PV - process value (juice level in 1 <sup>st</sup> evaporator)	0 – 100 <sup>3)</sup>	%
9		TC51_05	Juice temperature (1 <sup>st</sup> evaporator inlet)	50 – 150	°C
10		T51_08	Juice temperature (1 <sup>st</sup> evaporator outlet)	50 - 150	°C
11		D51_01	Juice density (1 <sup>st</sup> evaporator inlet)	0 - 25	Bx
12		D51_02	Juice density (1 <sup>st</sup> evaporator outlet)	13 - 41	Bx
13		F51_02	Steam flow	1 - 100	t/h
14		PC51_01	Steam pressure	100 - 300	kPa
15		T51_06	Steam temperature	50 - 150	°C
16		P51_03	Vapour pressure	0 - 250	kPa
17		T51_07	Vapour temperature	50 - 150	°C
18	2	P57_03	P1 – juice pressure (valve inlet)	0 - 1000	kPa
19		P57_04	P2 - juice pressure (valve outlet)	0 - 1000	kPa
20		T57_03	T - juice temperature (valve inlet)	0 - 150	°C
21		FC57_03PV	PV - process value (juice flow, 5 <sup>th</sup> evaporator outlet)	0 – 100	m <sup>3</sup> /h
22		FC57_03CV	CV – control value (controller output)	0 – 100 <sup>2)</sup>	%
23		FC57_03X	X – servomotor rod displacement	0 – 100 <sup>2)</sup>	%
24	3	P74_00	P1 – water pressure (valve inlet)	0 – 4000	kPa
25		P74_01	P2 – water pressure (valve outlet)	0 – 4000	kPa
26		T74_00	T - water temperature (valve outlet)	0 – 150	°C
27		F74_00	F – water flow (steam boiler inlet)	0 – 40	t/h
28		LC74_20CV	CV – control value (controller output)	0 – 100 <sup>2)</sup>	%
29		LC74_20X	X – servomotor rod displacement	0 – 100 <sup>2)</sup>	%
30		LC74_20PV	PV - process value (water level in steam boiler)	0 – 100	%
31		F74_30	Steam flow (steam boiler outlet)	0 – 40	t/h
32		P74_30	Steam pressure (steam boiler outlet)	0 - 4000	kPa
33		T74_30	Steam temperature (steam boiler outlet)	0 - 550	°C

<sup>1)</sup> Number of seconds from midnight

<sup>2)</sup> Value in percents of valve closing

<sup>3)</sup> 100% equals 1040mm

### 3. Set of actuator faults

Table 2. Actuator faults

Fault	Description
<i>Control valve faults</i>	
<b>f1</b>	Valve clogging
<b>f2</b>	Valve plug or valve seat sedimentation
<b>f3</b>	Valve plug or valve seat erosion
<b>f4</b>	Increased of valve or bushing friction
<b>f5</b>	External leakage (leaky bushing, covers, terminals)
<b>f6</b>	Internal leakage (valve tightness)
<b>f7</b>	Medium evaporation or critical flow
<i>Pneumatic servo-motor faults</i>	
<b>f8</b>	Twisted servo-motor's piston rod
<b>f9</b>	Servo-motor's housing or terminals tightness
<b>f10</b>	Servo-motor's diaphragm perforation
<b>f11</b>	Servo-motor's spring fault
<i>Positioner faults</i>	
<b>f12</b>	Electro-pneumatic transducer fault
<b>f13</b>	Rod displacement sensor fault
<b>f14</b>	Pressure sensor fault
<b>f15</b>	Positioner feedback fault
<i>General faults / external faults</i>	
<b>f16</b>	Positioner supply pressure drop
<b>f17</b>	Unexpected pressure change across the valve
<b>f18</b>	Fully or partly opened bypass valves
<b>f19</b>	Flow rate sensor fault

#### 4. Index of artificial faults

Artificial faults were introduced at: October 30, November 9, November 17, November 20, 2001. Below, the detailed description of introduced artificial faults is given.

*Table 3. Index of artificial faults introduced in Actuator 1 (thin juice inflow control)*

Item	Fault tag	Sample	Date	Fault description	Link
1	f18	58800-59800	October 30, 2001	Partly opened bypass valve	<a href="#">Figure 1</a>
2	f16	57275-57550	November 9, 2001	Positioner supply pressure drop	<a href="#">Figure 2</a>
3	f18	58830-58930	November 9, 2001	Partly opened bypass valve	<a href="#">Figure 3</a>
4	f18	58520-58625	November 9, 2001	Partly opened bypass valve	<a href="#">Figure 4</a>
5	f18	54600-54700	November 17, 2001	Partly opened bypass valve	<a href="#">Figure 5</a>
6	f16	56670-56770	November 17, 2001	Positioner supply pressure drop	<a href="#">Figure 6</a>
7	f17	37780-38400	November 20, 2001	Unexpected pressure drop across the valve	<a href="#">Figure 7</a>

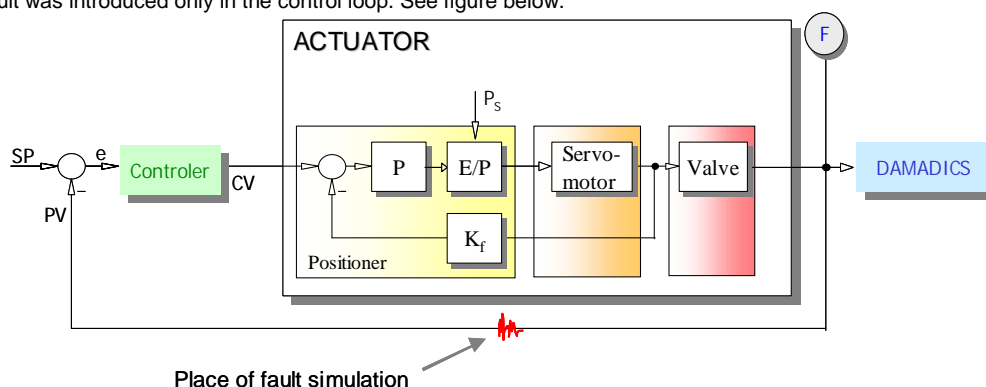
*Table 4. Index of artificial faults introduced in Actuator 2 (thick juice outflow control)*

Item	Fault tag	Sample	Date	Fault description	Link
8	f17	53780-53794	November 17, 2001	Unexpected pressure drop across the valve	<a href="#">Figure 8</a>
9	f17	54193-54215	November 17, 2001	Unexpected pressure drop across the valve	<a href="#">Figure 9</a>
10	f19 <sup>4)</sup>	55482-55517	November 17, 2001	Flow rate sensor fault	<a href="#">Figure 10</a>
11	f19 <sup>4)</sup>	55977-56015	November 17, 2001	Flow rate sensor fault	<a href="#">Figure 11</a>
12	f19 <sup>4)</sup>	57030-57072	November 17, 2001	Flow rate sensor fault	<a href="#">Figure 12</a>
13	f17	start at 44400	November 20, 2001	Unexpected pressure drop across the valve	<a href="#">Figure 13</a>

*Table 5. Index of artificial faults introduced in Actuator 3 (water inflow control)*

Item	Fault tag	Sample	Date	Fault description	Link
14	f18	57340-57890	October 30, 2001	Partly opened bypass valve	<a href="#">Figure 14</a>
15	f16	60650-60700	November 9, 2001	Positioner supply pressure drop	<a href="#">Figure 15</a>
16	f16	60870-60960	November 9, 2001	Positioner supply pressure drop	<a href="#">Figure 16</a>
17	f16	57475-57530	November 17, 2001	Positioner supply pressure drop	<a href="#">Figure 17</a>
18	f16	57675-57800	November 17, 2001	Positioner supply pressure drop	<a href="#">Figure 18</a>
19	f19	58150-58325	November 17, 2001	Flow rate sensor fault	<a href="#">Figure 19</a>

<sup>4)</sup> Actuator 2 works in flow control loop. Please pay attention that the flow signal available in DAMADICS data file is fault free. The fault was introduced only in the control loop. See figure below.



## 5. Examples of artificial faults

### Artificial faults introduced in Actuator 1

Figure 1. Fault **f18** - partly opened bypass valve on Actuator 1

[Return to Table 3](#)



Figure 2. Fault **f16** – positioner supply pressure drop on Actuator 1

[Return to Table 3](#)

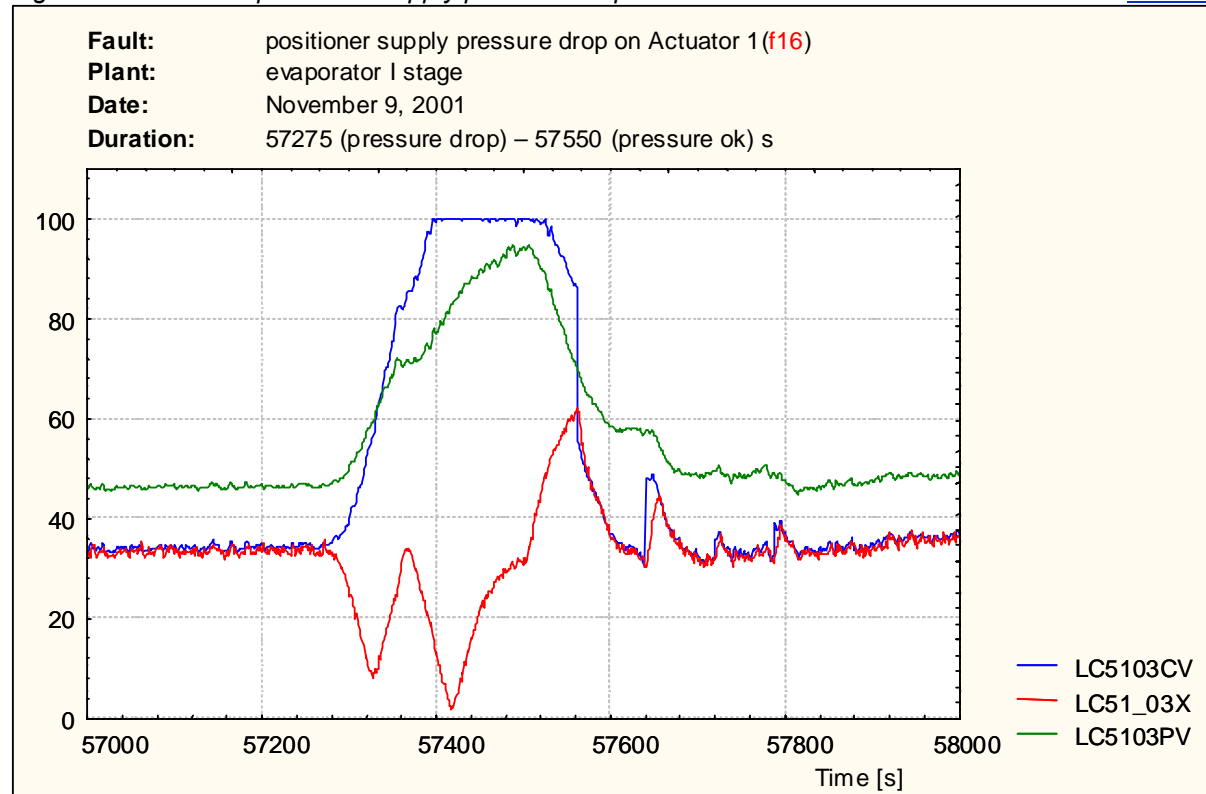


Figure 3. Fault **f18** – partly opened bypass valve on Actuator 1

[Return to Table 3](#)

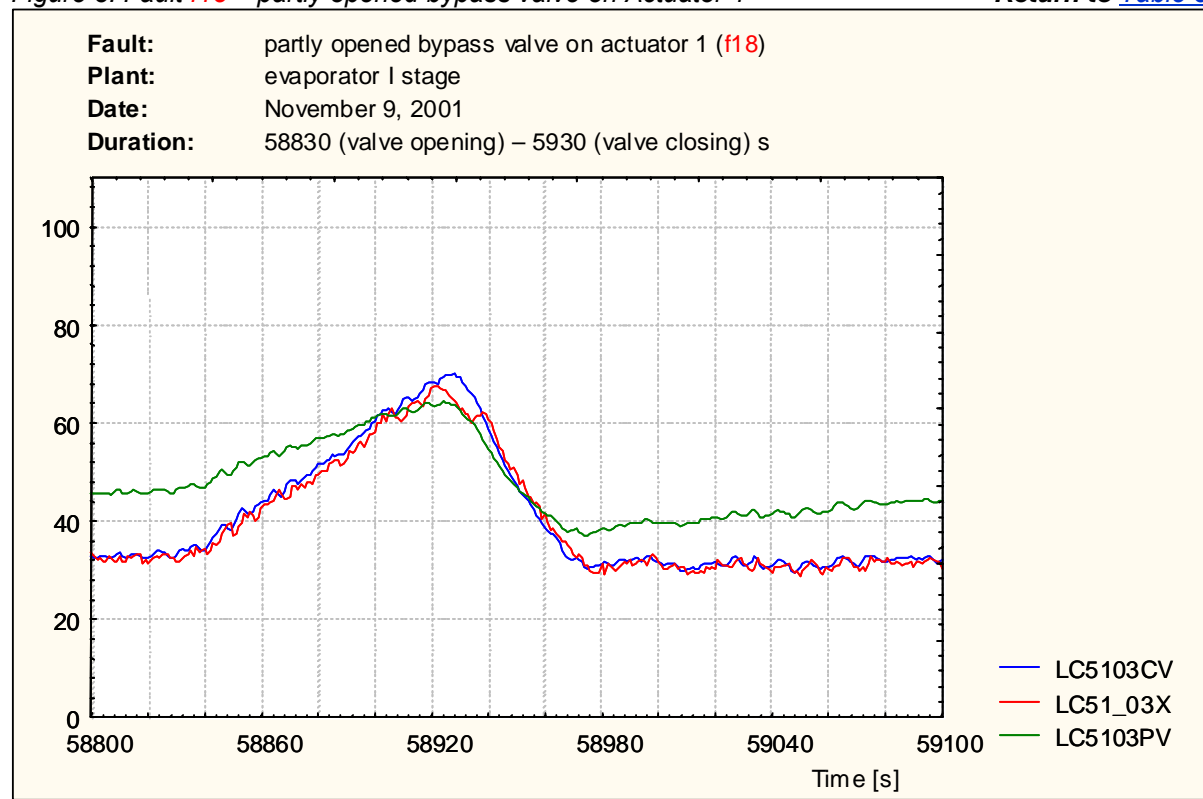


Figure 4. Fault **f18** – partly opened bypass valve on Actuator 1

[Return to Table 3](#)

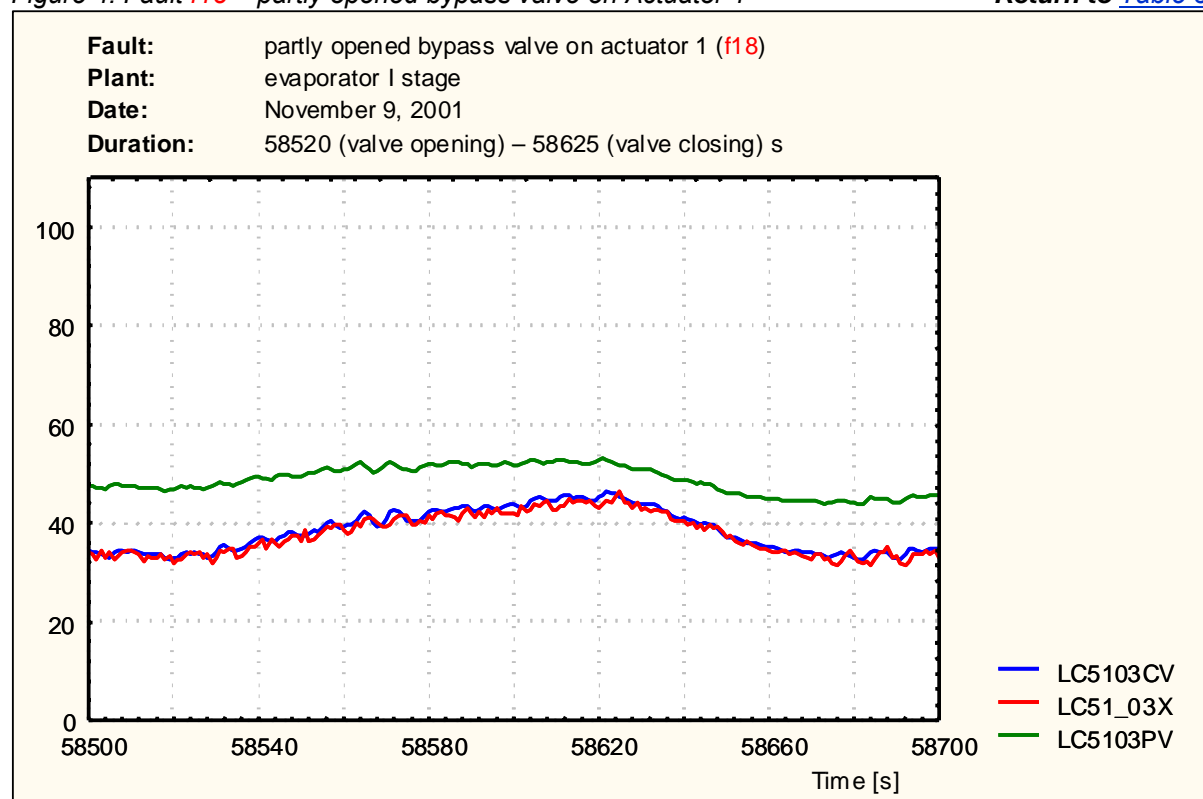


Figure 5. Fault **f18** – partly opened bypass valve on Actuator 1

[Return to Table 3](#)



Figure 6. Fault **f16** – positioner supply pressure drop on Actuator 1

[Return to Table 3](#)

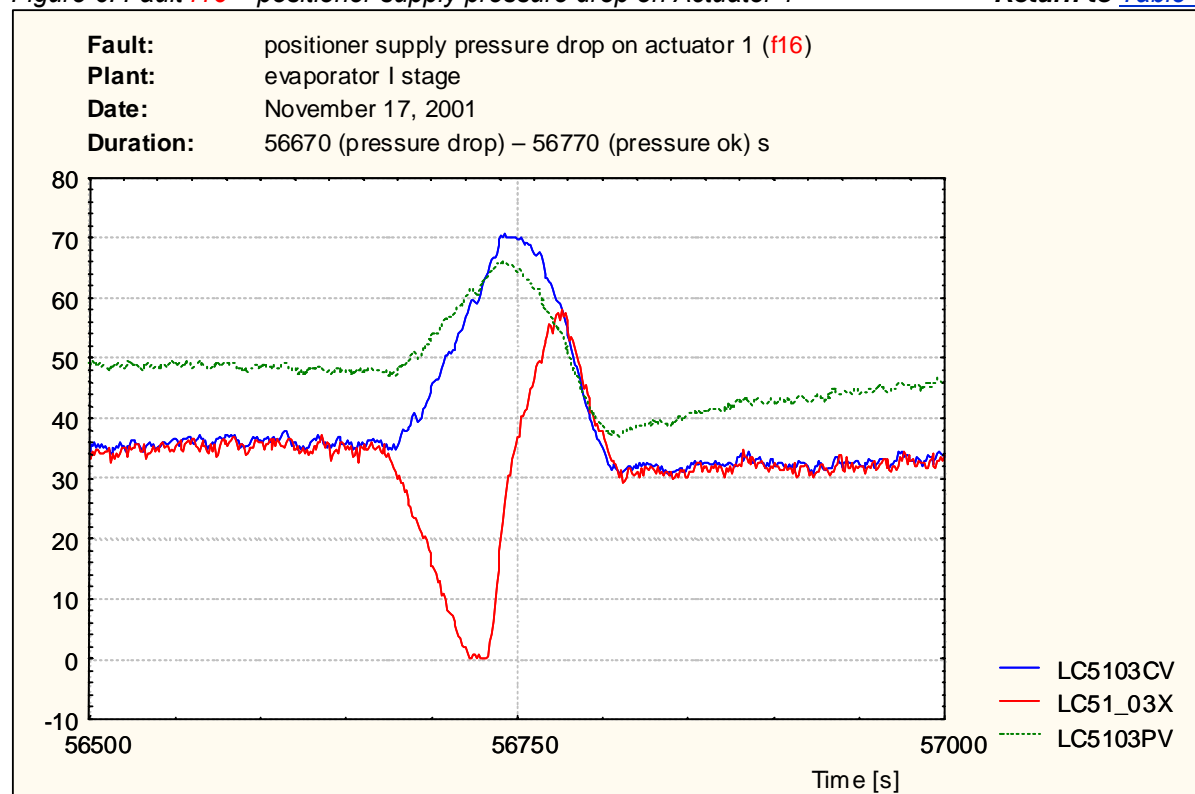




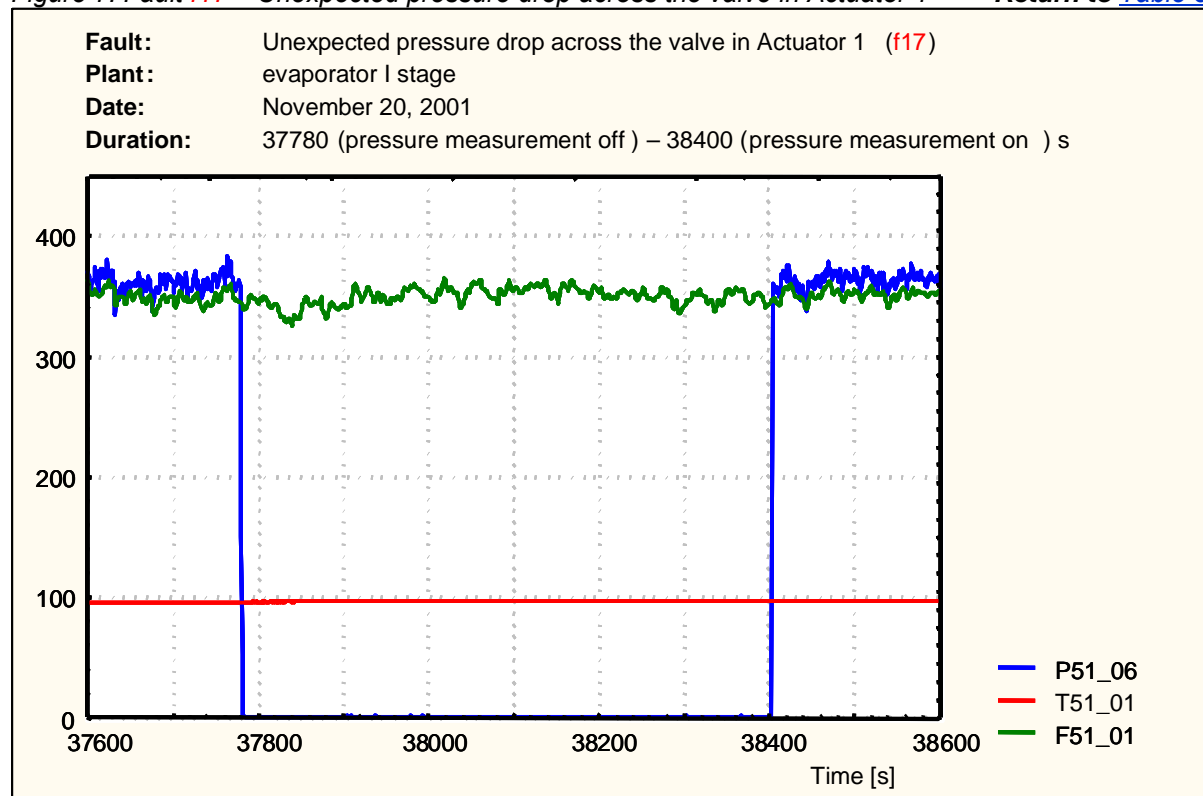
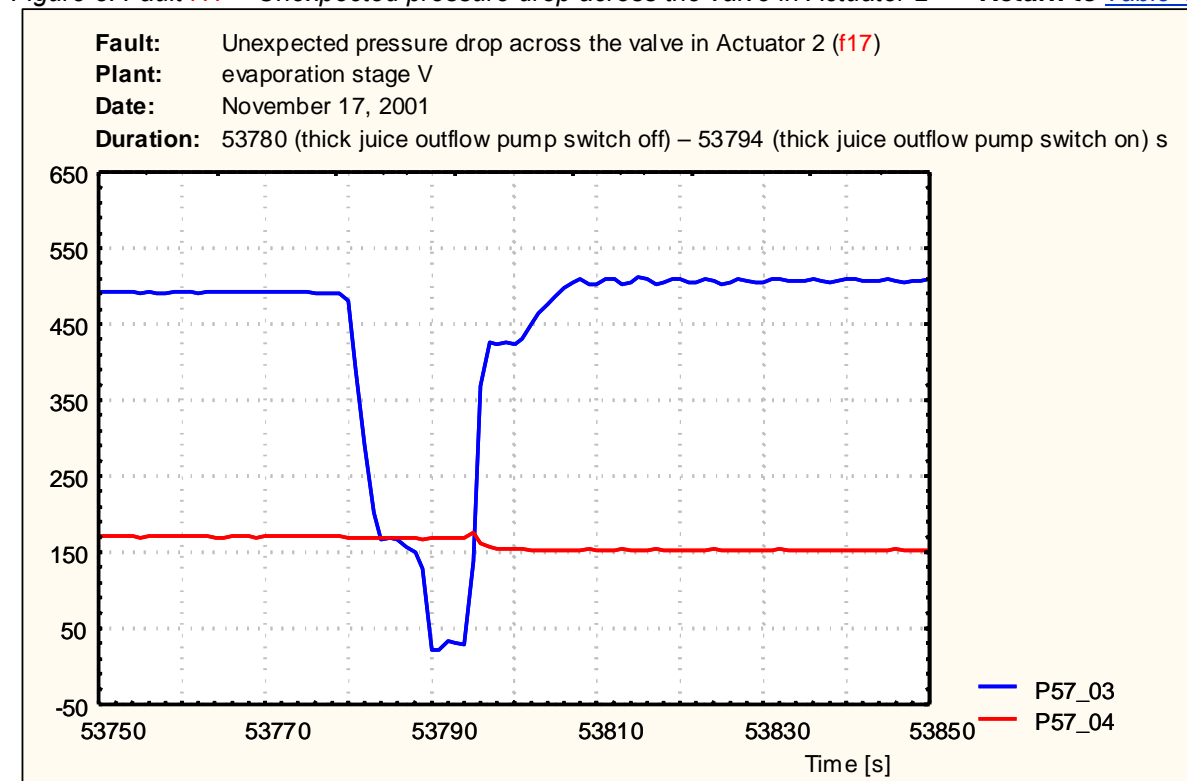
Figure 7. Fault **f17** – Unexpected pressure drop across the valve in Actuator 1 [Return to Table 3](#)**Artificial faults introduced in Actuator 2**Figure 8. Fault **f17** – Unexpected pressure drop across the valve in Actuator 2 [Return to Table 4](#)

Figure 9. Fault **f17** – Unexpected pressure drop across the valve in Actuator 2 [Return to Table 4](#)

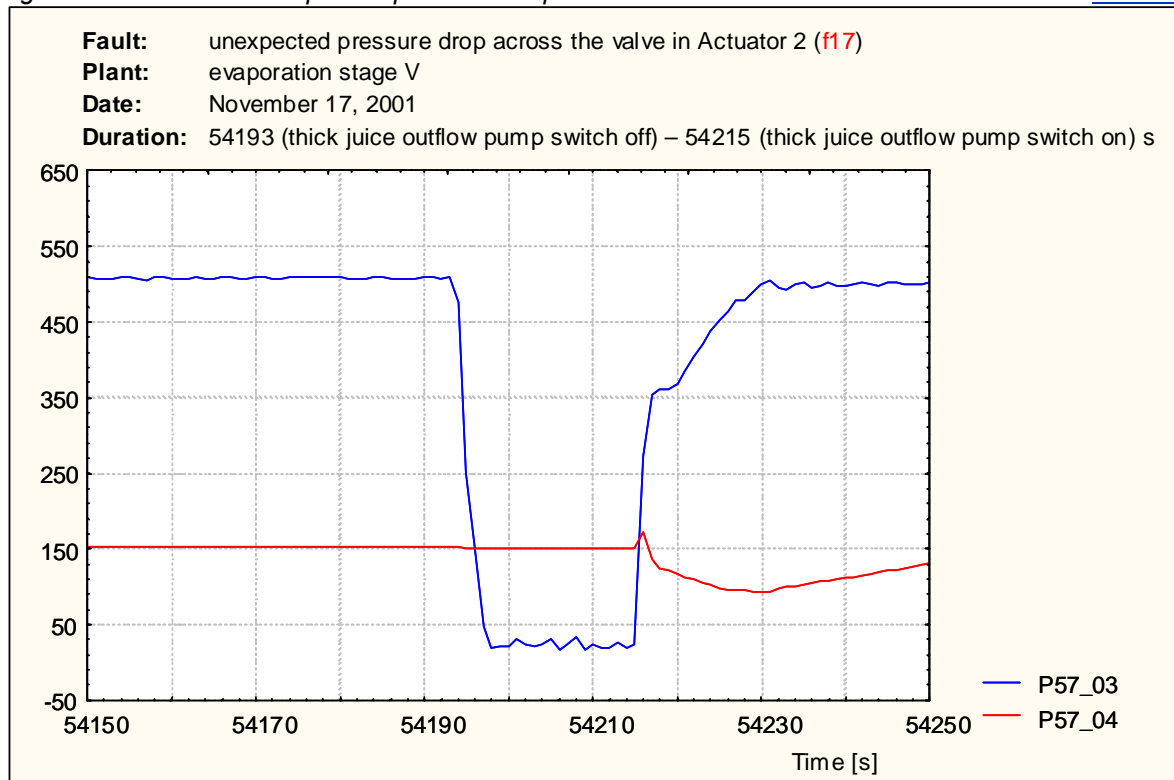


Figure 10. Fault **f19** – Flow rate sensor fault in Actuator 2

[Return to Table 4](#)

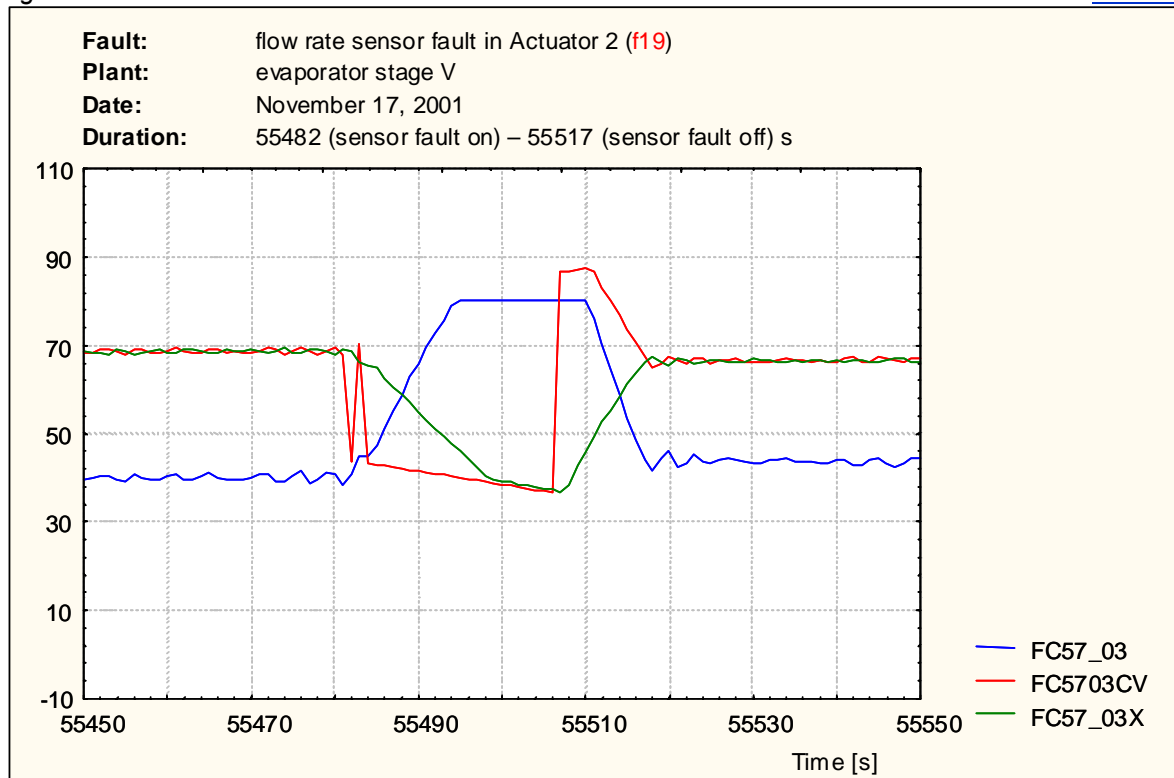


Figure 11. Fault **f19** – Flow rate sensor fault in Actuator 2

[Return to Table 4](#)

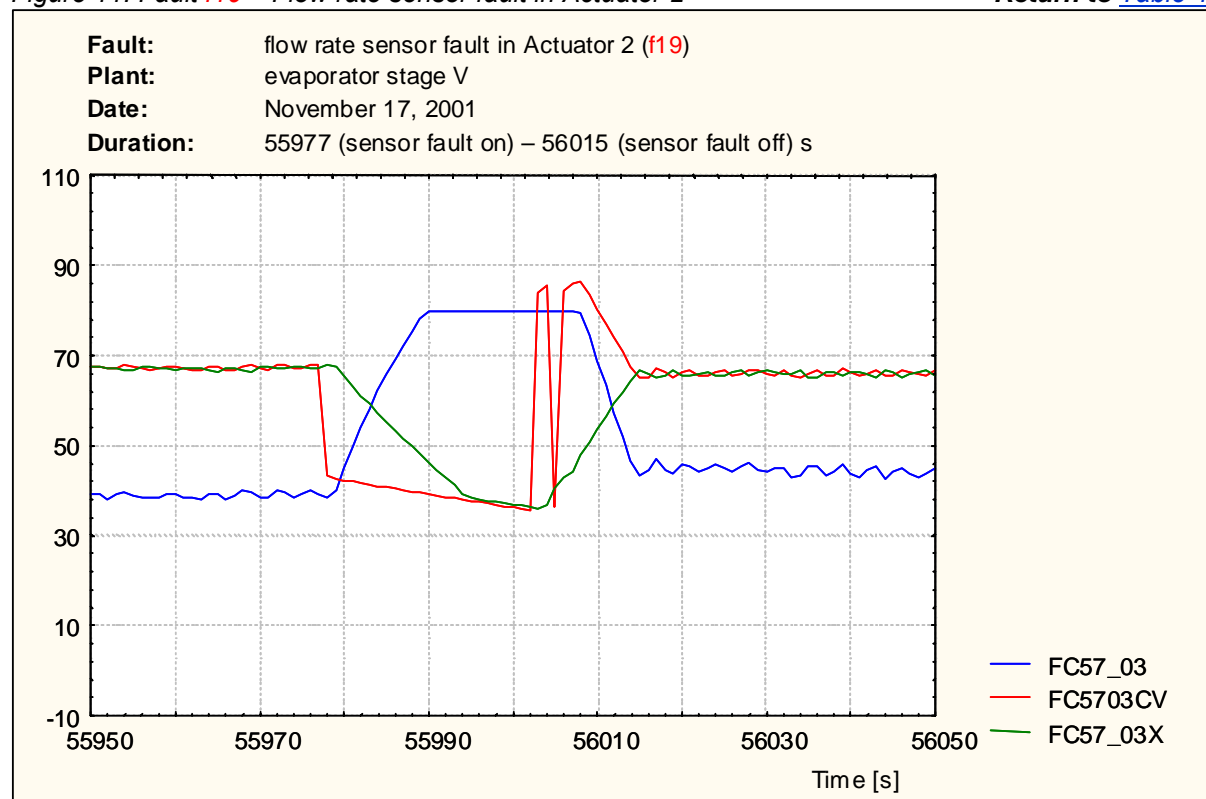


Figure 12. Fault **f19** – Flow rate sensor fault in Actuator 2

[Return to Table 4](#)

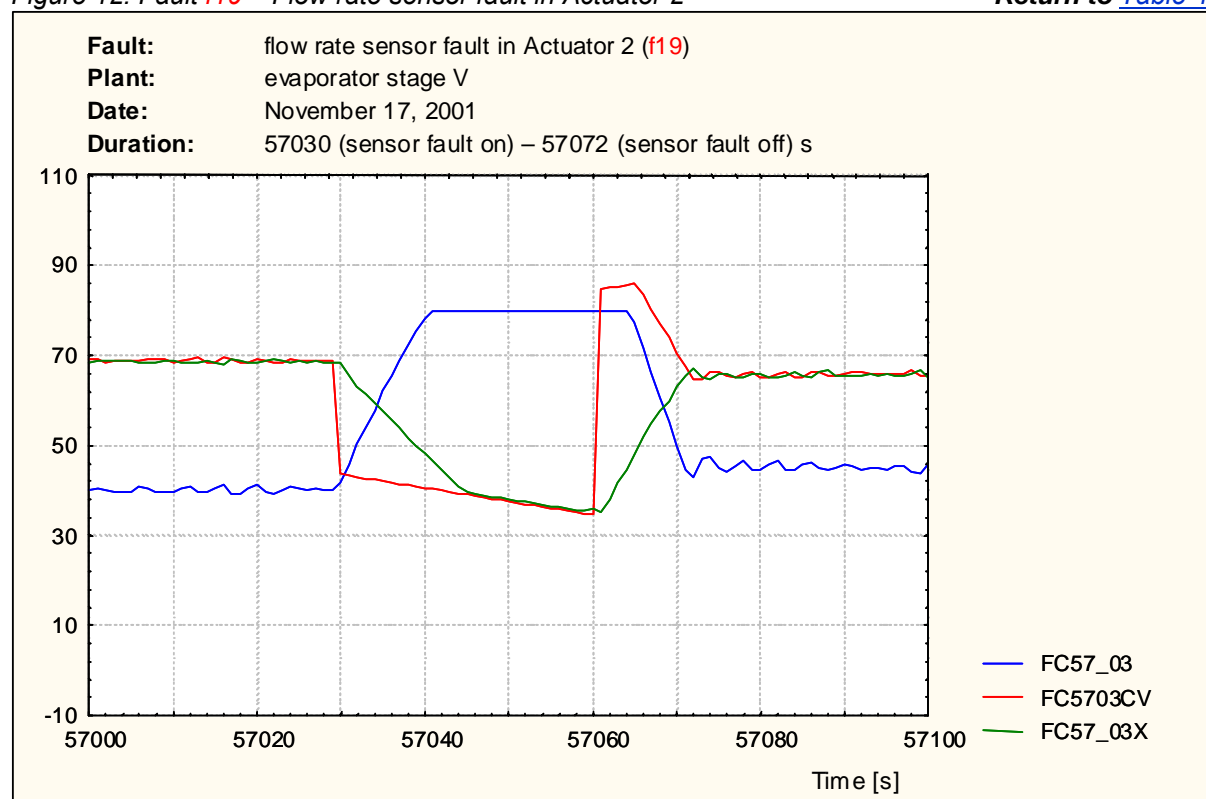
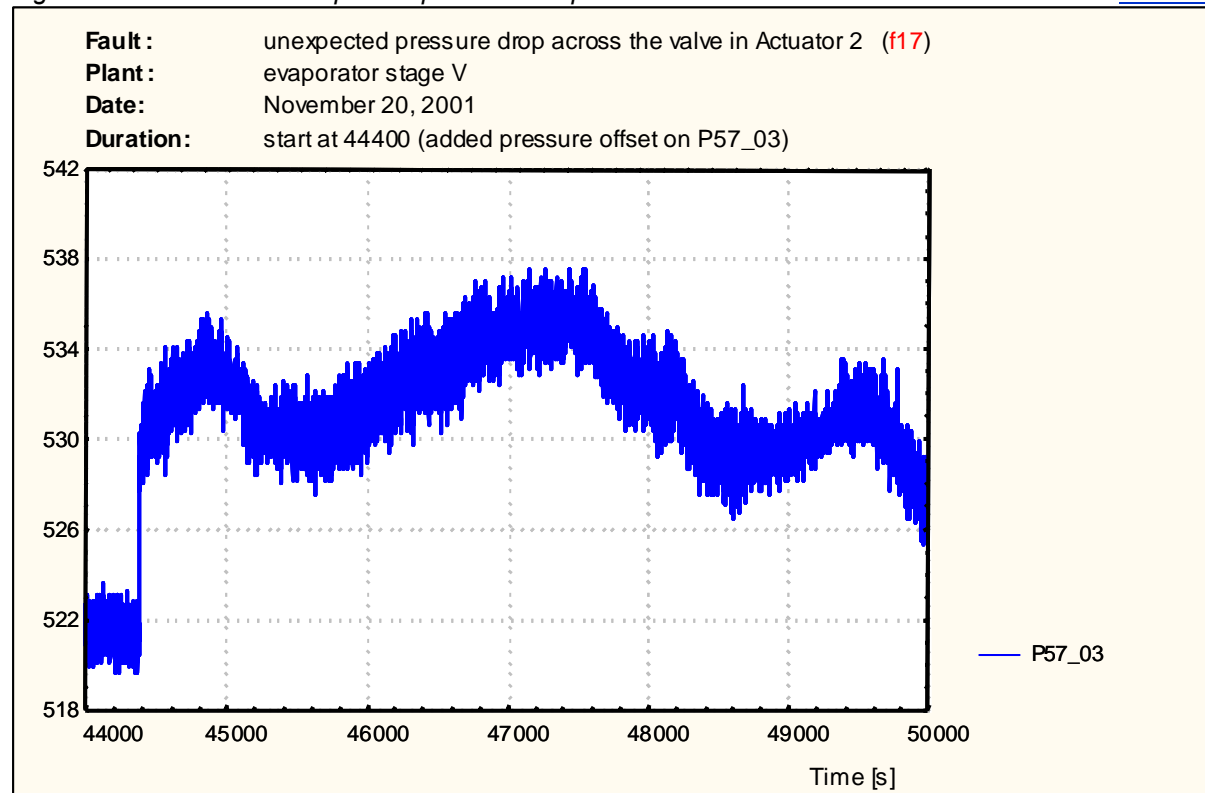


Figure 13. Fault **f17** – Unexpected pressure drop across the valve in Actuator 2 [Return to Table 4](#)



#### Artificial faults introduced in Actuator 3

Figure 14. Fault **f18** - Partly opened bypass valve on actuator 3

[Return to Table 5](#)

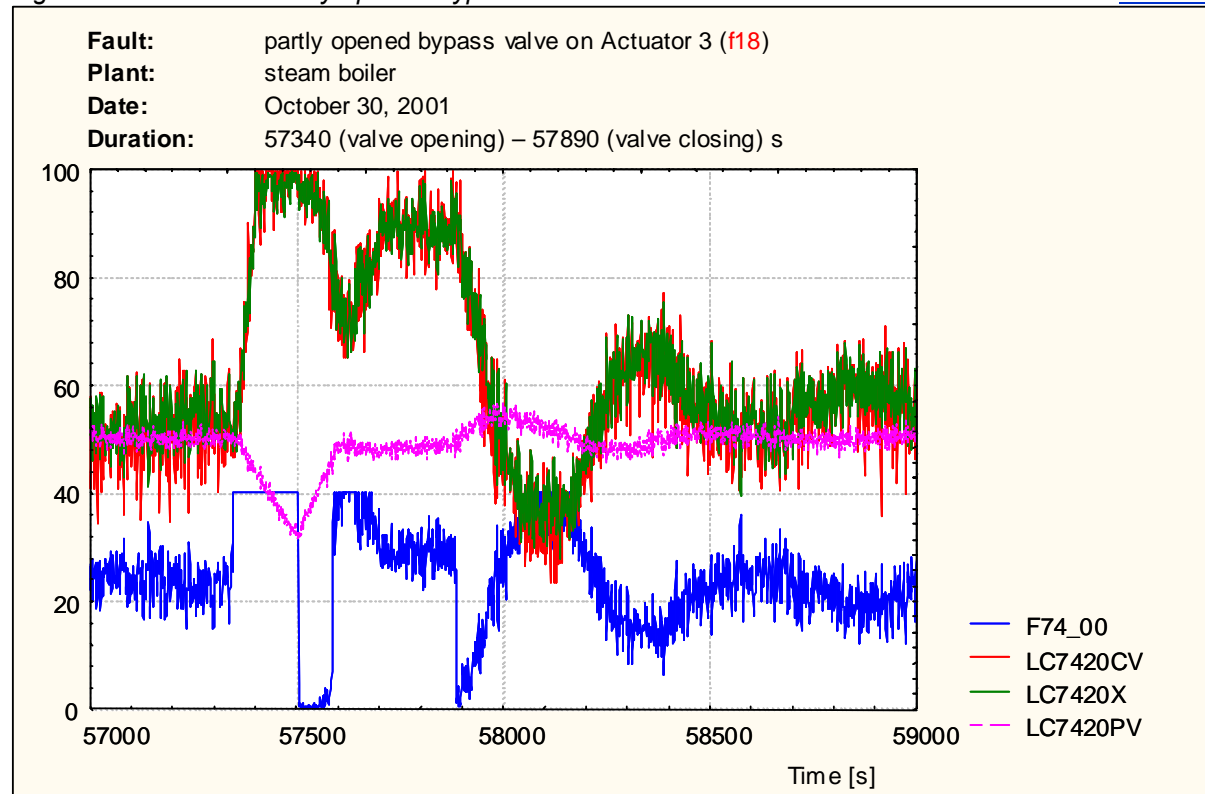


Figure 15. Fault **f16** – Positioner supply pressure drop on Actuator 3

[Return to Table 5](#)

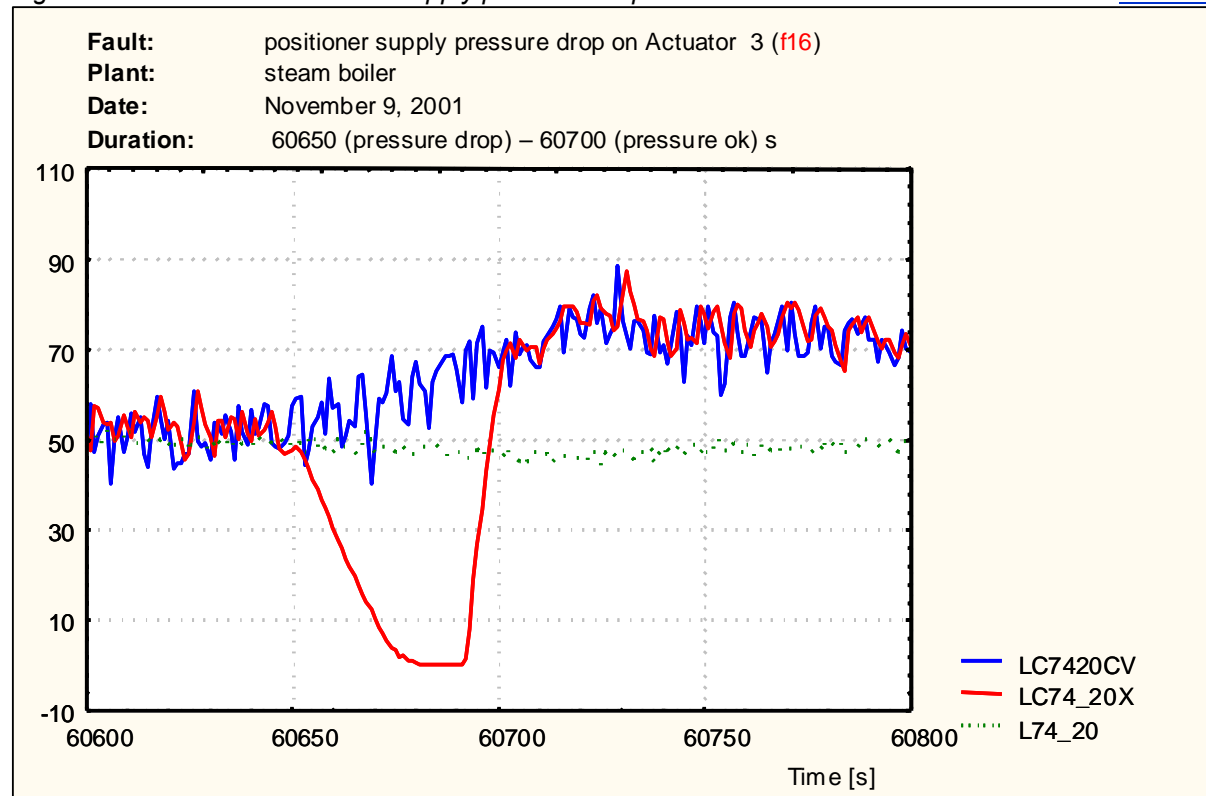


Figure 16. Fault **f16** – Positioner supply pressure drop on Actuator 3

[Return to Table 5](#)

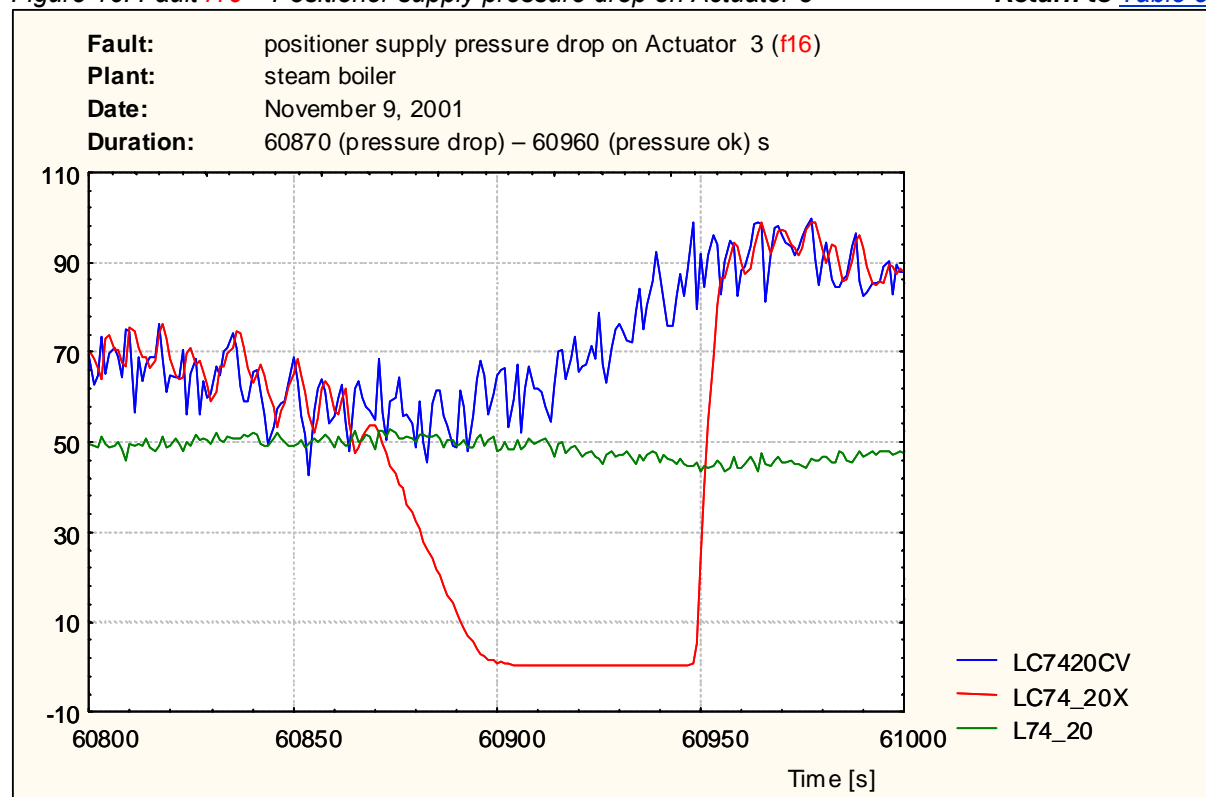


Figure 17. Fault **f16** – Positioner supply pressure drop on Actuator 3

[Return to Table 5](#)

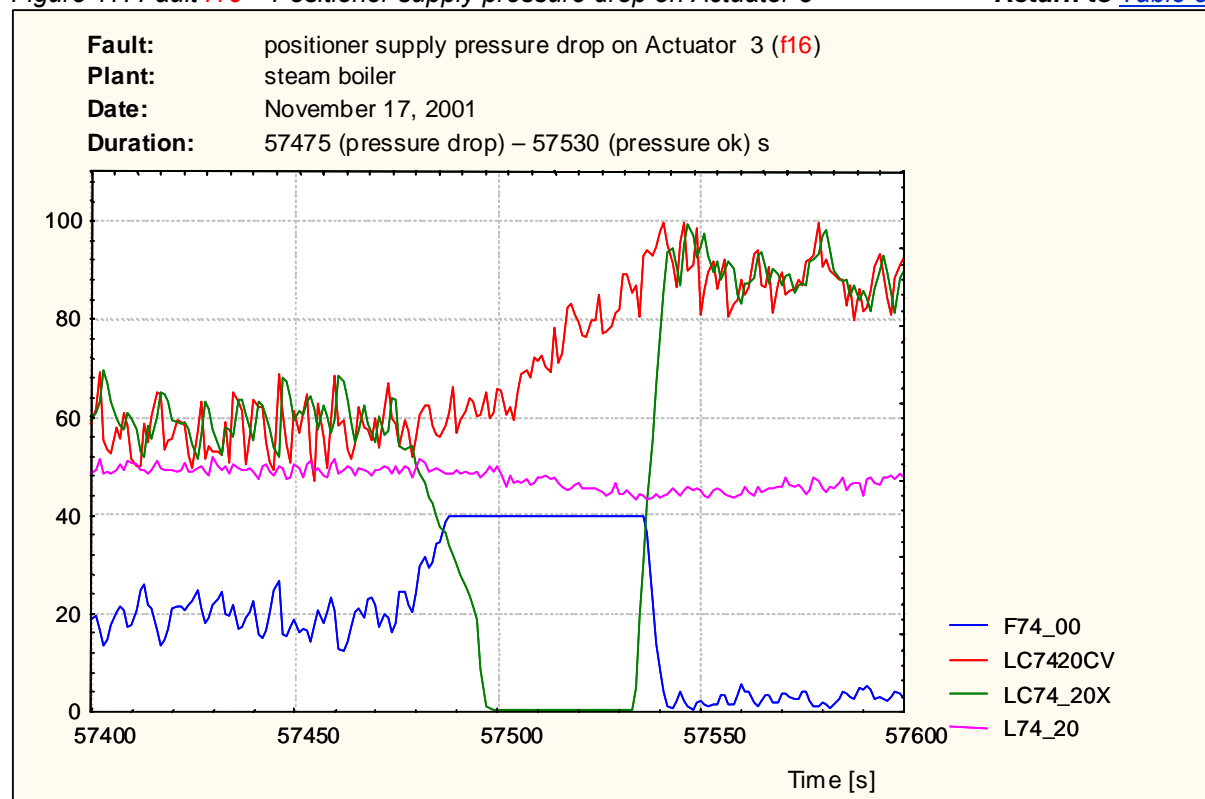


Figure 18. Fault **f16** – Positioner supply pressure drop on Actuator 3

[Return to Table 5](#)

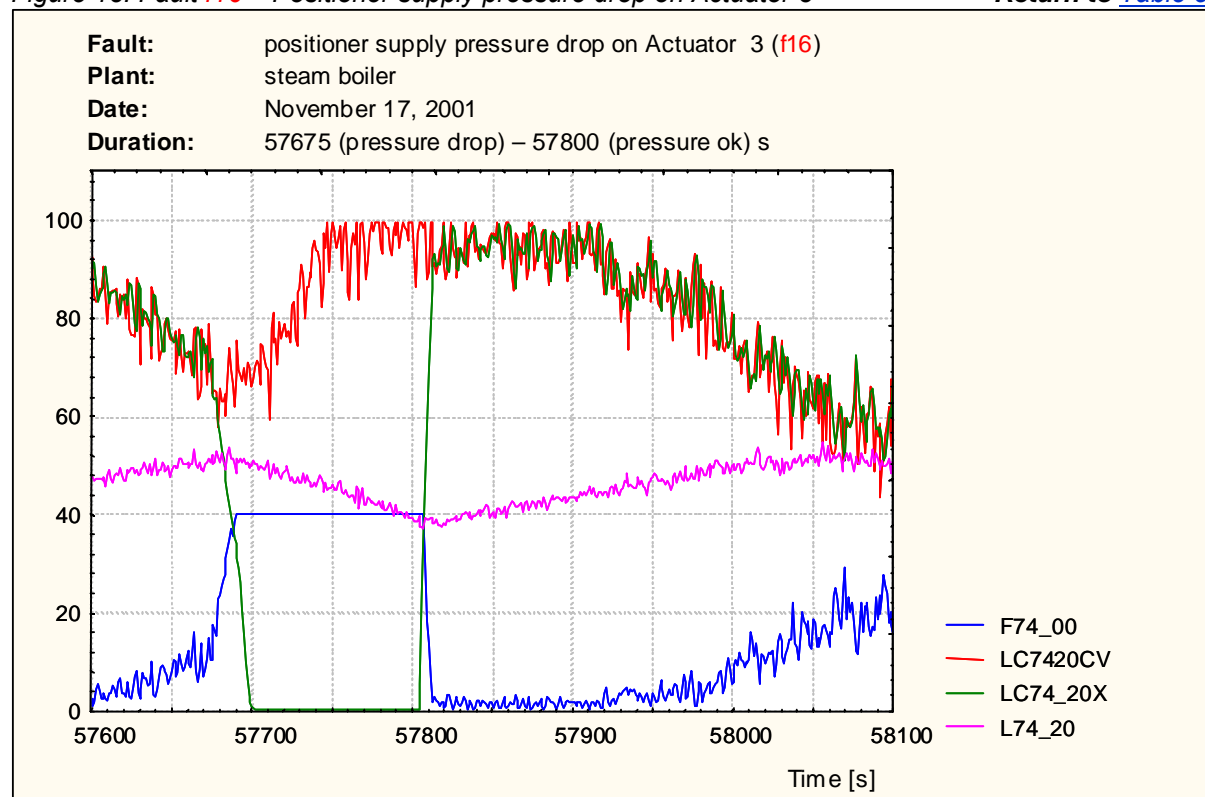


Figure 19. Fault **f19** – Flow rate sensor fault in Actuator 3

[Return to Table 5](#)

