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1 MACHINE
2   WaterTank_1Ctrl_2Tanks_Cylinder
3 REFINES
4   WaterTank_ode
5 SEES
6   WaterTank_2Tanks_Cylinder_Ctx
7 VARIABLES  $t, x_s, h1, h2$ 
8 INVARIANTIS
9   inv1:  $h1 \in RRealPlus \rightarrow RReal$ 
10  inv2:  $h2 \in RRealPlus \rightarrow RReal$ 
11  inv3:  $V = LinComb2(B1, h1, B2, h2)$ 
12 EVENTS
13 INITIALISATION
14 WITH
15    $V' = LinComb2(B1, h1', B2, h2')$ 
16 THEN
17   act1:  $t := Rzero$ 
18   act2:
19      $h1, h2 :|$ 
20      $h1' \in RRealPlus \rightarrow S \wedge$ 
21      $h2' \in RRealPlus \rightarrow S \wedge$ 
22     solutionOf(
23       RRealPlus,
24        $h1'$ ,
25       ode(
26         NoFlow,
27         H10,
28         Rzero
29       )
30     ) $\wedge$ 
31     solutionOf(
32       RRealPlus,
33        $h2'$ ,
34       ode(
35         NoFlow,
36         H20,
37         Rzero
38       )
39     )
40   act3:  $x_s := Stable$ 
41 END
42
43 Progress
44 REFINES Progress
45 THEN
46   act1:  $t :| t' \in RRealPlus \wedge (t \mapsto t' \in lt)$ 
47 END
48
49 Behave
50 REFINES Behave
51 ANY  $e$ 
52 WHERE
53   grd1:  $e \in DE(S)$ 
54   grd2:  $Solvable(Closed2Infinity(t), e)$ 
55 WITH
56    $V' = LinComb2(B1, h1', B2, h2')$ 
57 THEN
58   act1:
59      $h1, h2 :|$ 
60      $h1' \in RRealPlus \rightarrow S \wedge$ 
61      $h2' \in RRealPlus \rightarrow S \wedge$ 
62     AppendSolutionBAP(
63        $e$ ,
64       RRealPlus, Closed2Open(Rzero, t), Closed2Infinity(t),
65       LinComb2(B1, h1, B2, h2),
66       LinComb2(B1, h1', B2, h2')
67     )
68 END
69
70 ctrl_sense_too_high
71 REFINES ctrl_sense_too_high
72 WHERE
73   grd1:  $Vhigh \mapsto LinComb2(B1, h1, B2, h2)(t) \in leq$ 

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74 THEN
75   act1:  $x\_s := \text{Emptying}$ 
76 END
77
78 ctrl_sense_too_low
79 REFINES ctrl_sense_too_low
80 WHERE
81   grd1:  $\text{LinComb2}(B1, h1, B2, h2)(t) \mapsto Vlow \in leq$ 
82 THEN
83   act1:  $x\_s := \text{Filling}$ 
84 END
85
86 ctrl_transition_emptying
87 REFINES ctrl_transition_emptying
88 WHERE
89   grd1:  $Vlow \mapsto \text{LinComb2}(B1, h1, B2, h2)(t) \in lt$ 
90 THEN
91   act1:  $x\_s := \text{Emptying}$ 
92 END
93
94 ctrl_transition_filling
95 REFINES ctrl_transition_filling
96 WHERE
97   grd1:  $\text{LinComb2}(B1, h1, B2, h2)(t) \mapsto Vhigh \in lt$ 
98 THEN
99   act1:  $x\_s := \text{Filling}$ 
100 END
101
102 ctrl_transition_normal
103 REFINES ctrl_transition_normal
104 WHERE
105   grd1:  $Vlow \mapsto \text{LinComb2}(B1, h1, B2, h2)(t) \in lt$ 
106   grd2:  $\text{LinComb2}(B1, h1, B2, h2)(t) \mapsto Vhigh \in lt$ 
107 THEN
108   act1:  $x\_s := \text{Normal}$ 
109 END
110
111 ctrl_transition_stable
112 REFINES ctrl_transition_stable
113 WHERE
114   grd1:  $Vlow \mapsto \text{LinComb2}(B1, h1, B2, h2)(t) \in lt$ 
115   grd2:  $\text{LinComb2}(B1, h1, B2, h2)(t) \mapsto Vhigh \in lt$ 
116 THEN
117   act1:  $x\_s := \text{Stable}$ 
118 END
119
120 ctrl_actuate_pumps
121 REFINES ctrl_actuate_pumps
122 ANY io, ss
123 WHERE
124   grd4:  $ss \in STATES$ 
125   grd5:  $x\_s = ss$ 
126   grd6:  $io \in \text{SingleTankPolicy}(x\_s)$ 
127 WITH
128    $V': V' = \text{LinComb2}(B1, h1', B2, h2')$ 
129   Phi:
130      $\text{Phi} \in RRealPlus \times S \rightarrow S \wedge$ 
131      $\text{isFlowODE}(\text{Emptying}, \text{Closed2Infinity}(t), \text{Phi}, Rzero, Vmax) \wedge$ 
132      $\text{Solvable}(\text{Closed2Infinity}(t), \text{ode}(\text{Phi}, V(t), t)) \wedge$ 
133      $(\forall h1\_ , h2\_ .$ 
134        $h1\_ \in \text{Closed2Infinity}(t) \rightarrow RReal \wedge h2\_ \in \text{Closed2Infinity}(t) \rightarrow RReal \wedge$ 
135        $\text{solutionOf}(\text{Closed2Infinity}(t), h1\_ , \text{FlowIOODE}(Rzero, H1max, \text{delta\_in\_}h1, \text{delta\_out\_}h1)(io)(t \mapsto h1(t))) \wedge$ 
136        $\text{solutionOf}(\text{Closed2Infinity}(t), h2\_ , \text{FlowIOODE}(Rzero, H2max, \text{delta\_in\_}h2, \text{delta\_out\_}h2)(io)(t \mapsto h2(t))) \Rightarrow$ 
137        $\text{solutionOf}(\text{Closed2Infinity}(t), \text{LinComb2}(B1, h1\_ , B2, h2\_ ), \text{ode}(\text{Phi}, V(t), t))$ 
138     )
139 THEN
140   act1:
141      $h1, h2 :|$ 
142      $h1' \in RRealPlus \rightarrow S \wedge$ 
143      $h2' \in RRealPlus \rightarrow S \wedge$ 
144      $\text{AppendSolutionBAP}(\text{FlowIOODE}(Rzero, H1max, \text{delta\_in\_}h1, \text{delta\_out\_}h1)(io)(t \mapsto h1(t)),$ 
145      $RRealPlus,$ 
146      $\text{Closed2Open}(Rzero, t), \text{Closed2Infinity}(t),$ 

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148     h1, h1'
149 )^
150 AppendSolutionBAP(
151     FlowIOODE(Rzero, H2max, delta_in_h2, delta_out_h2)(io)(t ↦ h2(t)),
152     RRealPlus,
153     Closed2Open(Rzero, t), Closed2Infinity(t),
154     h2, h2'
155 )
156 END
157
158 END
```