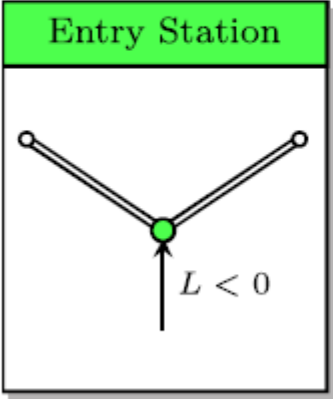


# General taxonomy of the Constraints

Types of Constraints		<i>description</i>	What if is violated?
HARD	<u>Internal</u>	Intrinsic to the way the item is working	<b>CHANGE OF BOUNDARY CONDITION</b>
	<i>User defined</i>	Operational limit	
SOFT	<u>Internal</u>	Intrinsic to the way the item is working	At least: retourning a <b>WARNING.</b> <i>Change of B.C. to be avaluated case by case</i>
	<i>User defined</i>	Usual working area/conditions	

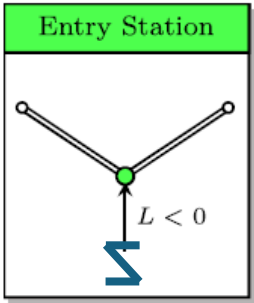
# ENTRY STATIONS

Facility	Control Modes	Constraints
 <p>The diagram shows a green circle representing an entry station at the junction of two pipes. An arrow points upwards from the circle, and the text <math>L &lt; 0</math> is written next to it. The entire diagram is enclosed in a box with a green header labeled 'Entry Station'.</p>	<p>pressure (<math>p_{set}</math>) ➡ <i>Remi stations/citygates</i> inflow (<math>Q_{set}</math>) ➡ <i>Injection Facilities</i></p>	<p><u>internal hard limits:</u> <math>L \leq 0</math> <u>user defined limits:</u> min. supply flow (<math>Q_{min}</math>) max. supply flow (<math>Q_{max}</math>) min. supply pressure (<math>p_{min}</math>) max. supply pressure (<math>p_{max}</math>)</p>

# ENTRY STATIONS

*p regulated*

$n$  is the node (n) to which the condition applies  
( $t$ ) is the timestep to which the condition is applied



## 1.1) ReMi Station w/o Backflow

B.C.'

$$p_n(t) = p_{\text{setpoint}}(t)$$

Constraints / limits:

**HARD - internal :**

$$L_n(t) \leq 0$$

**If NOT respected:**

B.C.ʹʹ

$$L_n(t) = 0$$

**SOFT – user defined :**

$$L_n(t) \leq L_n^{\text{min}}(t)$$

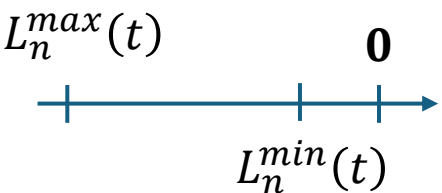
$$L_n(t) \geq L_n^{\text{max}}(t)$$

$$p_n(t) \leq p_n^{\text{max}}(t)$$

$$p_n(t) \geq p_n^{\text{min}}(t)$$

**If NOT respected:**

Warning message



Constraints / limits:

**HARD - internal :**

$$p_n(t) \geq p_{\text{setpoint}}(t)$$

**If NOT respected:**

**SOFT – user defined :**

$$L_n(t) \leq L_n^{\text{min}}(t)$$

$$L_n(t) \geq L_n^{\text{max}}(t)$$

$$p_n(t) \leq p_n^{\text{max}''}(t)$$

$$p_n(t) \geq p_n^{\text{min}''}(t)$$

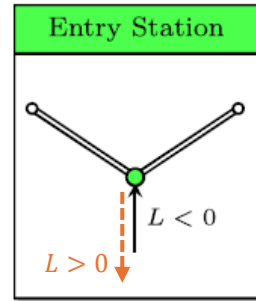
**If NOT respected:**

Warning message

# ENTRY STATIONS

*p regulated*

$n$  is the node (n) to which the condition applies  
( $t$ ) is the timestep to which the condition is applied



## 1.2) ReMi Station w free Backflow

**B.C.:**

$$p_n(t) = p_{\text{setpoint}}(t)$$

Constraints / limits:

**SOFT - internal:**

$$L_n(t) \leq 0$$

**If NOT respected:**

Warning  
message

«Reverse flow is happening»

**SOFT – user defined:**

$$L_n(t) \leq L_n^{\text{max}}(t)$$

$$L_n(t) \geq L_n^{\text{min}}(t)$$

$$p_n(t) \leq p_n^{\text{max}}(t)$$

$$p_n(t) \geq p_n^{\text{min}}(t)$$

**If NOT respected:**

Warning  
message

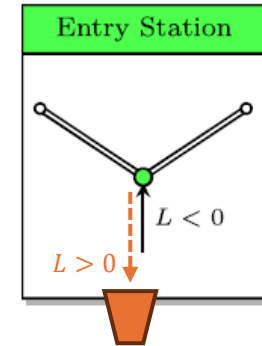


# ENTRY STATIONS

*p regulated*

$n$  is the node (n) to which the condition applies

( $t$ ) is the timestep to which the condition is applied



## 1.3) ReMi Station w controlled Backflow

**B.C.''**

$$p_n(t) = p_{setpoint}(t)$$

Constraints / limits:

**HARD - internal :**

$$L_n(t) \leq 0$$

OR

**HARD - user defined :**

$$p_{avg}^{network}(t) \leq f \cdot p_{setpoint}(t)$$

$f$  ← To be defined by user  $f=[0 - 1]$

**SOFT - user defined :**

$$L_n(t) \leq L_n^{min}(t)$$

$$L_n(t) \geq L_n^{max}(t)$$

$$p_n(t) \leq p_n^{max}(t)$$

$$p_n(t) \geq p_n^{min}(t)$$

**If NOT respected:**

Warning message



**B.C.''**

$$L_n(t) = L_{set}(t)$$

Constraints / limits:

**HARD - internal :**

$$p_{avg}^{network}(t) \geq f' \cdot p_{setpoint}(t)$$

$f'$  ← To be defined by user  $f'=[0 - 1]$

**SOFT - user defined :**

$$L_n(t) \leq L_n^{min}(t)$$

$$L_n(t) \geq L_n^{max}(t)$$

$$p_n(t) \leq p_n^{max''}(t)$$

$$p_n(t) \geq p_n^{min''}(t)$$

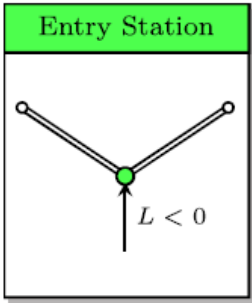
**If NOT respected:**

Warning message

\*check how to get back to  $p_n(t) = p_{setpoint}(t)$   
According to the value of  $p_n(t)$  calculated

# ENTRY STATIONS $L$ regulated

$n$  is the node (n) to which the condition applies  
( $t$ ) is the timestep to which the condition is applied



## 2.1) Injection Station w/o pressure control

**B.C.**

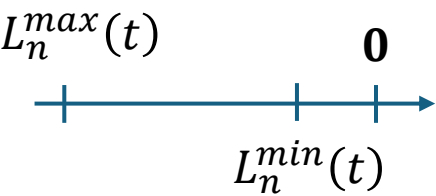
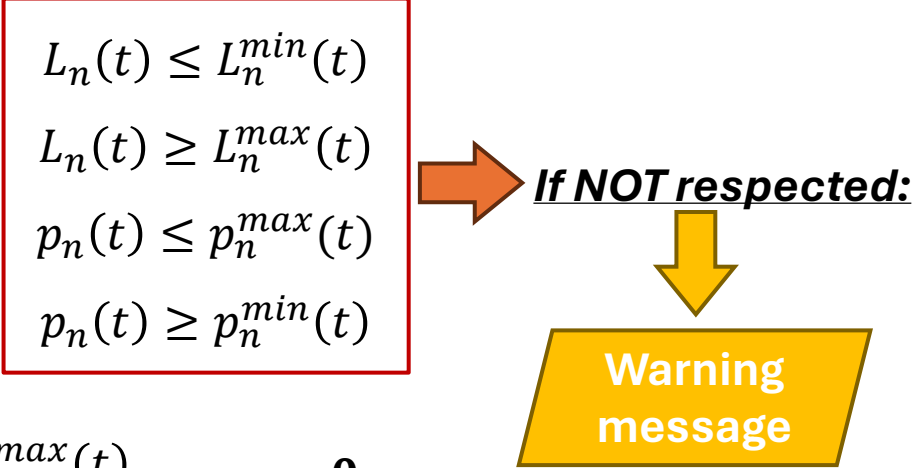
$L_n(t) = L_{set}(t)$

Constraints / limits:

**HARD - internal :**



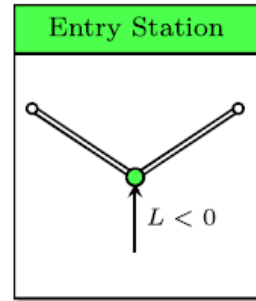
**SOFT – user defined :**



# ENTRY STATIONS

*L regulated*

$n$  is the node (n) to which the condition applies  
 $(t)$  is the timestep to which the condition is applied



## 2.2) Injection Station w pressure control



$$L_{set}(t)=0$$

**B.C.**

$$L_n(t) = L_{set}(t)$$

Constraints / limits:

HARD - internal :

$$L_n(t) \leq 0$$

**OR**

HARD - user defined :

$$p_n(t) \leq f \cdot p_{setpoint}(t)$$

**If NOT**

$f$  ← To be defined by user  $f > 0$   
 Possible also  $f > 1$

SOFT - user defined :

$$L_n(t) \leq L_n^{min}(t)$$

$$L_n(t) \geq L_n^{max}(t)$$

$$p_n(t) \leq p_n^{max}(t)$$

$$p_n(t) \geq p_n^{min}(t)$$

**If NOT respected:**

**Warning message**



**B.C.”**

$$p_n(t) = p_{setpoint}(t)$$

Constraints / limits:

HARD - internal :

$$L_n(t) \leq 0$$

**If NOT :**

SOFT - user defined :

$$L_n(t) \leq L_n^{min}(t)$$

$$L_n(t) \geq L_n^{max}(t)$$

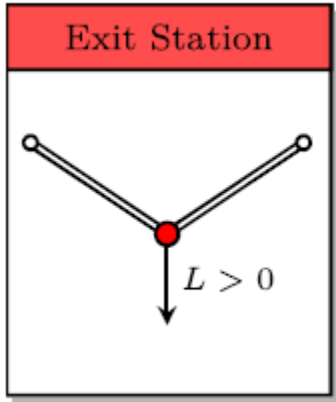
$$p_n(t) \leq p_n^{max''}(t)$$

$$p_n(t) \geq p_n^{min''}(t)$$

**If NOT respected:**

**Warning message**

# EXIT STATIONS

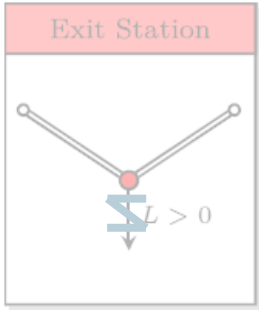
Facility	Control Modes	Constraints
	pressure ( $p_{set}$ ) <i>Not common</i> outflow ( $Q_{set}$ )	<u>internal hard limits:</u> $L \geq 0$ <u>user defined limits:</u> min. delivery flow ( $Q_{min}$ ) max. delivery flow ( $Q_{max}$ ) min. delivery pressure ( $p_{min}$ ) max. delivery pressure ( $p_{max}$ )



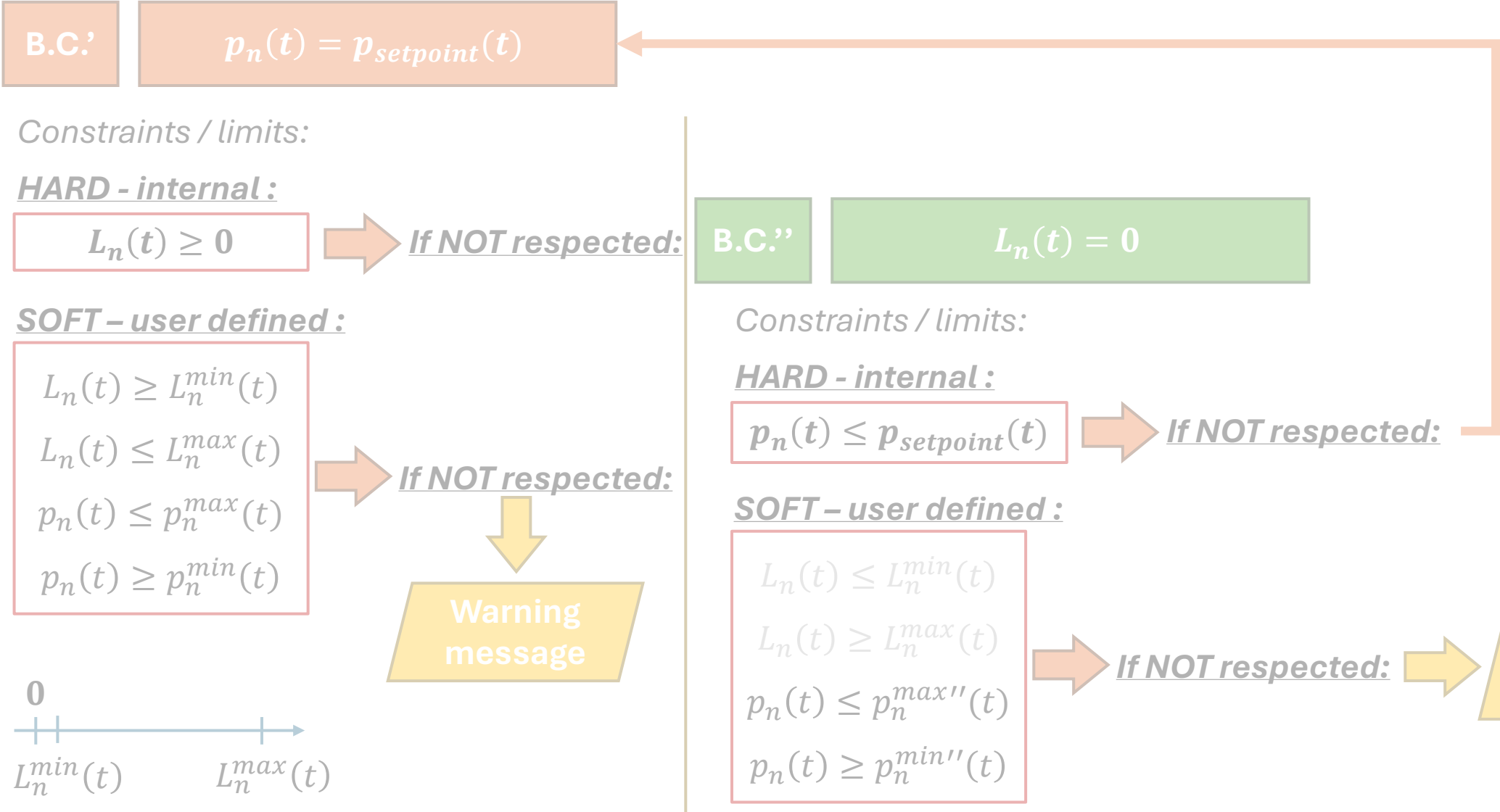
# EXIT STATIONS

*p regulated*

$n$  is the node (n) to which the condition applies  
( $t$ ) is the timestep to which the condition is applied



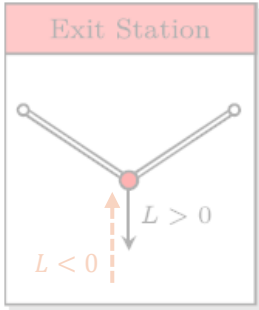
## 1.1) Exit Station w/o Backflow



# EXIT STATIONS

*p regulated*

$n$  is the node (n) to which the condition applies  
( $t$ ) is the timestep to which the condition is applied

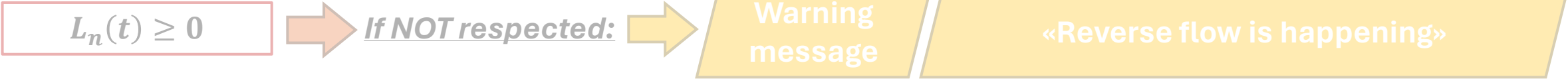


## 1.2) Exit Station w free Backflow

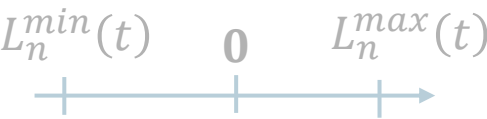
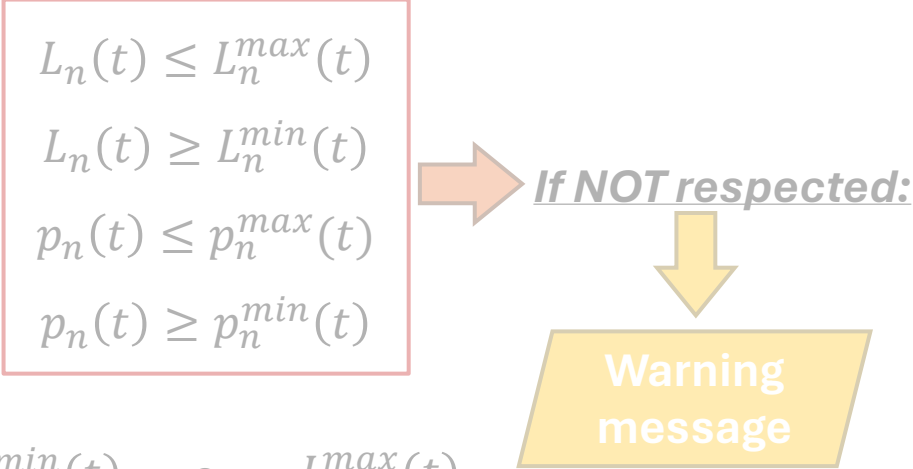
**B.C.:**  $p_n(t) = p_{setpoint}(t)$

Constraints / limits:

**SOFT - internal :**



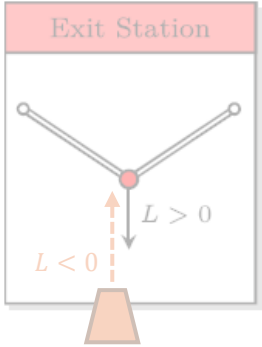
**SOFT – user defined :**



# EXIT STATIONS

*p regulated*

$n$  is the node (n) to which the condition applies  
( $t$ ) is the timestep to which the condition is applied



## 1.3) Exit Station w controlled Backflow

\*check how to get back to  $p_n(t) = p_{setpoint}(t)$   
According to the value of  $p_n(t)$  calculated

**B.C.''**  $p_n(t) = p_{setpoint}(t)$

Constraints / limits:

**HARD - internal :**

$$L_n(t) \geq 0$$

**HARD - user defined :**

$$p_{avg}^{network}(t) \geq f \cdot p_{setpoint}(t)$$

$f \leftarrow$  To be defined by user  $f = [0 - 1]$

**SOFT - user defined :**

$$\begin{aligned} L_n(t) &\geq L_n^{min}(t) \\ L_n(t) &\leq L_n^{max}(t) \\ p_n(t) &\leq p_n^{max}(t) \\ p_n(t) &\geq p_n^{min}(t) \end{aligned}$$

**If NOT respected:**

Warning message

**B.C.''**  $L_n(t) = L_{set}(t)$

Constraints / limits:

**HARD - internal :**

$$p_{avg}^{network}(t) \geq f' \cdot p_{setpoint}(t)$$

$f' \leftarrow$  To be defined by user  $f' = [0 - 1]$

**SOFT - user defined :**

$$\begin{aligned} L_n(t) &\leq L_n^{min}(t) \\ L_n(t) &\geq L_n^{max}(t) \\ p_n(t) &\leq p_n^{max''}(t) \\ p_n(t) &\geq p_n^{min''}(t) \end{aligned}$$

**If NOT respected:**

Warning message

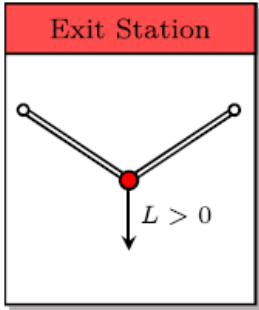


# EXIT STATIONS

*L regulated*



$n$  is the node (n) to which the condition applies  
( $t$ ) is the timestep to which the condition is applied



## 2.1) Consumption point w/o pressure control

**B.C.**  $L_n(t) = L_{set}(t)$

Constraints / limits:

**HARD - internal :**

$L_n(t) \geq 0$

➔ **If NOT respected:**

Warning message

«Error in the input data»

**SOFT – user defined :**

$L_n(t) \leq L_n^{min}(t)$   
 $L_n(t) \geq L_n^{max}(t)$   
 $p_n(t) \leq p_n^{max}(t)$   
 $p_n(t) \geq p_n^{min}(t)$

➔ **If NOT respected:**

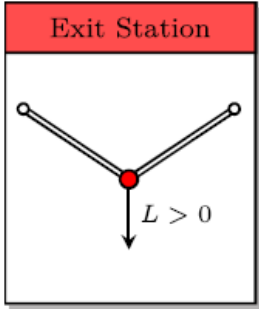
Warning message



# EXIT STATIONS

*L regulated*

$n$  is the node (n) to which the condition applies  
( $t$ ) is the timestep to which the condition is applied



## 2.2) Consumption point w pressure control

**B.C.**  $L_n(t) = L_{set}(t)$

Constraints / limits:

*HARD - internal :*

$L_n(t) \geq 0$

**OR** *HARD – user defined :*

$p_n(t) \geq f \cdot p_{setpoint}(t)$

**If NOT**

$f \leftarrow$  To be defined by user  $f = [0 - 1]$

*SOFT – user defined :*

$L_n(t) \leq L_n^{min}(t)$   
 $L_n(t) \geq L_n^{max}(t)$   
 $p_n(t) \leq p_n^{max}(t)$   
 $p_n(t) \geq p_n^{min}(t)$

**If NOT respected:**

Warning message



$L_n(t) = 0$

**If NOT:**  $p_n(t) \leq f' \cdot p_{setpoint}(t)$   
 $f' \leftarrow$  To be defined by user  $f' > 0$   
(possible also  $f' > 1$ )

**B.C.”**  $p_n(t) = p_{setpoint}(t)$

Constraints / limits:

*HARD - internal :*

$L_n(t) \geq 0$

**If NOT:**

*SOFT – user defined :*

$L_n(t) \leq L_n^{min}(t)$   
 $L_n(t) \geq L_n^{max}(t)$   
 $p_n(t) \leq p_n^{max''}(t)$   
 $p_n(t) \geq p_n^{min''}(t)$

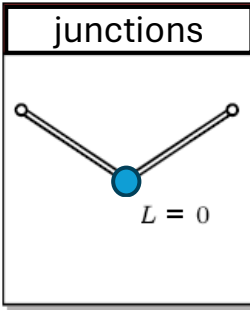
**If NOT respected:**

Warning message

# JUNCTIONS ●

*$L$  regulated*

$n$  is the node (n) to which the condition applies



B.C.

$$L_n(t) = 0$$

# SAMPLE NETWORK

