PLANT HIERARCHY

OBJECTIVE

Students will learn to structure an automation project based on technological aspects. By setting up hierarchy folders, a project structure is implemented that we call ***Plant Hierarchy (PH)***. In the folders of the plant hierarchy, the following is stored: CF and SF charts for the automation systems, pictures and reports for the operator stations and supplementary documents (such as unit descriptions, measuring point sheets, planning documents from other applications -for example, Word, Excel, etc.-). A well-planned plant hierarchy promotes locating objects and is the prerequisite for reusing generic solutions as well as automatic generation mechanisms.

THEORY IN SHORT

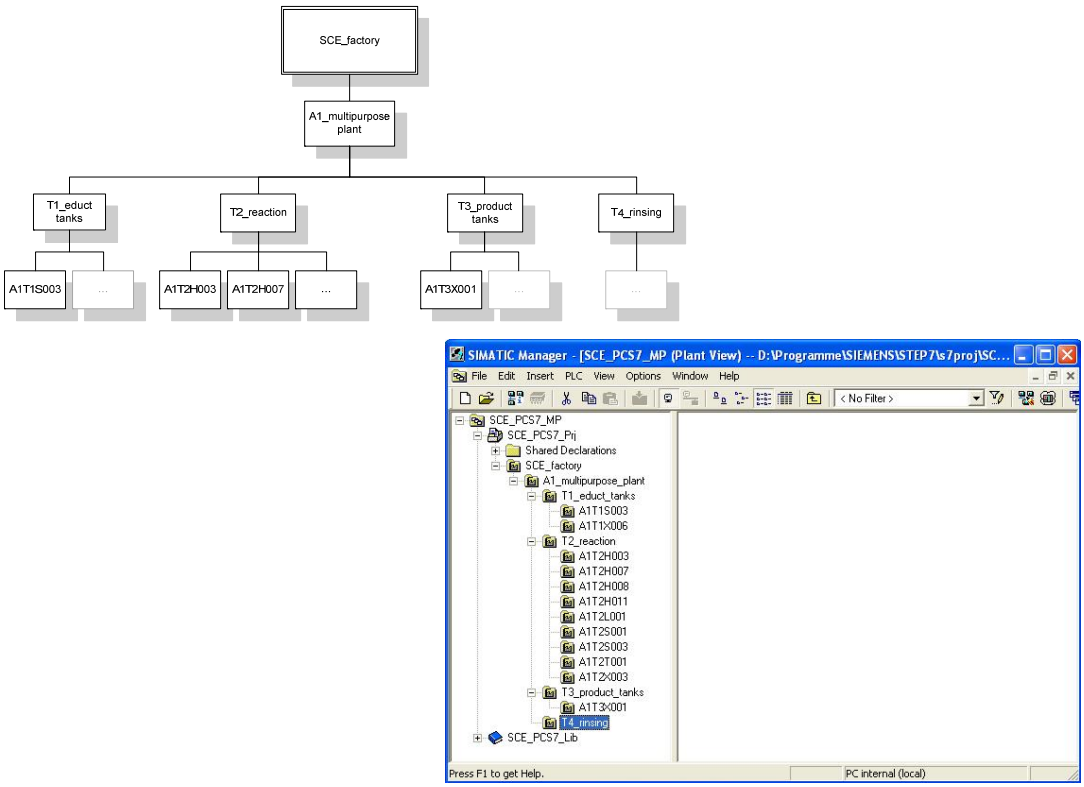


Figure 1: From physical model to plant hierarchy

Essentially, the plant hierarchy has three functions:

– It is used to map a hierarchical name scheme that can be used to break down a complex plant into sub-tasks that can be solved with justifiable effort.

– It is used for the structured storage of documents and objects in this hierarchical name scheme.

– It makes possible the automatic generation of the picture hierarchy for control and monitoring.

THEORY

STRUCTURING ACCORDING TO DIN EN 81346-1

In order to specify, plan, set up, maintain or operate a system effectively, the system as well as the information about the system is usually subdivided into parts. Each of these parts can be subdivided further. This successive subdividing into parts and the organization of these parts is called ***Structuring***.

Two general rules apply to this:

Rule 1: A technical system has to be structured based on '***constituent part of***' relationships, using the concept of ***aspects*** of objects.

Aspects affect an object like a filter that emphasizes relevant information. The aspects used in the standard have the following focal points:

– ***Functional aspect***: What is an object supposed to do, or what is it actually doing?

– ***Product aspect***: What means does an object use to do what it is supposed to?

– ***Location aspect***: Planned or actual space of the object

Figure 2: below shows that the 'object for filling' is a ***constituent part of*** the 'object for manufacturing Product 1' under the function aspect.

Rule 2: Structuring is carried out step by step either from top to bottom (***top-down***) or from bottom to top (***bottom-up***).

Usually, the method for top to bottom is this:

1. Selecting an object
2. Selecting a suitable aspect
3. Determining the sub-objects in the selected aspect if they exist

Steps 1 to 3 can then be repeated as often as necessary for the defined sub-objects

Usually, the method for bottom to top is this:

1. Selecting an aspect that we want to work with
2. Selecting objects that are to be considered jointly
3. Adding a higher level object for which the selected objects are constituent parts in the selected aspect

As in the case of the top to bottom method, here also steps 1 to 3 can be repeated for each added higher level object as often as required.

If an aspect is retained in the entire structure, the structure -according to the standard- is to be called aspect-related; that means, function related, product related or site related.

A process engineering plant is structured under the functional aspect (function view).

Function related structures are based on the purpose of a system. The purpose of a technical system is executing a technical process where input variables (energy, information, material) are processed into output variables (energy, information, material) taking into account specific parameters, as shown in the example in Figure 2: .

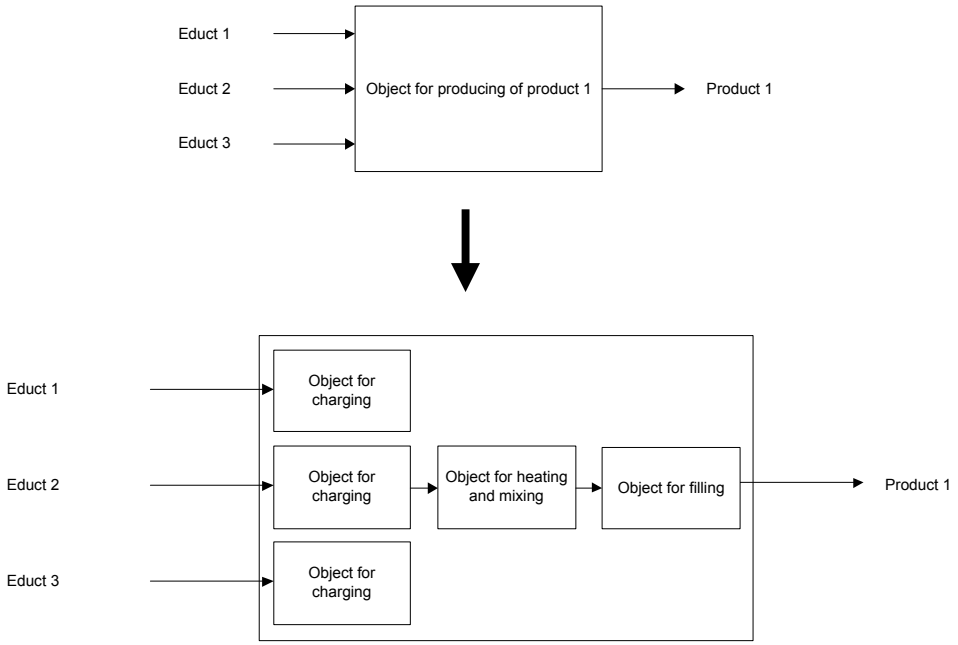


Figure 2: Function and subfunctions of the reactor

Structuring performed on this basis provides a system that can be used during all phases of the life cycle: planning the plant, automating the plant and operating the plant.

STRUCTURE OF THE PLANT HIERARCHY

The plant hierarchy can be directly adopted from the structuring of the plant that was performed for planning the plant. It has to be taken into account in this case that when deriving the display hierarchy from the plant hierarchy, this structure is mapped 1:1.

While planning a process engineering plant, the planning engineer generates a reference identification system that allows for the unmistakable identification of an object in a system under consideration. This reference identification system is based on structuring according to an aspect (in the case of process engineering plants, according to the function aspect).

In ***PCS7***, the reference identification system is called ***plant designation system (AKZ)***. In ***PCS7***, the structure of the plant is implemented by means of a folder structure. By nesting the hierarchy folders, even complex plants can be mapped. By setting the number of levels, the structural depth can be specified project wide. The maximum structural depth is limited to 8 levels.

DERIVING THE DISPLAY HIERARCHY AND OS AREAS FROM THE PH

The OS picture hierarchy for the plant operator at the operator station can be derived completely from the configured data of the plant hierarchy. This is automatic in the case of a generation run. For each level, an operating screen is generated. In it, associated operator symbols are set up for all automation blocks -to the extent available- used in the charts for this level. In addition, the corresponding group alarms and navigation hierarchies are set up.

Some areas of the plant structure in the plant hierarchy can be interfaced with OS areas. In the case of large plants, for example, only certain plant areas can be assigned to plant operators. In the process mode, the plant operator only sees and operates those plant areas for which he has the corresponding user authorization. Also, only the messages relevant to this area are displayed. As a rule, a unit in the plant hierarchy corresponds to an OS area.

In the general settings for the plant hierarchy we specify which hierarchy level of the plant hierarchy is to be an OS area level. For each hierarchy folder of this level, an area designation is defined. The standard setting for the area designation corresponds to the name of the hierarchy folder in the plant hierarchy. As soon as a hierarchy folder is

provided with an area designation, all lower level hierarchy folders and objects also receive the area designation. The representation of the hierarchy levels always starts with the hierarchy level that was defined as OS area.

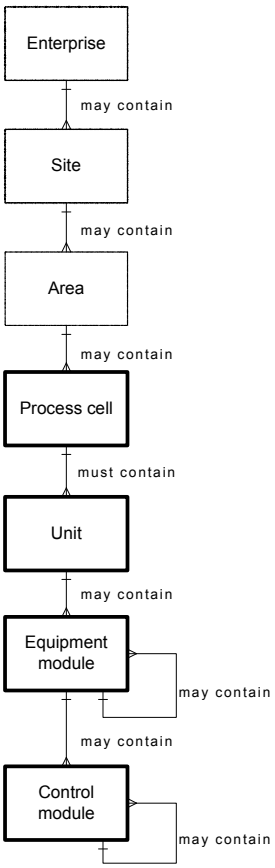
AS-OS ASSIGNMENT

For each hierarchy folder, an operator station has to be assigned to an automation system in the plant view. This AS-OS assignment has the following consequences for the component view:

– All CF and SF charts that are added in the plant view are stored in the chart folder of the assigned automation system

– All displays and reports that are added in the plant view are stored in the folder of the assigned operator station

TYPE DEFINITION ACCORDING TO ISA-S88.01



If when structuring the plant the physical model according to DIN EN 61512-1 (refer to Figure 3) is used -which is largely identical with the American standard ISA-S88.01-1995- the ***PCS7*** provides the option of setting up a type-defined hierarchy.

In this case, only the lower four levels of the model (plants, units, technical facilities and individual control units) are specified in detail. They refer to certain types of facilities. Such a type is a group of process and control engineering facilities that were combined for a certain purpose.

If the type-defined hierarchy in ***PCS7*** is to be used according to the ISA-S88.01 standard, the uppermost folder of the plant hierarchy has to represent the plant level.

Below the plant level, the hierarchy folders can then be type defined as unit, and below that as technical facility.

Folders or levels that are not type defined are designated as neutral and can be used for further structuring, or represent the level of the individual control units.

Type definition is the basis for working with the ***PCS7*** module BATCH. It has to be noted in this case that only one plant can be defined for each project.

Figure 3: Physical model according to ISA-S88.01-1995

LITERATURE

[1] Online Help TH. Siemens.

[2] DIN EN 81346-1 (edition 2010-05): Industrial Systems, Plants and Equipment and Industrial Products – Structuring Principles and Reference Designation

[3] DIN EN 61512-1 (edition. 2000-01): Batch Oriented Operation

STEP BY STEP INSTRUCTIONS

TASK

In this chapter, we are setting up and document a folder hierarchy in the plant view (plant hierarchy), corresponding to the project multi-purpose plant and the associated nomenclature.

OBJECTIVE

In this chapter, the student will learn the following:

– The plant view of the ***PCS7*** project

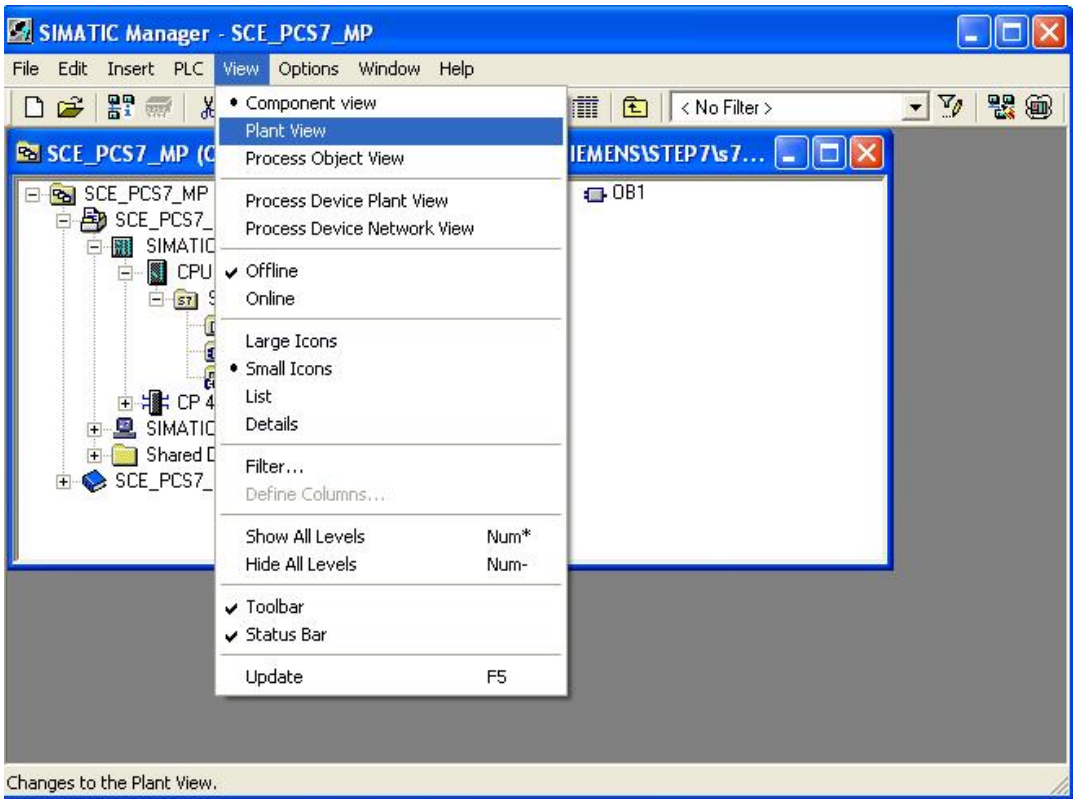
– Basic settings for the plant hierarchy

– Setting up and renaming folders in the plant hierarchy

PROGRAMMING

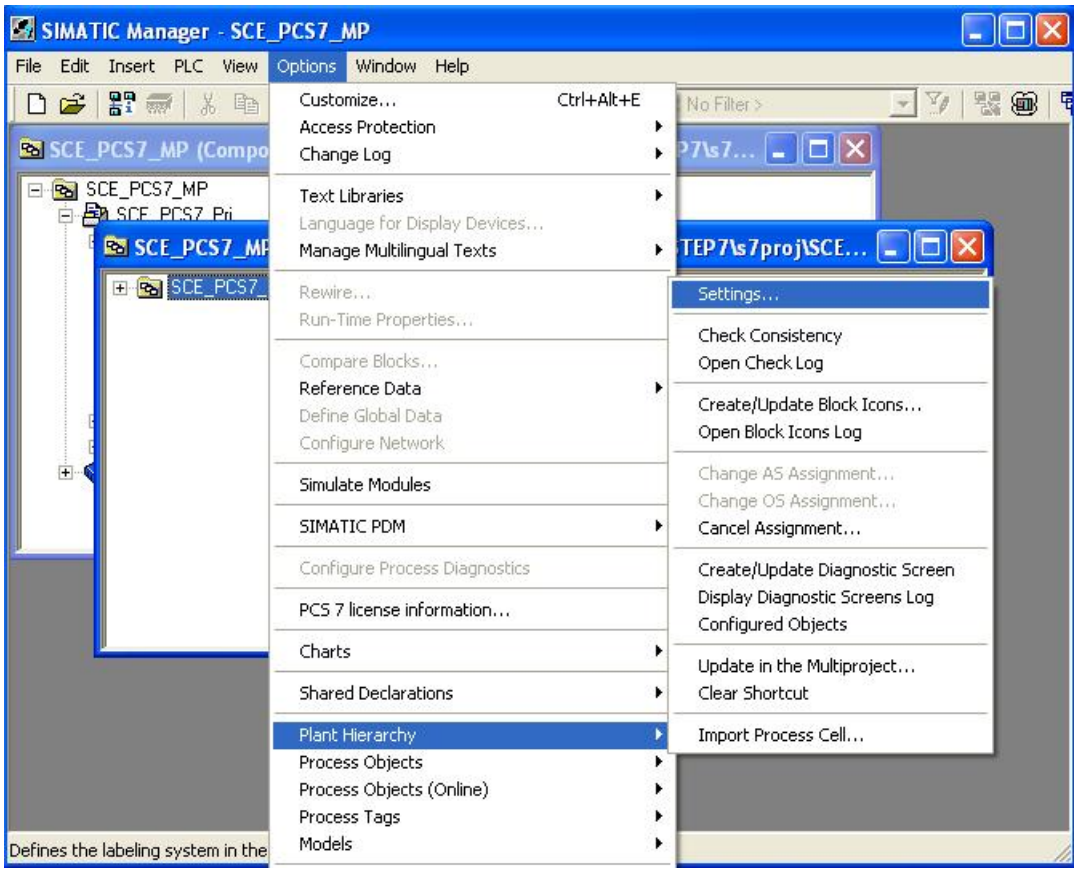
1. To set up the plant hierarchy in a ***PCS7*** project we have to change to the plant view.

   (→ View → plant view)



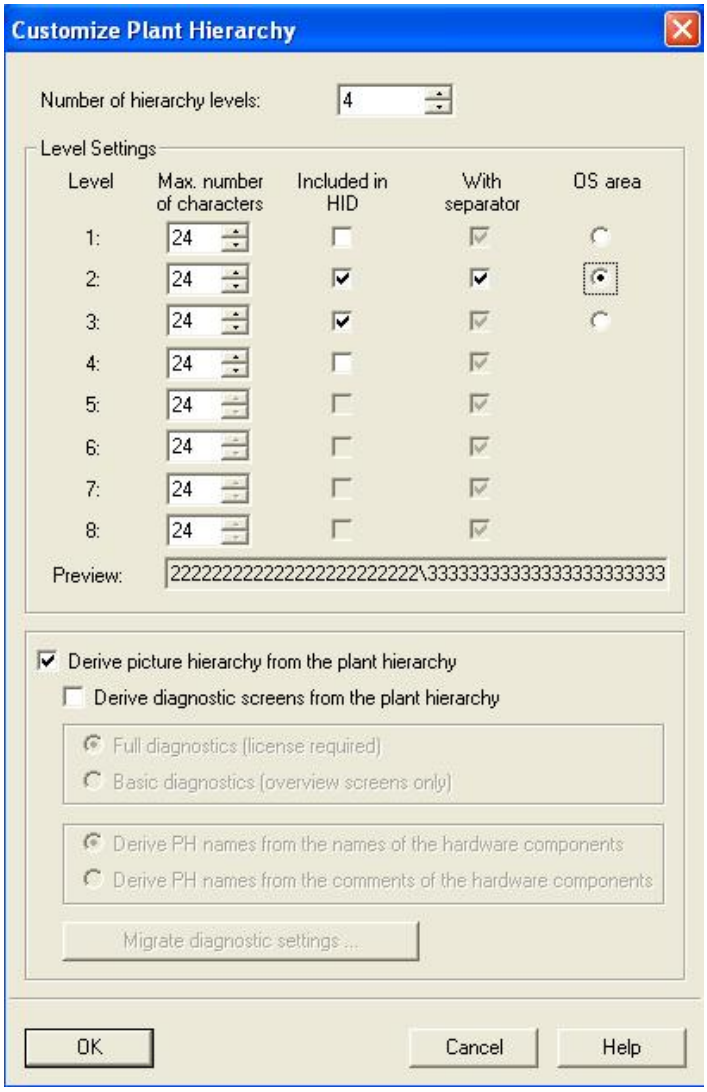
2. So that the automatic compilation runs for the OS (Operator Station) can later be executed correctly, a few basic settings have to be made for the plant hierarchy.

   (→ Plant hierarchy → Settings)

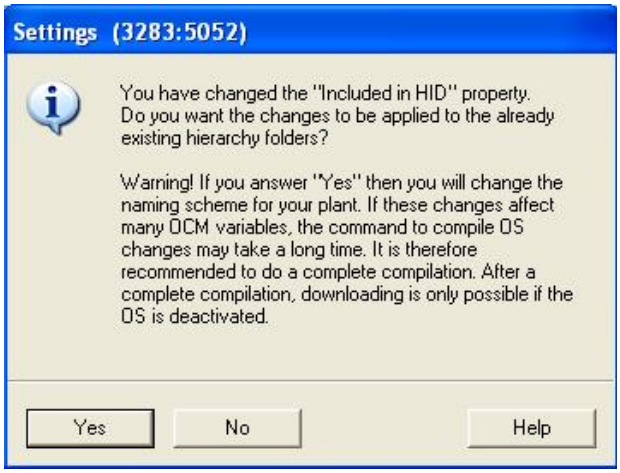


3. The following settings are made here and accepted with OK (→ OK)

– The number of hierarchy levels is set to 4, to match the project hierarchy. The hierarchy maps our plant as follows:
  – Factory (Level 1)
  – Plant (Level 2)
  – Unit (Level 3)
  – EMSR location (Level 4)
– 24 as the maximum number of characters in each level is relevant when automatically generating the variable names for the OS.
– Only levels 1 and 3 generate plant designations. That means, only the names of levels 2 and 3 appear in the variable name of the OS.
– The names have a separator '/' between the names of levels 2 and 3.
– The OS area specifies the level from which the process displays are incorporated in the picture hierarchy.
– For the picture hierarchy to be generated automatically, it is important to place a checkmark at 'Derive picture hierarchy from the plant hierarchy'.

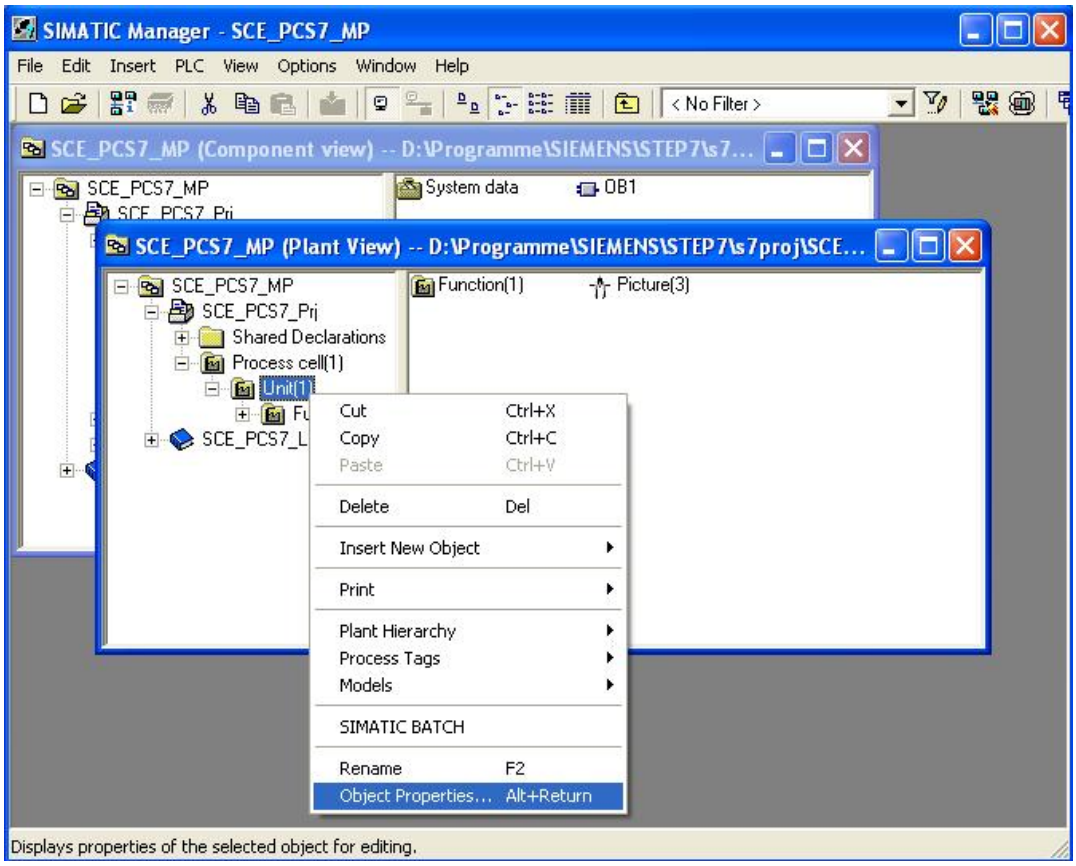


4. Accept the modified properties also for the hierarchy folders that have already been set up. (→ Yes)

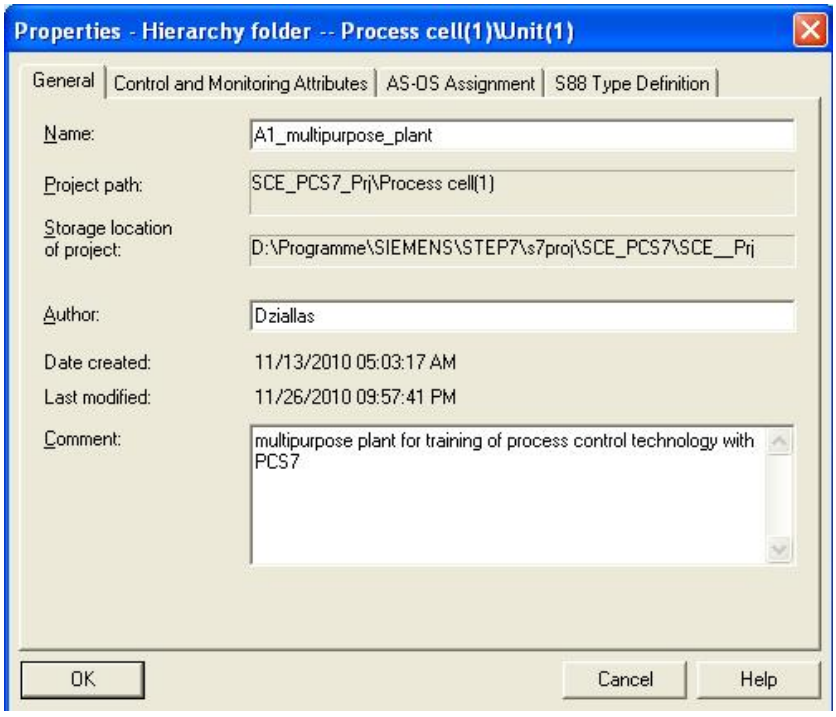


5. Next, the object properties are set for each hierarchy folder. Here, for example, for the folder of the second level.

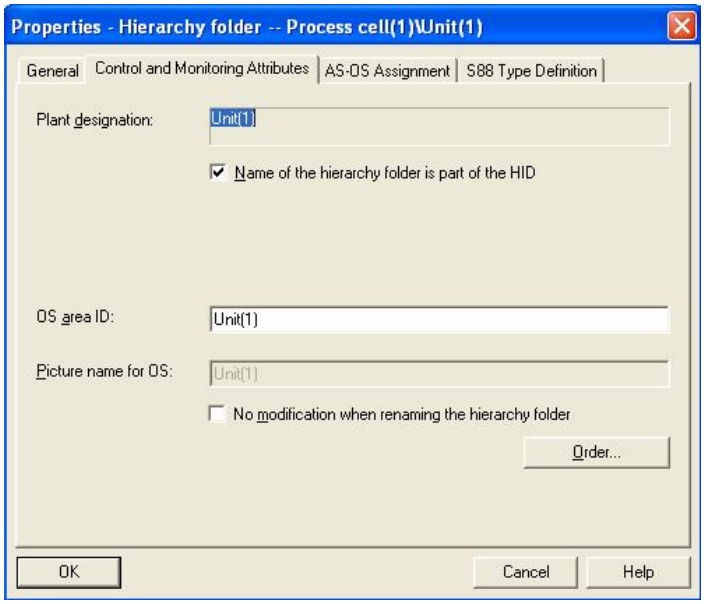
   (→ Unit(1) → Object Properties)



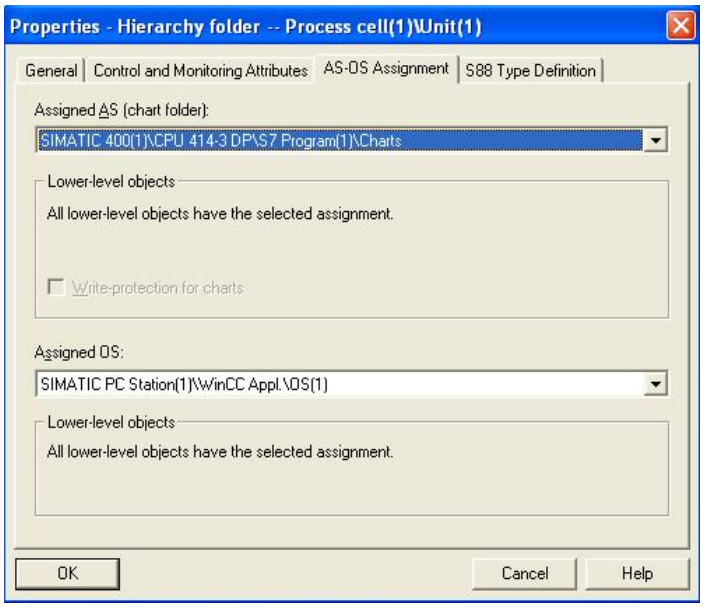
6. Under the tab 'General', the following is entered: the name, the author and above all a comment for clarity. (→ General)



7. Under the tab 'Control and Monitoring Attributes' it is indicated whether the name is part of the plant designation. The system enters this automatically based on the settings for the plant hierarchy. (→ Control and Monitoring Attributes)



8. Under the tab 'AS-OS Assignment', a hierarchy folder is assigned to an automation station (AS) and an operator station (OS). In our project, only one station respectively can be selected. The system enters it automatically based on the settings for the plant hierarchy. All properties are accepted with OK. (→ AS-OS Assignment → OK)

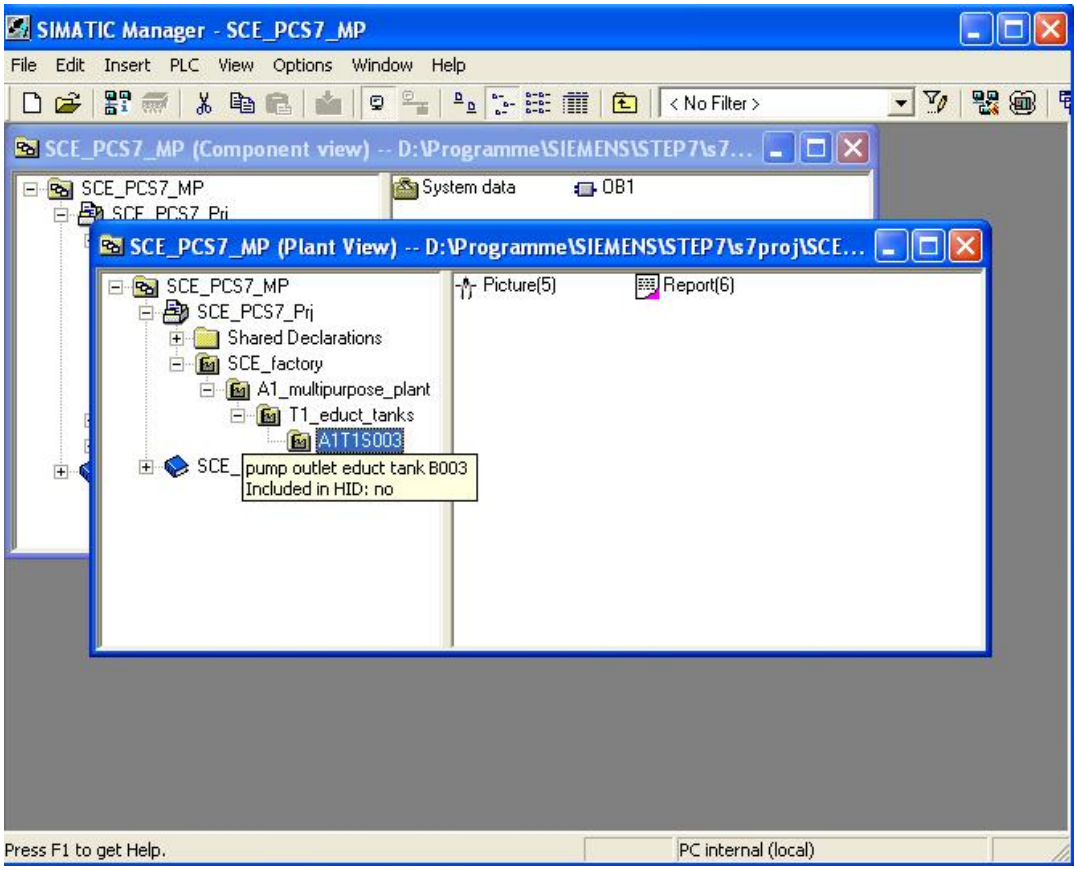


Note: Tab 'S88 Type Definition' is not relevant as yet. It is needed to implement batch processes.

Now, make the following changes for the four hierarchy folders:

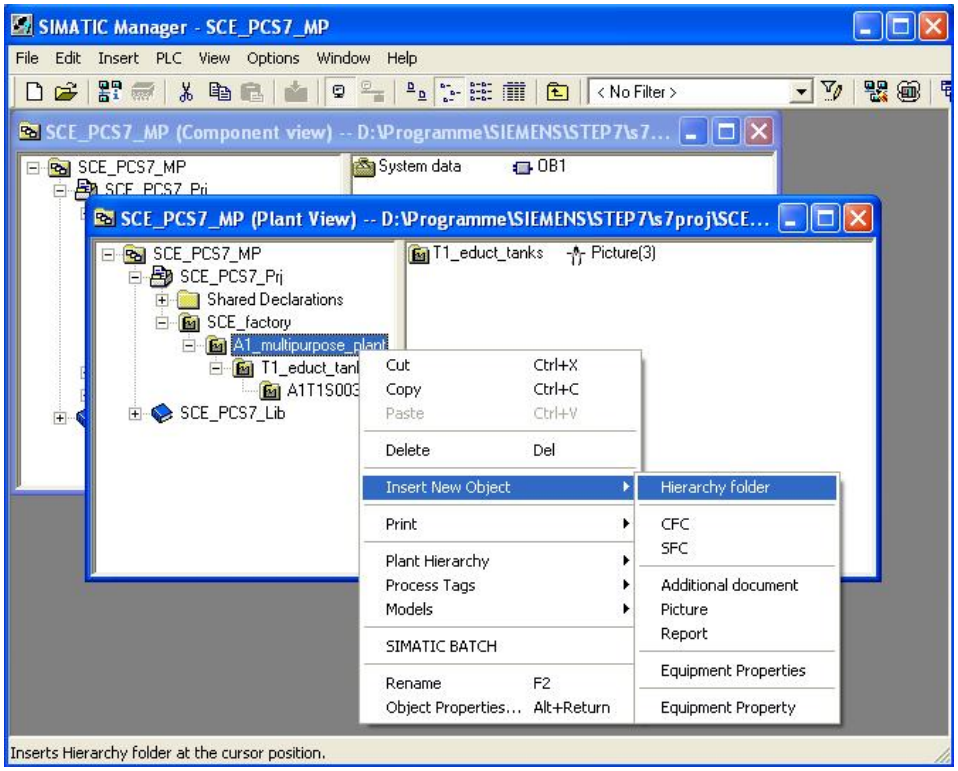
Name Folder Old	Name Folder New	Comment
Process cell(1)	SCE_factory	none
Unit(1)	A1_multipurpose_plant	multipurpose plant for training of process control technology with PCS7
Function(1)	T1_educt_tanks	unit educt tanks
Device(1)	A1T1S003	pump outlet educt tank B003

9. The hierarchy of the folders now looks like this. If we move the mouse over a folder, the comment is displayed. (→ A1T1S003)



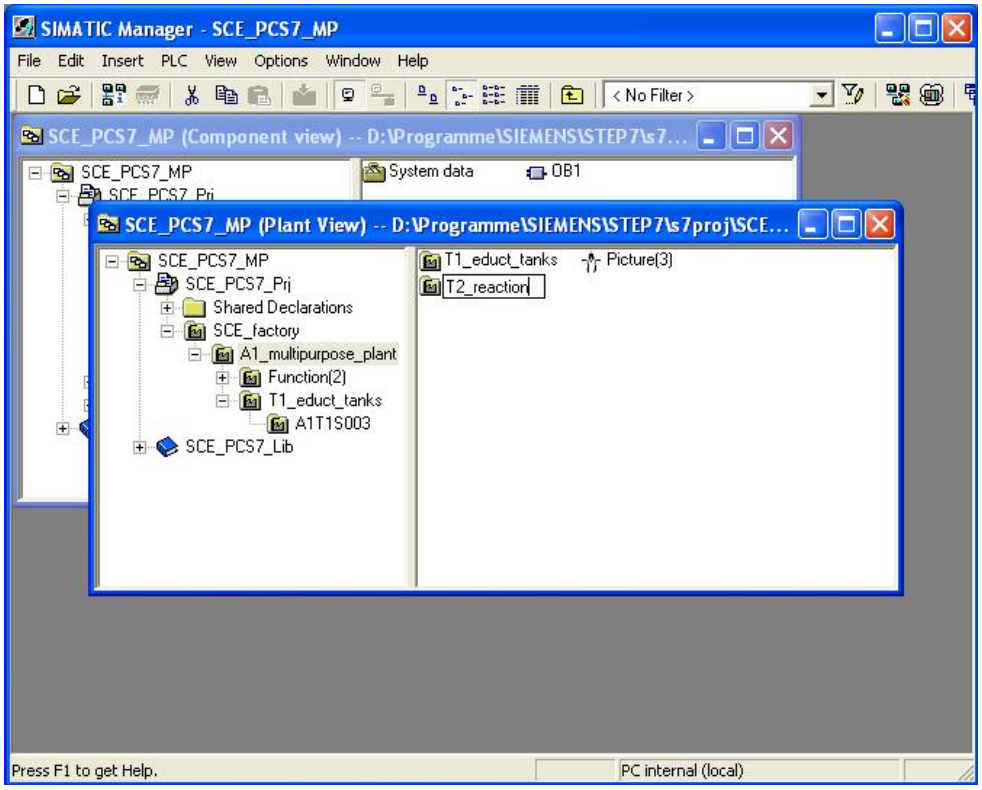
10. We still need additional folders for our project. To this end, right-click on the hierarchy under which you want to set up a new folder. Then select 'Insert New Object' and 'Hierarchy Folder'.

    (→ A1_multipurpose_plant → Insert New Object→ Hierarchy Folder)

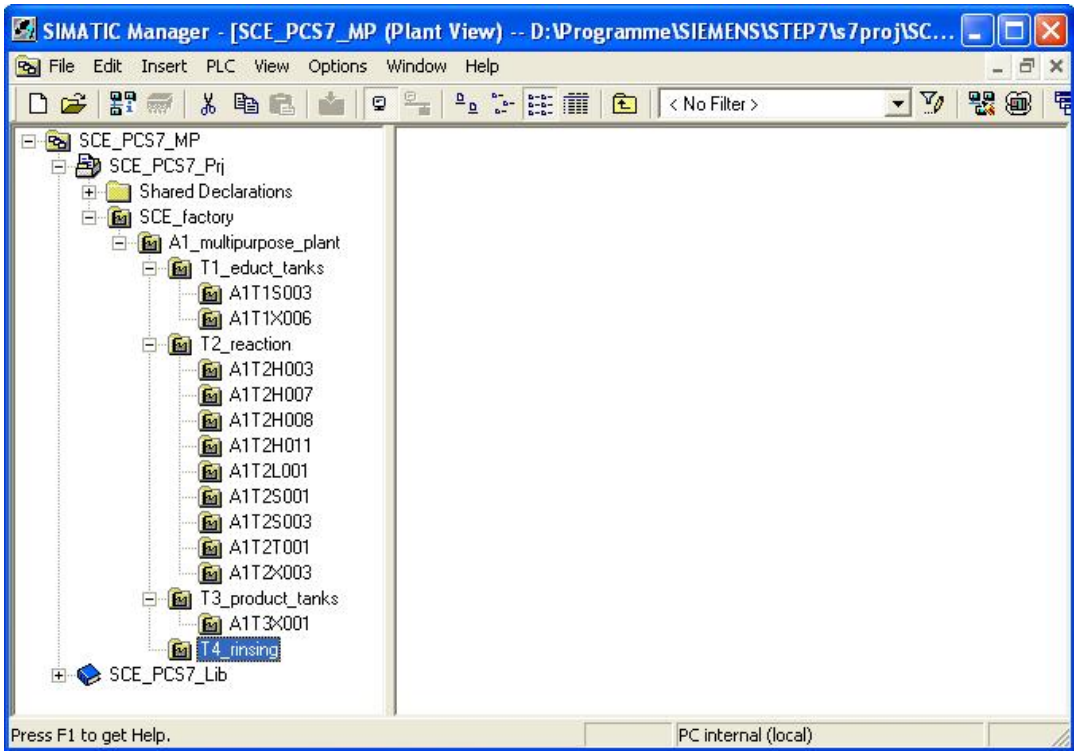


11. The folder's name and comment are entered also.

    (→ T2_reaction)



12. Corresponding to the steps described above, a hierarchy is set up that should to look like this:



The names and comments of all hierarchy folders are selected as follows:

Name folder	Comment
SCE_factory	none
A1_multipurpose_plant	multipurpose plant for training of process control technology with PCS7
T1_educt_tanks	unit educt tanks
A1T1S003	pump outlet educt tank B003
A1T1X006	open/close valve outlet educt tank B003
T2_reaction	unit reaction
A1T2H003	local operation educt B003 to reactor R001
A1T2H007	local operation reactor R001 stirring
A1T2H008	local operation reactor R001 heating
A1T2H011	local operation reactor R001 discharging
A1T2L001	filling level reactor R001
A1T2S001	stirrer reactor R001
A1T2S003	pump outlet reactor R001
A1T2T001	temperature reactor R001
A1T2X003	open/close valve inlet reactor R001 from educt tank B003
T3_product_tanks	unit product tanks
A1T3X001	open/close valve inlet product tank B001
T4_rinsing	unit rinsing

EXERCISES

We are now going to apply what we learned from the theory chapters and the step by step instructions to the exercises. To this end, we are using the existing multi-project from the step by step instructions and expand it (PCS7_SCE_0103_R1009.zip).

For the following exercises it is assumed that the experimental plant is utilized in the context of a larger production plant. For this production plant, we are designing a plant hierarchy and implementing it in the subproject that was set up in the exercise for the hardware configuration. The following new production units have to be processed:

1. There is another production unit that is identical with process cell A1 we already know. This process cell is designated as A2.
2. Process cell A3 is a production unit where a decomposition process takes place. In addition to the containers for educts, reactions and products, there is a collection container for waste (refer to Figure).

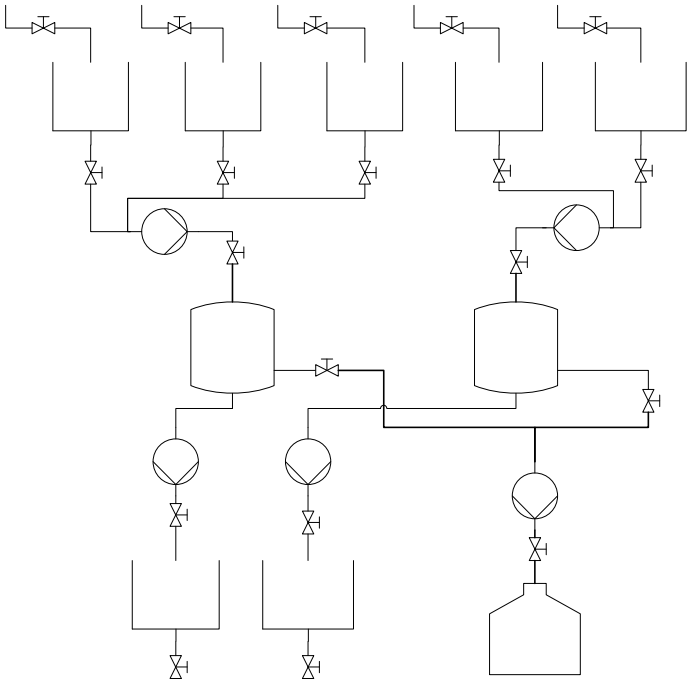


Figure 4: Drawing of process cell A3

3. In addition, there is process cell A4, where educts as well as products can be checked for quality. This process cell consists of the following: a rinsing cycle <<?>>, several containers for the materials to be checked, a check container where the actual quality check is performed, and a collection container where the material that was checked is temporarily stored until it is removed (refer to Figure).

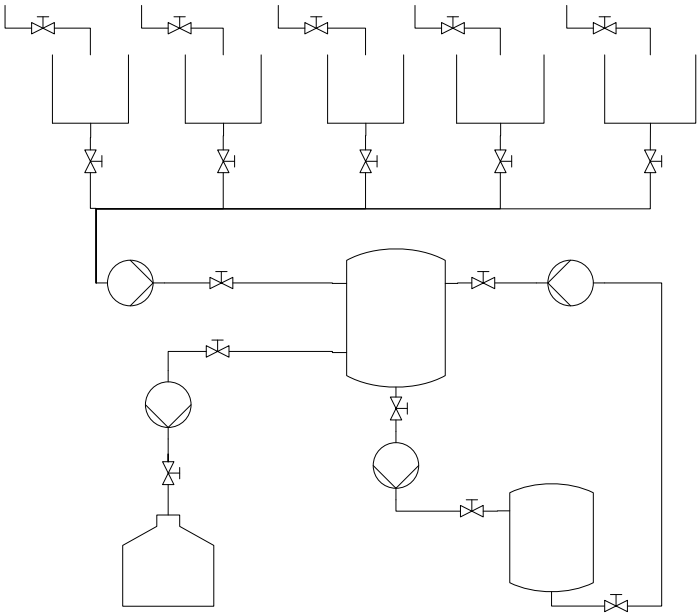


Figure 5: Drawing of process cell A4

The AS2 controls process cell A2, and the AS3 controls process cells A3 and A4. The controllers AS2 and AS3 were already configured for the exercise in the chapter 'Hardware Configuration'.

TASKS

1. Design a hierarchy for process cells A3 and A4. To the extent that it makes sense, refer to the specifications that were made for process cell A1 so that a uniform hierarchy that is easy to follow is the result.
2. Open the project that was created in the previous exercise with AS2 and AS3. Here, set up the plant hierarchy created in Task 1 for process cells A2, A3 and A4.
3. Make the AS-OS assignment for process cells A2, A3 and A4.