Contents

Application Knowledge

Part 2: Building Architecture

Fact *BD_17*

Information : In this part, the architecture and the installation of the given sensors and actuators of Building 32, 4th floor is described

Fact *BD_18*

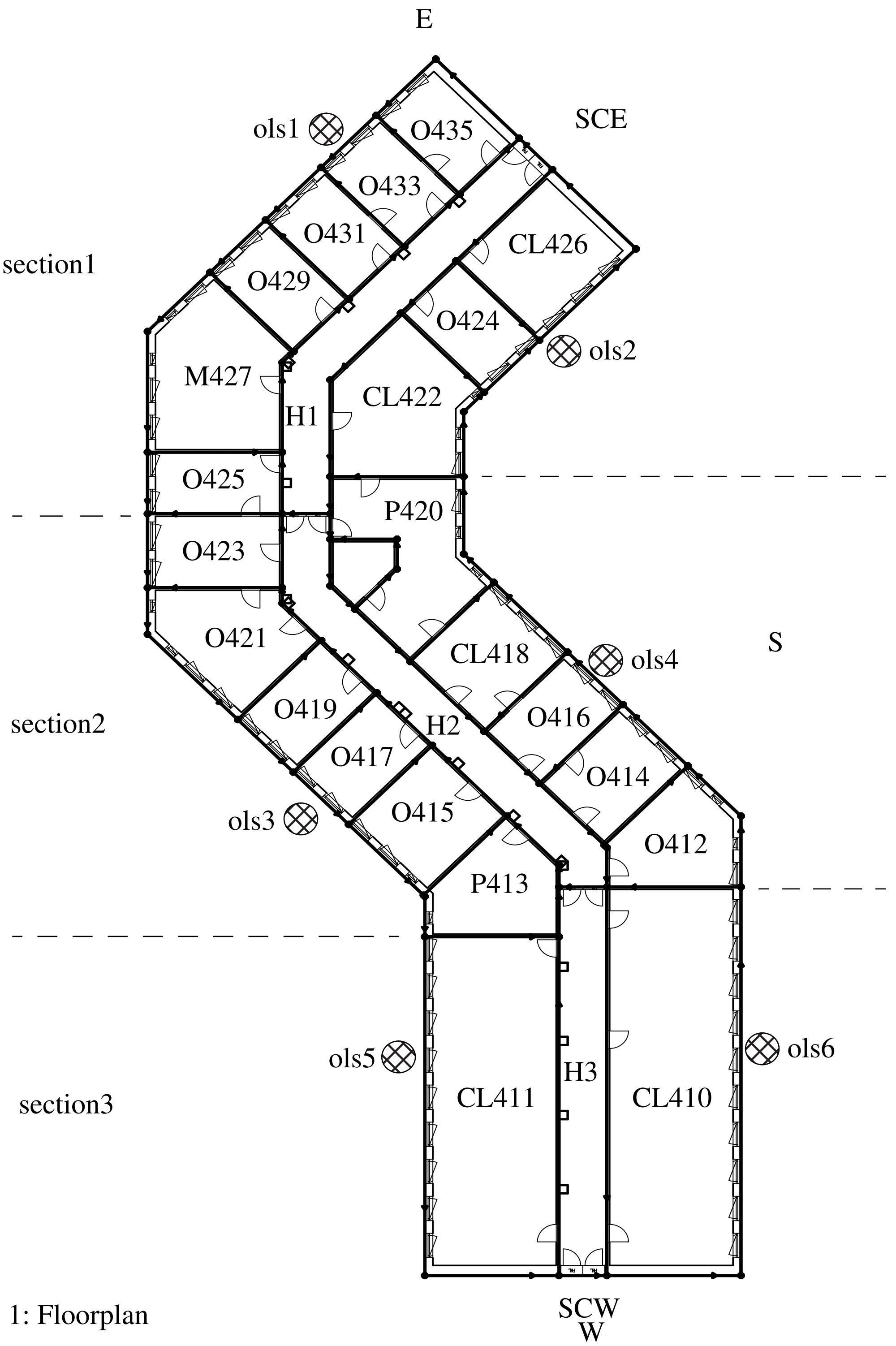
Information : In the following document, keywords are marked at their first occurrence and listed in the additional dictionary (Part 3).

Fact *BD_19*

Information : Words written in emphasis are names of physical sensors/actuators.

2.1 Building Structure

Fact *Floorplan*



Information : Figure 1: Floorplan

Fact *BD_20*

Information : The fourth floor of building 32 consists of three sections and shares two staircases SCE and SCW with other floors of the building, as shown in figure 1. Sections are divided into offices(O), computer labs(CL), hardware labs(HL), peripheral rooms(P), meeting rooms(M), and hallways(H). All rooms in a section are accessible via connected hallways. There are three hallways and 22 rooms to control. Figure 1 also shows the six outdoor light sensors (ols1 - ols6) and the major compass directions. The sensors cover the six directions of the different walls. The number in the rooms indicate the type of room plus a unique number.

2.2 Current Installation

Fact *BD_21*

Information : Currently, ceiling light groups in all rooms can only be turned on or off in groups.

Fact *BD_22*

Information : In all rooms each ceiling light group is controlled by one or more push-buttons, that toggle the light if switched to the other position.

Fact *BD_23*

Information : Task lights are controlled manually by one push-button.

Fact *BD_24*

Information : In the hallways, several push-buttons can toggle the ceiling light group on and off. All push-buttons are connected in parallel.

2.3 Planned Installation

2.3.1 Offices

Fact *BD_25*

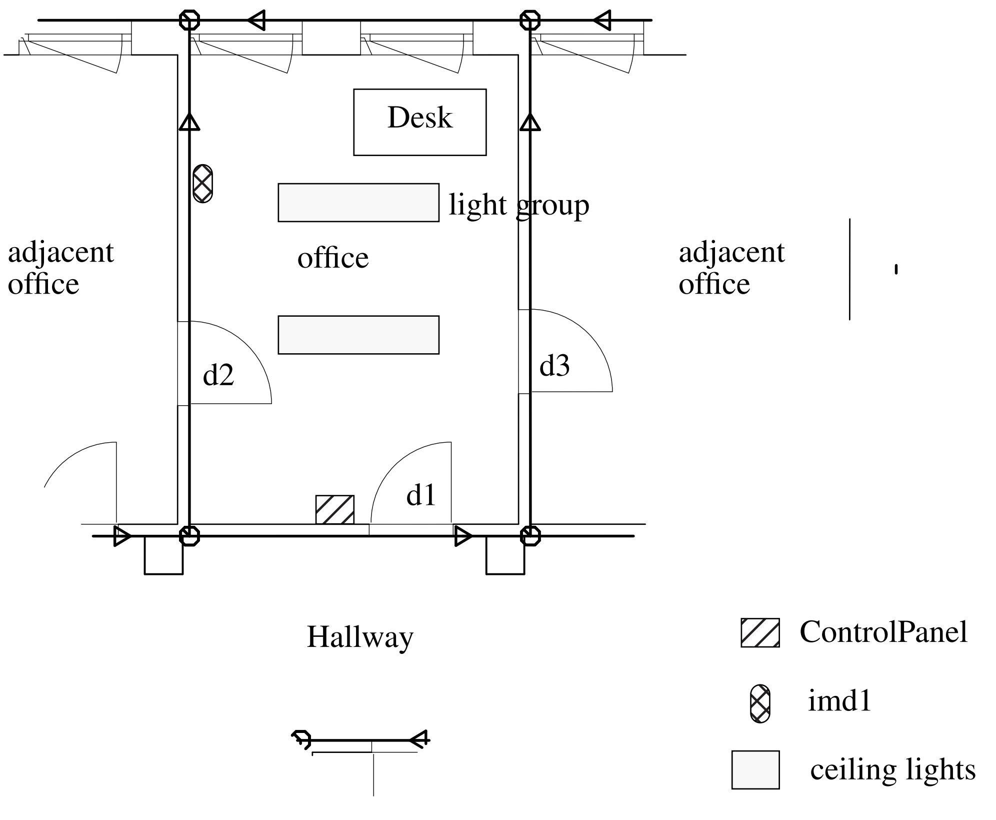
Information : An office (shown in Figure 2) has one door (d1) to the hallway and can have doors to the adjacent rooms (d2, d3). Only those doors are part of a room that open into the room. There fore, d3 is not an object of the shown room, but the name can be used as a reference. Each door is equipped with a door closed contact, named dcc¡n¿, where n is the number of the door in the room.

Fact *BD_26*

Information : Each office is equipped with

1. one motion detector, so that the room is fully covered (imd1). Actually several motion detectors can be connected in parallel to achieve the coverage.
2. two ceiling light groups (window and wall), that can be dimmed individually with dimmer-actuators lle1 (window) and lle2 (wall)
3. a panel to control the light groups directly or select light scenes,
4. a desk with a movable task light on it.The task light can be manually turned on and off (pb3).
5. two push-buttons (pb1 (window) and pb2 (wall)) for the control of the ceiling lights.
6. three status lines (sll1..3) that show the status of the three light sources.

Fact *Office*



Information : Figure 2: Office

2.4 Hallway

Fact *BD_27*

Information : Each hallway is limited by two doors, leading to the adjacent hallways. Each door is assigned to only one hallway. Therefore, in the given floor with 3 hallways and 4 doors, there exists one hallway with two doors and two hallways with only one door. The assignment of the doors and their associated names are shown in Figure 3. Each door is equipped with a door closed contact, named dcc<n>, where n is derived from the name of the door.

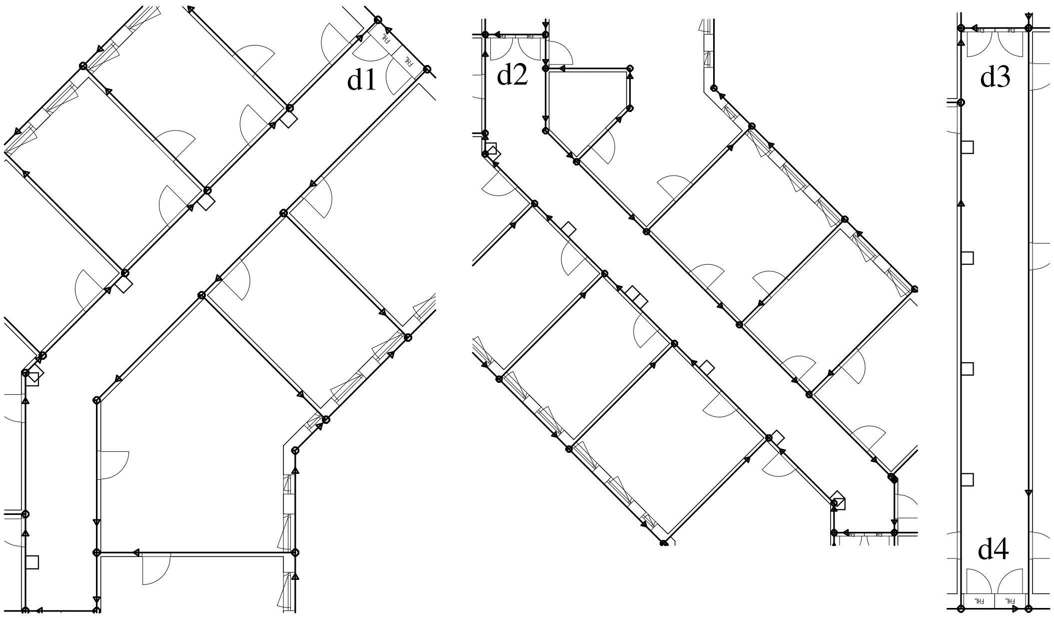
Fact *BD_28*

Information : Each hallway is equipped with

1. two motion detectors (imd1 and imd2), placed above the doors at each end of the hallway to determine the presence of a person near a door,
2. one motion detector to cover the whole section (imd3), can be several connected in parallel for coverage.
3. one ceiling light group that can be turned on and off,
4. several wall push-buttons (pb) to toggle the light, an impulse relay, which controls the ceiling light group, and normal relays in parallel to push-buttons.
5. one status line (sll1) that determines if the light is on or off (sl1)

2.4.1 Staircase

Fact *Hallways*



Information :

Figure 3: Three hallways

Fact *BD_29*

Information : Staircases connect several floors.

Fact *BD_30*

Information : At the floor level, a staircase is equipped with

1. one motion detector imd1 above the door to the adjacent hallway to detect motion near the door.

2.4.2 Computer Labs

Fact *BD_31*

Information : A computer lab has one door (d1) to the hallway and can have doors to the adjacent rooms (d2, d3). The light installation is the same as in the offices. The sensors at the doors are named like the ones at the offices.

Fact *BD_32*

Information : Each computer lab is equipped with

1. one motion detector, so that the room is fully covered (imd1). Actually, several motion detectors can be connected in parallel to achieve the coverage.
2. two ceiling light groups (window and wall) that can be dimmed individually with dimmer-actuators lle1 (window) and lle2 (wall)
3. a panel to control the light groups directly or select light scenes,
4. two push-buttons (pb1 (window) and pb2 (wall)) for the control of the ceiling lights.
5. two status lines (sll1, sll2) that show the status of the light sources.

2.4.3 Hardware Labs

Fact *BD_33*

Information : Same as computer labs, but with more than one door to the hallway.

2.4.4 Meeting Room

Fact *BD_34*

Information : Same as computer lab.

2.4.5 Peripheral Rooms

Fact *BD_35*

Information : The peripheral rooms will not be controlled by a computer system, and thus they will not be presented furthermore!

2.5 Sensors

Fact *BD_36*

Information : This section describes the real physical sensors including converters if necessary.

Fact *BD_37*

Information : Analog sensors typically have an exponential time response. Reaction time is the time from a change of the sensed property to the time when the sensor has reached 90% of the change, excluding conversion time. Conversion time is the time to convert the analog value to a digital one that can be accessed by the control system.

Fact *BD_38*

Information : NC means "normally closed". Closed is coded as 1, open as 0.

Fact *Table_1*

Information :

Table 1:

Name	Abbrev.	Type	Resolution	Range	Reaction / Conversion Time	Description
door contact	dcc	NC-contact		0, 1	10 ms	It is placed above the door and is 1 if the door is fully closed.
wall switch	lsw	switch		0, 1	10 ms	2 stable positions
push-button	pb	momentary push-button		0, 1	10 ms	1 as long as pushed
motion detector	imd	passive infrared motion detector		0, 1	1 s	1 means a person is moving, even very slowly, in the range of the detector. Transition to 0 can be delayed.
outdoor light sensor	ols	analog light sensor	1 lux	1 - 10000 lux	10 ms / 1 s	Mounted perpendicular to facade, measures the illuminance of the facade for the calculation of light flow through a window.

2.6 Actuators

Fact *BD_39*

Information : Actuators have a linear time response. Reaction time is therefore defined as the time to change from 0 to 100% / 100 to 0%, if different.

Fact *Table_2*

Information :

Table 2: Actuators

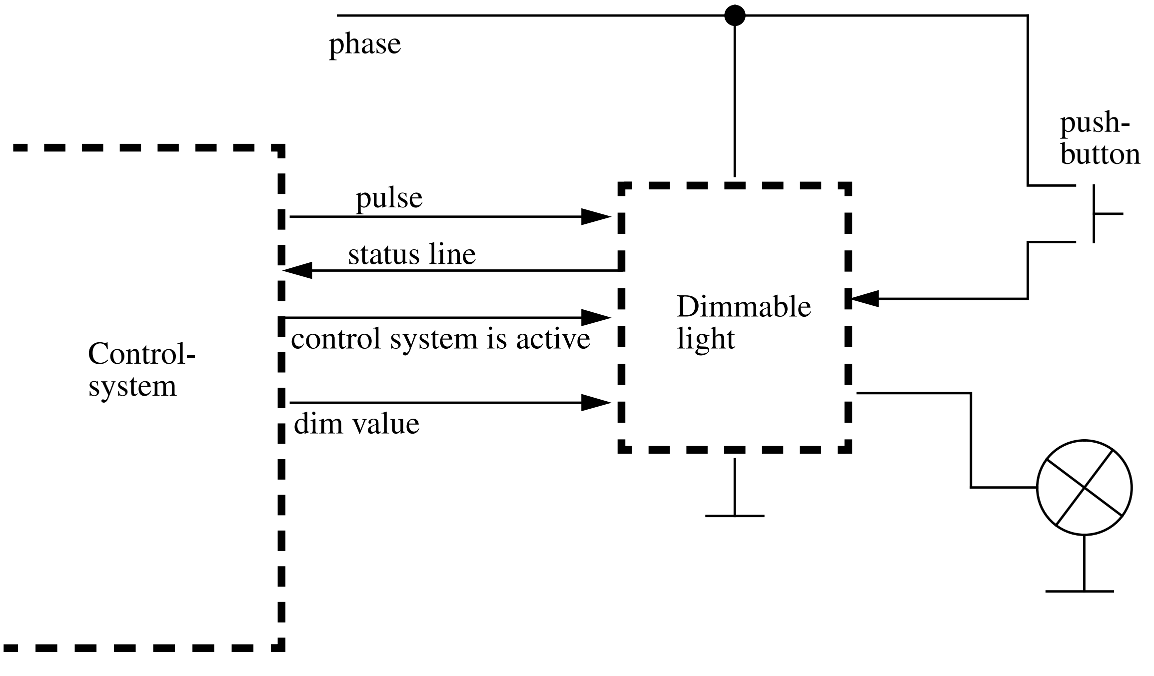
Name	Abbrev.	Type	Range	Control	Reaction Time	Description
dimmable light	sll	status line		0, 1	10 ms	Senses if the light has the voltage turned on or off.
	cia	status line		0, 1	10 ms	Even if the CS sends an 1 within every 60 s, the CS is still alive.
	dll	dimmer	0 - 100%		10 ms	Controls light between 0 (off) and 10-100% (on).
relays			1, 0		10 ms	

Fact *BD_40*

Information : The structure of the dimmable lights is shown in the next picture. Inputs to the dimmable light are the pulse line to toggle the light, a dim value to set the current dim value and the signal control system is active to show the status of the control system. If this signal is not sent every 60 s, the light switches to fail safe mode and dim value changes to 100%. The output is a status line to show the current state (on or off) of the light.

Fact *LightInstallation*

Information :



Problem Description

Part 1: Informal Requirements

Need *PD_1*

Information : This part contains the needs for a new light control system for the fourth floor of building 32 of the University of Kaiserslautern.

Need *PD_2*

Information : The main motivation for the development of a new light control system are the disadvan tages of the currently existing system. Since all lights are controlled manually, electrical energy is wasted by lighting rooms which are not occupied and by little possibilities to adjust light sources relative to need and daylight.

Need *PD_3*

Information : Paragraphs are numbered for easier reference.

1 Needs

Need *PD_4*

Information : In this section, the needs for the new light control system are presented. In 1.1, functional needs are listed and in 1.2 non-functional needs.

1.1 Functional Needs

Need *PD_5*

Information : The functional needs are split into two groups, user needs and facility manager needs, depending on the person who has expressed them.

1.1.1 User Needs

Need *PD_6*

Information : The user needs are numbered by U<number>.

Need *PD_7*

Information : At first, general user needs are listed, which are demanded for each kind of room:

Need *U1*

Information : If a person occupies a room, the light has to be sufficient to move safely, if nothing else is desired by a chosen light scene.

Need *U2*

Information : As long as the room is occupied, the actual chosen light scene has to be maintained.

Need *U3*

Information : If the room is reoccupied within T1 minutes after the last person has left the room, the last chosen light scene has to be reestablished.

Need *U4*

Information : If the room is reoccupied after more than T1 minutes since the last person has left the room, the standard light scene has to be established.

Need *U5*

Information : The wall switches for the window- and the wall-ceiling light group in a room should show the following behavior:

- if the corresponding ceiling light is completely on, then the light will be switched off
- otherwise the ceiling light will be switched on completely

Need *U6*

Information : The light scenes can be determined by using the control panel.

Need *U7*

Information : For each room, the actual ambient light level can be set by the user using the control panel.

Need *U8*

Information : For each room, a default light scene can be set (not by using the control panel).

Need *U9*

Information : For each room, a default ambient light level can be set (not by using the control panel).

Need *U10*

Information : The value T1 can be set for each room separately (not by using the control panel).

Need *U11*

Information : If the outdoor light sensor or the motion detector of a room does not work correctly, the user has to be informed.

Need *PD_8*

Information : The user needs concerning the offices are:

Need *U12*

Information : The ceiling lights and the task light should be maintained by the control system depending on different light scenes.

Need *U13*

Information : The control panel should be movable in the offices, like a telephone.

Need *U14*

Information : The control panel should contain at least:

- a switch to set the task light (on/off)
- a switch to set the ceiling lights (on/off/ambient)
- a possibility to set the actual ambient light level

Need *PD_9*

Information : The user needs concerning the remaining rooms are:

Need *U15*

Information : In all other rooms the control panel should be installed near a door to the hallway.

Need *U16*

Information : The control panel should contain at least:

- a switch to set the ceiling lights (on/off/ambient)
- a possibility to set the actual ambient light level

Need *PD_10*

Information : The user needs for the hallway sections are:

Need *U17*

Information : When a hallway section is occupied by a person, the light in this hallway section has to be sufficient to move safely.

Need *U18*

Information : Before a person enters one hallway section from another one, the light in the section being entered is turned on if necessary.

Need *U19*

Information : The wall switches for lights in the hallway section have to show the following behavior:

- if the light is on, then the light will be switched off
- otherwise the light will be switched on.

1.1.2 Facility Manager Needs

Need *PD_11*

Information : The facility manager needs are numbered by FM<number>.

Need *FM1*

Information : Use daylight to achieve the desired light whenever possible.

Need *FM2*

Information : Lights in a hallway section have to be switched off when the section has been unoccupied for T2 min.

Need *FM3*

Information : If a room is unoccupied for more than T3 minutes, all lights must be switched off.

Need *FM4*

Information : The value T2 can be set for each hallway section separately.

Need *FM5*

Information : The value T3 can be set for each room separately.

Need *FM6*

Information : The facility manager can turn off any light in a room or hallway section that is not occupied.

Need *FM7*

Information : If a malfunction occurs, the facility manager has to be informed.

Need *FM8*

Information : If a malfunction occurs, the control system supports the facility manager by finding the reason.

Need *FM9*

Information : The system provides reports on current and past energy consumption.

Need *FM10*

Information : All malfunctions and unusual conditions are stored and reported on request.

Need *FM11*

Information : Malfunctions that the system cannot detect can be entered manually.

1.2 Non-Functional Needs

Need *PD_12*

Information : The non-functional needs are split into several groups depending on the aspect they are dealing with. They are numbered by NF<number>.

1.2.1 Fault Tolerance

In any case of failure the system shall provide a stepwise degradation of functionality down to manual operability.

Needs in the case of a malfunction of the outdoor light sensor:

Need *PD_13*

Information : In any case of failure the system shall provide a stepwise degradation of functionality down to manual operability.

Need *PD_14*

Information : Needs in the case of a malfunction of the outdoor light sensor:

Need *NF1*

Information : If the outdoor light sensor does not work correctly, the control system for rooms should behave as if the outdoor light sensor had been submitting the last correct measurement of the outdoor light constantly.

Need *NF2*

Information : If the outdoor light sensor does not work correctly, the standard light scene for all rooms is that all ceiling lights are on.

Need *NF3*

Information : If the outdoor light sensor does not work correctly and a hallway section is occupied, the lights in this hallway section has to be on.

Need *PD_15*

Information : Needs in the case of a malfunction of the motion detector:

Need *NF4*

Information : If the motion detector of a room or a hallway section does not work correctly, the control system should behave as if the room or the hallway section mere occupied.

Need *PD_16*

Information : Needs in a worst case failure of the control system:

Need *NF5*

Information : If the lights in a hallway section are neither controllable automatically nor manually, the lights have to be on.

1.2.1 Safety and Legal Aspects

Need *NF6*

Information : All hardware connections have to be made according to DIN standards.

Need *NF7*

Information : No hazardous conditions for persons, inventory, or building are allowed.

1.2.1 User Interface

Need *NF8*

Information : The control panel should be easy and intuitive to use.

Need *NF9*

Information : The system issues warnings on unreasonable inputs.

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