Electrical survey and risk analysis of a museum building

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ABSTRACT

Author Olli Juuti **Year** 2017

Title Museorakennuksen sähkökartoitus ja korjauskehotuksen laadinta

Supervisor(s) Timo Viitala

TIIVISTELMÄ

Työn tavoite on muodostaa sähkökartoitus ja korjauskehotus rakennuksen sähköisistä asennuksista ja niiden riskeistä sekä näiden toteuttamisen avulla minimoida tulipalovaara. 1950-luvulla valmistuneessa teollisuusrakennuksessa on sekä useita vanhoja toimivia että käytöstä poistettuja järjestelmiä.

Työn koostuu sähkötasokartoituksesta, sähköasennusten turvallisuuden selvittämisestä ja tarpeellisten korjausten esilletuonnista työn tilaajalle. Työn tilaajana toimi linja-automuseon toimitusjohtaja Timo Lehtonen.

Sähköjen selvityksen aikana ilmeni useita puutteita, jotka on tuotu toimeksiantajan tietoisuuteen. Puutteiden korjauskehotuksen laadinta vahvisti alkuperäiset epäilykset johtimien huonokuntoisuudesta ja huonosta huoltotoiminnasta. Monia sähköjärjestelmiä ei ole purettu vaikka ne ovat olleet käyttämättöminä pitkiä aikoja.

Korjauskehotuksen ehdottamat korjaukset suorittamalla rakennuksen sähköiset asennukset ovat askeleen lähempänä turvallista ja standardien mukaista kokonaisuutta.

Avainsanat Sähkö, Sähköturvallisuus, Sähköjärjestelmät.

Sivut 86 sivua, joista liitteitä 59 sivua

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ABSTRACT

The goal of this thesis project was to provide an electrical survey and suggestions on repairs to the electrical installations in the property, as well as to inform of the existing risks and minimize risk of electrical fire. The industrial building built in the 1950s had many original functioning systems as well as multiple already disabled systems.

The work includes electrical mapping, determination of the safety of the electrical installations and informing the commissioner of necessary repairs. The commissioner of the work was Timo Lehtonen, the CEO of the museum.

During the mapping many defects came up. These were notified to the commissioner. Creating the action proposal confirmed the original doubts about the condition of the wires and the poor maintenance level throughout the building. Many of the original electrical systems had not been disassembled even though they have been unused and disabled for many years.

Implementing the recommended actions will make the affected electrical installations safer and bring them closer to current standards.

Keywords Electricity, electrical safety, electrical system

Pages 86 pages including appendices 59 pages

CONTENTS

1 INTRODUCTION

Electricity is an important part of a modern society. Ever since inventing electricity the technology has developed to be extremely efficient. Electricity is introduced as source of power to many new applications. Electric energy has its downsides and dangers, which has led to collecting data from incidents and accidents to prevent and reduce them.

Electrical safety affects every device, system and people. To ensure the safety of people and processes, electrical safety standards have been established. These standards set the requirements for installations, systems and equipment that minimize the risk of fire, electric shock and explosion.

Electricity safety standards are a collection of codes and guidelines. The International Organization of Standardization (ISO) and the European Committee for Standardization (CEN) are the wider standardization organizations that perform the establishment and adoption of standards. The Finnish Standardization Association SFS RY is a member of both ISO and CEN. Renewing standards from time to time is made to ensure safety or to refine guidance when needed. Standards are a necessity for legitimate and safe operation. The most important standards related to this thesis are electrical standards SFS 6000 (2017), SFS 6001 (2015) and SFS 6002 (2015).(SFS. Wikipedia 2017, retrieved on November 16.)

The industrial building under review is expected to have passed the standard requirements when it was built. Those standards have been updated or changed during the years. To improve safety, the installations are compared to the current standard requirements to see which are dangerous or even illegal. A particular risk consists of wooden buildings and degraded cables. Some devices may also have lost their security capacity over time.
The names of the cabinets and rooms are given by the orderer and describe the prior use of each space. The premises upstairs have functioned as apartments or offices.

The electrical installations in the office spaces in the upstairs of the newer building are flush mounted. They were visually inspected without any noticeable defects so there are no pictures from those rooms. The offices were built later and have newer cables than the rest of the property.
The working methods are presented after the more precise goal and limitation of the work. Following the methods is an introduction to the relevant safety standards and requirements from Tiainen (2013) for the installations.

The data describes the essential areas of the property and presents the division of the apartments by letters, thus clarifying the appended descriptions. The analysis presents the found defects compared to the requirements according to Tiainen(2013).
The defect list summarises the defects based on an analysis and categorizes them to simplify further steps. The action proposal list gives each defect a proposed of required action to correct each installation.

2 GOALS AND LIMITATIONS OF THE PROJECT

The goal was to find relevant standards to the work and estimate the safety of the electrical installations in the property. The purpose of the thesis project was to visually examine the condition of the installed cabinets, cables and devices and to conduct this also with a cable-tracing device.
Since the workload of thesis work was restricted, all of the relevant standards could not be addressed. The evaluation was restricted to cover the requirements discussed in Tiainen (2013).

The purpose of the "D1-2012" handbook (Tiainen,2013) is to give additional information and guidance to the application of safety requirements and relevant standards in electrical installations in buildings. The scope of the survey was limited since there was no access to an insulation tester and therefore some of the requirements of "D1-2012" handbook (Tiainen,2013) were excluded from this project.

Since the electrical installations of an industrial property are under 1kV the standard SFS 6001 (2015) is not relevant to the work. The electrical delivery post with its equipment were not accessible safely so this was not reviewed as part of the work.

The industrial facility was built in the 1950s and it functions today as a museum. Most of the machinery on the property are original and require guidance to be safely used. The condition of the machinery was visually assessed but a proper investigation of the machines would require professional skills and a validated electrician. The purpose of use of the facility had been changed and the owner wanted to ensure the safety aspects of the property's electricity for it to function as intended in its current use.

The results and suggested actions based on the insulation resistance measurement were not included into the thesis. The work was performed with the knowledge acquired during studies at Häme University of Applied Sciences on the S2 electrical installation theory and occupational- and electrical safety cards.

3 RESEARCH METHODS

3.1 Relevant safety standards

This work examines the safety of electrical installations in an industrial facility. The current international safety standards related to electricity have been developed to increase the safety and consistency of installations. Electrical installation standard SFS 6000(2017) focuses on installations and systems under 1 kV current. Electrical safety standard SFS 6002(2015) focuses on work methods, safety equipment and working environment. SFS 6002(2015) was followed during the data gathering.

3.2 Data gathering

The data gathering was completed using the necessary safety equipment and tools used for electric work, as well as special caution in the vicinity of hazardous areas. The goal was to provide a comprehensive mapping of the electric installations, to find out potentially hazardous areas to inform about the defects and to suggest the required repairs. Photos of the electrical installations were taken from each room to provide visual information for this thesis project.

3.2.1 Blueprints

The original blueprints were not available so the building's layout had to be made on an electronic platform to enable the electrical mapping. The program used to make the blueprints was CADS House PRO. The building was sketched on paper with precise measurements using a laser measurement tool and measuring tape and later this data was transferred to an electronic platform. The walls of the building are not completely straight nor at straight angles to each other, whereby the final drawings represented the structures at a centimetre accuracy. Large rooms and the restriction of the laser measurements distance caused difficulties for getting accurate measurements. Three dimensional perception helped understanding the structures of a three-story facility with up to three metres of a height difference. Combining the blueprints clarified the electrical installations of the facility.

3.2.2 Placement of instruments

Instruments were added directly into the CADS Electric Pro software using the blueprints of each floor as reference picture. Each instrument was measured from fixed elements: walls, windows or posts. Most of the instruments were flush mounted or clearly visible and were easily accessible. The facility has functioning 3-phase outputs and production equipment.

3.2.3 Exploration of cables

Visual examination revealed many faulty or dangerous connections. Due to the complexity of the building and the structures built at different times, old uninstalled cables still existed. Some of the cut cables were still connected to the cabinets. The main tool for mapping the flush mounted installations was Laserliner AC-Tracer.

3.2.4 Connecting electricity

Connecting the instruments and cables into the electrical drawings was possible with the photographs taken and utilizing the mobility of a laptop. Cables passing through the structures and a three-dimensional perception were helpful.

3.3 **Data analysis**

The data included blueprints of the facility, electrical drawings and photos of each room of each building. The photos were named and numbered according to the building, floor and room. Forming the analysis the detected defects and possible faults were compared to the requirements presented by Tiainen (2013,9-33).

3.4 **Forming the defection list**

The defection list compiled the results of the analysis into a simple table which displayed the type of defect in each installation. Each column illustrated the defects as seen in Table 3. The listed defects did not meet all of the requirements.

3.5 **Forming the action proposal**

The proposed actions depend on the severity of the faults and defects from adding a junction box to repairing or removal of a whole cabinet. Each of the actions must be completed so that the electrical installations will be safe and meet the requirements in the future.

4 ELECTRICAL SAFETY STANDARDS

SFS 6000(2017) deals with the safety of installations below 1 kV and with selecting instruments and cables for each environment. Various parts of the standard deal with basic concepts, guides with designing, and details specific requirements for the subject in question. For example, SFS 6000-

5-56: 2017 deals with Security Systems, describing the features mentioned and provides instructions for meeting the requirements.

The requirements for the electrical safety standards were translated from

Finnish to English by the author of the thesis based on Tiainen (2013,9-33):

1. People and household animals have to be protected from dangers that may occur when coming in touch with or getting too close to live parts.
2. People and household animals have to be protected from the dangers that may occur from contact or close proximity during a malfunction in an electrical installation.
3. The structure of an electrical installation shall be such that no ignition of a combustible substance, caused by a high temperature or an electric arc, is generated.
4. Electric installations shall not cause the risk of burns to humans or household animals.
5. An overflow that may pass through live wires must not cause high temperatures or electromechanical strains that can damage people, household animals or property.
6. In the event of a fault in an electrical installation, in the normal situation, non-conductive conductors and other conductive parts must withstand any fault current flowing through them without their temperature rising dangerously high or posing a mechanical hazard.
7. Protective devices shall operate at such currents, voltages and within a period of time sufficient to ensure adequate safety.
8. The electrical protection system of electrical equipment must be selected in such a way that it can be maintained operationally and reliably throughout the life of the electrical installation.
9. The voltage between the live parts of the circuits supplied with different voltage or the overvoltage caused by other electrical equipment for other reasons must not cause danger or injury to humans, household animals or property.
10. The electrical strength of the electrical installation and the insulation level shall correspond to the voltages present in the operating conditions.
11. The structure of an electrical installation shall be such that it will withstand the external stresses and circumstances likely to affect the intended use and the location of use.

12. Electricity equipment shall be constructed of electrical devices and other equipment intended for such use and conditions, as well as materials the structure of which complies with the relevant regulations. Equipment and accessories must be installed in the manner intended by the manufacturer and maintained in such a way as to ensure their safety.
13. The structure of equipment intended for use by non-electrical persons shall be such that these persons can safely use the equipment and carry out the tasks for them without the risk of contact and the risk of electric shock from the live parts.
14. The structure and position of a railroad electrical installation shall be such that the hazards of unknown persons are not readily accessible to live parts.
15. External hazards associated with railroad electrical equipment or other special electrical equipment must be taken into account in the construction or shielding of the equipment.
16. In an area containing a medical facility, an explosive atmosphere or other exceptional hazards, only an electrical installation with the structure or protection that ensures the safety of the installation in that space shall be installed.
17 .In the structures of power lines and other electrical equipment related to electricity distribution, consideration must be given to the safety requirements for conventional electrical installations: weather conditions, distance from buildings, movement of persons and traffic.
18. The various components of the electrical installation must be compatible with each other. Electrical equipment or electrical equipment must not compromise the safety of another electrical installation or electrical appliance.
19. The electrical equipment shall be such that there is no harmful effect between it and non - electrical installations.
20. The electrical equipment must be so clearly structured that no hazardous incidents can occur during its operation and maintenance.
21. The electrical equipment shall be equipped with the necessary markings and warning signs for its use and maintenance. The protective devices, wires and conductors must be clearly grouped and labelled where necessary so that the circuits can be identified. The diagrams and instructions necessary for the construction, operation and maintenance of electrical equipment must be created.
22. The structure of an electrical installation shall be such that all foreseeable electrical equipment inspection, testing, maintenance or repair operations can be carried out safely and appropriately.
23. Electrical equipment must have sufficient separation devices so that circuits or individual equipment can be separated from the network for service, testing, troubleshooting or repair.
24. If, in the event of a risk, it is necessary to immediately disconnect the power supply, the disconnecting device or the control device must be installed to be easily detectable and effective and quickly accessible.

The relevant requirements as to this building under inspection are marked with X in the Table 1:

Table 1 Scope of the work.

D1-2012 Requirements	Within Scope of this work
1. People and household animals have to be protected from dangers that may occur when coming in touch with or getting too close to live parts.	X
2. People and household animals have to be protected from the dangers that may occur from contact or close proximity during a malfunction in an electrical installation.	X
3. The structure of an electrical installation shall be such that no ignition of a combustible substance, caused by a high temperature or an electric arc, is generated.	X
4. Electric installations shall not cause the risk of burns to humans or household animals.	X
5. An overflow that may pass through live wires must not cause high temperatures or electromechanical strains that can damage people, household animals or property.	
6. In the event of a fault in an electrical installation, in the normal situation, non-conductive conductors and other conductive parts must withstand any fault current flowing through them without their temperature rising dangerously high or posing a mechanical hazard.	
7. Protective devices shall operate at such currents, voltages and within a period of time sufficient to ensure adequate safety.	
8. The electrical protection system of electrical equipment must be selected in such a way that it can be maintained operationally and reliably throughout the life of the electrical installation.	
9. The voltage between the live parts of the circuits supplied with different voltage or the overvoltage caused by other electrical equipment for other reasons must not cause danger or injury to humans, household animals or property.	
10. The electrical strength of the electrical installation and the insulation level shall correspond to the voltages present in the operating conditions.	
11. The structure of an electrical installation shall be such that it will withstand the external stresses and circumstances likely to affect the intended use and the location of use.	
12. Electricity equipment shall be constructed of electrical devices and other equipment intended for such use and conditions, as well as materials the structure of which complies with the relevant regulations. Equipment and accessories must be installed in the manner intended by the manufacturer and maintained in such a way as to ensure their safety.	X
13. The structure of equipment intended for use by non-electrical persons shall be such that these persons can safely use the equipment and carry out the tasks for them without the risk of contact and the risk of electric shock from the live parts.	X
14. The structure and position of an railroad electrical installation shall be such that the hazards of unknown persons are not readily accessible to live parts.	X
15. External hazards associated with railroad electrical equipment or other special electrical equipment must be taken into account in the construction or shielding of the equipment.	
16. In an area containing a medical facility, an explosive atmosphere or other exceptional hazards, only an electrical installation with the structure or protection that ensures the safety of the installation in that space shall be located.	
17 .In the structures of power lines and other electrical equipment related to electricity distribution, consideration must be given to the safety requirements for conventional electrical installations: weather conditions, distance from buildings, movement of persons and traffic.	X
18. The various components of the electrical installation must be compatible with each other. Electrical equipment or electrical equipment must not compromise the safety of another electrical installation or electrical appliance.	X
19. The electrical equipment shall be such that there is no harmful effect between it and non - electrical installations.	X
20. The electrical equipment must be so clearly structured that no hazardous incidents can occur during it's operation and maintenance.	X
21. The electrical equipment shall be equipped with the necessary markings and warning signs for its use and maintenance. The protective devices, wires and conductors must be clearly grouped and labeled where necessary so that the circuits can be identified. The diagrams and instructions necessary for the construction, operation and maintenance of electrical equipment must be created.	X
22. The structure of an electrical installation shall be such that all foreseeable electrical equipment inspection, testing, maintenance or repair operations can be carried out safely and appropriately.	X
23. Electrical equipment must have sufficient separation devices so that circuits or individual equipment can be separated from the network for service, testing, troubleshooting or repair.	
24. If, in the event of a risk, it is necessary to immediately disconnect the power supply, the disconnecting device or the control device must be installed to be easily detectable and effective and quickly accessible.	X

The scope of the survey and the thesis were limited because there was no access to an insulation tester and therefore some of the requirements presented by Tiainen (2013,9-33) were excluded.

5 DATA

The industrial property, consisting of four buildings and a warehouse, was built between 1940 and 1953. This property was operating as a vehicle bodywork factory until 1982 and as a depot until 2011. In 2012,the real estate was purchased for museum use. (Lehtonen, Linja-automuseon synty, 2015)

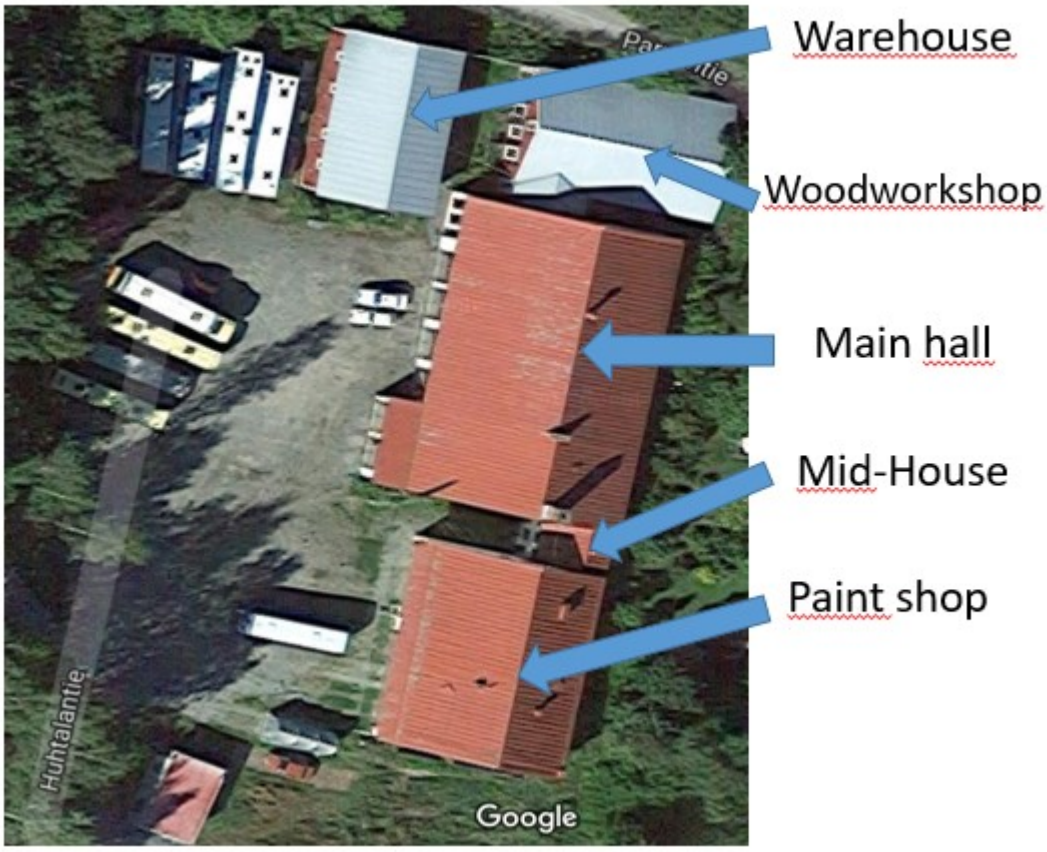


Figure 1.Aerial photo of the premises. (Google maps n.d.)

The facility's four buildings have been designated for industrial use; the main hall in the middle of the aerial view, the paint shop on the southern side, the woodworkshop on the northern side, and a detached wood warehouse. The Mid-House with an upholstery and the present-day showroom on the second floor is located between the main hall and the paint shop.

Blueprints illustrating the different floors of the different buildings are shown in figures 1 to 5

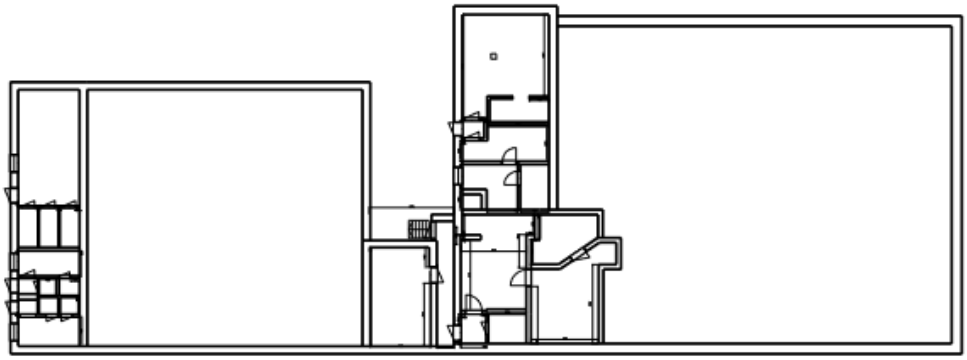


Figure 2. Basement blueprint.

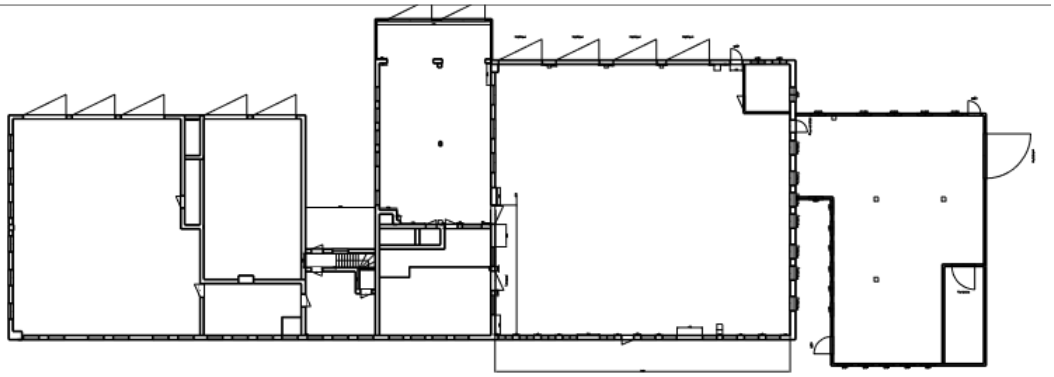


Figure 3. Main floor blueprint.

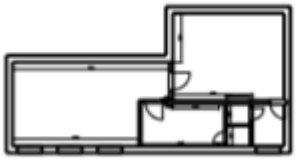


Figure 4. Mid-house upstairs blueprint.

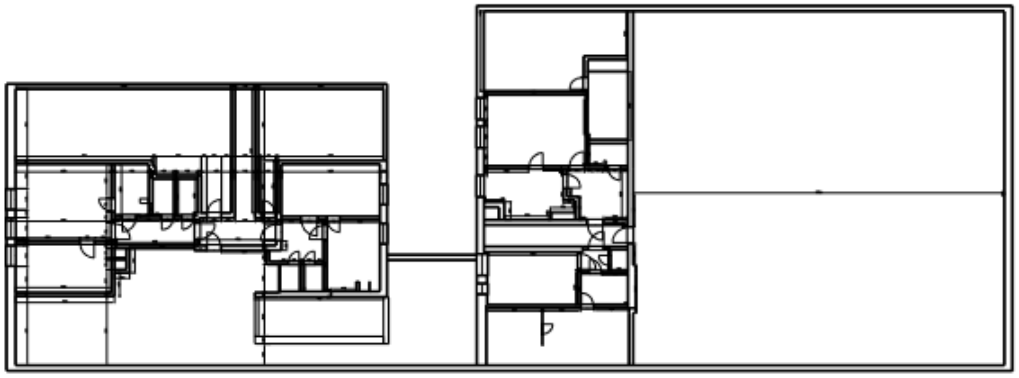


Figure 5. Upstairs blueprint.

Figures 6 to 10 illustrate the electrical drawings in each building and floor.

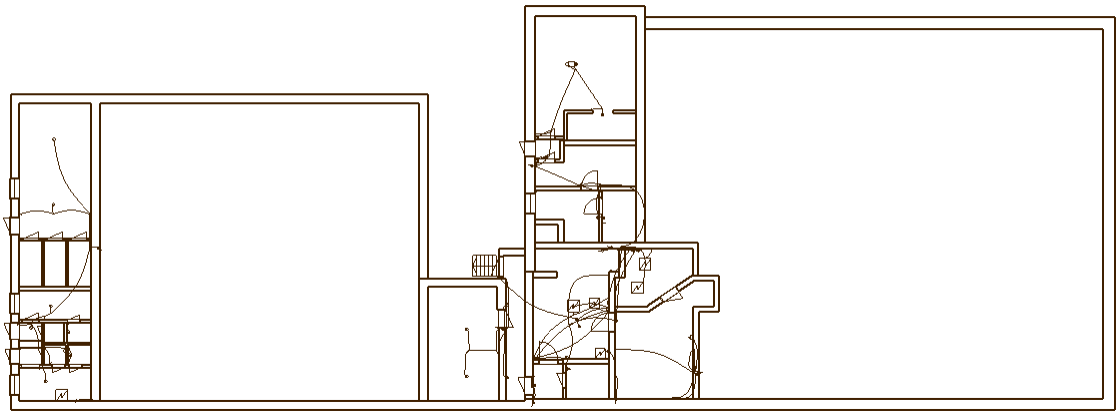


Figure 6. Electrical drawing of basement

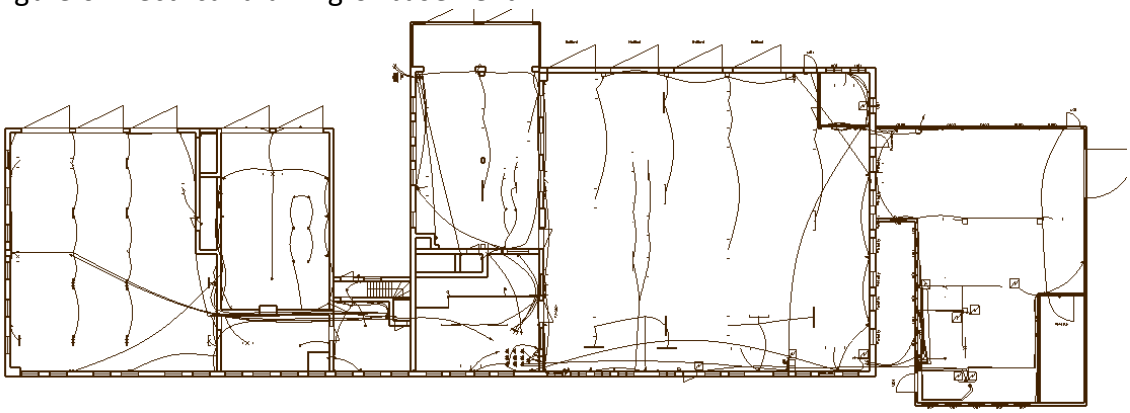


Figure 7. Electrical drawing of main floor.

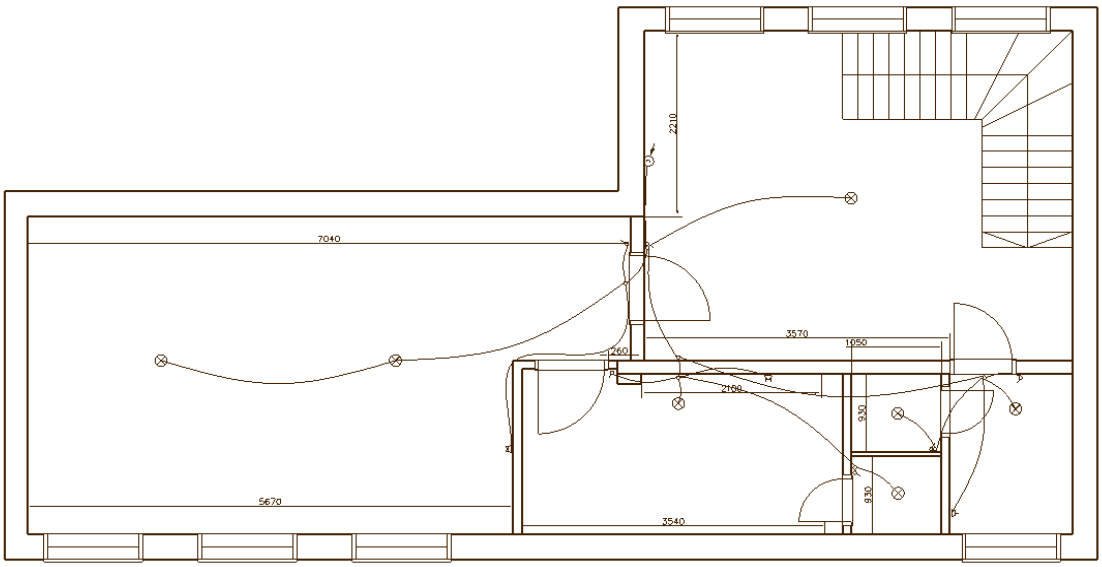


Figure 8. Electrical drawing of mid-house.

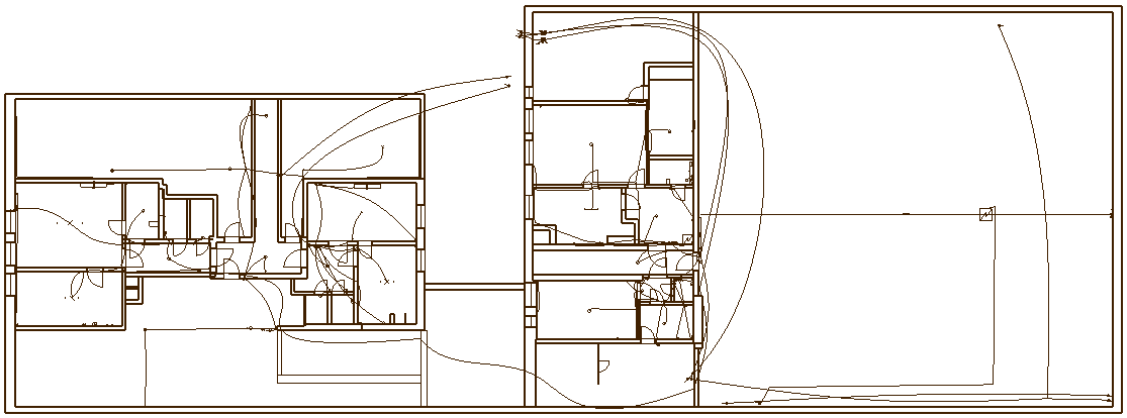


Figure 9. Electrical drawing of upstairs.

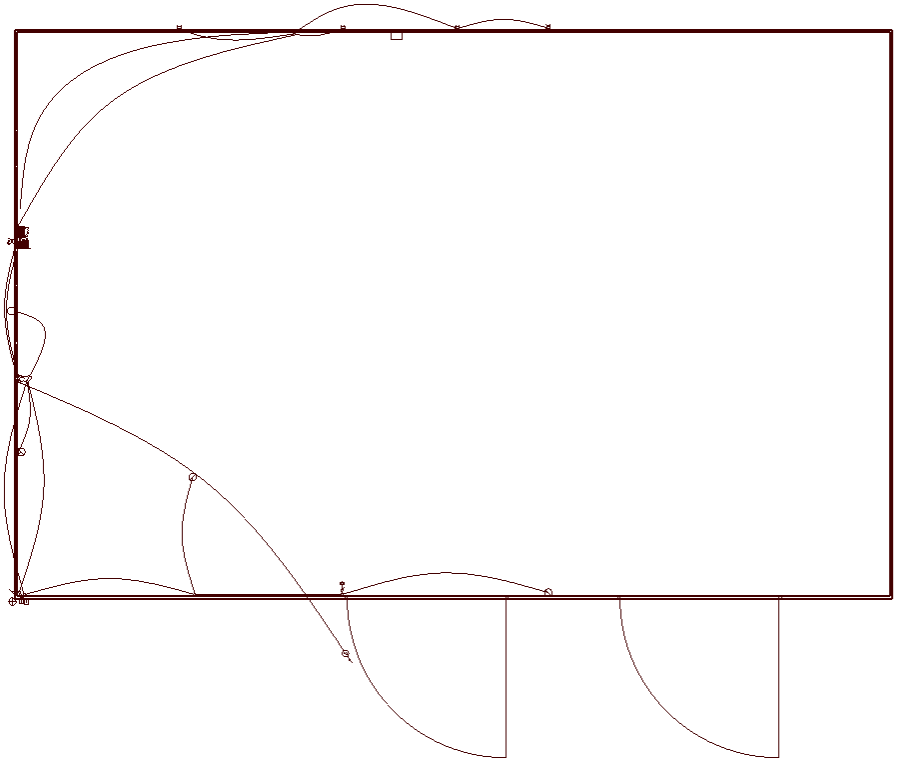


Figure 10. Electrical drawing of warehouse.

The industrial building has a total of 39 cabinets, of which 25 are located on the main floor and these share the necessary power for the industrial equipment and lighting. Two cabinets are located in the main junction pole which distributes power to other cabinets.

The cabinets are named according to their location on the basis of the names of the building's premises(T.Lehtonen, personal communication,March 18,2017). The inputs and outputs of the cabinets are named mainly from the top left to the bottom right corner in a numerical order. Sorting the internal connections of the electrical cabinets wasn't part of the work but they were recorded as far as possible.

Photographs taken of all the rooms can be found as Appendix 1. Figures 11 to 14 illustrate the different rooms in the buildings.

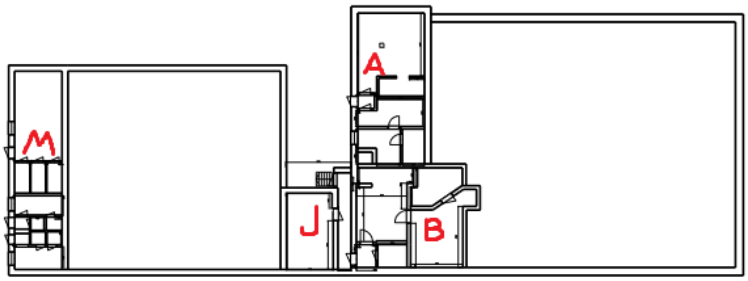


Figure 11 Basement rooms.

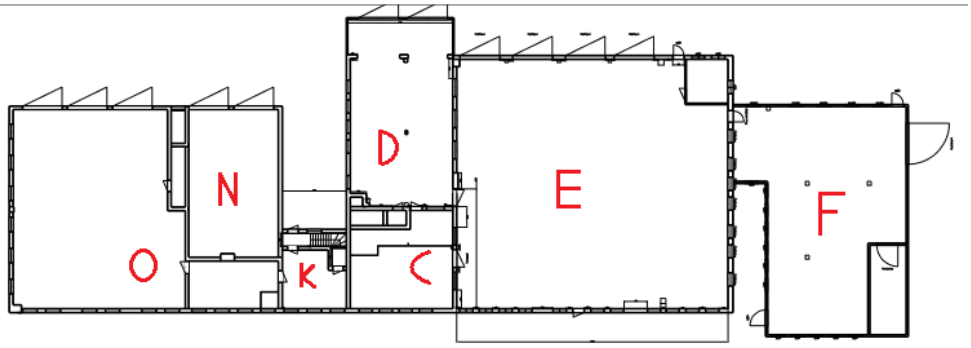


Figure 12. Main floor rooms.

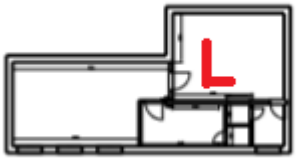


Figure 13. Mid-house top floor.

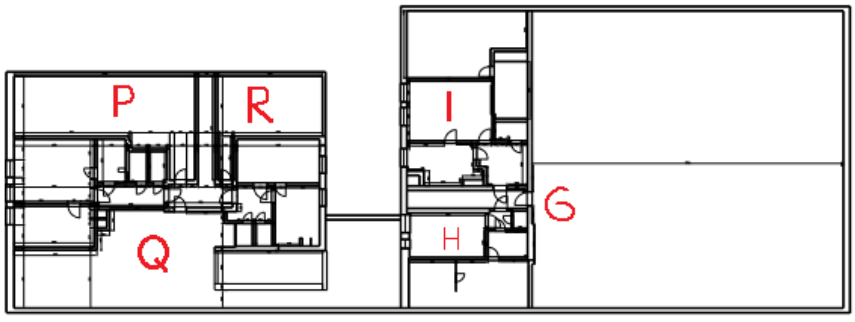


Figure 14. Top floor/attic rooms.

Warehouse as S.

Figures from this point on are marked according to the room they were taken from marked after the number. e.g. Figure 15 C is the 15th figure in this thesis and the photograph was taken from room C.

The electrical cabinets are listed in Table 2.

Table 2. Electrical cabinets

Upstairs	Element	UPM	Hautamäki	Mummonkammari	Pääsyöttö	PR Yläkerta
Main floor	PK1	PK2	PK3	PK4	PK5	PK6
	PK7	PK8	PK9	PK10	PK11	Verhoilu
	Maalaamo	HH1	HH2	Syöttö	Isohalli	Jako
	PHUlkoovi	Sorvi 1	Sorvi 2	Sorvi 3	PV 1	PV 2
	PV 3	PV 4	PV 5	Puu 1	Puu 2	
Basement	TT 1	TT 2				

Figures 15C, 16D, 17E 18F, 19F and 20S illustrate the main distribution cabinet clusters.

Figure 15 C. Main distribution cabinets.

Figure 16 D. Service hall cabinet

Figure 17 E. Lathe room cabinets

Figure 18 F&19 F. Wood workshop cabinets

Figure 20 S. Warehouse cabinets

6 ANALYSIS

There was an analysis made of the defects found in the electrical systems that did not meet the requirements stated by Tiainen (2013,9-33). Table 3 includes the requirements and the cabinet installations which did not meet the requirements. The table includes the cabinets in the columns and defective requirements marked on the rows.

Table 3. Defects of cabinets compared to "D1-2012" requirements.

Defects	PK1	PK2	PK3	PK6	PK9	PK10	PK11	Sorvi 1	PV 4	TT 1	Puu 1	Puu 2
1. People and household animals have to be protected from dangers that may occur when coming in touch with or getting too close to live parts.	X	X	X	X	X	X	X	X	X	X	X	X
2. People and household animals have to be protected from the dangers that may occur from contact or close proximity during a malfunction in an electrical installation.	X	X	X	X	X	X	X	X	X	X	X	X
4.Electric installations shall not cause the risk of burns to humans or household animals.	X	X	X	X	X	X	X	X	X	X	X	X
14.The structure and position of an railroad electrical installation shall be such that the hazards of unknown persons are not readily accessible to live parts.	X	X	X	X	X	X	X	X	X	X	X	X
17.In the structures of power lines and other electrical equipment related to electricity distribution, account must be taken of the safety requirements for conventional electrical installations: weather conditions, distance from buildings, movement of persons and traffic.	X											
20. The electrical equipment must be so clearly structured that no hazardous incidents can occur in its operation and maintenance.	X	X	X	X	X	X		X	X	X	X	X
21.The electrical equipment shall be equipped with the necessary markings and warning signs for its use and maintenance. The protective devices, wires and conductors must be clearly grouped and labeled where necessary so that the circuits can be identified. The diagrams and instructions necessary for the construction, operation and maintenance of electrical equipment must be drawn up.	X	X	X	X	X	X	X	X	X	X	X	X
22.The structure of an electrical installation shall be such that all foreseeable electrical equipment inspection, testing, maintenance or repair operations can be carried out safely and appropriately.	X	X	X	X	X	X	X	X	X	X	X	X
24.If, in the event of a risk, it is necessary to immediately disconnect the power supply, the disconnecting device or the control device must be installed in such a way as to be easily detectable and effective and quickly accessible.									X	X		

Figures 21,22,23 and 24 illustrate the defects in PK1.

PK1 defects 1.3 Incomplete junction boxes
1.8. Cables cut upstairs.
Old system replaced with a new system.
1.9. Cables cut upstairs.
Old system replaced with a new system.

Figure 21 room A Missing cover &22 room C missing distribution box.

Figure 23 room C Cabinet PK1 &24 room H cables on the attic.

Figures 25 & 26 illustrate the defects in PK2.

PK2 defects Cables cut and not removed.
Old system replaced with a new system.

Figure 25 room C Cabinet PK2 &26 room H corresponding cables on the attic.

Figures 27 &28 illustrate the defects of PK3.

PK3 defects 3.3 System disabled
3.4 System disabled
3.5 System disabled

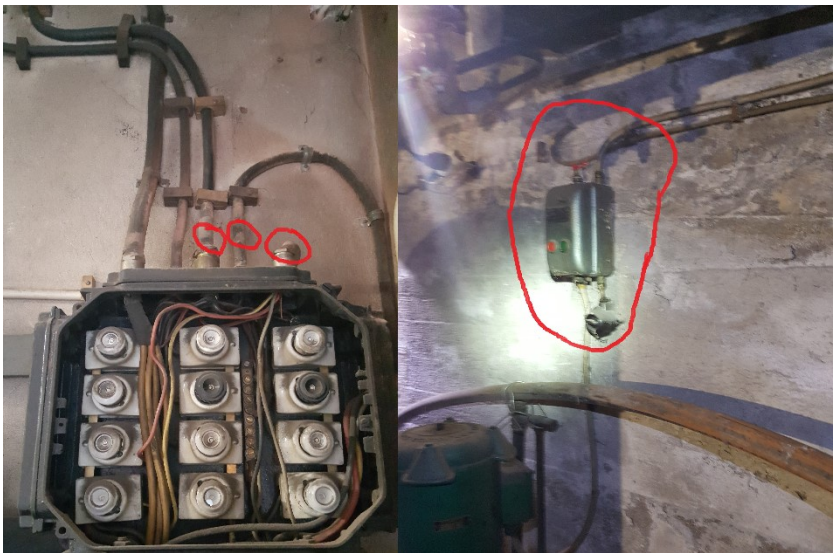


Figure 27 room C Cabinet PK3 &28 room B system in basement.

Figure 29 illustrates the defects in PK6.
PK6 defects Open ended live cables.

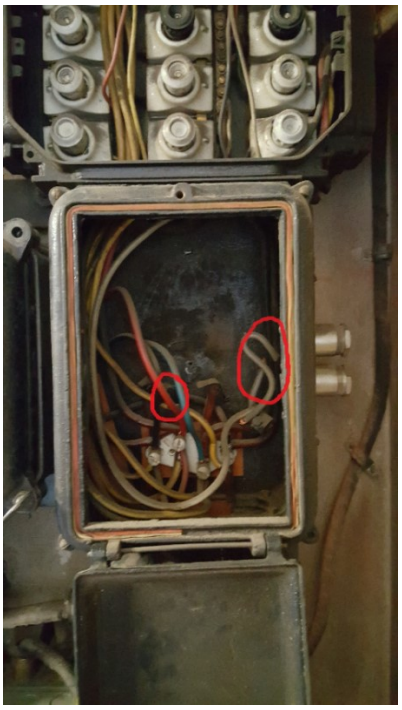
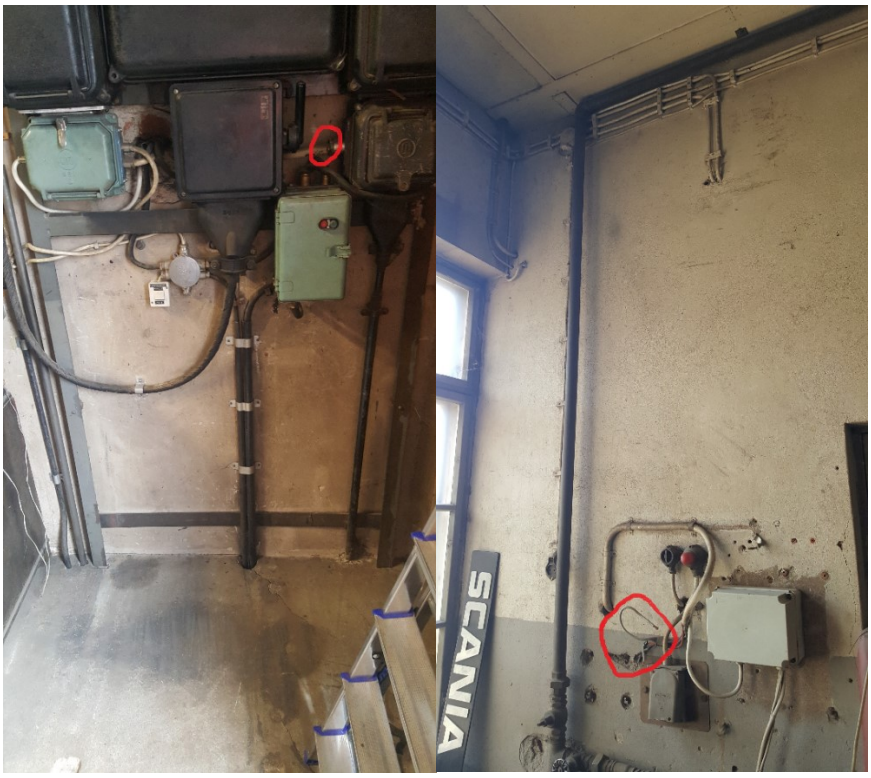


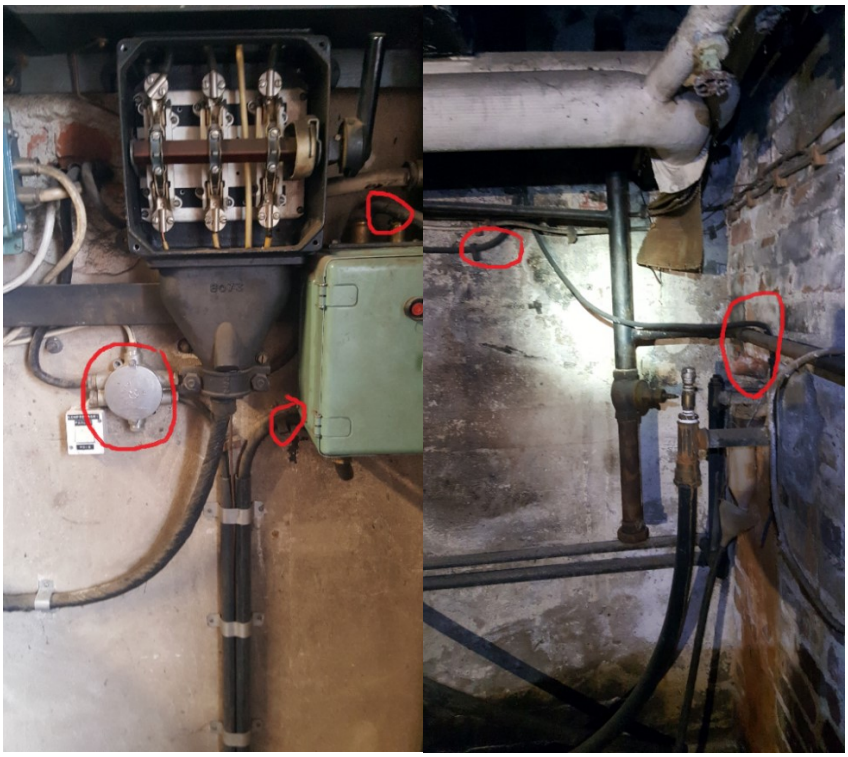
Figure 29 room C. Cabinet PK6

Figures 30 and 31 illustrate the defects of PK9.
PK9 defects Open ended 3-phase cable in main hall



Figures 30 room C Cabinet PK9 &31 room H open 3-phase cable.

Figures 32 and 33 show the defects of PK10.
PK10 defects System disabled (compressor system / junction box).



Figures 32 room C PK10&33 room B highlighted out of use cables in basement.

Figures 34 &35 illustrate the defects of PK11.
PK11 defects Open ended cable, System disabled.

Figure 34 room H Open ended cable & 35 room C cabinet PK11.

Figure 36 shows the defects of Sorvi 1.
Sorvi 1 defects Open ended 3-phase cables.

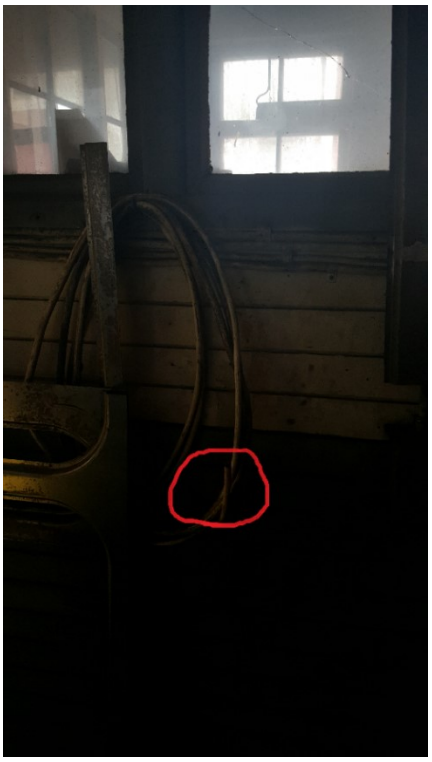


Figure 36 room H. Open ended 3-phase cables of Sorvi1.

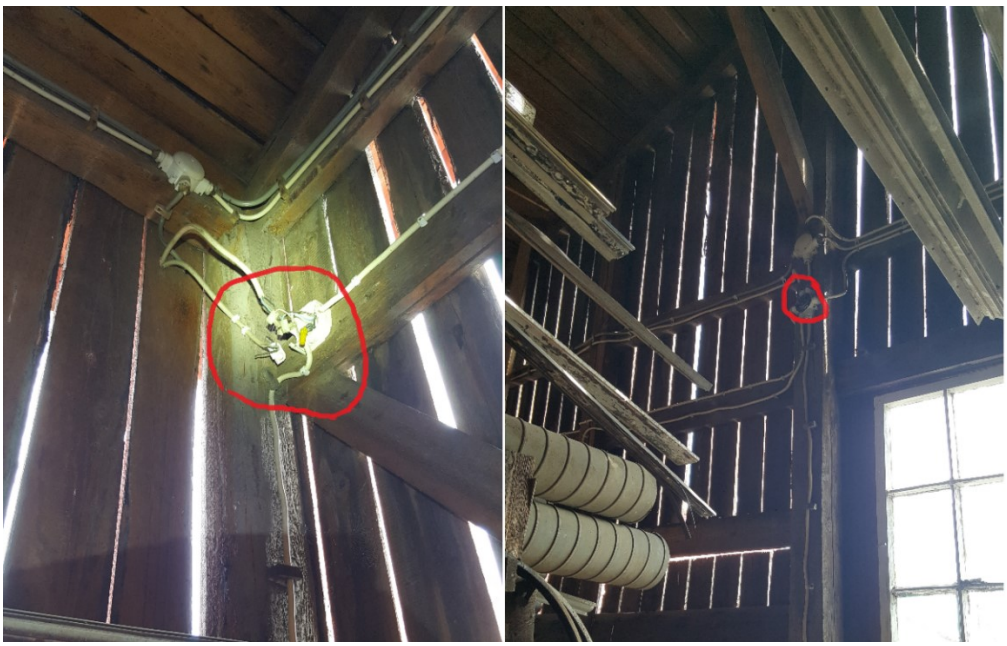
Figures 37 &38 illustrate the defects of PV4.
PV4 defects Open ended cables and worn aerial cable between buildings.

Figures 37 room F Open ended cable & 38 room F worn main cable between buildings.

Figures 39 &40 show the defect of TT1.
TT1 defects 1.1 System disabled.

Figures 39 room B Cabinet TT1 old output &40 room B old heating system out of use.

Figures 41&42 illustrate the defects of Puu1 & Puu2.
Puu1 & Puu2 defects Open distribution boxes and connections.



Figures 41&42 room S. Warehouse open cables and distribution boxes.

7 DEFECTION LIST

The results of the defect analysis are listed in Table 4.

Table 4. Defection list.

	Missing covers	Open ended cables	System disabled
PK1			
1.3	X		
1.8		X	
1.9		X	
PK2			
2.1		X	X
2.2		X	X
PK3			
3.3		X	X
3.4		X	X
3.5		X	X
PK6		X	
PK9			
9.1		X	x
PK10			
10.2		X	X
10.3		X	X
PK11			
11.3		X	X
Sorvi1			
1.1		X	
1.2		X	
PV4			
4.3		X	
4.4		X	
TT1			
1.1			X
PUU1	X	X	
PUU2	X	X	

8 ACTION PROPOSALS

The action proposes recommended in this project are listed in Table 5.

Table 5. Action proposal list

	Actions
PK1	
1.3	Adding a distribution box
1.8	Disassembly and removal from cabinet
1.9	Disassembly and removal from cabinet
PK2	
2.1	Disassembly and removal from cabinet
2.2	Disassembly and removal from cabinet
PK3	
3.3	Disassembly and removal from cabinet
3.4	Disassembly and removal from cabinet
3.5	Disassembly and removal from cabinet
PK6	Remove extra cables from live connections
PK9	
9.1	Disassembly and removal from cabinet
PK10	Dissassembly of cabinet
10.2	Disassembly and removal from cabinet
10.3	Disassembly and removal from cabinet
PK11	
11.3	Disassembly of cables from distribution box
Sorvi1	
1.1	Disassembly and removal from cabinet
1.2	Disassembly and removal from cabinet
PV4	
4.3	Disassembly of open ended cables
4.4	Disassembly of open ended cables
TT1	
1.1	Removal from cabinet and disassembly
PUU1	Replacement of cables and distribution boxes
PUU2	Replacement of cables and distribution boxes

It was recommended here to conduct an insulation resistance test as to all the installations in the property, to confirm the condition of the cables. The connections and cables of the electrical delivery post are recommended to be inspected by an electrician.

The commissioner wanted specifically to find out about the safety of the woodwork shop due to a fire hazard. That is why it is necessary to renew or at least revise the installations of the building and in particular the control systems of the machines.

The procedure for implementing the proposals must comply with the SFS 6002(2015) maintenance practices.

9 CONCLUSION

The main objective for the present thesis project was to provide the commissioner with a risk analysis of the existing electrical installations and to give recommendations for improving the safety of the property. In addition to the risk analysis and recommendations the thesis project produced blueprints of the buildings and electrical drawings with all the electrical instruments and cables connected.

At first, background research was carried out concerning the relevant safety standards and requirements for the electrical installations. Studying online sources and literature related to electrical installations brought the author to knowledge of the subject. With the acquired information the practical work on site with multiple dangers and hazardous areas was safer and accidents were evaded.

Completing the practical work provided the author with an understanding of which installations needed to be studied more in detail and how to complete the placement of electrical equipment effectively into the CADS Electric Pro software. During the practical work the author learned how to make blueprints, how to connect installations between the building structures and the importance of proper maintenance.

All in all, the results met the goals set by the commissioner within the agreed timetable. However, the author recommends surpassing the presented recommendations by asking an expert's opinion on the electrical installations and possibly renewing all of the old installations in the premises.

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Appendix 1 Photo collection

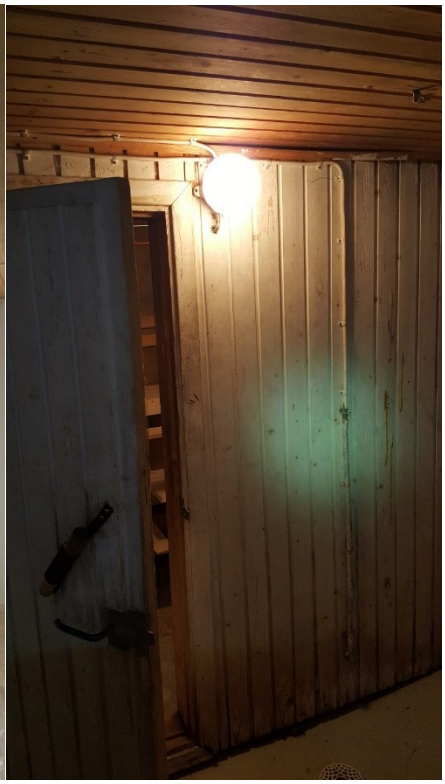
APPENDIX HEADING

Room	Pictures
A	1-4
B	5-19
C	20-27
D	28-35
E	36-51
F	52-70
G	71-78
H	79-91
I	92-111
J	112-117
K	118-127
L	128-135
M	136-154
N	155-164
O	165-183
P	184-188
Q	189-193
R	194-199

1 PR0SA2ITÄ1

2 PR0SA2ITÄ2

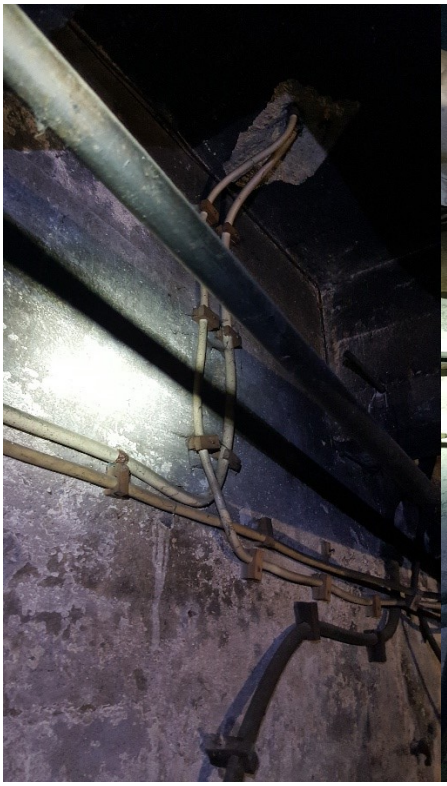
3 PR0SA3ITÄ1



4 PR0SA4POH2

5 PR0TT1ETE1

6 PR0TT1ETE4



7 PR0TT1POH2

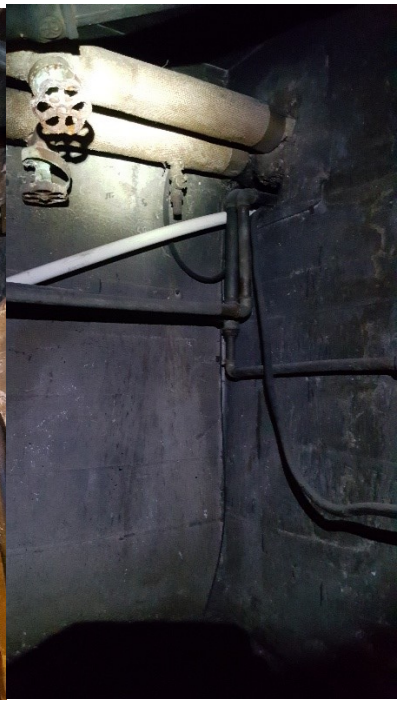
8 PR0TT1ITÄ1

9 PR0TT2ETE1

10 PR0TT2LÄN2

11 PR0TT2LÄN1

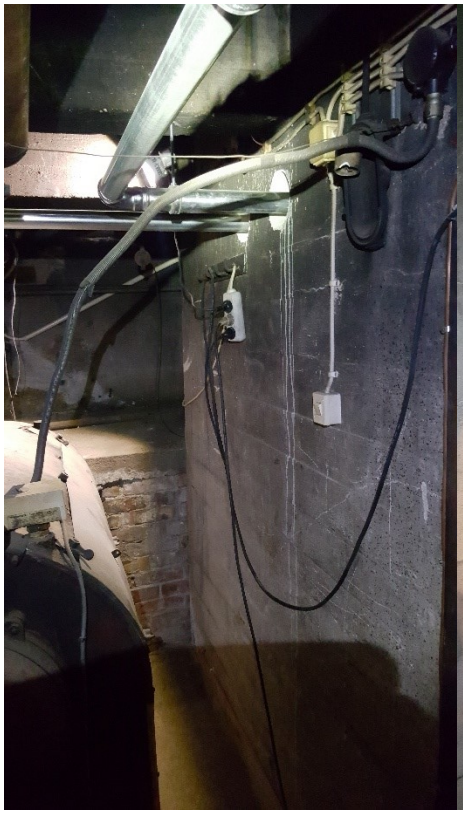
12 PR0TT3ITÄ1



13 PR0TT3LÄN1

14 PR0TT3LÄN3.4

15 PR0TT3LÄN4.5



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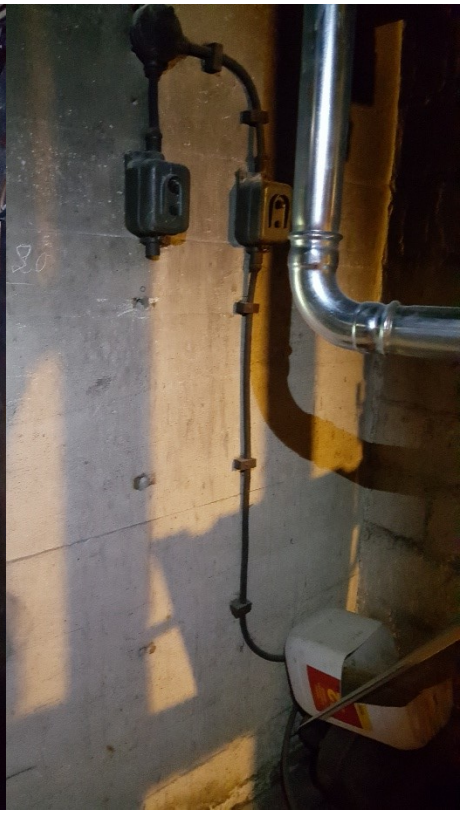

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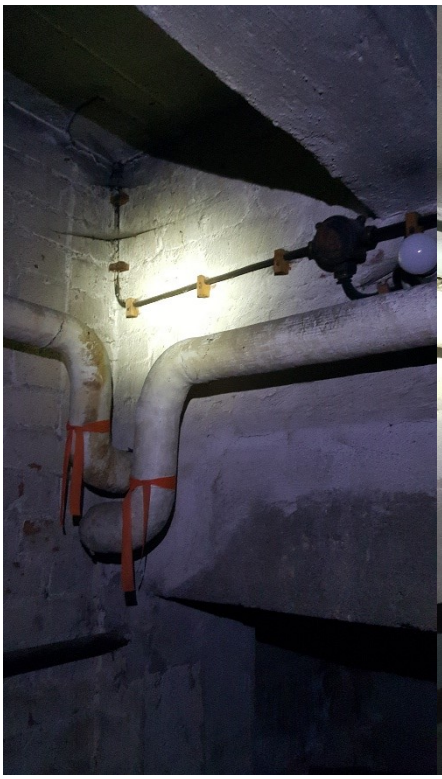
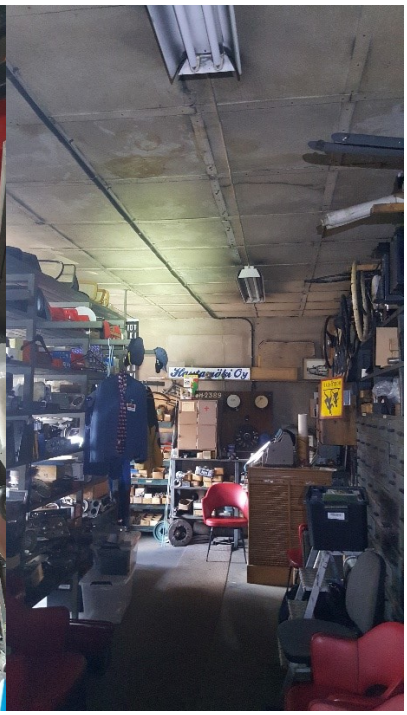


18 PR0TT4ETE2

19 PR0TT4ETE1

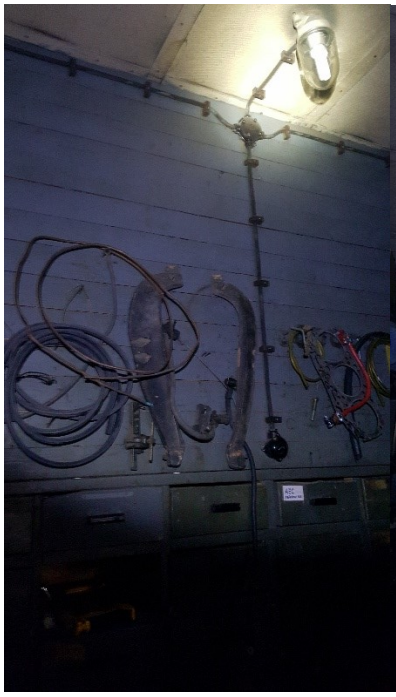
20 PR1TK1ITÄ2



21 PR1TK1ETE1

22 PR1TK1POH2

23 PR1TK1POH1



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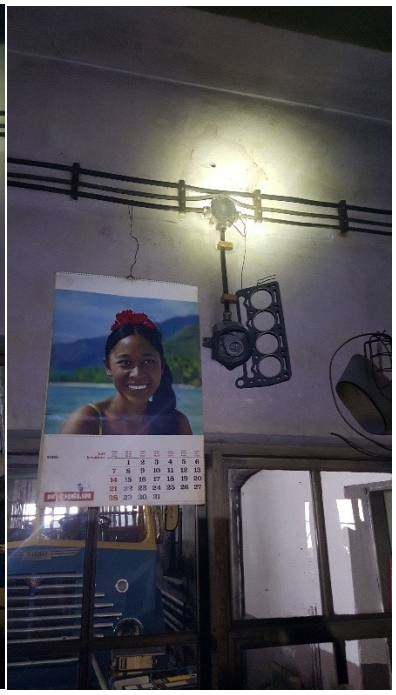
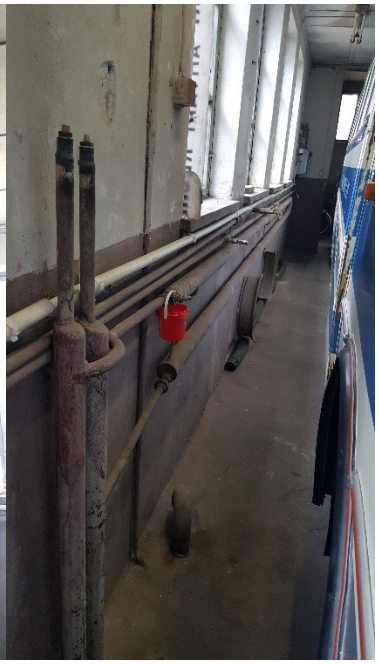
25 PR1AV1ITÄ2

25 PR1AV1LÄN2



27 PR1AV1LÄN1

28 PR1HH1ETE1



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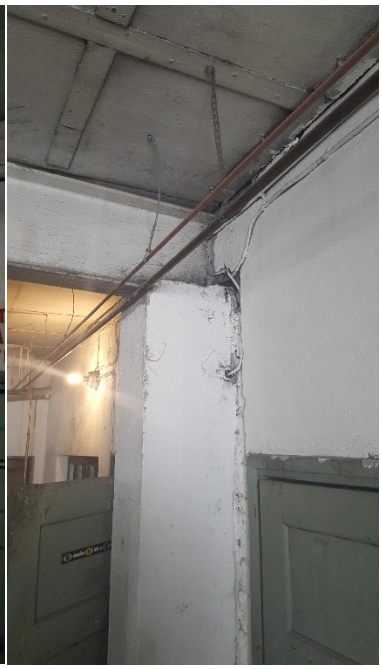
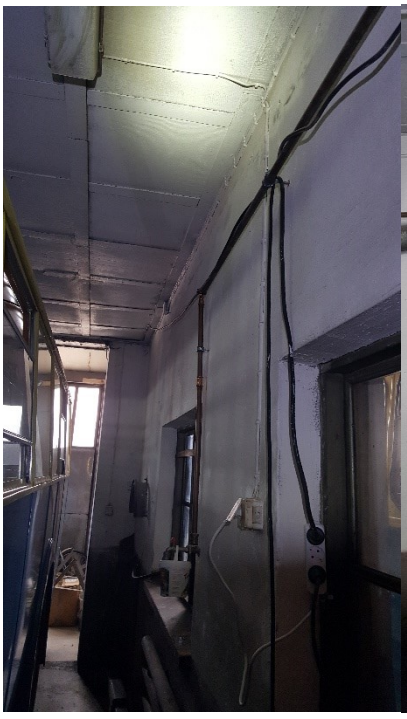
30 PR1HH1ITÄ1



31 PR1HH1ITÄ3

32 PR1HH1LÄN2.5

33 PR1HH1Monttu1



34 PR1HH1POH3

35 PR1HH1POH1

36 PR1PH1ETE5

37 PR1PH1ETE4

38 PR1PH1ETE3

39 PR1PH1ETE2

40 PR1PH1ETE1

41 PR1PH1LÄN1

42 PR1PH1LÄN2

43 PR1PH1LÄN5

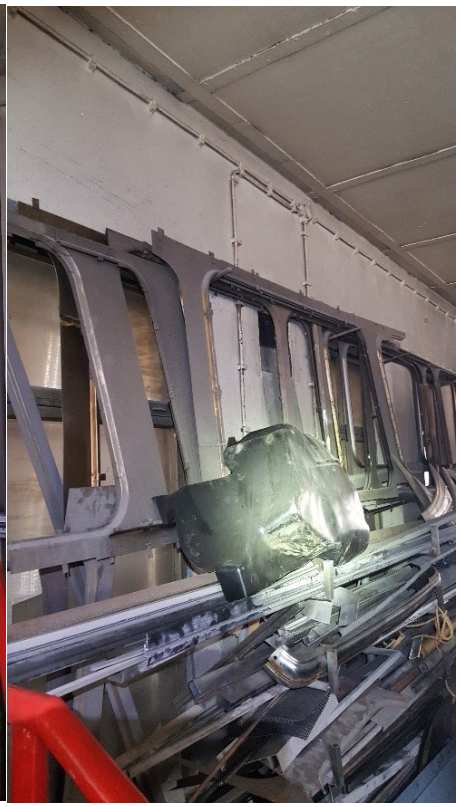
44 PR1PH2LÄN2

45 PR1PH2POH1

46 PR1PH1LÄN1.3

47 PR1PH1LÄN1.2

48 PR1PV1POH1



49 PR1PV1POH2

50 PR1PV1POH4

51 PR1PV1POH5

52 PV1YT1ETE1

53 PV1YT1ETE2

54 PV1YT1LÄN1

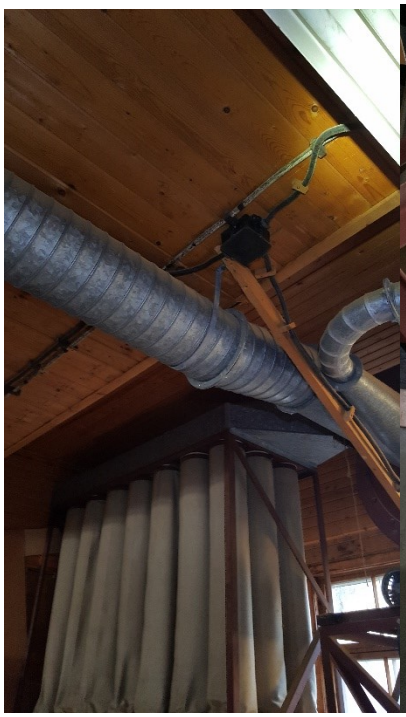
55 PV1YT1LÄN2

56 PV1YT1LÄN4

57 PV1AT1Keskusta

58 PV1AT1Keskusta2

59 PV1AT1POH3



60 PV1AT1ITÄ5

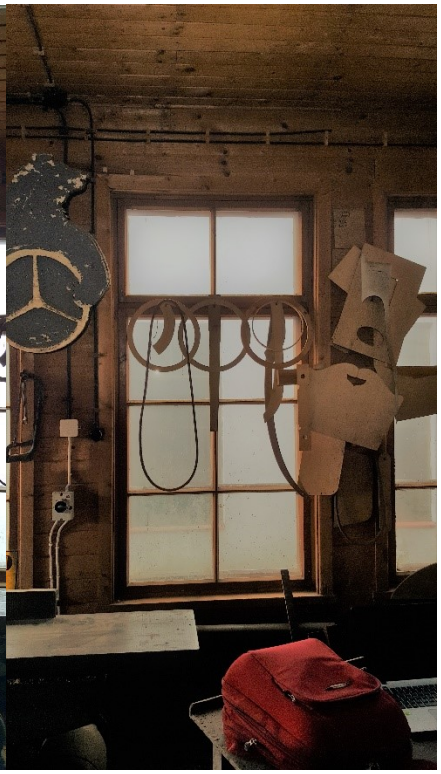
61 PV1AT1ITÄ3

62 PV1AT1ITÄ2

63 PV1AT1ETE1

64 PV1AT1ETE2

65 PV1AT1ETE4



66 PV1AT1ETE5

67 PV1AT1ETE6

68 PV1YT1ITÄ1

69 Syöttö PVete

70 Syöttö PVpoh

71 PR1PK1LÄN1

71 PR2PK1LÄN1

73 PR2PK1POH1

74 PR2PU1ETE5

75 PR2PU1ETE6

76 PR2PU1ETE3

77 PR2PU1ITÄ1

78 PR2PU1ETE1

79 PR2MK1ITÄ1

80 PR2MK2ETE1

81 PR2MK3LÄN2

82 PR2MK3POH1

83 PR2MK3ITÄ3

84 PR2MK3ETE1

85 PR2MK4POH2

86 PR2MK4ITÄ1

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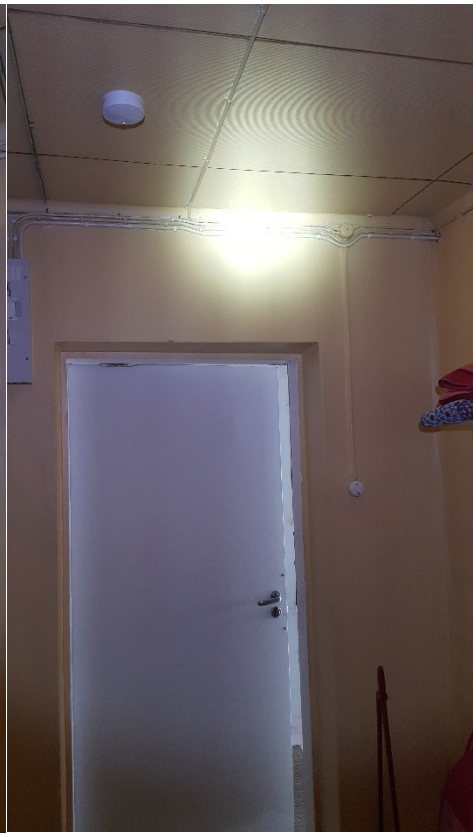
90 PR2MK5ITÄ2

91 PR2MK5ET1

92 PR2MR1ITÄ1



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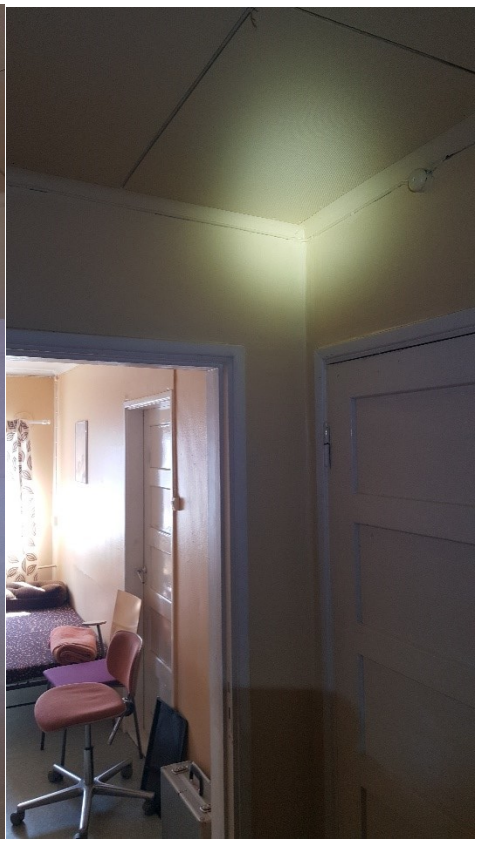
94 PR2MR1ETE1



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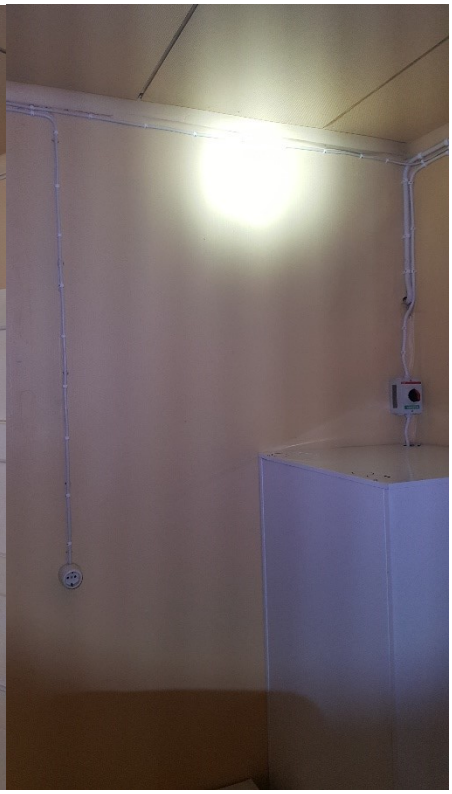
96 PR2MR1LÄN1



97 PR2MR1POH1

98 PR2MR5POH1

99 PR2MR5ITÄ1

100 PR2MR2LÄN1

101 PR2MR2LÄN2

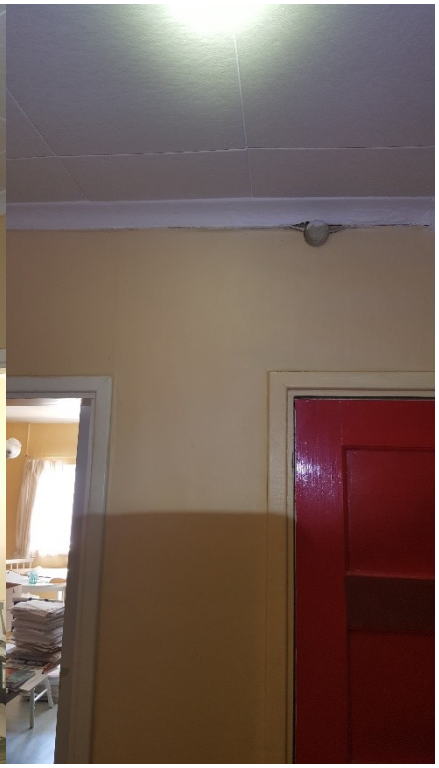
102 PR2MR2ITÄ2

103 PR2MR2ITÄ1

104 PR2MR3ITÄ1

105 PR2MR3ITÄ3

106 PR2MR3ETE3



107 PR2MR3ETE4

108 PR2MR4POH2

109 PR2MR4ITÄ1

110 PR2MR4ETE2

111 PR2MR4LÄN1

112 VT0PK1POH2

113 VT0PK1POH1

114 VT0PK1POH3

115 VT0PK1ETE1

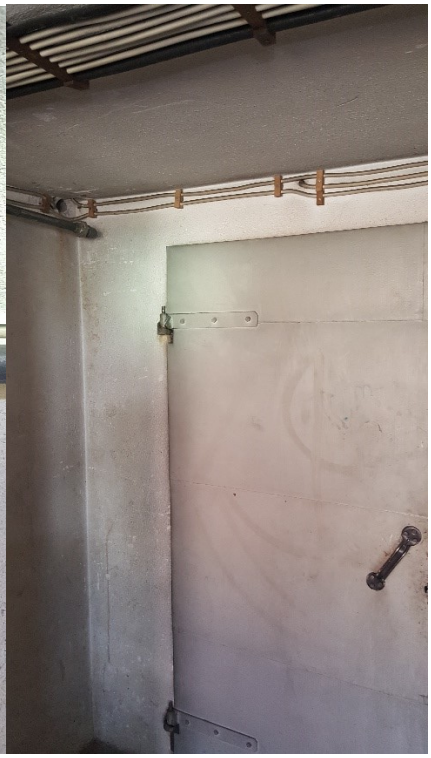
116 VT0PK2POH2

117 VT0PK2POH3

118 VT1OP1LÄN1

119 VT1OP1ETE1

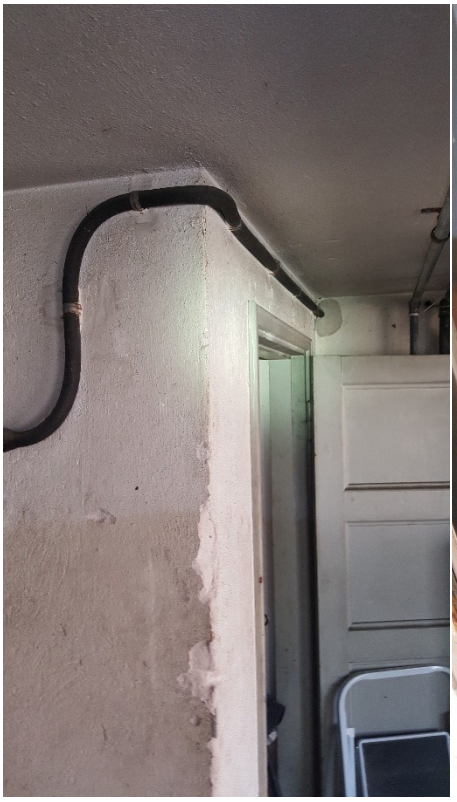
120 VT1OP2ETE1



121 VT1OP2LÄN2

122 VT1OP2LÄN1

123 VT1OP2POH1



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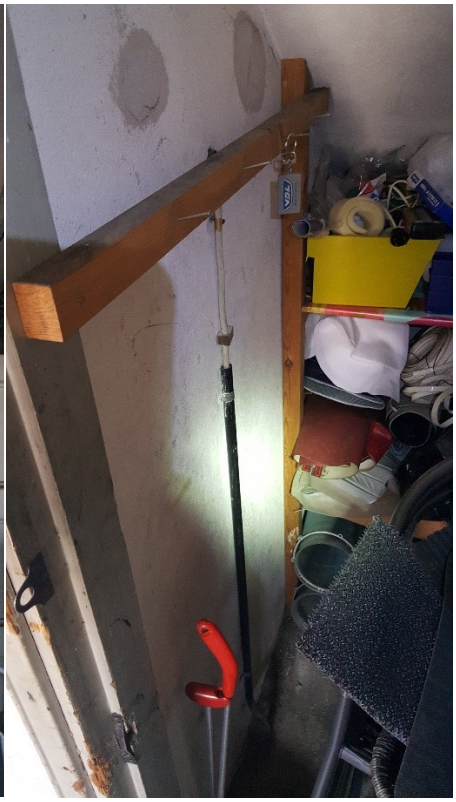

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126 VT1OP2ITÄ1

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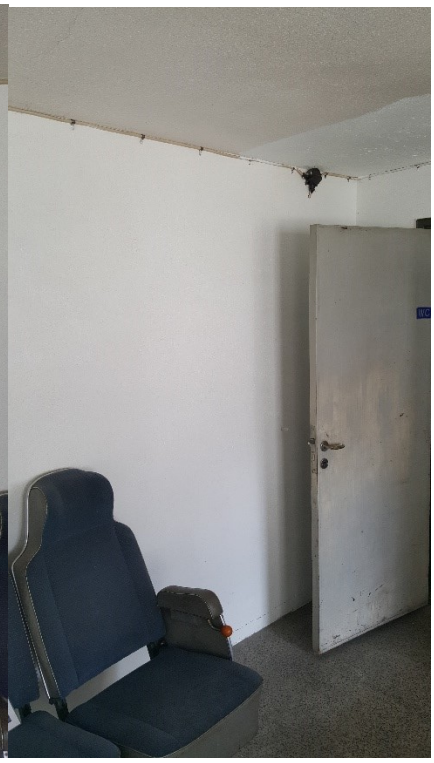
128 VT2NH2ETE1

129 VT2NH2ETE2

130 VT2NH2ITÄ1



131 VT2NH2ITÄ2

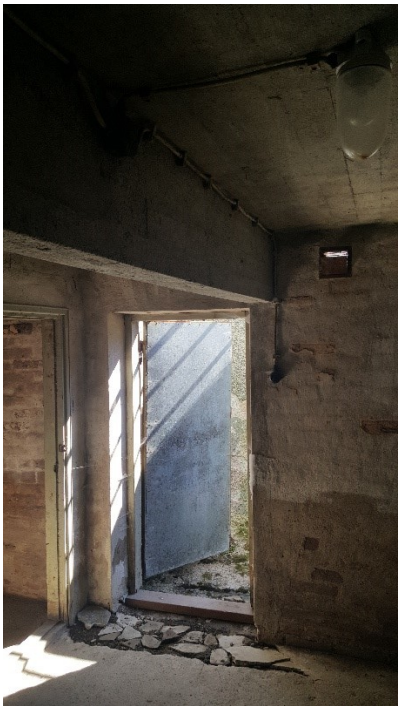
132 VT2NH1ETE1

133 VT2NH1LÄN1

134 VT2NH3LÄN1

135 VT2NH3POH2

136 UH0ML1POH1



137 UH0ML1ETE1

138 UH0ML1POH3

139 UH0ML1POH4

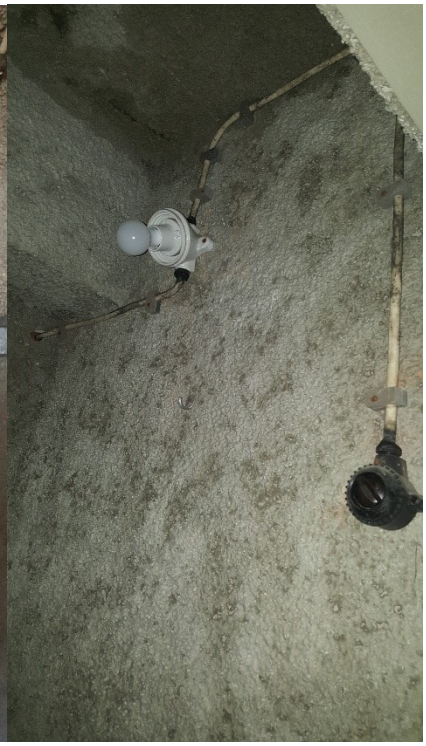
140 UH0ML2ETE1

141 UH0ML2POH1

142 UH0ML2ETE2

143 UH0ML2ETE3

144 UH0ML2POH2



145 UH0ML2WC1ETE1

146 UH0ML3LÄN1

147 UH0ML3LÄN3

148 UH0ML3LÄN2

149 UH0ML3ITÄ1

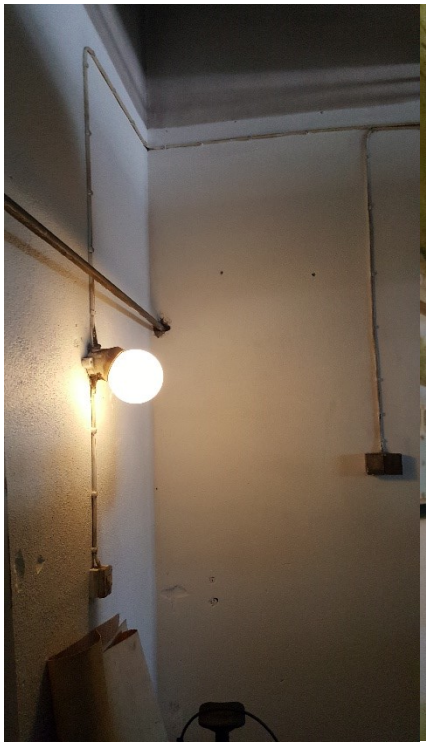
150 UH0ML3ITÄ2

151 UH0ML3WC1ETE1

152 UH0ML3WC1ETE2

153 UH0ML3WC2ETE1

154 UH0ML3WC2POH1



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156 UH1HH1ETE3

157 UH1HH1ETE4

158 UH1HH1ETE7

159 UH1HH1LÄN1

160 UH1HH1LÄN3

161 UH1HH1POH4

162 UH1HH1POH3

163 UH1HH1POH1

164 UH1HH1Monttu

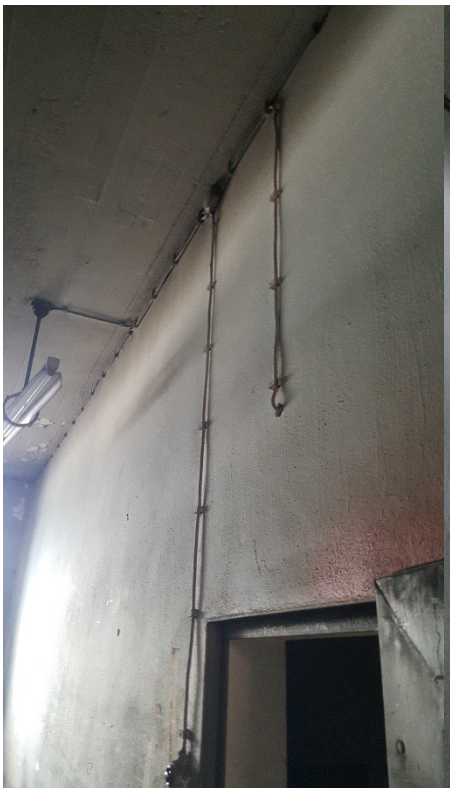
165 UH1MA1POH1

166 UH1MA1POH2

167 UH1MA1LÄN3

168 UH1MA1LÄN2

169 UH1MA1ETE1



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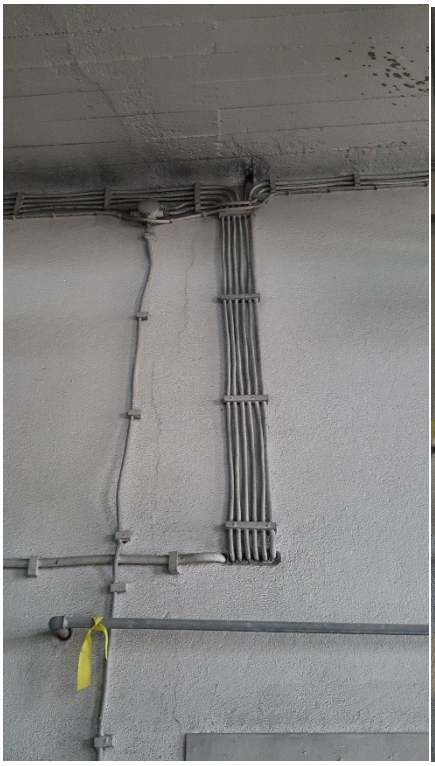
171 UH1MA2POH6

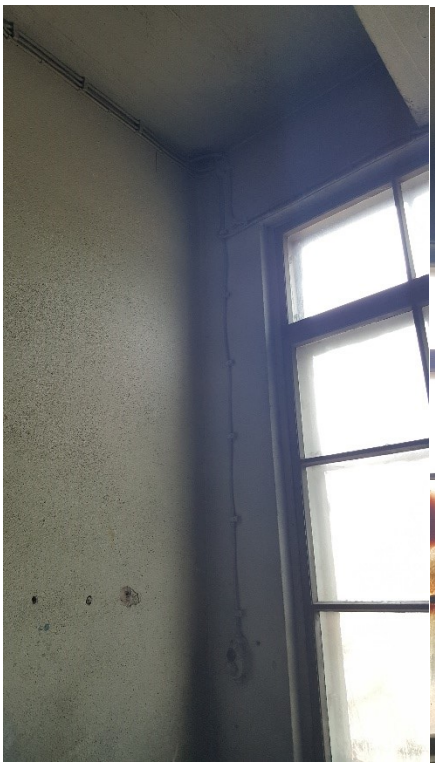
172 UH1MA2LÄN1

173 UH1MA2POH5



174 UH1MA2POH3

175 UH1MA2POH2



176 UH1MA2POH1

177 UH1MA2ITÄ2

178 UH1MA2ITÄ4

179 UH1MA2ETE1

180 UH1MA2ETE2

181 UH1MA2LÄN2

182 UH1MA2LÄN1.5

183 UH1MA2ITÄ0.5

184 UH2UE1POH1

185 UH2UE1ITÄ1

186 UH2UE1ITÄ3

187 UH2UE1ITÄ4

188 UH2UE1LÄN1

189 UH2UL1ITÄ1

190 UH2UL1ETE1

191 UH2UL1LÄN1

192 UH2UL1POH3

193 UH2UL1POH4

194 UH2UP1ITÄ1

195 UH2UP1ETE1

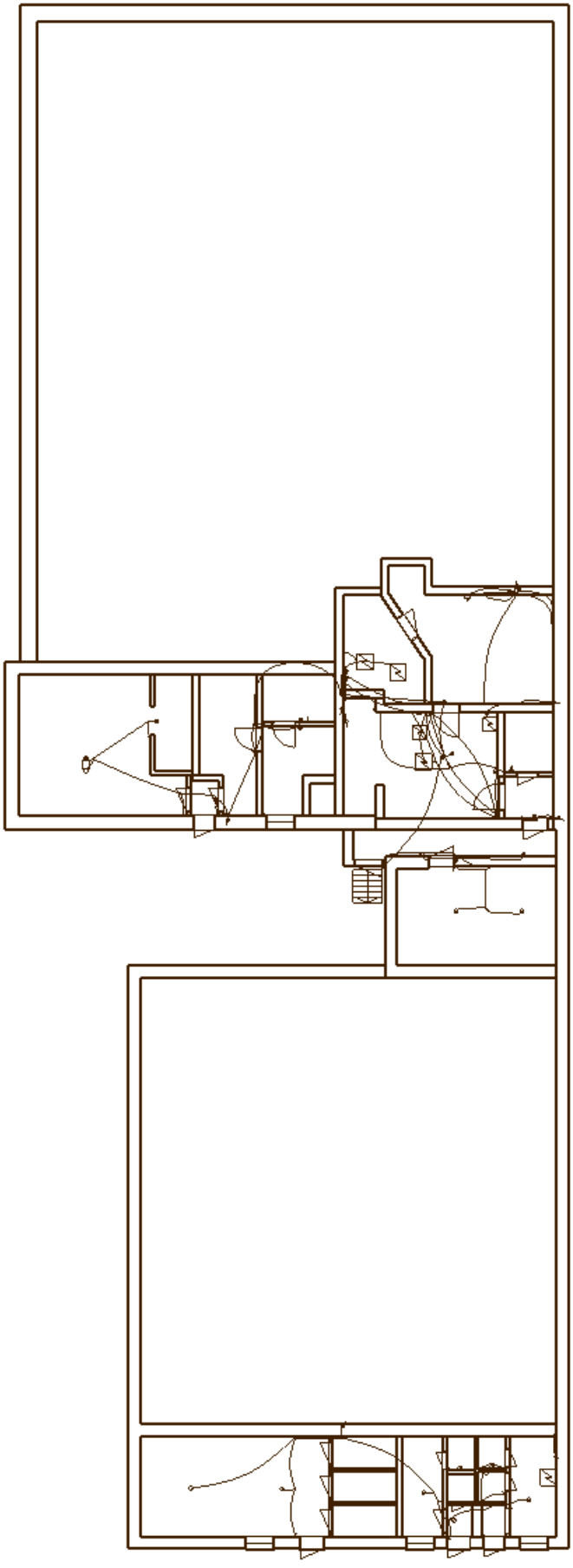
196 UH2UP1ITÄ2

197 UH2UP1POH1

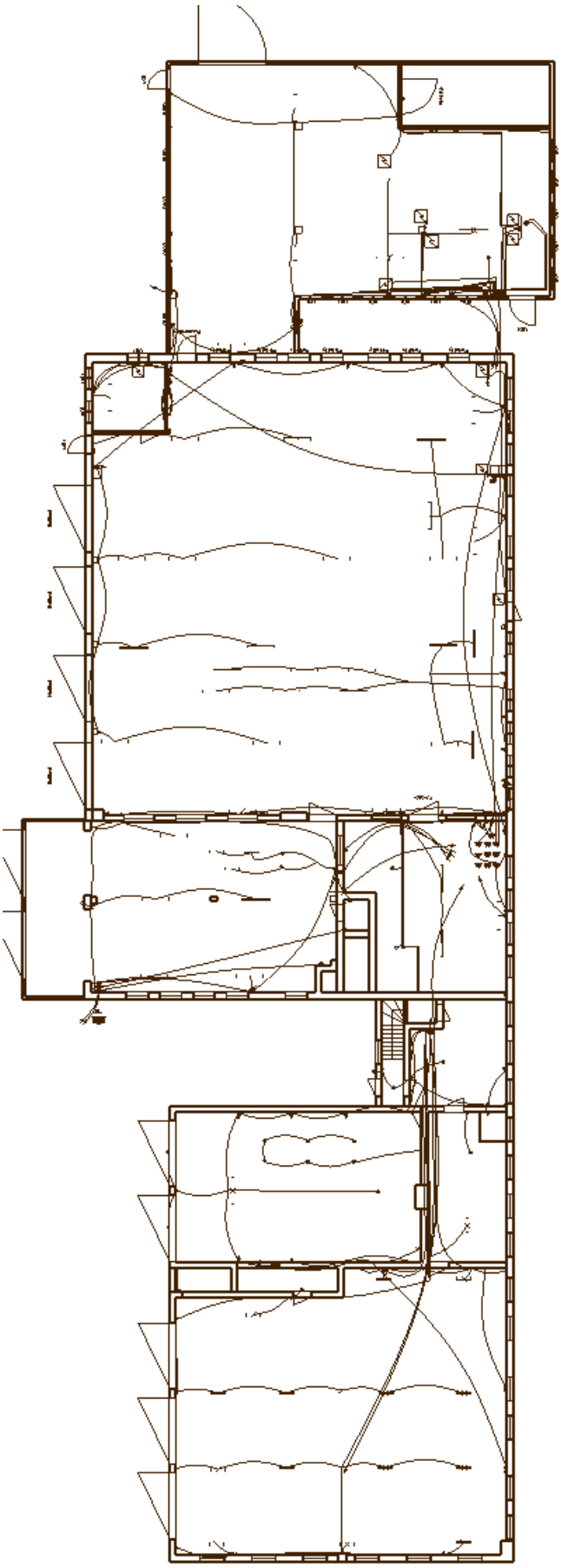
198 UH2UP1POH2

199 UH2UP1POH3

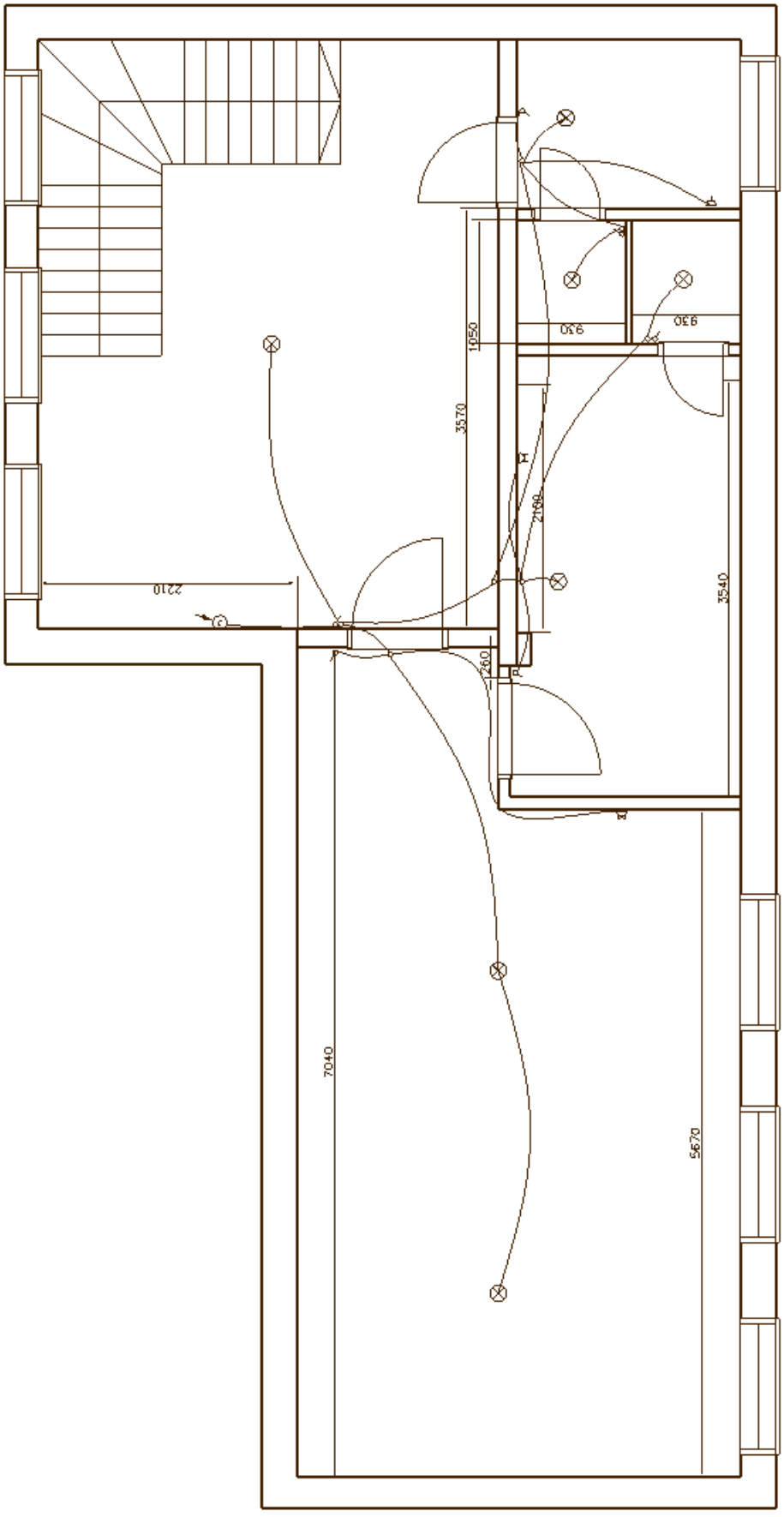
Appendix 2 Electrical drawings



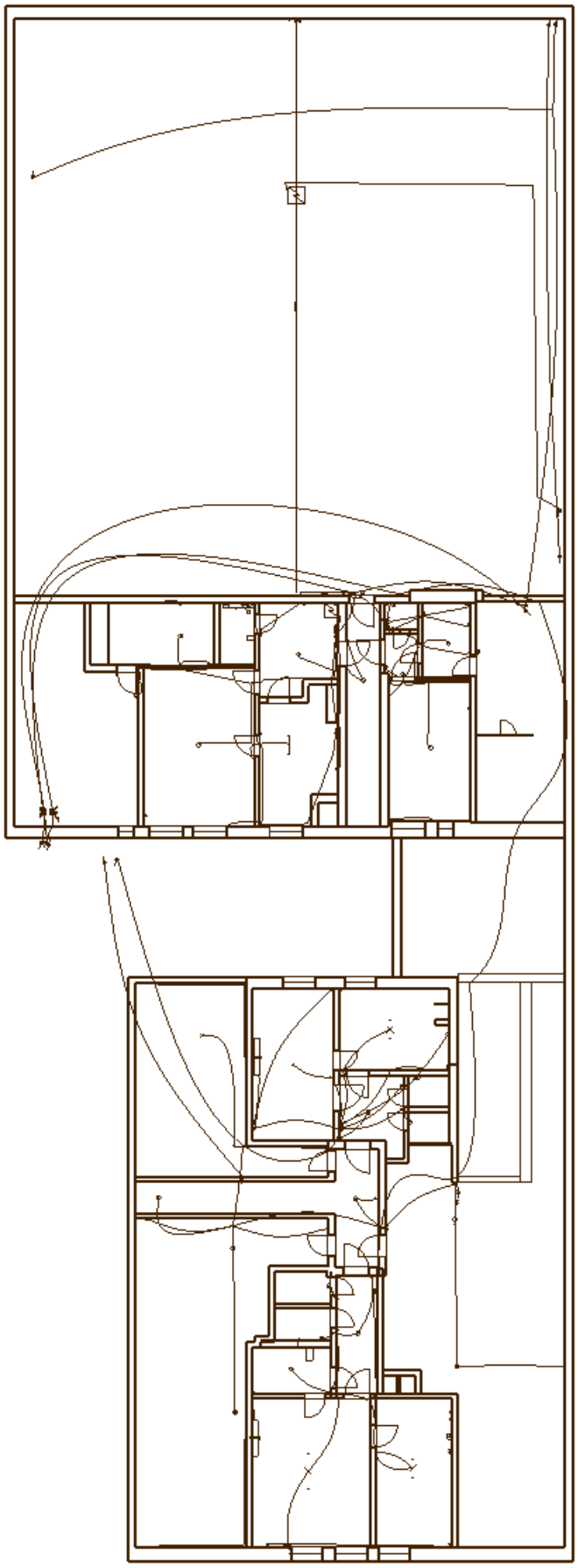
Basement



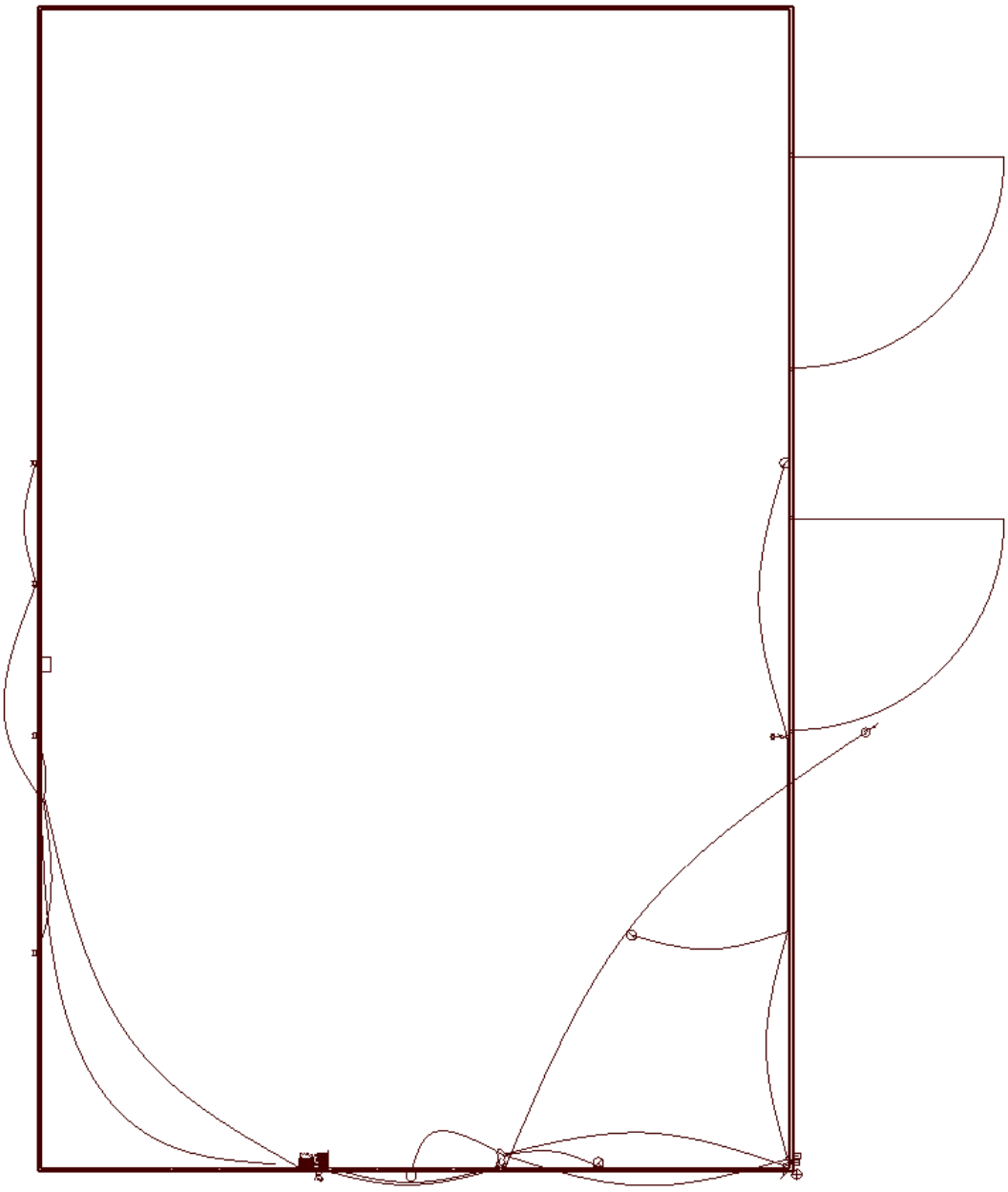
Main floor



Mid-house



Upstairs



Warehouse.