HELSINGIN PELASTUSLIITTO RY

CIVIL DEFENCE SHELTER COMMISSIONING EXPERIMENT

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2007

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Organisation responsible for the arrangements

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The control centre

1. Introduction

Civil defence refers to measures aiming to protect people from the effects of accidents, exceptional conditions and other dangerous situations.

Civil defence and the tasks it involves are defined in the Protocol Additional to the Geneva Conventions of 1977. Pursuant to Article 61 of this Protocol, civil defence means the performance of some or all of the undermentioned humanitarian tasks intended to protect civilian population against the dangers of hostilities or disasters. These tasks include the ***management of shelters***.

Under the Rescue Act, civil defence preparations in normal circumstances include planning and training for exceptional conditions, building shelters, maintenance of command, supervision and alarm systems and data communication links as well as making provision for evacuations, rescue operations, first aid, providing the population with supplies required and clearing and cleaning (the Rescue Act Section 50). In exceptional conditions, civil defence includes the performance of similar tasks.

The SUOJA 2007 project set out to test the self-preparedness of the civil defence organisation and taking shelter in a civil defence shelter. The shelter used in this experiment is located in Helsinki at the address Castreninkatu 14. The experiment was organised by the Helsinki Rescue Association. In addition, the Ministry of the Interior, the State Provincial Office of Southern Finland, the Emergency Services College, the City of Helsinki Rescue Department, the Finnish National Rescue Association and the Finnish Association of Fire Chiefs were involved in the experiment.

This project was a continuation of the SUOJA 2000 experiment, which looked at conditions in a civil defence shelter during sheltering. Similarly, the SUOJA 2007 experiment aimed to establish if a civil defence shelter can be commissioned and prepared for use in exceptional conditions within 24 hours. All stages of the experiment were documented by a group of observers and by means of forms filled in by the participants. Five video cameras were installed inside the civil defence shelter to record all actions associated with commissioning the shelter.

2. Purpose of the experiment

1) The primary purpose of the experiment was to establish if a typical civil defence shelter in its original condition built in compliance with the 1971 regulations can be commissioned and prepared for use in exceptional conditions within the 24-hour period prescribed in the regulations by independent action of the building's civil defence organisation.

A thorough inspection of the civil defence shelter was carried out before the experiment. Based on this inspection, the possibilities of the housing company to complete the necessary repairs before the start of the experiment were assessed. Removing objects from the shelter or taking any measures relevant to sheltering were not allowed prior to the experiment.

2) Additionally, the experiment aimed at examining the activities of the civil defence organisation and residents in a block of flats, the civil defence training received and the person hours spent on the experiment.

The basic assumption was that a person who is in a position of trust in the housing company will also take on a leading role during sheltering. It was assumed that Board members also are more committed to the affairs of the housing company than ordinary flat owners.

The experiment focused attention on interaction between the building's security staff and civil defence organisation (subdivision command centre). In addition, the experiment monitored the reactions of the building's security personnel and their ability to cope with the tasks assigned to them during the experiment. For the duration of the experiment, a control centre was set up, which assumed the role of a subdivision command centre and the Finnish Broadcasting Company, transmitting the official bulletins broadcast during the experiment.

To enable the experiment to focus on the self-preparation of housing company residents in an emergency, a conscious decision was made not to include in the preliminary information detailed instructions on commissioning the shelter, which the rescue authorities would in a real-life situation disseminate in order to increase the level of preparedness.

For the purposes of this experiment, a situation picture was drawn up by the City of Helsinki Rescue Department, which described actions undertaken by the authorities at various stages to improve the level of preparedness. In addition, a general description was drawn up of actions which buildings in the area had to take as a result of decisions made by the authorities. The situation picture was approved by a working group that consisted of not only representatives of the

City of Helsinki Rescue Department but also the Rescue Department of the State Provincial Office of Southern Finland and the Emergency Services College.

During the experiment, a Civil Defence Planning Officer from the City of Helsinki Rescue Department and two training officers from Helsinki Voluntary Fire Department were working in the control centre.

3. Finding a location for the experiment

As a precondition for the location of the experiment was set that the shelter should represent the most common type of civil defence shelters, or those built under the 1971 regulations. The shelter had to be located in a residential building, and its use in normal conditions had to be storage space for the flat owners in a residential building. In addition, 60-80% of the residents should take part in the experiment over 27 hours. A suitable shelter was sought by means of several advertisements, and the idea was publicised in home protection training courses organised by Helsinki Rescue Association. In early 2007, a building meeting the above-listed criteria was found.

The first briefing for those taking part in the experiment was organised at the City of Helsinki Central Rescue Station on 29 May 2007. An information leaflet was distributed to the residents on 15 May 2007. At the end of May, a registration form and agreement to take part in the experiment were distributed to all residents.

A thorough condition assessment of the civil defence shelter was carried out by an inspection team on 27 June 2007. As an inspection record, forms prepared for condition assessments of civil defence shelters drawn up in 2004 were used. At the same time, the civil defence shelter, its materials and equipment were photographed. Based on the condition assessment report, an assessment of required repairs and their costs, a list of materials needed and an estimate of the working time to be spent were drawn up. **The starting point for the test was that the shelter should be in the condition it would be on a working day in normal conditions before it was prepared for sheltering in order to gain accurate information of how successfully the commissioning could be carried out.**

4. Location of the experim

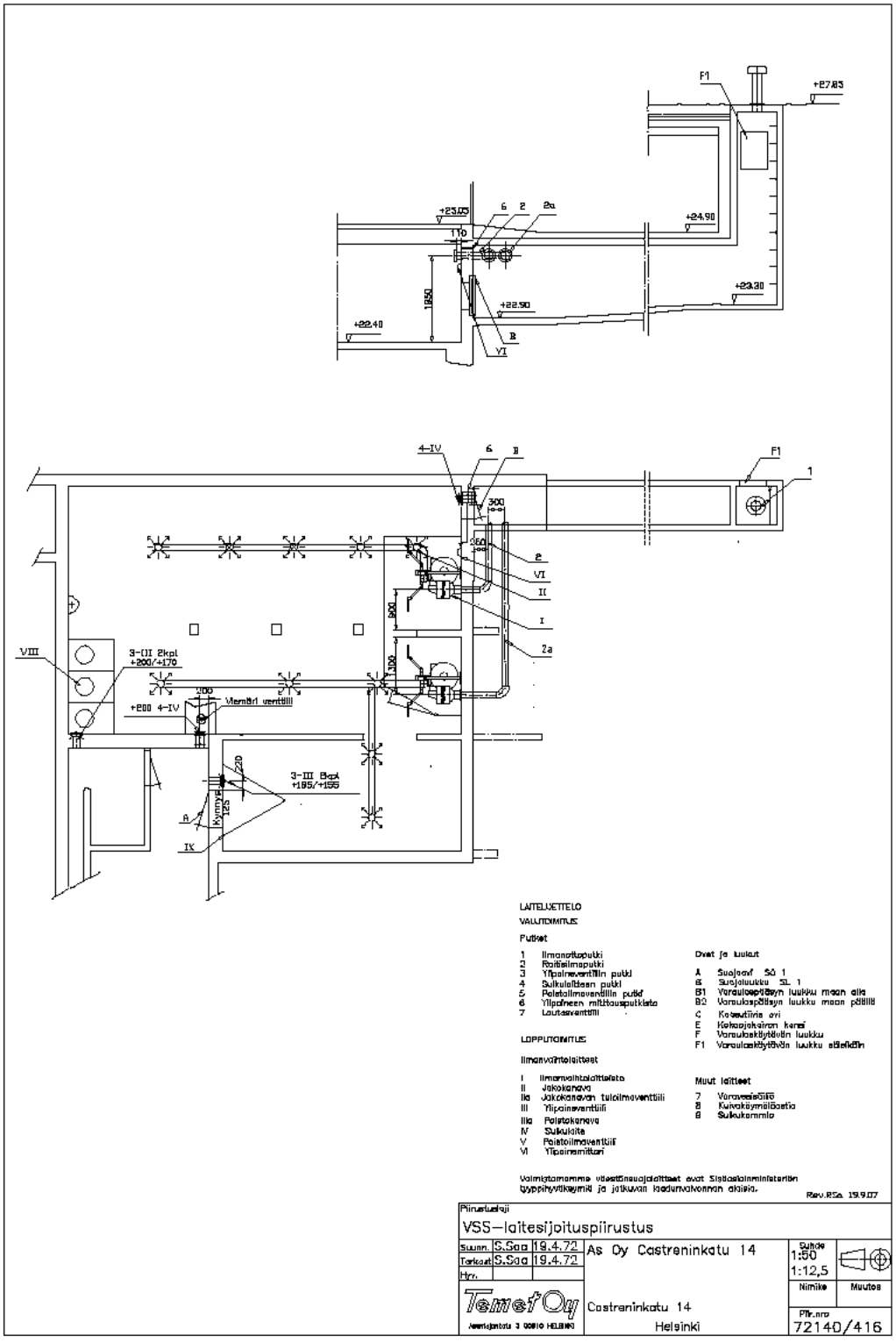
The civil defence shelter in question is located in Kallio district in the City of Helsinki, at the address Castreninkatu 14. The residential building has seven floors, and its floor area is 2,610 m^2. The building also has a basement, below which the civil defence shelter is located. The ground level outside the building is +27.85, while the civil defence shelter floor level is + 22.40. In other words, the shelter is situated more than 5 m below the ground level. The property was built in 1973, and it contains 42 flats. At the time of the experiment, the number of residents was 61. The building comprises a residents' garage, with parking spaces rented out to non-residents. The age distribution of the residents extended from an infant aged less than 12 months to a 95-year-old. A total of 35 residents took part in the experiment, with an age distribution of 7 – 82 years. The very youngest and oldest residents only took part in the sheltering experiment for 2 hours. 20 people played an active role in the commissioning of the shelter, representing one third of the total number of residents.

5. The housing company's civil defence organisation

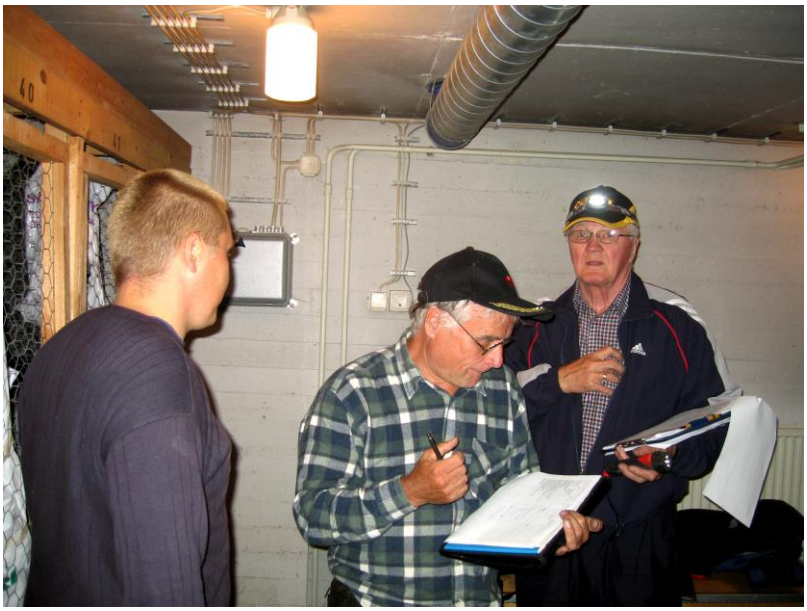
The Civil Defence Manager had taken part in a civil defence course organised by Helsinki Rescue Association in 2005. The Assistant Civil Defence Manager had taken a similar course in spring 2007. The Shelter Manager had received training in spring 2007, but the Assistant Shelter Manager had not taken part in training. Of the 24 residents who responded to the enquiry, five had received civil defence training. In the civil defence organisation of the building, only the Civil Defence Manager had had training before the organisation was informed of the experiment.

6. Technical specifications of the civil defence shelter

The overall area of the facility is 58 m^2 and the actual shelter area 52.2 m^2. The internal height is 2,200 mm, volume 127.6 m^3 and external wall thickness 300 mm. The shelter is located 5.45 m under the ground level. In the original drawings, toilets were marked down in the wrong location. The toilets should be positioned so that there are exhaust valves inside the toilets, and that the air from them can be directed elsewhere – in this case, into the stairwell. The length of the emergency exit passage must be a minimum of one third of the building height, in this case some 10 m. At the time of inspection, the civil defence shelter was in a good condition technically.



7. Civil defence shelter condition assessment



The condition assessment of the civil defence shelter took place on 27 June 2007.

The civil defence shelter had been built in 1972, and no alterations or repairs had been carried out since its completion. The shelter was built in compliance with the regulations valid at the time. The condition assessment of the civil defence shelter was carried out on 27 June 2007 following the method applied in civil defence shelter condition assessments implemented in 2004 – 2005 (Appendix 10). Based on the assessment, the shelter was in a good condition, and with minor repairs, capable of being commissioned within 24 hours.

The following passages contain a detailed description of the shelter's condition at the time of assessment. The numbers refer to numbering in the assessment form. No repairs were allowed between the assessment and the start of the experiment.

1. **Access route to the shelter** was signposted with appropriate signs from the front door to the shelter.

2. **Safety door** (SO-1 Temet Oy) did not work appropriately, as the door leaf had either been left open or removed for casting. The door frame was distorted in proportion to the door leaf, and the door did not close tightly against the frame. Brackets had been welded onto the door for a lock. The brackets did not interfere with the door operation. The seals were in a good condition. The door could not be closed fully because of the frame distortion. A light test showed a clearance in the range of 13 mm between the door leaf and frame.

3. **Airlock tent** (Temet Oy, no 1973) was in its package, which was not opened. Assessed by visual inspection, the tent material seemed to be in a good condition. The tent fixing points in the ceiling and floor of the shelter were in place and in a good condition.

4. ***Gas-tight airlock room door*** (SO-K) The shelter does not have an airlock room.

5. ***Exhaust valve PV-15*** The shelter does not have an airlock room, and no valves are needed.

6. **Overpressure valves** (Temet Oy) There were a total of four of these valves, two of which were located at the airlock tent. The valves were askew by 12.5 degrees, and consequently their opening pressure had increased slightly from the original 30 Pa.

Axial friction due to this skewness causes a clear hysteresis phenomenon in the opening and closing pressure graph of the valve. The two valves located at the toilet were correctly aligned and worked flawlessly, but the flow-throughs of the dry toilets and airlock chamber did not work as planned and as provided in the specialised regulations. The deviations in the flow volumes did not have a practical significance, but the technical specifications set for the industry are meaningless without proper shuttering inspections.

7. **Heat and light lead-throughs**, the pipes traversed the concrete wall via lead-through pipes and had been sealed well. The pipe shutoff valves on the shelter side were in a working condition. There was an extra lead-through pipe in the wall, through which the cables of the monitoring cameras were led into the exterior of the shelter.

8. **Electrical lead-throughs**, the rising main from the main distribution board traverses the concrete wall without a lead-through. The opening is fully sealed and complies with current and construction period requirements.

9. **Closing devices**, the shelter has two 150 mm lead-throughs for use in normal conditions. In both of these, the shutoff device is suspended from the lead-through pipe by a bolt.

10. **Air intake pipe**, the air is taken through the emergency exit passage. The air intake pipe rises to the height of approx. one metre above the top of the upright shaft. The pipe is in a good condition.

11. **Overpressure gauge** is the original one and in a fully working condition.

12. **Ventilation system** works well technically. There are two systems (Temet Oy).

13. **Ventilation system pressure valve and pre-filter**, the pressure valve works faultlessly. In connection with servicing the valve, the pre-filter was found to be dusty and have lost some of its filtering capacity.

14. **Ventilation system special filter**, the filter was weighed as it was served. Filter seals were in a good condition, and no leaks had occurred.

15. **Ventilation system safety blower** was in a good condition. Some superfluous noise was observed in the gear-box. It was noted that the equipment needed a service and oil check.
16. **Ventilation distribution channels** were appropriately installed. There were five air intake valves for each. The channel was only fixed on one side of the air intake valve.

17. **Emergency exit passage** features a long horizontal section (10 m), and a vertical rise of some 5 m, at the top end of which there is a 23-kg emergency exit external cover fixed with bolts. The top of the cover is approx. 1 m below the ground level. The passage has lighting, ventilation and an extra lead-through for an aerial. The emergency exit passage was dry at the time of assessment.

18. **Emergency exit cover hatch** (SL-1 Temet Oy) lower edge was rusty. The seal had to be replaced and the cover cleaned and painted. The positioning inspection of the cover and frame casting mould had not been carried out carefully enough, and the door leaf had either been left open or removed for casting. This is why the cover frame had remained in a distorted position compared to the cover leaf, and the

cover did not close tightly enough against the frame. The cover was impossible to close fully because of the frame distortion. A light test showed that the clearance between the cover leaf and frame was in the range of 10 mm.

19. **Toilet exhaust air channel** is not required.

20. **Toilets**, in the drawings the toilets were shown on a different wall with the overpressure valves. The wash-hand basin was in the location shown in the drawings. The toilets must be built of such as timber. Toilet locations were not marked on the floor.

21. **Toilet seats we**re cardboard seats manufactured by Piippo Oy (3 units). The required number of plastic bags were present.

22. **Sewers**, there is a floor sewer in the vicinity of the airlock tent below the water inlet.

23. **Sewer shutoff valve**, which was located in the storage closet of one of the residents, could not be found during the inspection. The condition of the shutoff valve could be inspected after the shelter was cleared out. There was no movement in the valve.

24. **Emergency water containers** were cardboard containers manufactured by Piippo Oy. There were 5 sets of containers with a capacity of 510 litres each, or a total capacity of 2,050 l. The containers had the associated plastic bags inside them. The containers were in a good condition.

25. **Water mains**, the shelter is equipped with a cold water pipe. The pipe traverses the wall via a lead-through pipe. The shutoff valve was located immediately after the concrete wall lead-through. The shelter has two water inlets. One of these is located at the toilets, the other in the vicinity of the entrance, where a hosepipe for filling in the containers is also stored.

26. **Leakage water removal**, the shelter does not have drainage equipment. Sewage water from the shelter is evacuated through a pumping plant located outside the shelter.

27. Electrical equipment, the supply cable comes directly from the main distribution board. The cable traverses the concrete wall without a lead-through close to the ceiling and extends to a metal distribution board in the shelter. The shelter has two sockets, one beside the distribution board and the other beside the entrance. In the shelter, the cables are installed on the ceiling surface. The shelter has 7 lighting fixtures.

28. Heating, the shelter is equipped with water central heating. The heat pipes traverse the concrete wall inside a lead-through pipe. There are shutoff valves inside the wall. The shelter has two large radiators. The shelter temperature is continuously some 20 degrees.

29. Telecommunications equipment, the shelter has aerial and telephone sockets beside the distribution board. The telephone line is connected to the network. There is no signal for mobile phones in the shelter.

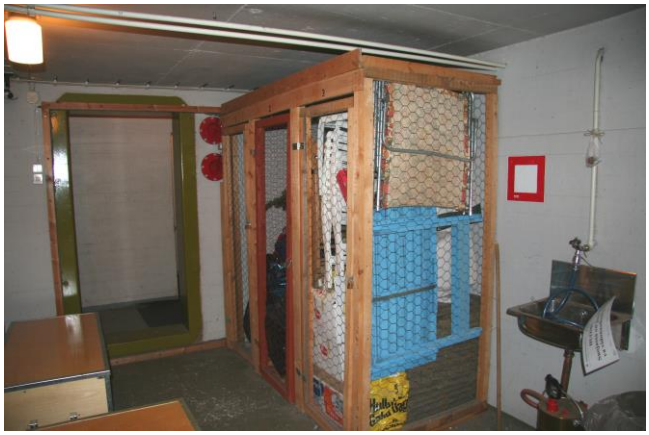
30. Civil defence supplies, civil defence tools and equipment needed in a shelter and supplies required by the civil defence organisation are available in the shelter.

31. **Ventilation system protective screen**, screens have been provided for the ventilation equipment, in which all shelter equipment can be stored. Test running of system equipment is possible.

32. **Air tightness test**, the air tightness of the shelter was tested by lowering the pressure for 20 seconds. Once the safety door and hatch had been closed by means of forceful impacts directed at their catches, the shelter met the air tightness requirements, even if the emergency exit hatch seal was broken.

8. Use of the civil defence shelter in normal conditions

The civil defence shelter contains the private storage closets of 42 flats (so-called wire mesh cabinets) and two closets with ventilation equipment. The storage closets were built from timber and iron wire mesh. The closet size was 730 x 990 mm= 0.72 m^2 and used capacity 50% (0.8 m^3). Four of the private closets were empty. The closets were locked with normal padlocks. The door hinges were installed so that they could be detached from the outside using a battery-operated screwdriver.



Basement storage closets

9. Arrangements before the experiment

For the duration of the experiment, a campervan providing services for the observers was parked beside the building, and a container serving as headquarters for the control centre was placed outside by the Rescue Department. A civil defence subdivision command centre set up in accordance with the situation picture operated in the control centre during the experiment, and it transmitted official bulletins in accordance with the situation picture. The control centre was also prepared to respond to questions put by the security personnel of the property; however, no questions were asked during the experiment.

To provide a link between the control centre simulating the civil defence system and the leaders of the training exercise, a conductor telephone line was set up to simulate not only the conductor telephone connection between the subdivision and the shelter, but also the information, advisory and educational activities provided by the Finnish Broadcasting Company for the civil defence organisation.

Four recording cameras, and one for monitoring purposes only, were installed in the ceiling of the shelter. The screen connected to the monitoring cameras was in the immediate vicinity of the civil defence shelter door. In addition to the cameras, the screen could be used to observe the commissioning of the shelter. The screen was monitored continuously, and the course of events was recorded in monitoring forms prepared in advance.

Conductors of the study

Monitoring camera screen

Roller cages for the residents' belongings were brought into the garage in advance. The number of roller cages was 1.5 times the number of flats. A skip was brought into the courtyard of the building, in which were placed dismantled storage closet materials and goods rejected by the residents. The residents were handed work monitoring forms one day before the experiment started.

Commissioning of the civil defence shelter

10.1 Clearing out the civil defence shelter

The goods were placed in roller cages.

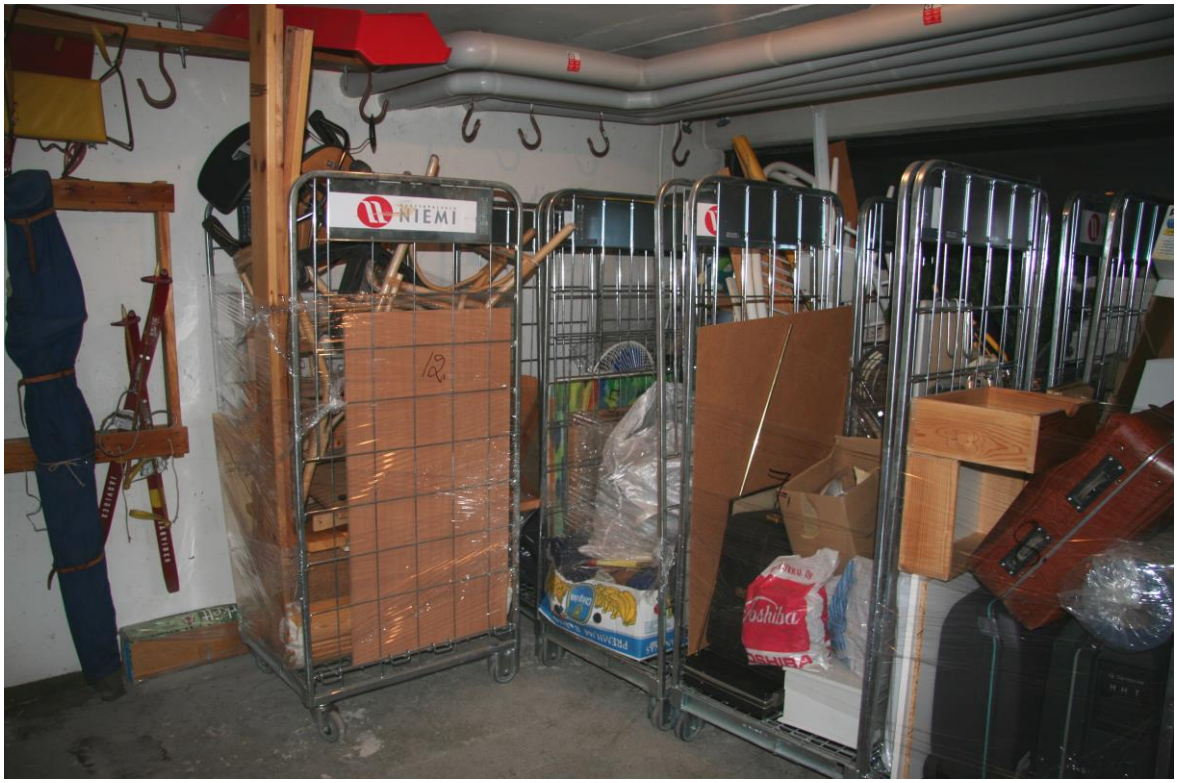
Dismantled structures were taken to a skip.

The experiment started on Friday 28 September at ***6 p.m.*** with a briefing delivered by the Civil Defence Manager in the housing company's garage. Part of the residents had gone directly to the basement. The Shelter Manager read out the order issued by the City of Helsinki Rescue Manager to commission the shelter.

The order did not contain certain essential information needed for successfully performing the task, such as a list of priority tasks during the initial steps that are vital for commissioning the shelter (immediately switching off heating in the shelter, connecting the radio, TV and telephone). Consequently, those working in the shelter had no command, information or alarm links at their disposal throughout the commissioning phase. On the other hand, neither did the residents comprehend the situation this caused, and they failed to send the duty officer of the shelter into one of the flats to monitor radio and TV broadcasts. The failure to make use of communication links and the commissioning instructions obtainable through them significantly extended the time required to commission the shelter. The subdivision was prepared to issue such information.

At 6.08 p.m. the Civil Defence Manager held a briefing and divided the 20-strong group into four teams. The first team had to clear out the residents' belongings from the storage closets. The second team had the task of dismantling the storage closets and taking them directly to the skip in the courtyard. The third one had to put the goods cleared out from the shelter into roller cages on the basement landing. The fourth team had to take the goods to the bicycle shelter and garage, which had been cleared out. The briefing took a total of 10 minutes.

The building has two bicycle stores. By order of the civil defence management, one person stayed behind to clear out the 20 m^2 bicycle store. The bicycles were moved to the other bicycle store. It took one person some 10 minutes to clear out the store. The bicycle store was empty ***at 6.23 p.m.***



Most of the roller cages were moved into the bicycle store.

At 6.12 p.m. the residents grouped together in the shelter with rather mixed feelings. At the best, 25 persons had squeezed into the shelter. This included 10 outsiders. In the beginning, journalists and organisers of the experiment were allowed in the shelter.

The first belongings from the storage closets had been moved to the upper basement landing by ***6.19 p.m.*** or some 10 minutes after the work started. This is the time it took for the participants to get over their confusion and for 20 people to crowd into the civil defence shelter. The residents did not at any stage allow reporters to disrupt their work.

In the beginning, an attempt was made to form a chain to move the goods. Organising this work adequately well proved impossible, which is why the idea was abandoned.

Moving the dismantled store structures to the courtyard and shifting the goods.

Those clearing out the closets took the goods up one flight of stairs, after which the goods were placed in roller cages one closet at a time. On average, 8 people were involved in carrying the goods.

Two people worked at filling the roller cages. The roller cages were wrapped in a plastic film, and the closet number was written on them with a marker. From the landing, the roller cages were pushed over a distance of 10 m to the bicycle store that had been cleared out. Once the bicycle store was full at 7.50 p.m., the remaining 10 roller cages were placed in the garage. The distance to the garage was 30 m, and it was positioned half a floor lower. At 7.40, a ramp was erected on the stairs with boards. Two people were engaged in moving the roller cages.

Closets that were locked slowed down the clearing out to some extent.

At 7.15 p.m., or after working for one hour, one half of the storage closets had been cleared out.

10.2 Dismantling the storage closets

Dismantling in progress.

Detaching hinges with a battery-operated drill.

At 6.20 p.m., as soon as the first closets had been cleared out, the dismantling of the closet structures started. The hinges on closet doors were detached using a battery-operated drill. Two battery-operated drills were used in this work. On average, four people were involved in dismantling the closets. Four people were carrying out the dismantled structures. The dismantling team mainly consisted of men.

The dismantling equipment was obtained from the shelter tool kit, including an iron bar, spade, crowbar and axe, the handle of which broke towards the end.

The dismantled closet partitions and doors were taken directly to the skip placed in the courtyard. From the start, one resident was working at the skip to receive the materials.

During the first hour, 13 closets had been dismantled and taken into the skip. In the beginning, the dismantling team had to wait for the closets to be cleared out.

At 8 p.m., after working for two hours, the pace of clearing out the shelter started to slacken. Up till this point, the residents had been working continuously, only stopping for a drink of water. Everyone was perspiring. While the closets were being cleared out, the temperature of

the shelter had increased by 4 degrees (+25C). This was due to the fact that the feed circuit of the shelter radiators had not been closed with the heating circuit shutoff valves (input-output) installed for this purpose. The temperature in the shelter and its structures went up, and the ambient air humidity increased by nearly 20 percentage points (68%).

Dismantling nearly completed.

At 8.50 p.m. 32 closets had been dismantled. The only minor accident took place as the supporting beam of a closet broke the ceiling lamp cover. However, the light itself remained in working order.

A dismantling team member positioned himself beside the door with the iron bar and proposed to dismantle the airlock tent fixing battens. Fortunately, this did not go ahead.

Dismantling the closets.

Should we pull this one out, too?

All closets had been dismantled and taken to the skip by 9 p.m.

At 9 p.m. the clearing of the floor started. Firstly, the fixing nails of the closet bottom runners were detached or broken. These had been attached to the concrete floor by a nail gun in the construction phase, and could not be removed except by breaking with a hammer. The floor was brushed clean, which resulted in a great deal of dust.

Removing steel nails from the floor.

The emergency exit passage is 10 m in length.

At 9.22 the Civil Defence Manager decided to stop the work. The plan was to continue the following morning at 9 a.m. with a smaller team mainly consisting of the civil defence management.

The cleaning of the shelter continued immediately on Saturday at 9 a.m. At first, this was done by brushing, which raised a lot of dust in the air. No breathing masks were used in the cleaning work. The brushing was continued, and after a short delay, a vacuum cleaner was brought in. It took two persons approx. one hour to clean the shelter, and the cleaning was thus completed by 10.30 a.m.

Cleaning the shelter on Saturday morning.

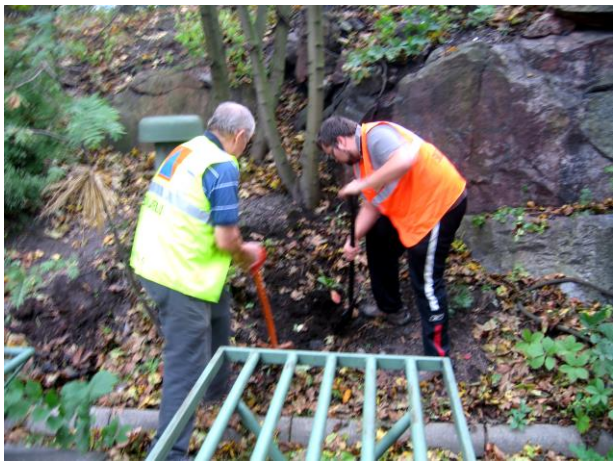
11. Preparing the shelter for civil defence use

11.1 Digging out the outer cover of the civil defence shelter emergency exit hatch

The first shovelfuls of soil were removed at 9 a.m. from top of the emergency exit passage. One of the spades used for digging was obtained from the civil defence supplies kit. The civil defence management collected a torch from the kit and went inside the passage to establish on which side of the passage the hatch was located.

Initially, two persons were engaged in the digging. The top of the hatch was located after half an hour's digging. At this stage, two more persons joined in. One of them was digging soil from the hole, the other was moving it further away. The workers were relieved every five minutes. One woman was involved in the digging. The hole ended up approx. 1.5 m in depth and 1 square m in area. The soil type was moraine that was easy to dig. It took four people a total of 2.5 hrs to dig the hole. The digging was finished by 11.30 a.m., after which the hole was for safety reasons covered with wire mesh doors from the storage closets.

At 12.20 p.m. two persons attempted to open the external hatch of the emergency exit passage. The screws were completely rusted, and an anti-corrosive agent had to be applied. All but one of the screws opened. The hatch weighs 23 kg, and the team was wondering whether it was worth lifting the cover off. They decided to leave it.



Digging out the emergency exit passage hatch.

Vertical shaft (5 m climb) and the cover whose bolts need to be detached.

11.2 Building of the toilet closets

As all timber had been taken to the skip the night before, it was necessary to return to the skip to fetch support structures for the toilets. It took one person one hour to set up the support structures. At 12 noon, four people started building the wall structures (privacy protection) from refuse sacks. Building this protection took five minutes.

Building the toilet walls.

Finished toilet.

11.3 Filling the water containers

At 11 a.m. three women started filling the drinking water containers. The connecting hose had a small diameter, and the filling progressed slowly. By decision of the shelter management, only one large container was filled.

At 2.45 p.m., the observers shut off the water mains valve on the side of the shelter. At 3.08 p.m., the subdivision issued an order to empty out the water container that had been filled in because of a contamination risk and to provide water for 65 people.

At 3.10 p.m., the Civil Defence Manager asked additional people to help fill in the containers. After ten minutes, the residents found the shutoff valve, and the filling started at 3.20 p.m. The filling of the water container progressed slowly, which is why another pair started filling containers from the second water inlet beside the toilet. At 5.25 the water containers were full with a total of 510 l of water.

Filling in a water container.

Water containers made from cardboard easily disintegrate when damp.

11.4 Setting up the airlock tent

At 11 a.m., setting up of the airlock tent started. Initially, this occupied four people, who misread the instructions when attempting to fit the tent battens in place. The planning and experimentation took half an hour. Two people transferred from filling in water containers to assist those setting up the tent, after which the work started progressing more systematically. One person was reading out the instructions, while the others installed the battens accordingly. After this, the tent was set up in 20 minutes. By 11.50 a.m., the airlock tent had been set up. In total, it took four person-hours. The zippered wall of the airlock tent was closed, after which access was through the front slit, which obstructed moving around and carrying objects.
Under the Decree currently in force, the setting up of the airlock tent may take a maximum of 20 minutes. In an optimal situation, the civil defence system would support all key measures involved in commissioning a civil defence shelter with almost constantly repeated audio and video inputs. The civil defence system would publish type solutions for technical and strategic problems.

At 12.25 p.m. the zippers of the airlock tent were undone, which facilitated access to the shelter.

Setting up the airlock tent.

11.5 Door, cover, sewer shutoff valve, lead-throughs and airlock devices

At 1.30 p.m., the closing of the door was tested in the shelter, otherwise all was quiet.

At 1.40 p.m. the replacement air valve for normal conditions above the safety hatch was closed using a so-called blind flange. The shutoff flange was suspended from the lead-through, and all necessary seals, fixing screws, washers and nuts were in place.

At 2 p.m., the functioning of the overpressure gauge was checked. Too much liquid was inserted in the overpressure gauge. The zero point of the gauge had shifted slightly. An attempt was made to remove the extra liquid using a small syringe, but this was not successful.

At 2.05 p.m., the camera cable lead-throughs were sealed by tape. This took one person 15 minutes to complete.

Attempting to open the sewer shutoff valve.

Sealing the lead-throughs with tape.

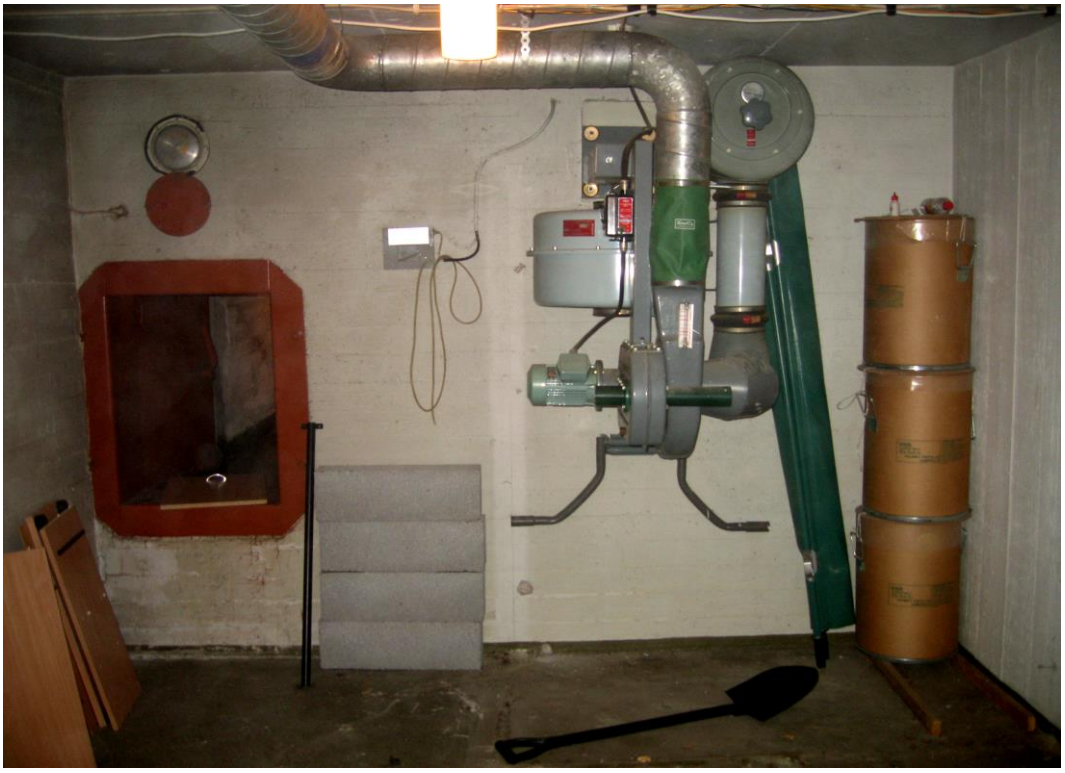
11.6 Ventilation equipment

Ventilation of the shelter started automatically at 12.40 p.m. One ventilation system with by-pass air flow was used for this.

At 2.30 p.m., the residents independently decided to test the air tightness of the shelter. They had instructions for using and maintaining a civil defence shelter at their disposal. The residents closed all overpressure valves in the shelter and the emergency exit hatch. The instructions were vague about the location of the air flow gauge position. This ventilation system model did not have the setting *airtight position*, even if the instructions referred to it. Confusion ensued. The procedure for performing the air tightness test (pressure decrease from 20 mmWC to 5 mmWC in 20 seconds) was not adequately clear.
The instructions should be more accurate, and they should proceed step by step. In addition, the training should include practical experience. The ventilation equipment dated back to 1972, at which time the air tightness testing position did not yet exist. The original instructions gave clear and detailed instructions on how to proceed to an air tightness test. The shelter managers had updated the instructions for the use and maintenance of the shelter, failing to see the detrimental effects of changing the instructions. This risk should be taken into account in training programmes.

At 2.45 p.m. the subdivision issued a command to proceed to a shelter air tightness test.
At 3.22 p.m., the new air tightness test started. Adequate air tightness was not achieved, after which a plastic bag was taped in front of the emergency exit hatch. Between the plastic bag

and the hatch, a clearance the size of the frame remained. Towards the end of the air tightness test, the tapes of the plastic bag gave up, and it was necessary to remove the bag. The shelter hatch and door were sealed by hitting the handle with the sledgehammer found in the tool kit several times, after which the required air tightness was obtained.



Ventilation system

Civil defence supplies

11.7 Other shelter equipment

At 12.30 p.m., a radio set was brought into the shelter and connected to the building aerial. The spare aerial of the radio was never installed.

At 12.45 p.m., wooden benches from the sauna were brought in, which provided seating for almost the entire test group taking shelter.

At 3.07 p.m. the civil defence management went to shut off ventilation in the whole house from the main switch. Ventilation was reconnected.

At 4.25 p.m. the shelter telephone was manned. Because of noise and echoes in the shelter, the telephone connection was difficult to hear.

12. Taking shelter

By 5.49 p.m., most of the residents were in the shelter, quietly sitting on the benches.

At 5.52 p.m., all residents taking part in the experiment (32 people) and 7 observers were in the shelter. In total, there were 39 people in the shelter during the sheltering experiment. The shelter has two ventilation systems for 60 people. According to currently valid regulations, the civil defence shelter (0.75m^2) is dimensioned for 69 people.

12.1. Airlock situation

The civil defence organisation at council of war.

Installing the filter.

At 6.04 p.m., the subdivision issued an order to take shelter. The civil defence organisation of the shelter immediately started sealing off the shelter. The emergency exit passage door on the side of the shelter, emergency exit passage hatch, overpressure valves and water connection were shut, and the airlock tent was set in the safety position. The residents also tried to close the sewer shutoff valve, but the valve had not been serviced, and it was not possible to close it. The steps listed above had been completed by 6.16 p.m.

The stay in the shelter in airlock conditions went well. During the 50-minute period in airlock conditions, the air temperature only went up by 3 degrees and the humidity by 10 percentage points. The slight increase in temperature and humidity was due to the fact that the shelter provides nearly 1.5 m^2 of space per person.

12.2 Filtering operation

At 6.55 p.m., the subdivision issued an order to switch the ventilation system to filtering mode. A filter had been installed in one of the ventilation systems in the shelter. During filtering operation, only this system was used.

At 7.03 p.m., a telephone call was received from the subdivision, which urged the civil defence organisation to send out two fully equipped scouts.

At 7.10 p.m., the power was cut off in the shelter. The Civil Defence Manager immediately assigned shifts for ventilation system operators.

At 7.12 p.m., the ventilation equipment started operating manually. A working hand torch was located in advance in the equipment kit of the shelter. Modern ventilation equipment includes a dynamo-powered light integrated in the equipment.

At 7.19 p.m., the power came back on. The ventilation equipment resumed electrical operation. When switching over to manual operation, the pressure valve should have been opened slightly to also obtain an adequate volume of air in manual use. Training in ventilation equipment operation should be included in the training of civil defence organisations, and the accuracy of manuals should be improved.

Taking shelter

The residents sat on benches brought in from the sauna.

12.4 By-pass operation

At 7.40 p.m., the control centre announced that the ventilation could be switched to by-pass operation. The ventilation system that had been in the by-pass operation mode all the time, or the one in which the filter had not been installed for filtering operation, was switched on.

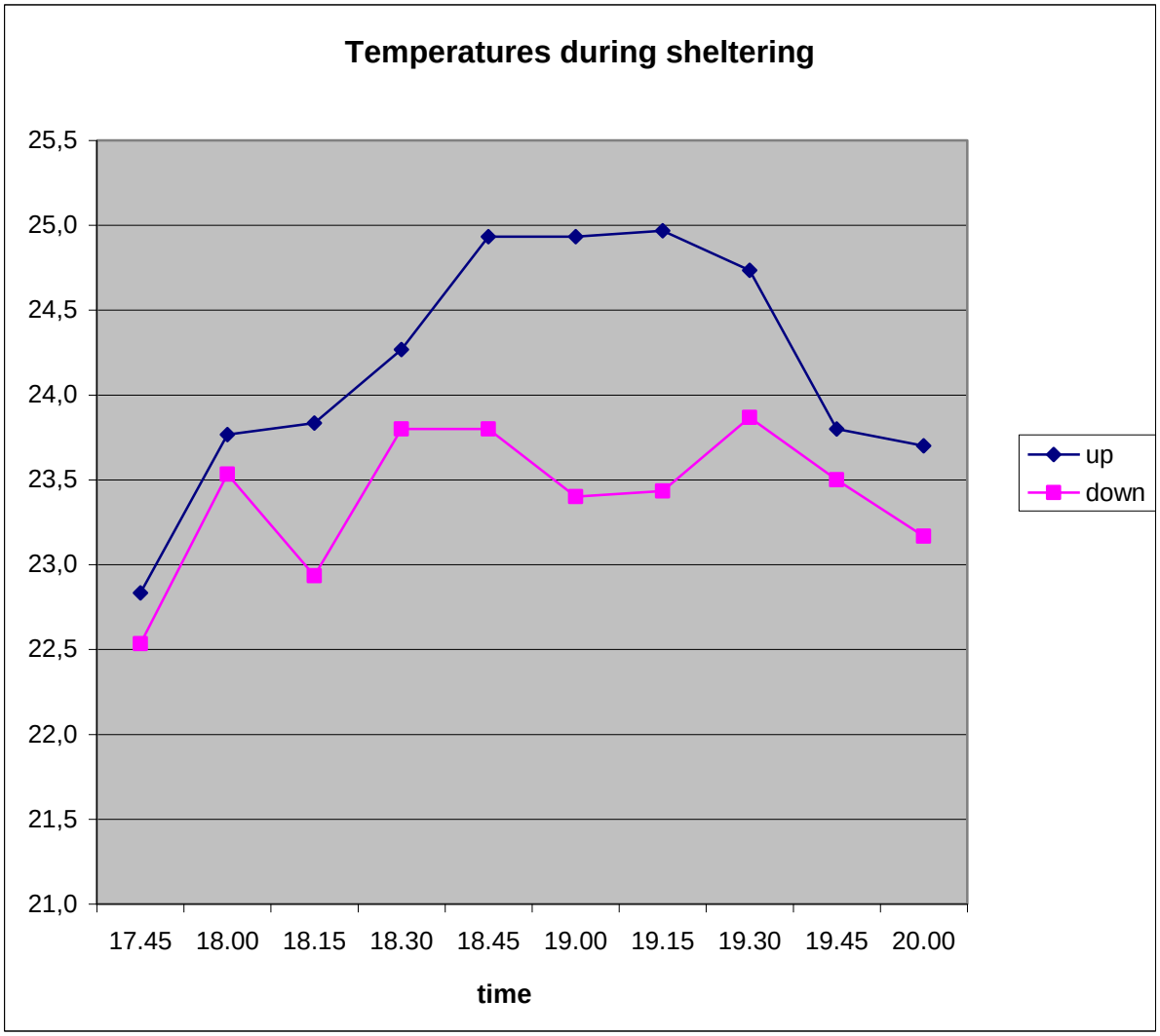
Dressing up the scouts

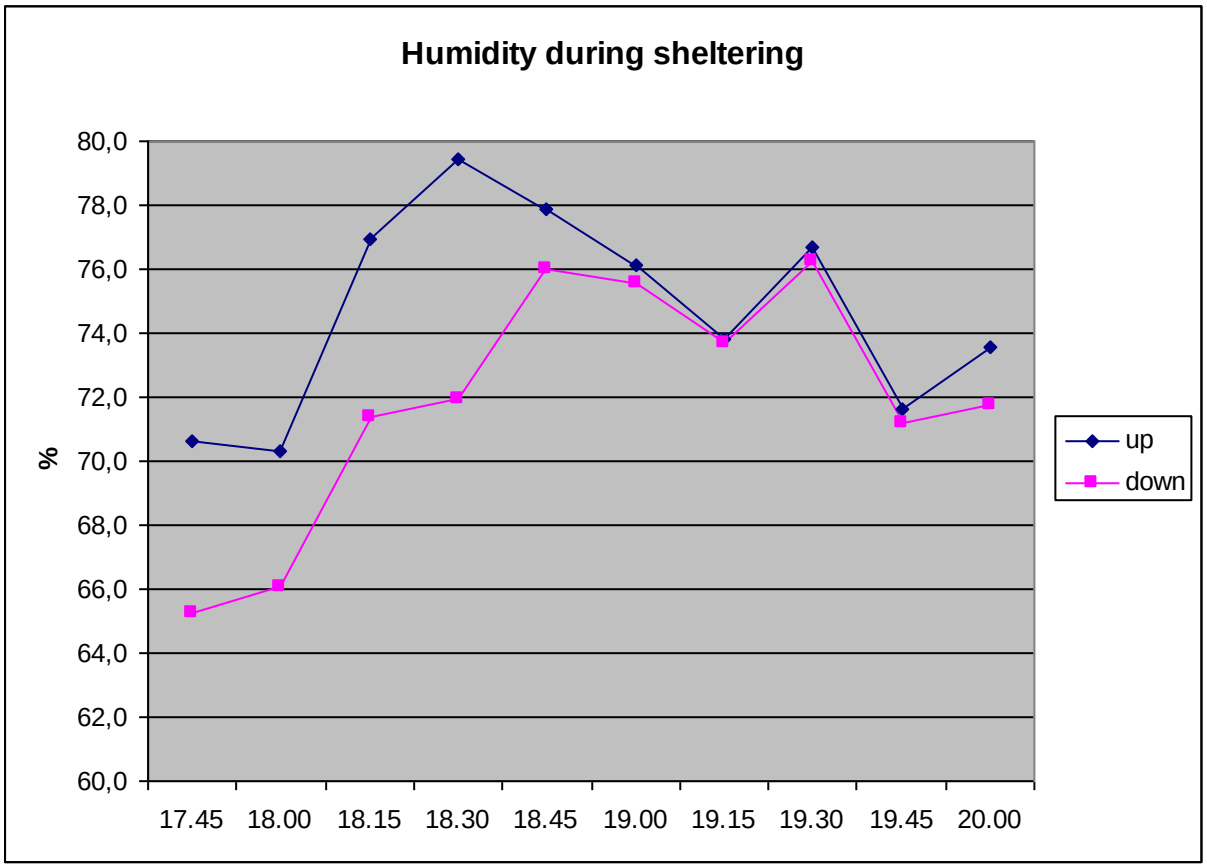
Scouting team setting off

12.5 Team of scouts

At 7.18 p.m. the control centre announced that a team of scouts should go out to see if the shelter could be left safely.
The Civil Defence Manager ordered two persons to go out as scouts. Others assisted them in dressing up: their sleeves were tightly sealed by tape, and protective masks were put in place. One of the scouts initially had trouble breathing through the filter. The protective suits lacked hoods, and consequently the necks of the scouts remained completely exposed. In a real-life situation, it would have been necessary to protect the neck area by such as a refuse sack.
At first, the team was informed that the door of the shelter could not be opened, and the scouts needed to go out through the emergency exit passage. However, the cover at the external end was still bolted shut, and opening the 23-kilogram cover in a space with a vertical height of 5 meters would have been too risky. Finally, it was decided that the scouts would go out through the shelter door.
At 7.45 p.m. the scouts went out.
At 7.55 p.m., the scouts returned to the shelter and announced that the danger was over.

At 7.59 p.m., the control centre gave permission to transfer to lighter protection in the garage. All those involved in the training exercise moved on to the garage to receive feedback on the experiment.


Temperatures during sheltering
25,5
25,0
24,5
24,0
23,5
23,0
22,5
22,0
21,5
21,0
17.45
18.00
18.15
18.30
18.45
19.00
19.15
19.30
19.45
20.00
time
up
down


Humidity during sheltering
80,0
78,0
76,0
74,0
72,0
70,0
68,0
66,0
64,0
62,0
60,0
%
17.45
18.00
18.15
18.30
18.45
19.00
19.15
19.30
19.45
20.00
up
down

Exiting the shelter.

Final briefing in the garage.

12.6 Lighter protection

All residents having taken part in the experiment moved on to the garage. The residents filled in a questionnaire.

13. Renovation of the civil defence shelter

The shelter floor and walls were carefully washed clean of any dirt. The floor and walls were painted.

Original sewer shutoff valve.

Repaired and serviced sewer shutoff valve.

The sewer shutoff valve was completely stuck. By help of an anti-corrosive agent, it was possible to open the valve cover. Anti-corrosive agent (CRC) was sprayed on the valve cover fixing bolts and left to work for two days. The valve cover was then relatively easy to open. The valve spindle could not be moved. Anti-corrosive agent was sprayed on the valve spindle,

and it gradually started moving. Presumably, the sewer shutoff valve had not been used once since the house was built. A valve of this type should be tested and served at least every 5 years, or even more frequently. By the actions described above, the valve was reverted to working order and installed in its place. See photograph for the valve structure.

The ventilation equipment blower was completely served on site. The service included such as an oil change in the gearbox and replacing the rubber seals of the by-pass pipe.

The reconditioned filter.

Ventilation system filters. Even if only one of the two ventilation system special filters were used during the experiment, a decision was made to replace both to ensure that they will work in the future. The operating condition of the filters and ageing of materials were examined by VTT Technical Research Centre Finland and the Finnish Defence Forces Technical Research Centre. At the time of the sheltering experiment, the filters were fully functional, but the filter that was used had taken in less than one kilogram of humidity. As humidity rapidly undermines the filtering properties of active carbon, replacing the filter was justified. The filter testing reports of both VTT Technical Research Centre Finland and the Defence Forces Technical Research Centre are attached.

The system pressure valve pre-filter in both valves was soiled and useless because of dust from the air intake channel. Both filters were replaced to ensure that they will also work for the next 30 years.

Pressure valve pre-filter.

Testing the filter.

Test observers.

The bottom part of the filter contains carbon, while the top part contains a particle filter.

The water containers were filled during the experiment. A water sample was taken from one of the containers after the experiment and sent to the City of Helsinki Environment Centre laboratory for analysis. After the first sample had been taken, the water was left to stand in the containers for another couple of weeks, after which a second sample was taken for analysis. The laboratory test results of both water samples showed that the water was potable. Some of the containers were exposed to damp during the experiment. As cardboard containers loose their properties when damp, new water containers compliant with the currently valid dimensioning principles were purchased. The test reports of the Environment Centre are attached.

For **civil defence shelter toilets**, free-standing toilet closets without supports that are compliant with modern dimensioning principles were purchased (3 units). At the location of the toilet closets, there were pipes and a radiator, which would have had to be moved if using closets attached to the wall.

New plastic toilet seats were also purchased for the shelter to replace the old cardboard ones.

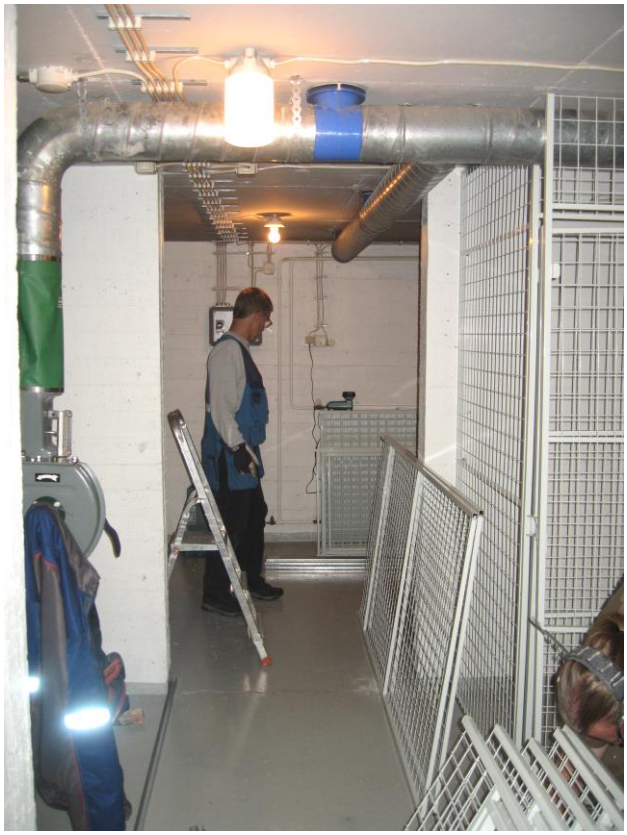
The door and the emergency exit hatch were repaired.

The bottom edge of the hatch was rusty and the seal was broken.

14. Building of the wire mesh closets

The old timber closets were dismantled and taken to the dump as the shelter was commissioned. For rebuilding the closets, three alternatives were examined.

1. Building closed-in closets with timber alone. This plan was abandoned because of the high fire load.
2. Closed-in closets made from profiled sheet metal. The price of this alternative was excessively high.
3. The frame and walls of the closets would be made from pure steel using standard elements. A decision was made to procure this alternative for the civil defence shelter. It took three days to build the closets.



The new closets with wire mesh doors.

8 units of triple bunk beds were procured for the civil defence shelter, providing beds for 24, or one third of the residents.

Triple bunks purchased for the civil defence shelter.

The repaired hatch.

15. Cost of renovating the civil defence shelter

The cost of repairing the crisis period equipment of the civil defence shelter, testing the old equipment and procuring new equipment totalled EUR 20,214. New filters were purchased for the civil defence shelter, which would filter not only combat gases but also radioactive methyl iodine (131 ICH3) and some other harmful gases produced in normal time accidents (chlorine, sulphur oxide and ammonium).

The idea was to be prepared for carrying out the next renovation after 30 years. Had the repairs and procurements been limited to the products that were absolutely necessary, the cost would have remained at EUR 8,000 – 10,000.

1. Complete service of the ventilation equipment
2. Replacement of filter
3. Replacement of pressure valve pre-filter
4. Replacement of water containers
5. Procurement of toilet closets
6. Replacement of toilet accessories
7. 7 triple bunk beds (21 beds)
8. Cleaning the sewer shutoff valve of rust
9. Reconditioning the civil defence shelter door catches
10. Repairs to the emergency exit hatch, replacement of seals and painting of the hatch
11. Repairs to the emergency exit passage top end cover
12. Skip and its disposal
13. New drawings
14. Testing of old equipment

The costs of normal time repairs totalled EUR 12,550.

1. The new wire mesh door closets	EUR 8,100
2. Painting of the floor and walls	EUR 3,720
3. Locks for the closets	EUR 730

16. Summary

1. Location of the experiment at Castreninkatu 14

The building used in the experiment is a seven-floor residential building with a floor area of 2,610 m^2. The building is located in Helsinki at the address Castreninkatu 14. The property was built in 1973. It has 42 flats, in which 61 residents were living at the time of the experiment.
The age distribution of the residents extends from an infant aged less than 12 months to a 95-year-old. A total of 35 residents took part in the experiment. 20 of these were actively involved in dismantling and commissioning, which is 30% of the residents in the building.
The test building corresponded with a typical building in Helsinki inner city.

2. Housing company civil defence organisation

The Civil Defence Manager, Assistant Civil Defence Manager and Shelter Manager had taken part in training courses organised by the Helsinki Rescue Association within the last two years. According to the resident questionnaire, two other persons who took part in the experiment had received civil defence training. ***It should be noted that the civil defence organisation of the housing company was far better trained than average.***

3. Civil defence shelter

The actual shelter area of the civil defence shelter is 52.2 m^2, and based on the requirements valid at the time of construction (0.6 ms^2/person) it is dimensioned for 87 people. The current dimensioning principle (0.75 m^2) would mean 70 people, and even that figure is overrated. The shelter is located 5.45 m under the ground level. The length of the emergency exit passage must be a minimum of one third of the building height, or in this case some 10 m. At the end of the emergency exit passage, there is a vertical shaft of 5 m. Exiting through the emergency exit passage would be extremely difficult and time-consuming, but possible.
The civil defence shelter contains the private storage closets of 42 flats and two closets for ventilation equipment. The storage closets were built from timber and iron wire mesh. The closet size was 730 x 990 mm= 0.72 m^2 and the used capacity was 50% (0.8 m^3).

In the condition assessment, the shelter was found to be in a better than average condition. The emergency exit passage hatch and its seal had to be repaired. The sewer shutoff valve could not be opened during the sheltering experiment. This could be solved by cleaning the valve of rust.

A precondition for immediate commissioning (24 hrs) of a shelter is that the shelter is in a perfect technical condition and does not require repairs to its equipment.

4. Clearing out of the civil defence shelter and dismantling of wire mesh closets

> *60 person hours were spent on clearing out the shelter. The cleaning took 3 person hours.*

The Civil Defence Manager divided the group of 20 people into four teams. The belongings in the wire mesh closets were put into roller cages, which were moved into the bicycle storage and garage that had been cleared out.

It took 20 people more than three hours to clear out the civil defence shelter. The work was carried out without taking breaks, except to drink water. The roller cages made the work somewhat faster.

5. Equipping the shelter for civil defence use

A total of 80 person hours were spent on equipping the shelter.

Digging out the external hatch of the emergency exit passage

The top of the hatch was found after half an hour's digging. The hole ended up approx. 1.5 m in depth and 1 square m in area. The soil type was moraine that was easy to dig. It took four people a total of 2.5 hrs to dig the hole. The digging was finished by 11.30 a.m., after which the hole was covered with wire mesh doors from the storage closets.

Building of toilet closets

The civil defence management decided to only build one toilet. The toilet was built with wire mesh closet support structures. A split refuse bag was wrapped around the support structures. This provided protection of privacy, but without a roof structure, almost all smells lingered inside the shelter. This solution was easy, but there would have been time for building proper toilets. On the other hand, there were no instructions for building a toilet in the shelter. The working time used was approx. two person-hours.

Filling in the water containers

By decision of the civil defence management, only one 100-litre container was filled with water. By order of the subdivision, the filled water contained had to be drained and the filling restarted, ensuring that there was enough water for 65 people. The filling in of the water container progressed slowly. Water was obtained from both water inlets of the shelter. Filling in the containers took 2.5 hrs. The total working time was 10 person-hours.

Setting up the airlock tent

Initially, four people worked on setting up the airlock tent. They misread the instructions, and the setting up was not successful at first. On the second attempt, one person concentrated on reading the instructions, while the others placed the battens as instructed. After this, the tent was set up in 20 minutes.

Air tightness test

All lead-throughs of the shelter were sealed, and the overpressure gauge was filled with liquid. The air tightness test could not be carried out successfully at first, as the air flow gauge did not have the setting referred to in the instructions. The instructions should be more accurate, and they should proceed step by step. In addition, practical exercises should be included in the training.

6. Taking shelter

All residents taking part in the experiment (32 people) were in the shelter in good time before the sheltering started. In total, there were 39 people in the shelter during the sheltering experiment. The shelter has two ventilation systems for 60 people. According to current regulations, the civil defence shelter ($0.75m^2$) is dimensioned for 70 people. In filtering operation, manual operation was started after the power went out, but increasing the air volume in the pressure valve by opening the valve was forgotten. In the use of the ventilation equipment, lack of opportunities to practise showed clearly. The opening of pressure valves in the airlock tent was forgotten. Similarly, the pressure valves of both toilets were opened.

Two scouts were equipped with protective suits and the sleeves were sealed tightly with tape, but the suit did not have a hood, which exposed the neck area. This could have been solved by covering the neck with a plastic bag.

7. Renovation of the civil defence shelter

The wooden wire mesh closets were replaced by modern steel mesh closets.