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Autor: Nichols, Sarah
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Sonnenberg: Dark Days Ahead

Sarah Nichols

Sarah Nichols is Assistant Professor of Architecture at Rice University in Houston, Texas.

Perfect Security

Since industrially produced concrete came into use as a building material in the mid-nineteenth century, it has been positioned as uniquely resistant to calamities from fire to civil unrest. Claims that the solidity of concrete made it invulnerable reflected a desire for security that ultimately shaped how the material was researched, used, and perceived. As applications expanded from infrastructure to inhabitable buildings, late nineteenth-century advertising by early reinforced concrete patent holders portrayed the material as fireproof, earthquake-proof, explosion-proof, and thus safe in the face of any catastrophe, even as mounting evidence pointed to the contrary. [1]

The celebration of concrete's durability found its fullest expression in the eschatology of the Cold War. The paradigmatic site where concrete was deployed to resist disaster was the nuclear bunker, and perhaps the most impressive example of a civilian bunker was a defense shelter deep within a mountain in the City of Lucerne. The project's name, Sonnenberg (Sun Mountain), asserted an optimistic faith in technological solutions to the problems of surviving doomsday, even as the project betrayed a grim view of what survival would actually entail.

In 1961, as Switzerland was gradually completing its national highway network, the City of Lucerne began planning an extension of the national north—south highway. The proposed route skirted, rather than crossed, the town and was criticized as being only beneficial to those bypassing the city, not to those living in it. Public support in this case was particularly important because, as with all large public projects in Switzerland, funding had to be approved by way of a public vote. The citizens' advocacy group Verkehrsaktion Luzern suggested alternatives that reflected the spirit of the times, including rerouting the highway close to the central Kapellbrücke so that it would be more useful for local traffic.

While debate about the highway route continued, shifting geopolitical concerns served to change the focus of the discussion. Local civil defense leaders became interested in the thick concrete tunnel the proposed highway required. Their impetus was the adoption, in 1963, of a new federal law mandating nuclear civil defense shelters (Bundesgesetz über die baulichen Massnahmen im Zivilschutz) for all residents of towns with more than 1,000 inhabitants. [2] A 1951 federal decree (Bundesbeschluss betreffend der baulichen Zivilschutz) had already required civil defense

1 Famously, François Hennebique's first brochure was titled "Plus d'incendies désastreux" (no more disastrous fires), a banner slogan that ran on the front page of the Hennebique journal, *Le béton armé*. See also: R. Saliger "Die Sicherheit gegen Feuer, Blitz und Rost," in Fritz von Emperger, ed., *Bauausführung aus dem Hochbau und Baugesetze,* Handbuch für Eisenbetonbau, vol. 4. (Berlin: Wilhelm Ernst & Sohn, 1909.)

2 A revised law from 1971 extended the requirement to inhabitants of all towns, regardless of size. By 1989, Switzerland was close enough to that goal to begin a debate on the possibility of bunkers for livestock.

shelters to be included in all new buildings and major renovations, an incursion of geopolitical threats into the space of the home. Defense shelters proliferated amidst the domestic and commercial spaces of the city, as every building project began with the obligatory construction of a basement room made of thick concrete. [3] By the end of the 1950s, 65,000 such air raid shelters had been built—a significant number, but still far from sufficient to protect most civilians. [4] The 1963 law increased the pressure: instead of waiting for the shelters to be added incrementally, municipalities were required to provide the missing bunkers or face fines. The 1951 decree had not explicitly taken into account nuclear weapons—largely because their effects were almost completely unknown at that time. Broadening the intended scope of protection, the updated 1963 rules covered the so-called ABCs of pre-emptive defense: to provide against atomic, biological, and chemical attacks. [5] Planning was primarily oriented towards protection against atomic bombs, under the assumption that "a good nuclear shelter always also offers good protection against conventional, chemical, and biological weapons." [6] Good protection, according to the guidelines, was offered by heavily reinforced concrete—now explicitly required—as well as a reliable ventilation system. Seemingly precise tables calculating the material thickness required for different impact levels concealed just how limited empirical knowledge behind the guidelines actually was. As Silvia Berger Ziauddin has pointed out in her work on the Swiss nuclear bunker, a series of studies, conferences, and transatlantic exchanges with American scientists gave the bulk of guidelines proliferating in the 1960s—of which the 1963 law was just the beginning—the sheen of scientific grounding. [7]

Before World War I, the purported resistance of concrete to munitions had caught the attention of the Swiss military. The Swiss concrete journal *Beton- und Eisenkonstruktionen* wrote:

"Numerous military departments have already conducted extensive tests of the effect of munitions on reinforced concrete, and although the details of the results of these military tests have not been made public, enough has been said to know that the resistance of concrete against destruction by munitions can be significantly increased with appropriate reinforcement." [8]

Two years later, the same journal reported that the Swiss military was in the process of building military fortifications in Monte Gambarogno with reinforced concrete. Yet, as the quote suggests, what little testing was conducted to determine the resistance of concrete was often kept secret. This remained the case even at the end of World War II, when hope for lasting peace was balanced against wary preparedness for another conflict,

3 Giulio Rossetti, "Die Entwicklung des baulichen Zivilschutzes seit 1950," *Zivilschutz* 30, no. 10 (1983), 51–57.

4 Silvia Berger Ziauddin, "Superpower Underground: Switzerland's Rise to Global Bunker Expertise in the Atomic Age," *Technology and Culture* 58, no. 4 (October 2017), 921–54.

5 In general, the Swiss strategy of building civilian protection is somewhat peculiar. The two Cold War superpowers—where the threat of nuclear attack originated—never constructed shelters en masse. Initially, both the US and the Soviet Union opted instead for forms of dispersal: in the United States, by fostering the decentralization of industry and housing at densities too low to target; in the Soviet Union by drawing up detailed evacuation plans that could move city-dwellers to collective farms in the countryside. More broadly, neither state took these plans very seriously after the introduction of thermonuclear weapons in the early 1950s and intercontinental ballistic missiles (ICBMs) in the latter part of that decade, as they considered them largely futile.

6 Eidgenössisches Justiz- und Polizeidepartement and Bundesamt für Zivilschutz, *TWP 1966: Technische Weisungen für den privaten Schutzraumbau*, 5th ed. (Bern: Eidgenössiche Drucksachen- und Materialzentrale, 1973), para.1.41. All translations by the author unless noted otherwise.

7 Among these were the international symposium on civil defense, held at ETH Zurich in 1963, and the 1964 *Handbuch der Waffenwirkung für die Bemessung von Schutzbauten* by Werner Heierli.

8 "Eisenbeton im Kriegsbau," *Beton- und Eisenkonstruktionen* 2, no. 1 (January 1911), 46.

exemplified by the rounds of testing made by the Swiss army, in 1946, on concrete bunkers hurriedly built during the war. After having subjected bunkers near Stockhorn to a barrage of bullets and explosives, they were astounded to find that the concrete was not as resistant as had been assumed. Instead, it had crumbled under direct fire. At some sites, bullets had even penetrated straight through the thick walls.

After the poor results at this site, the army tasked the Swiss Federal Laboratories for Materials Science and Technology (Eidgenössische Materialprüfungs- und Forschungsanstalt, or Empa) to survey and test numerous other bunkers at fifty-two sites, built under the supervision of a single army division but by two different contractors during the war. Although previous studies, conducted in the 1930s for the development of aerial defense guidelines, had used purpose-built test structures and material samples, these later tests, instead, involved defense structures that had been in use during the war and thus revealed once again the disjunction between controlled laboratory results and actual construction practices. The results showed that approximately one third of the structures had been built with inferior cement. Ten percent of the structures were deemed unusable. The results of the study, considered shameful, were concealed from the public but were leaked to the press in 1949.

A subsequent federal investigation and trial uncovered not only criminal profiteering on the part of the contractors, but also drew attention to an untenable organizational structure for the design and construction process within the army. Projects drawn up by the army's head of engineering had been given directly to individual troops and were subsequently overseen by officers with no engineering or construction competence. One head construction supervisor (*Oberbauleiter*) testified that he was not familiar with the Swiss Society of Engineers and Architects (Schweizerischer Ingenieur- und Architektenverein, or SIA) engineering and architectural regulations on reinforced concrete, had never heard of common on-site material tests, and did not even understand the process of concrete construction.

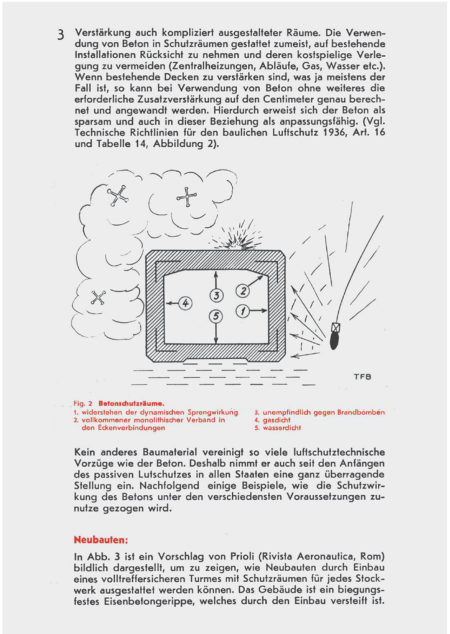
Rank in the non-professional Swiss Armed Forces did not correspond to expertise. Issues that arose with projects completed during wartime that had relied, in part, on conscripted and often unskilled military labor, such as the "melting" bunkers from World War II, seemed to influence a turn in peacetime to defense projects that were instead contracted out to private engineers and builders, resulting in a system where expertise for complex military and defense projects was held within the construction industry at large rather than restricted to a military elite. Many

engineers, architects, contractors, and material producers also held dual positions in private business and as high-ranking volunteer officers, creating personal and professional overlaps between defense projects for the military and civilian work undertaken by the construction industry.

From Air Raid Shelters to Nuclear Bunkers

In the wake of the 1963 law mandating nuclear civil defense shelters, the City of Lucerne was therefore suddenly faced with a large deficit of civil defense shelter spaces just as the highway project was moving from the planning to the design phase. At the time, small basement shelters comprised the majority of secured spaces in the civilian protection scheme, which, until then, had been based on assumptions about the nature of warfare drawn mainly from experience and research conducted up until the outbreak of World War II. While Switzerland had been spared destruction during the first two world wars, the country could not assume that it would be so fortunate in future conflicts. The devastation of neighboring countries served as a tangible warning of what could come.

Prompted by the civilian casualties in World War I from nerve gas and aerial bombing, in 1928 the Red Cross encouraged nations to set standards for, and fund the construction of, civilian protection shelters. In the same year, the Swiss federal government followed suit by creating an air raid protection commission (Luftschutzkommission). The work of the commission set an example for other nations by responding swiftly to the Red Cross's call and also contributed to the Swiss government's preparation for the ultimately ineffectual World Disarmament Conference held by the League of Nations in Geneva in the early 1930s.



3 Verstärkung auch kompliziert ausgestalteter Räume. Die Verwendung von Beton in Schutzräumen gestattet zumeist, auf bestehende Installationen Rücksicht zu nehmen und deren kostspielige Verlegung zu vermeiden (Zentralheizungen, Abläufe, Gas, Wasser etc.). Wenn bestehende Decken zu verstärken sind, was ja meistens der Fall ist, so kann bei Verwendung von Beton ohne weiteres die erforderliche Zusatzverstärkung auf den Centimeter genau berechnet und angewandt werden. Hierdurch erweist sich der Beton als sparsam und auch in dieser Beziehung als anpassungsfähig. (Vgl. Technische Richtlinien für den baulichen Luftschutz 1936, Art. 16 und Tabelle 14, Abbildung 2).

Fig. 2 **Betonschutzräume.**
1. widerstehen der dynamischen Sprengwirkung
2. vollkommener monolithischer Verband in den Eckenverbindungen
3. unempfindlich gegen Brandbomben
4. gasdicht
5. wasserdicht

Kein anderes Baumaterial vereinigt so viele luftschutztechnische Vorzüge wie der Beton. Deshalb nimmt er auch seit den Anfängen des passiven Lutschutzes in allen Staaten eine ganz überragende Stellung ein. Nachfolgend einige Beispiele, wie die Schutzwirkung des Betons unter den verschiedensten Voraussetzungen zunutze gezogen wird.

Neubauten:

In Abb. 3 ist ein Vorschlag von Prioli (Rivista Aeronautica, Rom) bildlich dargestellt, um zu zeigen, wie Neubauten durch Einbau eines volltreffersicheren Turmes mit Schutzräumen für jedes Stockwerk ausgestattet werden können. Das Gebäude ist ein biegungsfestes Eisenbetongerippe, welches durch den Einbau versteift ist.

fig. 1 Section showing a concrete bunker resisting gas, fire, and bombing.
Source: "Der Beton im Luftschutz," *Cementbulletin* 9, no. 7 (1941), 1–6, here 3.

To develop suitable guidelines for civil and military defense, some of the early claims concerning concrete's resistance to fire and munitions were tested in the laboratory. Columns of different materials and varying dimensions, for example, were tested in fire until they failed. At a glance, the results largely substantiated claims that concrete resisted fire more effectively than untreated steel and wood. But, more importantly, the tests also underscored the fact that no material was completely fireproof, and that the durability of samples could radically vary for reasons

that were still poorly understood. [9] The non-binding guidelines provided sample construction sections and tabulations for the material thicknesses required to resist different explosive impacts. Plans and sections through purpose-built shelters show ceilings and walls made from either 1.1 or 1.5 meters of reinforced concrete, forming a compact interior not much larger than the thickness of the material enclosing it. [10] The shelters were envisioned as sealed spaces with filtered ventilation systems to protect those inside from chemical attacks, but they could only be temporarily inhabited. The only reserves to be stocked in the bunker were potable water and spare clothes (in the case of a chemical attack), not food or any other necessities for longer stays. [11] In plan and section, the guidelines show benches for upright seating.

The cement industry recognized the opportunity the guidelines presented. In 1935, the *Cementbulletin* claimed:

"The fact that large industrial buildings, public buildings, and dwellings are subject to destruction by force majeure, costing people their lives and inflicting serious material damage, makes it a duty for the Konstrukteur *to identify and promote construction methods that are fire-, water-, explosion-, and shock-proof. Especially during the World War, the resistance of various building materials to violent destruction could be determined with great clarity. Today, where air defense has become a national duty in all countries, this question is of particular interest. ... Reinforced concrete's remarkable behavior in the face of violent impacts is explained through steel reinforcement being embedded in pressure-resistant, fireproof concrete. Combined, concrete gains considerable tensile and bending strength and can be developed into a monolith construction that resists not only the most diverse static demands but also dynamic forces (shaking, blows)."* [12]

A few years later, in the midst of the anticipated war, the *Cementbulletin* published propaganda for concrete claiming that "experience from previous wars proves that concrete and particularly reinforced concrete are the most difficult, as it were, to 'wipe off the map'." The same article went on to claim that structurally monolithic reinforced concrete offered unprecedented protection. An accompanying illustration encapsulated the cement industry's argument, showing a thick mass of concrete simultaneously resisting gas, fire, and explosives. fig. 1

Design decisions in the civil defense guidelines reflected scenarios in which attacks were anticipated, even if only by a few minutes. Required material resistance was plotted against a threat localized in space and time to either a discrete point of impact or a cloud of gas limited to a relatively small area. Small shelters were envisioned as myriad parts of a decentralized

9 A study by the Swiss Luftschutzkommission found differences of up to 100 percent in test results. See "Technische Richtlinien für den baulichen Luftschutz," *Das Rote Kreuz* 44, no. 11 (1936), 263–64.

10 Eidg. Luftschutzkommission, ed., *Technische Richtlinien für den baulichen Luftschutz* (Bern: Drucksachenbureau der Bundeskanzlei, 1936), paras.77–78.

11 "Technische Richtlinien für den Baulichen Luftschutz in der Schweiz," *Baulicher Luftschutz: Mitteilungsblatt Amtlicher Nachrichten unter besonderer Mitwirkung der Baugruppe der Dienststelle des Chefs des zivilen Luftschutzwesens im Reichsluftfahrtministerium* 9 (August 1939), 53.

12 "Das Verhalten der Eisenbetonbauten bei gewaltsamen Zerstörungen," *Cementbulletin* 3, no. 9 (November 1935), 2.

network of protective spaces distributed across the territory, each accessible within three to four minutes. The defense guidelines also recommended decentralization and de-densification of the city as a means of distributing risk. The committee endorsed skeleton frame buildings in order to reduce the risk of structural collapse and, at the level of the city, the dispersion of industry to avoid the clustering of facilities that would provide attractive targets. [13] In a passage echoing modernist planning principles, albeit in the guise of defense strategy, the committee further suggested, "The effect of air raids on buildings can be significantly reduced through appropriate city planning measures such as the thinning out of settlement patterns, [14] widening of streets, and proliferation of green spaces." [15] As with the guidelines regarding the accessibility of shelters, these particular recommendations for architecture and urban design implied a type of bombardment in which each bomb would only have a limited range of impact, and that the main challenge was to prevent a chain reaction of collapsing buildings or the spread of fire from one structure to another. In keeping with contemporary "hygienic" views of urbanism, the guidelines expressed concern about the proliferation of threats facilitated by density, whether in the form of disease, slums, or fire. [16] The recommendations for urban planning and architecture made in the name of civil defense thus aligned well with broader anxieties about maintaining order during times of peace as well as war.

The 1963 law radically altered earlier assumptions. The requirement that a shelter space be accessible within two to three minutes was revoked because authorities realized that the exact moment of attack could not be predicted. [17] Moreover, the envisioned scope of destruction expanded: scattered carpet bombing was no longer considered the primary threat, but rather a bomb that could wipe out an entire city. Even as adding shelters to private construction projects continued, municipal authorities seeking to supplement the general strategy of building small, domestic bunkers began investigating the defense capacities of large concrete infrastructure projects. As train stations, parking garages, or highway tunnels appeared on the drawing board, they were routinely assessed for their suitability as military or civilian bunkers. [18] Many parking garages, for instance, were eventually built to serve as shelters that were hermetically sealable and structurally resistant to collapse (such as the Parkhaus Urania in Zurich, completed in 1968).

The need for preparedness produced not just concrete spaces for civil defense but also an organization capable of managing disaster: the Civil Defense Corps. Established in 1963 as a

13 Eidg. Luftschutzkommission, *Richtlinien* (see note 10), para.113, para.122.

14 "Auflockerung der Bauweise"—the same phrase used by Hermann Muthesius in *Kleinhaus und Kleinsiedlung* (Munich: Bruckmann, 1918), 22.

15 Eidgenössische Luftschutzkommission, *Richtlinien* (see note 10), para.122.

16 In mind, of course, is the Athens Charter, the result of the fourth CIAM congress. The document focused on the city, calling for, among other things, urban renewal through the destruction of slums, which were viewed as a blight that would, as the borrowed term suggested, spread uncontrolled and undesired, infecting other areas of the city that were perceived to be healthier.

17 "Bundesgesetz über die baulichen Massnahmen im Zivilschutz von 4. Oktober 1963," *Zivilschutz* 10, no. 6 (1963), 127–29.

18 On three shelters in Zurich, including Parkhaus Urania, see Andreas W. Putz, "Sheltered. Parked. Respirated: Three Underground Spaces by Gottfried Schindler," in Ine Wouters et al., eds., *Building Knowledge, Constructing Histories: Proceedings of the 6th International Congress on Construction History, July 9–13, 2018, Brussels, Belgium* (Leiden: CRC/Balkema, 2018), 1067–74.

sub-group of the Swiss Armed Forces, the Civil Defense Corps was responsible for coordinating disaster preparations, as well as for organizing the management of large public shelters like the Sonnenberg tunnel. More broadly, the concept of civil defense was tied to a three-pronged strategy of military, economic, and spiritual/intellectual (*geistige*) defense. The nationalist fringe of the civil defense movement saw its role reaching beyond merely sheltering bodies to ensuring the survival of a particular way of life: in this respect, civil protection schemes aligned with and reinforced notions of the nuclear family, assigning roles for individuals as part of a family unit, and delegating care of the family to women.

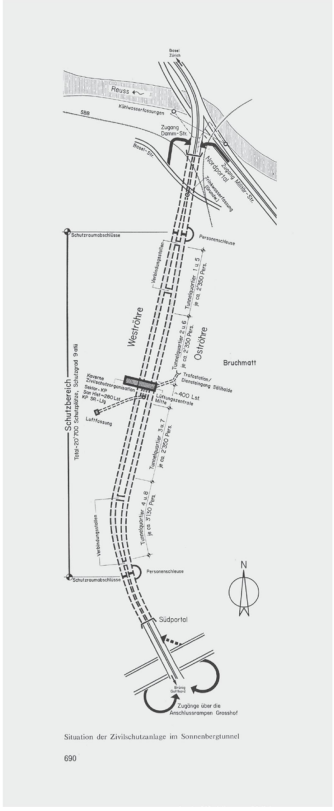


fig. 2 Plan of the Sonnenberg tunnel, indicating the sealable area and the civil protection "cavern." Source: Werner Heierli, Leonard Jundt, and Erwin Kessler, "Die Zivilschutzanlage Sonnenbergtunnel in Luzern," *Schweizerische Bauzeitung* 94, no. 46 (Nov. 11, 1976), 689–99, here 690.

Against this backdrop, in December 1964, Lucerne's city council hired the Zurich engineering office W., R., & Dr. W. Heierli to study whether the planned highway tunnel could indeed be used for civil protection. If the two, parallel 1.2-kilometer-long tubes could be hermetically sealed, 20,800 people could be sheltered, thus reducing Lucerne's shortage of shelter spaces by nearly 50 percent. **19/fig. 2** The same year, Werner Heierli had released a handbook on the effects of weapons on defensive structures **20** and had become one of the foremost experts on bunker construction in Switzerland. Heierli went to work immediately, writing requests for information even during the holiday break at the end of the year. One year later, Heierli submitted an initial report concluding that the tunnel offered an "excellent chance" for civil defense. **21** The City of Lucerne agreed to pursue the project in 1967 and gave the commission to Heierli. After further development, the proposal for the highway tunnel and civil protection shelter was submitted to the citizens of Lucerne in 1969 for a public vote. It was approved by a narrow majority of 4,739 to 4,227 votes, and the project subsequently opened in 1976. **22**

19 At the time of the public vote to finance the project, there were 43,063 shelter spaces in Lucerne, 16,991 of which were without ventilation, and a deficit of 29,000 spaces.

20 "Handbook" perhaps gives the wrong impression of the book, as the content is largely calculations for how to mathematically model different types of impacts (see note 7).

21 Letter from Werner Heierli to the Tiefbauamt of the City of Lucerne from December 11, 1965, Schweizerisches Bundesarchiv.

22 "Ein klares und ein zögerndes Ja—ein deutliches Nein," *Luzerner Neueste Nachrichten* (June 2, 1969), page unknown, Schweizerisches Bundesarchiv. Construction of the highway tunnel cost CHF 75 million; adding the use as civil protection cost an additional CHF 38 million.

Submission

The Civil Protection Corps considered it crucial that the social order remain intact in times of crisis. Reinforcing societal order within peacetime life thus became a necessary part of preparedness. In 1969, 2.6 million copies of the 320-page book *Zivilverteidigung* (Civil Defense) were distributed to all households in Switzerland. Work on the book began with the approval of the

federal council in 1961. The "little red book," as it was called, outlined the rationale for civil defense and its operations not only in wartime but also in peacetime, and in situations of heightened risk, and played out possible scenarios, often through fictional narratives. The publication focused on the threat of nuclear war

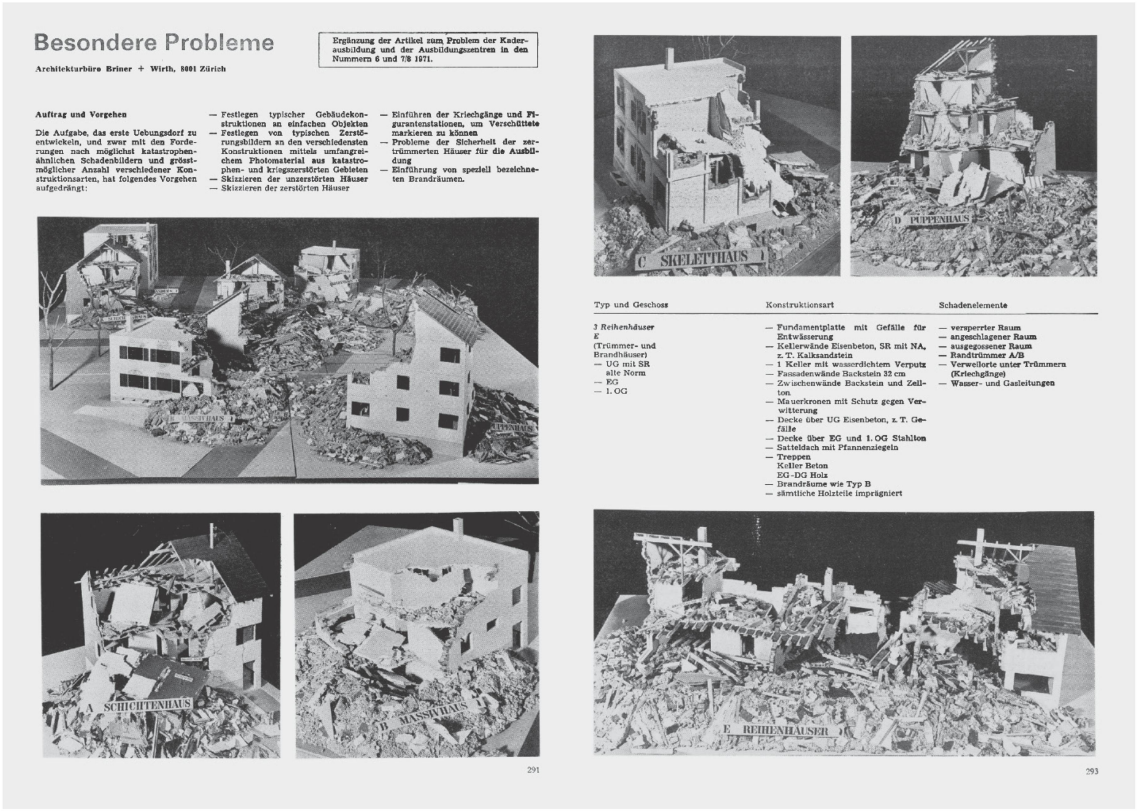
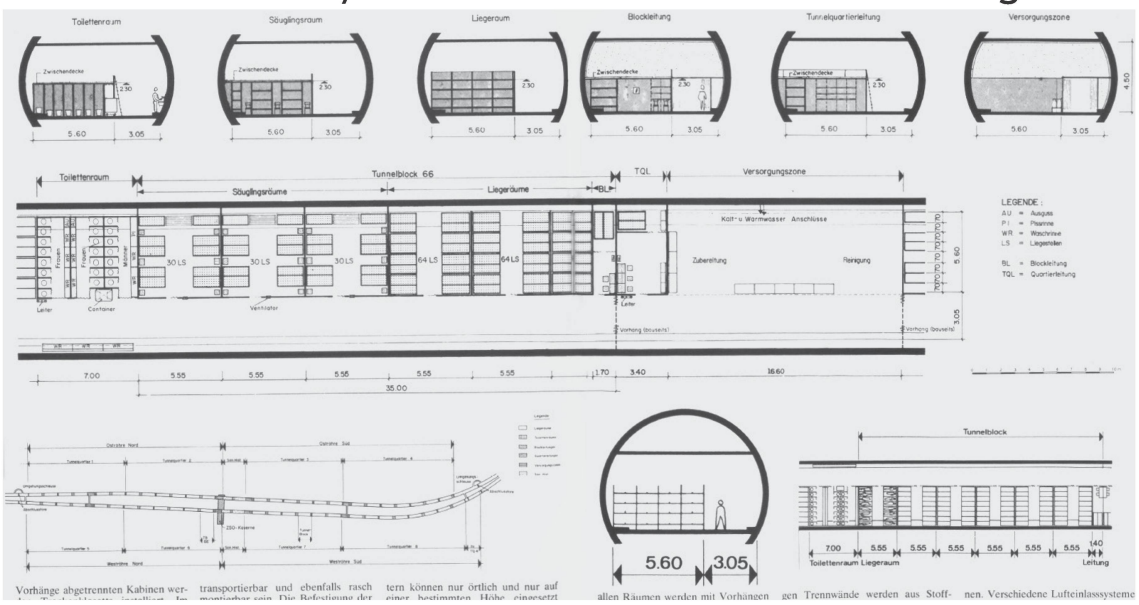


fig. 3 Scale models of the civil defense practice village for the Canton of Zurich used as construction guides and as instructional tools.
Source: Architekturbüro Briner + Wirth, "Besondere Probleme," *Zivilschutz* 18, no. 9 (1971): 291–96.

but also highlighted a range of other weapons and forms of assault, such as carpet bombing, ground troop invasions, nuclear strikes on a neighboring country, catastrophic flooding from the destruction of a dam, and so forth. Threats were paired with ways to prepare for them. The threat of bombing, for example, was coupled with information about building bunkers, keeping a stock of food and water, sealing windows, emptying the attic and filling it with sand to avoid fire, along with other similar measures. The book's structure thereby promoted the idea that everything would be all right so long as one was ready.

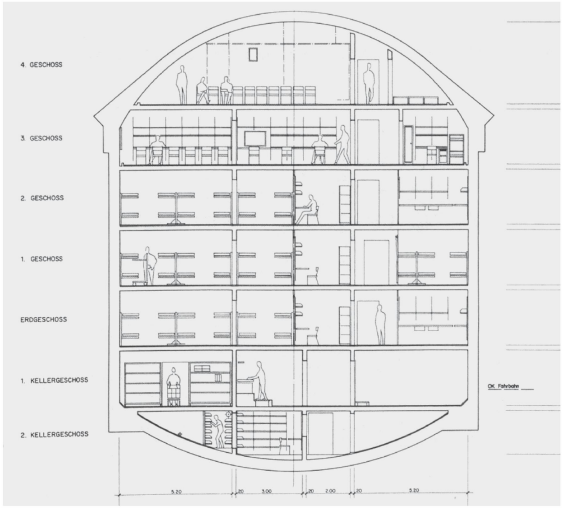
To cultivate preparedness, the Corps also rehearsed disasters. As the Sonnenberg tunnel was under construction, the Canton of Zurich approved the construction of the first civil defense "practice village" in 1971. The practice village was built to train civil defense officers, to familiarize them with rubble and fire, and to practice rescue operations involving injured people or those trapped under rubble. Rather than using dummies, which were not deemed realistic enough, actors were employed to play disaster victims. Non-flammable and ventilated protective reinforced concrete spaces were built to shelter the actors during training runs. The structures thus had to be as realistic as possible,

but even the modeled ruins had to be capable of withstanding repeated drills, while also remaining safe throughout the exercises. Empa provided consultation in developing a system of moveable *Trümmergarnituren* that allowed the Civil Defense Corps to "work realistically with these elements while excluding risks."



figs. 4 a–b Plan and section of the Sonnenberg highway tunnel when converted for occupancy (top) and section through the civil protection cavern (bottom).
Source: M. Luchsinger, "Sonnenbergtunnel Luzern," *Zivilschutz* 23, no. 9 (1976), 223–30, here 226–27.

The architecture office given the commission, Briner + Wirth, was asked to recreate as accurately as possible the destruction of seven structures made using common construction methods, "from mixed construction with large wood components to modern concrete frame construction" with a basement civil defense shelter. Each building was drawn twice: as a finished structure and in a state of partial destruction. On the basis of the plans, models at the scale of 1:20 were developed to serve as "three-dimensional construction plans" and were later used for instructional purposes. **fig. 3** In building the houses for the practice village, Briner + Wirth attempted to accurately determine typical patterns of destruction "using extensive photographic material from areas destroyed by catastrophes and wars."



What is readiness at the scale of a small city? To transform the Sonnenberg tunnel into a blast-proof, sealed space capable of safely sheltering 20,800 people required extensive additional spaces and systems, including a seven-story underground cavern with a command center, first aid station, operating rooms, jail, kitchen, emergency power station, air supply, and storage for furniture, oil, water, and rations. **figs. 4 a–b** While the mass of the Sonnenberg

itself provided substantial material thickness for defense purposes, along the length of the tunnel the ends still had to be sealed to make the space a truly viable defense shelter. **figs. *5* a–b** Four 350-ton, moveable, arched concrete doors were developed to seal the highway entrances. The doors were some of the first

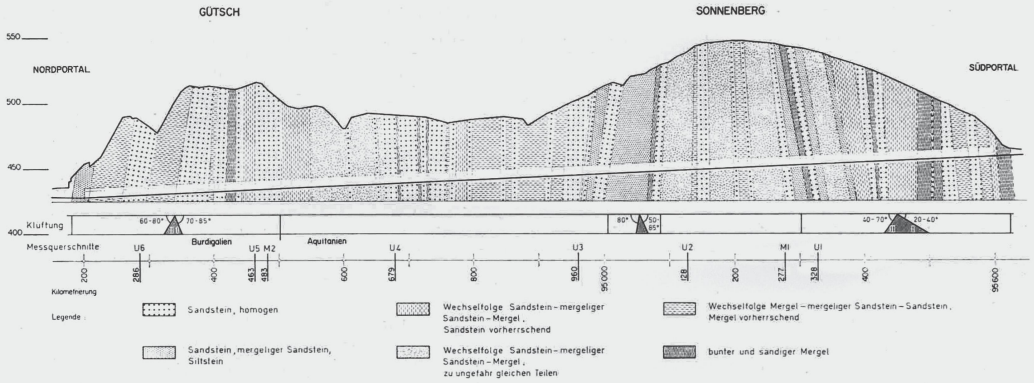


Bild 1. Geologisches Längenprofil gemäss Aufnahme im Pilotstollen West

figs. *5* a–b Sections through the Sonnenberg tunnel, showing the location within the mountain (top) and the cross-section of the tunnel (bottom). Source: E. Beusch and W. Studer, "Ausbruch und Verkleidung des Sonnenbergtunnels," *Schweizerische Bauzeitung* 90, no. 36 (Sep. 7, 1972), 853–57, here 854, 855.

objects ever built whose deflection capacities in an atomic blast had been accurately modeled. But to move something weighing 350 tons proved to be a formidable task. The doors were products of state-of-the-art engineering practice and constituted

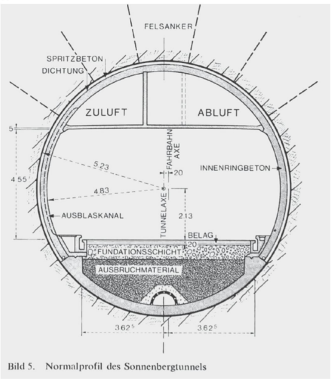


Bild 5. Normalprofil des Sonnenbergtunnels

exceptional pieces of low-tolerance construction. In Switzerland, the theoretical knowledge needed to design such complex objects and the requisite coordination for its construction were not held by a professional military elite (such as with the Army Corps of Engineers in the United States), but rather by private contractors brought in for the commissioned work. High-tech, high-skill construction projects like Sonnenberg—as well as large hydropower projects—contributed to the development of a body of knowledge within the civil construction industry, whose ramifications have not been fully traced. **23**

Following an attack, so the planning scenario went, Sonnenberg's 20,800 inhabitants would remain underground for up to two weeks. But with no guarantee of prior warning before an attack, the bunker was to be occupied ahead of time in high-risk cases, perhaps weeks in advance. While waiting, inhabitants would have been allowed to venture outside for two hours per day in rotating shifts. **24** As with all Swiss households, those assigned to the tunnel were expected to keep emergency rations of food and water at home. Estimates of the food and water rations required within the bunker relied on the assumption that those entering would bring their own stock of food with them. Hot meals would have been provided as a means of keeping the

23 One recent example being Valerio Olgiati's use in Graubünden of contractors who had built the hydropower projects there, as identified by Irina Davidovici, *Forms of Practice: German-Swiss Architecture 1980–2000* (Zurich: gta Verlag, 2012).

24 Ingenieurbüro W., R., & Dr. W. Heierli, *Grossschutzraum Sonnenbergtunnel Vorprojekt: Bericht über die Organisation*, January 20, 1969, Bern, Schweizerisches Bundesarchiv, fig. 4.

population docile, but in case of a prolonged period of occupation, freeze-dried nutritional packets would be distributed. In the planning documents, clear concerns were expressed about possible problems that might arise with enforced occupancy. The advising psychiatrist assumed that people would in fact enter if they were convinced that their chance of survival would be better and that the conditions within the shelter would be tolerable. [25] Heierli touched upon this very issue, writing that the tunnel's overall success would rest on the assurance of livable standards underground, as well as on the state's ability to convince the public of the threat at hand. He further assumed that initial attacks like aerial bombardment would be enough to prompt the population to move into the shelter, noting wryly that civilians need their "baptism by fire." [26]

Leaving one's home and entering a vast, dank, minimally-equipped cavern, of course would have required an act of near-complete faith in the state, ample trust that its assessment of a risk was correct, complete submission to the Civil Protection Corps, and temporary relinquishment of one's home and property—all without any sense of immediate physical danger, since the shelter would have been occupied before invading ground troops entered a city or before any mushroom cloud appeared on the horizon. Despite indications that the planners were aware of the difficulties that came with such prerequisites, the project's construction lent credence to the view that the state viewed its own interests and those of the population as one and the same.

As for the defense shelter itself, the heaviness of the concrete tunnel and its strictly determined boundaries enabled the flexible division of the interior. The tunnel facility was organized in small units bordered by fabric partitions that would, at the suggestion of a consulting psychiatrist, visually separate each unit. fig.7 The sub-units not only blocked perception of the large space enclosing them, they were also intended to hinder the possibility of mass congregation, since the planners were also concerned about civilians protesting or staging uprisings against the Civil Protection Corps. Designers developed several schemes for modular furniture. Embru, a company better known for its iconic work with Bauhaus designers, but also one with a long history of providing institutional furniture in Switzerland, eventually fabricated a simplified version of the demountable furniture for the shelter. figs. 6 a–b The final design for the furniture was modular so that it could be stored in the adjacent cavern but was not transformable. The psychiatrist's suggestion that the "*Wille zum Durchhalten*" (will to endure) [27] would be improved if sleeping and waking spaces were separated was not fulfilled in the realized scheme.

25 PD Dr. med. H. Kind, *Sammelschutzräume Sonnenbergtunnel Luzern und Milchbucktunnel Zürich*, Kantonsspital Zürich, Psychiatrische Universitäts-Poliklinik, February 11, 1969, Bern, Schweizerisches Bundesarchiv.

26 Werner Heierli, Leonard Jundt, and Erwin Kessler, "Die Zivilschutzanlage Sonnenbergtunnel in Luzern," *Schweizerische Bauzeitung* 94, no. 46 (November 11, 1976), 689–99, here 694.

27 Kind, *Sammelschutzräume* (see note 25).

Each unit in the tunnel was to be supervised by a member of the Civil Protection Corps. During the planning phase, the psychiatric report supporting the project had conditionally based its final approval on the familiarity and thereby comfort of those in charge inside the bunker, noting that an "atmosphere of trust," premised on familiarity and being at ease, was the "basis of survival." [28] The report recommended that the Civil Protection Corps hold exercises that would simulate not only the conditions in the shelter but also take account of the duration of enclosure. As it turned out, these exercises never took place. Management of the tunnel was also considered in pharmacological terms: each section was to receive a first aid officer with a supply of sleeping pills, headache pills, and painkillers for a "positive influence on the preservation of peace and order in the tunnel." [29] Bodily functions were to be scrutinized and closely managed as well. Dry toilets and troughs were to collect urine and fecal matter separately, while drinking water taps were to be under constant surveillance. Tables regulated when occupants would be allowed outdoors during the time prior to an attack and when they would be fed. Finally, if such preventative measures failed to maintain order and security, the Law, Order, and Security Troop would have managed to control the situation with a special court outfitted with holding cells and anti-riot gear.

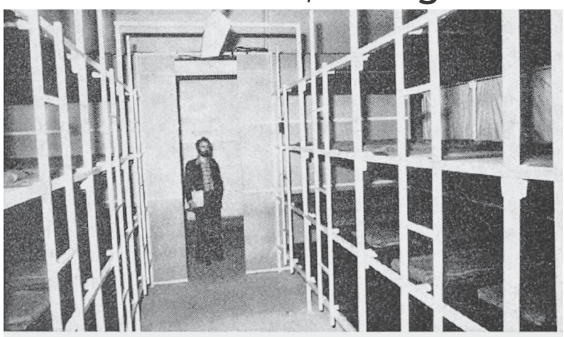
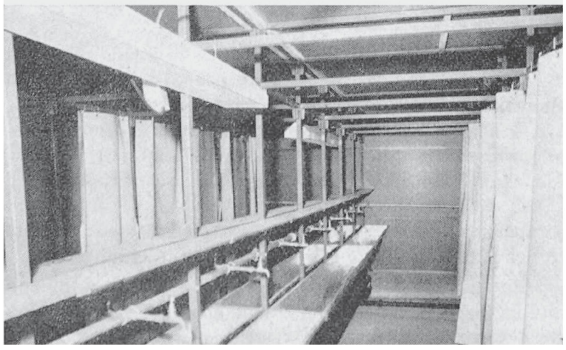


Bild 13. Innenansicht eines Liegeraumes

Bild 14. Innenansicht einer Toiletteneinheit



figs. 6 a–b
Photographs of the furniture and partitions produced by Embru for the Sonnenberg tunnel. Source: Werner Heierli, Leonard Jundt, and Erwin Kessler, "Die Zivilschutzanlage Sonnenbergtunnel in Luzern," *Schweizerische Bauzeitung* 94, no. 46 (Nov. 11, 1976), 689–99, here 696.

28 The psychological analysis was done on the basis of specific questions from Heierli. Ibid.

29 Heierli, *Grossschutzraum* (see note 24).

Life Support, City Abandonment

The army was restructured in the late 1960s, as Sonnenberg was under construction, entailing a strategic shift from entrenchment in fixed fortresses in the Alps to the use of lighter, more mobile, and responsive equipment that could be deployed rapidly anywhere in the country. [30] The Alpine Redoubt, a secure retreat deep within in the mountains, was slowly decommissioned, in spite of its mythical status, replaced by a portable fleet of helicopters, tanks, and missiles. The build-out of fixed civil defense bunkers represented a new, distributed type of redoubt, and therefore, in principle, continued the defense strategy that was premised on abandoning the nation's cities in case of attack.

30 "The national defense, substituting lean, mechanized forces for the old fortress paradigm. Instead of barricades, bunkers, and fortifications, the army would now rely on the mobile battle capability of their upgraded motorized divisions," David Gugerli, Patrick Kupper, and Daniel Speich, *Transforming the Future: ETH Zurich and the Construction of Modern Switzerland 1855–2005* (Zurich: Chronos, 2010), 260.

fig. 7 Section through the Sonnenberg tunnel showing the fabric partitions used as subdividers to break up perception of the large space. Drawing by Werner Heierli. Source: Sonnenberg Tunnel Museum collection.
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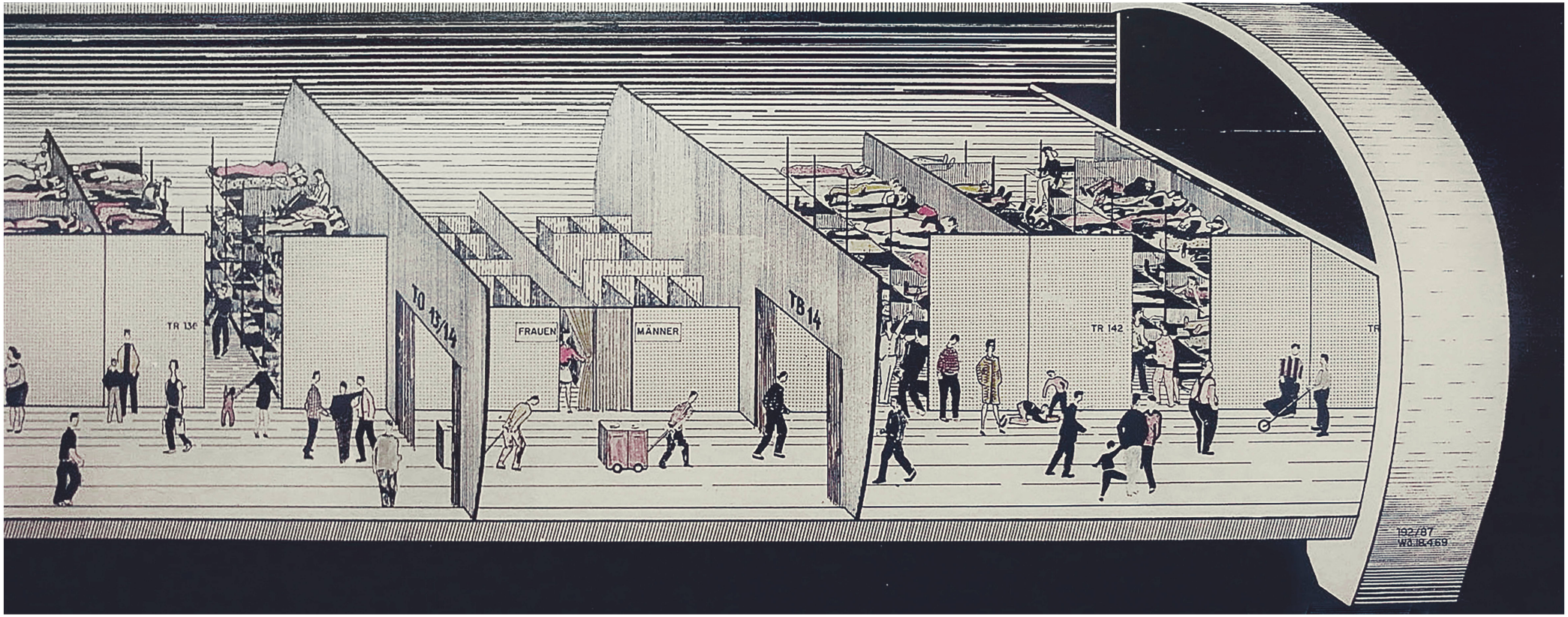
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Once sequestered below ground, the civilian population would be effectively stripped of its rights and treated more abstractly, in statistical terms of probability and risk.

While the postwar economic boom reshaped Switzerland into a single, interconnected urban system, the civil defense program built an alternate subterranean domain predicated on the prospect of its catastrophic collapse. As the tunnel project was under construction, Heierli suggested that "the image of a defense space, which after cessation of contact with the outside world continues to exist amidst a sea of destruction, can vividly be described as an 'island of survival'." [31] The project, according to Heierli, could "function completely independently from the outside world for weeks on end after a successful attack." [32] To achieve full isolation, the Sonnenberg tunnel was hermetically sealed from air, water, and electromagnetic radiation by stone, concrete, and steel, then supported by air conditioning, artificial lighting, and pharmaceuticals. Paul Virilio referred to this as tightness, a fail-safe containment like that of a submarine run aground, which endures any environmental vicissitudes beyond its thick, impermeable shell. [33]

As construction at Sonnenberg was completed, the tunnel was used almost without interruption as a major national thoroughfare. Despite the planner's assertions that success of the project in a time of crisis would rely on the readiness of those in charge, Sonnenberg was not actually tested as a shelter until 1981. The Civil Defense Corps's rehearsal exercise "Operation Ant" revealed the varied possibilities for failure that come with a project devised on the basis of technical analysis alone. Only a third of the Civil Defense Corps volunteers assigned to the exercise even reported for duty—the majority were not willing to spend days underground. The modular furniture, comprised of twenty-seven unique types, proved in reality to be difficult to transport and assemble, and thousands of beds and dividers were still incomplete at the conclusion of the exercise. The gargantuan doors—the most technically complicated components of the entire project—had been shut only once prior to the exercise, by the company that built them. Five years later, Civil Defense Corps volunteers removed the flashing that protected the doorjamb from passing cars and found that the stones beneath it had been pulverized by the continuous vibration from traffic. The doors, though movable, were blocked by the fine particles of crushed stone and could not be completely closed to form the airtight seal upon which the project was predicated—their enormous mass defeated by mere handfuls of dust.

31 Werner Heierli, "Der Schutzraum als Überlebensinsel," *Zivilschutz* 16, no. 5 (1969), 152–54.

32 Draft of a newspaper article about the Sonnenberg bunker by Werner Heierli for A. Ineichen, May 22, 1969, Bern, Schweizerisches Bundesarchiv.

33 Paul Virilio, *Bunker Archaeology* (New York: Princeton Architectural Press, 1994), 38.