NKS-454
ISBN 978-87-7893-547-2

Seminar on the use of nuclear weapons towards a Nordic country: Scenarios, impact assessments and protective measures

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January 2022

Abstract

After the cold war, the use of nuclear weapons towards countries in Northern Europe has been seen as an increasingly unlikely scenario by policy makers and academics. In the last few years, however, there has been significant changes in the international security environment, and the view has now changed. Several Nordic countries have currently an interest in scenarios related to the use and detonation of nuclear weapons within their borders. In that regard, a Nordic seminar (NUCSEM) was held in Oslo 2-3 November 2021 with NKS funding. The purpose of the NUCSEM seminar was to coordinate efforts, and exchange knowledge and views in this work.

Key words

nuclear weapons, scenarios, assessments, Nordic countries

NKS-454
ISBN 978-87-7893-547-2
Electronic report, January 2022
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Seminar on the use of nuclear weapons towards a Nordic country: Scenarios, impact assessments and protective measures

Final Report from the NKS-B NUCSEM activity (Contract: AFT/B(20)8)

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Acknowledgements

The project partners wish to acknowledge the NKS, the participating organizations and all contributors to the NKS-B NUCSEM project for their valuable support and contributions.

NKS conveys its gratitude to all organizations and persons who by means of financial support or contributions in kind have made the work presented in this report possible.

Disclaimer

1. Introduction

After the cold war, the use of nuclear weapons towards countries in Northern Europe has been seen as an increasingly unlikely scenario by policy makers and academics. In the last few years, however, there has been significant changes in the international security environment, and the view has now changed. In 2017, The Bulletin of the Atomic Scientists moved its famous Doomsday Clock a half-minute closer to midnight, partly because of what they refer to as reckless approaches towards nuclear weapons.

In addition to the threat of international nuclear weapons use, there have been several books and reports detailing alarming numbers of mishaps with these weapons during and after the cold war, including near the Nordic countries. These discoveries are largely based on recently declassified documents from nuclear weapons states, and cover situations with loss of command and control structures, technical errors and miscommunication, among others. The then US president Barack Obama stated at the Nuclear Security Summit in 2016 that he considered the danger of a terrorist group obtaining and using a nuclear weapon to be one of the greatest threats to global security.

With the three international conferences on the humanitarian impact of nuclear weapons held during 2013 and 2014, renewed attention has been drawn to the risks and consequences of nuclear detonations. The first conference, held in Oslo, established that "It is unlikely that any state or international body could address the immediate humanitarian emergency caused by a nuclear weapon detonation in an adequate manner and provide sufficient assistance to those affected. Moreover it might not be possible to establish such capacities, even if it were attempted". The United Nations Institute for Disarmament Research (UNIDIR) followed on by concluding that the United Nations humanitarian system would not be able to render adequate assistance to states in nuclear detonation events. The official position of the International Red Cross and Red Crescent Movement is also that it is lacking any adequate humanitarian response capacity to nuclear detonations. It is therefore important for states themselves to assess the risk and work towards an adequate level of preparedness.

Several Nordic countries have currently an interest in scenarios related to the use and detonation of nuclear weapons within their borders. In order to coordinate efforts, and exchange knowledge and views in this work, a seminar was organised at Grand Hotel in Oslo on 2nd and 3rd of November 2021. The seminar was divided in three parts: Part A) Scenarios, Part B) Impact assessments and methodologies, and Part C) Protective measures.

The seminar was originally planned for the autumn of 2020. Due to the covid-19 pandemic, it was postponed to November 2021. Due to the pandemic, it was possible to attend the seminar by video conference.

The NKS-B NUCSEM project has been funded by Nordic Nuclear Safety Research (NKS). The project follows up on previous NKS-funded projects on threat and hazard assessments, such as the NKS NordThreat project in 2008 (Eikelmann et al. 2009) and the malicious use seminar arranged as part of the NKS SBA-1 project in 2000. It is also based on ongoing work on national threat and hazard assessments in the Nordic countries, such as the ongoing work in Norway on establishing a scenario on use of nuclear weapons towards or in proximity of Norway and establishing relevant protective measures (JD, FD & HOD 2016).

The presentations held at the seminar has been made publicly available at nks.org.

2. Project participants

The NKS-B NUCSEM seminar was organised by the Norwegian Radiation and Nuclear Safety Authority (DSA), the Radiation and Nuclear Safety Authority of Finland (STUK), the Icelandic Radiation Safety Authority (IRSA) and the Danish Emergency Management Agency (DEMA).

Project participants from the different organisations were:

- From DSA: Øyvind Gjølme Selnæs and Inger Margrethe Eikelmann
- From STUK: Aleksi Mattilä
- From IRSA: Gísli Jónsson
- From DEMA: Dan Bohr and Steen Nordstrøm

3. Seminar program

The NKS-B NUCSEM seminar was held at Grand Hotel in Oslo, Norway, on 2nd and 3rd of November 2021.

Tuesday 2nd of November 2021

12:00 – 12:30	Welcome, practical issues (Øyvind Gjølme Selnæs, DSA) Presentation of participating organizations
12:30 – 12:45	Background for the NKS-B NUCSEM project (Øyvind Gjølme Selnæs, DSA)

Part A: Scenarios (Chair: Inger Margrethe Eikelmann, DSA)

12:45 – 13:15	The Norwegian seventh scenario (Øyvind Gjølme Selnæs, DSA)
13:15 – 13:45	Ongoing project to assess radiological consequences of fallout from nuclear weapon use on Swedish territory (Anders Axelsson, SSM)
13:45 – 14:05	The capabilities of STUK to assess radiological consequences of nuclear explosions (Tuomas Peltonen, STUK)
14:05 – 14:30	Coffee break
14:30 – 14:40	What if the worst thing happens in Iceland? (Gísli Jónsson, IRSA)
14:40 – 16:00	Discussions on national scenario approaches

Wednesday 3rd of November 2021

Part A: Scenarios continues (Chair: Inger Margrethe Eikelmann, DSA)

09:00 – 09:10	Opening second day (Øyvind Gjølme Selnæs, DSA)
09:10 – 09:40	Nuclear weapons, their effects and recent developments (Steinar Høibråten, FFI)
09:40 – 10:10	Russian doctrine and scenarios for possible Russian use of nuclear weapons in Northern Europe (Kristin Ven Bruusgaard, University of Oslo/Oslo Nuclear Project)
10:10 – 10:30	Coffee break

Part B: Impact assessments and methodologies (Chair: Øyvind Gjølme Selnæs, DSA)

10:30 – 10:50	Hiroshima and Nagasaki (Ingrid Dypvik Landmark, DSA)
10:50 – 11:10	Fallout and environmental consequences (Tone Bergan, Atomkameratene)
11:10 – 11:30	The CTBT IMS radionuclide network – a lookback to Fukushima and thoughts on its usefulness for nuclear weapons dispersion assessment (Mikael Moring, STUK)

11:30 – 12:30	Lunch
12:30 – 13:00	Humanitarian consequences (Charlotte Lunde, International Physicians for the Prevention of Nuclear War, IPPNW)
13:00 – 13:30	The Thule accident (Sven P. Nielsen, Risø/DTU)
13:30 – 13:50	Nuclear weapons accidents (Madeleine Barbru, DSA)
13:50 – 14:30	Discussion on impact assessments and methodologies
14:30 – 15:00	Coffee break

Part C: Protective measures (Chair: Inger Margrethe Eikelmann, DSA)

15:00 – 15:20	Protective measures during the cold war and today (Erik Furevik, DSB)
15:20 – 15:50	Discussion on protective measures
15:50 – 16:00	Closing remarks (Øyvind Gjølme Selnæs, DSA)

The seminar was available through video conference (Microsoft Teams).

4. Seminar participants

There were 54 participants to the seminar. Approximately 20 of these were physically present at Grand Hotel in Oslo, the rest participated through video conference.

List of participating organizations:

Norway:
- Atomkameratene
- Norwegian Armed Forces CBRN & EP School
- Norwegian Defence Research Establishment (FFI)
- Norwegian Directorate for Civil Protection (DSB)
- Norwegian Radiation and Nuclear Safety Authority (DSA)
- The Norwegian Parliament
- University of Oslo/Oslo Nuclear Project

Finland:
- Finnish Defence Research Agency (FDRA)
- Radiation and Nuclear Safety Authority of Finland (STUK)
- VTT

Iceland:
- Government of Iceland/University of Iceland
- Icelandic Radiation Safety Authority (IRSA)

Denmark:
- Danish Emergency Management Agency (DEMA)
- Risø/Technical University of Denmark (DTU)

Sweden:
- County Administrative Board of Skåne
- Swedish CBRN Association
- Swedish Defence Research Agency (FOI)
- Swedish National CBRN Defence Centre
- Swedish Radiation Safety Authority (SSM)

Others:
- Haut Comité Français pour la Résilience Nationale (HCFDC)
- International Campaign to Abolish Nuclear Weapons Norway (ICAN Norway)
- International Physicians for the Prevention of Nuclear War (IPPNW)

5. Presentation summaries

Background for the NKS-B NUCSEM project (Øyvind Gjølme Selnæs, DSA)

Ever since the first nuclear weapon test in New Mexico in July 1945 and the use of nuclear weapons against the Japanese cities of Hiroshima and Nagasaki later the same year, nuclear weapons have been a central part of the global geopolitical situation and everyday life for the citizens of most nations of the world. Atmospheric and underground testing of nuclear weapons, nuclear weapons development, nuclear arms race, arms limitation and disarmament treaties, new doctrines and strategies on use of nuclear weapons etc. have had a major impact throughout the cold war. This has also been reflected in civilian emergency preparedness planning. After 1991, both policy makers and academics have considered the risk of use of nuclear weapons and nuclear war in Northern Europe to be decreasing, and contingencies towards use of nuclear weapons have been less emphasised in civilian emergency preparedness planning, at least in the Nordic countries.

Today, the development in the international security environment, development in nuclear weapon technologies and designs, proliferation of nuclear weapon capabilities and more available knowledge on weapon designs and concepts, have made several nations again consider the possibility of use of nuclear weapons, also in civilian emergency preparedness planning. In the Nordic countries, many civilian authorities, policy makers and academics are once more considering scenarios for use of nuclear weapons in or in the proximity of Nordic countries.

The Norwegian Radiation and Nuclear Safety Authority (DSA), the Radiation and Nuclear Safety Authority of Finland (STUK), the Icelandic Radiation Safety Authority (IRSA) and the Danish Emergency Management Agency (DEMA) have received funding from the Nordic Nuclear Safety Research (NKS) in order to arrange a Nordic seminar on the use of nuclear weapons towards a Nordic country, and to share knowledge and exchange views on approached towards scenarios, impact assessments, methodologies and protective measures (the NKS-B NUCSEM project).

The aim of the project is to provide a platform for coordinating efforts, exchanging knowledge and views, and to provide an opportunity to build networks between participants from different countries and fields of expertise.

The outcome of the project will be disseminated through the final project report and making the presentations from the seminar available at the NKS website (nks.org).

Part A: Scenarios

The Norwegian seventh scenario (Øyvind Gjølme Selnæs, DSA)

The Norwegian Crisis Committee for Nuclear and Radiological Emergency Preparedness and Response is the national board in Norway with responsibility and authority to make decisions on protective measures in the early phase of a nuclear or radiological event (NRPA 2013). The Norwegian Radiation and Nuclear Safety Authority (DSA), as chair and secretariat for the Crisis Committee, has a continuous responsibility to assess radiological and nuclear threats and hazards. DSA publishes on occasion renewed threat and hazard assessments, e.g. the latest publication of changes in nuclear and radiological threats and hazards in 2018 (Selnæs et al. 2018).

In 2010, the Norwegian government decided on six planning scenarios that should be used in the ongoing work on improving and maintaining the national emergency preparedness towards radiological and nuclear events. In 2016, the Ministry of Justice and Public Security (JD), the Ministry of Defence (FD) and the Ministry og Health and Care Services (HOD) developed a joint national strategy on CBRNE emergency preparedness. In this strategy, the Crisis Committee was given the task of extending the existing planning scenarios with an additional scenario on use of a nuclear weapon close to or on Norwegian territory, and to work out relevant protective measures in such an event (JD, FD & HOD 2016).

A working group under the Crisis Committee is currently working on developing a description of the scenario and the consequences it will have. It is important that the scenario is meaningful as a realistic planning scenario. The working group considers consequences for both lives and health, the environment and important public interests in both a short and long timeframe. The working group has developed two sub-scenarios: A) a non-strategic use of a nuclear weapon against a target outside a Norwegian city, and B) a strategic use of a nuclear weapon against a major Norwegian city.

The work on the scenario description is planned to be finalised before the end of 2021. This will be followed up by work on relevant protective measures in 2022.

Ongoing project to assess radiological consequences of fallout from nuclear weapon use on Swedish territory (Anders Axelsson, SSM)
SSM is engaged in a study of radiological consequences of fallout from nuclear weapon use on Swedish territory. The work started in 2018 and the aim for 2021 is to conclude development of suitable source terms and dispersion and dose modelling tools to represent fallout from ground surface and near-surface bursts and to initiate modelling runs for a representative set of weather conditions. Results will be expressed mainly in statistical terms, as e.g. maximum distances at which given dose criteria are exceeded for a significant fraction of weather conditions, and are expected to yield insights into emergency actions and combinations of emergency actions that may be possible and relevant in order to mitigate radiological consequences to the public. A report will be produced during 2022, and the work is expected to continue thereafter based on the outcomes of the initial study.

The capabilities of STUK to assess radiological consequences of nuclear explosions (Tuomas Peltonen, STUK)
In order to make computational assessments of radiological consequences of nuclear explosions STUK can use SILAM model. SILAM is a global-to-meso-scale dispersion model developed by Finnish Meteorological Institute (FMI). STUK har a dedicated service to run SILAM 24/7 and it is coupled with STUK's emergency management system TIUKU. The nuclear source term for SILAM was made for 20 years ago and it has been further developed during recent years under EU project EUNADICS-AV for instance. STUK has provided nuclide composition of the source term for SILAM. In addition STUK has capabilities to use some other modelling software like HotSpot which is also coupled with TIUKU system.

Nuclear weapons, their effects and recent development (Steinar Høibråten, FFI)
Nuclear weapons, their effects and recent developments: The presentation was an introduction to the topic of nuclear weapons. It gave a general, non-scientific background, provided an overview of today's nuclear arsenals, discussed new Russian nuclear weapons in some detail and showed some estimates of the effects of nuclear weapons exploding in or above Oslo.

Russian doctrine and scenarios for possible Russian use of nuclear weapons in Northern Europe (Kristin Ven Bruusgaard, University of Oslo/Oslo Nuclear Project)
Russia may use nuclear weapons in military conflict to coerce potential adversaries. Although Russia is less reliant on nuclear weapons today than they were 20 years ago, Russian military planners still discuss how nuclear weapons can be used to produce political and military effects in a conflict with other states. A military conflict that becomes grave enough to threaten Russian state existence will produce Russian consideration of using nuclear weapons 1) For escalation management when conventional force has failed to have impact, 2) For warfighting when conventional force is deemed insufficient, and 3) For strategic retaliation if Russia is subject to strategic attack.

Part B: Impact assessments and methodologies

Hiroshima and Nagasaki (Ingrid Dypvik Landmark, DSA)
A brief summary of the bombings, the short and long term health consequences and what we have learned from the LSS study.

The most common immediate effects were thermal injuries, mechanical blast injuries and acute radiation syndrome. 13,500 died of ARS the first months, with the most frequent signs being epilation and purpura, a skin rash with blood spots. Of the long term effects leukemia dominated from 2 to 6 years after the bombs, with solid cancer taking over from early 1950s until today. No heritable effects have been detected.

Fallout and environmental consequences after a nuclear detonation (Tone Bergan, Atomkameratene)
Apart from the physical damages following a nuclear blast, the radioactive fallout will cause severe contamination in an urban environment. Around 300 isotopes based on 36 elements will be produced, and 1 kt detonation power amounts to about 10^{21} disintegrations per second the first minutes after a detonation. In general, between 20% -50% of the radionuclides will be deposited locally, depending on the height of detonation. Many of these isotopes are short lived, but the radionuclides of most concern are long-lived and will contaminate air, drinking water and surfaces.

In a more long-term perspective locally produced food and consumable goods will be contaminated, and countermeasures are needed.

Considering the major pathways, external exposure, internal exposure via inhalation and ingestion the radionuclides of major concern will be ^{3}H, ^{131}I, ^{140}Ba/La, ^{137}Cs, ^{90}Sr, ^{89}Sr, ^{55}Fe, Pu and Am-isotopes, ^{141}Ce, ^{106}Ru, ^{54}Mn, ^{125}Sb, ^{95}Zr/Nb, ^{91}Y and ^{14}C.

Many of the existing decontamination and countermeasures are planned for normal conditions with functioning infrastructure. A nuclear blast will affect all available infrastructure, and thus further complicate rescue work and add to the consequences.

The Thule accident (Sven P. Nielsen, Risø/DTU)
In 1968 an American B-52 bomber carrying nuclear weapons crashed on the sea ice near Thule Air base in Northwest Greenland. One crew member was killed in the accident which resulted in local radioactive pollution in the marine and terrestrial environments. Shortly after the accident the US organized cleanup operations on the ice and removed most of the pollution. The remaining plutonium contamination in the sea and on land has been

investigated by Risø/DTU from numerous expeditions since 1968 indicating inventories of about 1 kg Pu in the sea sediments and 0.1 kg on land. The levels of environmental Pu contamination are low and show that doses to humans have no significance to heath.

Nuclear weapons accidents (Madeleine Barbru, DSA)
Nuclear accidents can be divided in to three main categories: physical accidents, mishaps following security challenges, and cases of near use. No accidental nuclear detonations are known to have occurred, but there have been several instances of conventional explosions and accidental dispersion of nuclear material. Some of these cases have required comprehensive clean-up operations. There have been quite a few recorded instances of mishaps following security challenges. Furthermore, there have been a range of cases of near use, due to conflict escalation, miscommunication, misperception of situation, misinterpretation of data and technical failure.

Part C: Protective measures

Protective measures during the cold war and today (Erik Furevik, DSB)
There will be great uncertainty associated with the assessment of societal consequences. Small changes in the conditions will have a major impact on the impact picture, such as the size (kt) of the detonation, the number of (simultaneous) attacks in Norway, the season and the possible use of nuclear weapons in the rest of the world.

The impact will be greater and more all-encompassing the closer you are to the actual detonation site. In addition to loss of life and health, there will be extensive immediate damage to buildings and infrastructure, which can take a very long time to repair. Damaged infrastructure, such as the loss of electricity, communication systems and damaged roads and buildings, will in turn lead other key functions in society, such as health and care services and the emergency services and the authorities' crisis management at various levels, having major problems functioning (optimally).

A nuclear incident will lead to great social unrest in the entire population. For those who are directly affected, the incident will entail great strain, with immediate evacuation out of the most affected area, with the consequences it will entail. Depending on the scenario, a large number of people across large parts of the country are expected to stay at home instead of going to work. Public transport, schools and kindergartens will be shut down for a long period. The consequences will be perceived as life-threatening even by those who are not directly affected, and in addition as a threat to future generations.

A scenario that destroys parts of the city venter in a capital (100 kt), will involve the eradication of (personnel who are critical of) the central administration and the governing bodies in the country. National governance, including crisis management, will be immediately put out of action and severely weakened in the longer term (after the first 24 hours). Similarly, (personnel who are critical for maintaining) a number of critical societal functions will be affected. The nuclear attack will create great panic reactions and fear in the population, and the situation will be perceived as almost apocalyptic.

Norway, as a member of NATO, adheres to NATO's seven baseline requirements for national resilience through civil preparedness. These are:

1. Assured continuity of government and critical government services;
2. Resilient energy supplies;

3. Ability to deal effectively with the uncontrolled movement of people;
4. Resilient food and water resources;
5. Ability to deal with mass casualties;
6. Resilient civil communications systems;
7. Resilient transport systems.

The Norwegian Civil Defence ("Sivilforsvaret" in Norwegian) takes care of the population's need for protection in the event of war. This can be evacuation, contribution to medical care or support for radioactive or chemical pollution. Norwegian Civil Defence personnel is protected under the Geneva Convention. This means that they should not be attacked by the warring parties.

According to the Geneva convention, "civil defence" means the performance of some or all of the undermentioned humanitarian tasks intended to protect the civilian population against the dangers, and to help it to recover from the immediate effects, of hostilities or disasters and also to provide the conditions necessary for its survival. These tasks are:

I. warning;
II. evacuation;
III. management of shelters;
IV. management of blackout measures;
V. rescue;
VI. medical services, including first aid, and religious assistance;
VII. fire-fighting;
VIII. detection and marking of danger areas;
IX. decontamination and similar protective measures;
X. provision of emergency accommodation and supplies;
XI. emergency assistance in the restoration and maintenance of order in distressed areas;
XII. emergency repair of indispensable public utilities;
XIII. emergency disposal of the dead;
XIV. assistance in the preservation of objects essential for survival;
XV. complementary activities necessary to carry out any of the tasks mentioned above, including, but not limited to, planning and organization.

Some suggestions for follow-up of the NUCSEM seminar:

- Describe concrete consequences that the civilian population is exposed to in order to ensure a common understanding of the current and future situation.
- Stress test vulnerabilities in key civilian functions in NATO's seven baseline requirements
- Elaborate findings and incorporate them into future editions of the Norwegian 7th scenario.
- As a supplement to different countries' work with CBRNE strategies; consider expanding the chapters on B (Covid 19) and RN (nuclear weapons)
- Arrange a follow-up conference to the NUCSEM seminar.

6. Recommended literature

Morten Bremer Mærli has worked for a long time as a research scientist in the field of nuclear terrorism and nuclear weapons, and his Doctoral Thesis deals with the risk of nuclear terrorism (see below). He presented a number of relevant books and other literature he recommended at the seminar.

Books and other literature presented by Mærli:

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7. Conclusions

The aim of the NKS-B NUCSEM project was to organise a Nordic seminar in order to share knowledge and exchange views on approaches towards scenarios, impact assessments, methodologies and protective measures related to use of nuclear weapons towards Nordic countries. A further aim of the project was to provide an opportunity to build networks between participants from different countries and fields of expertise.

The seminar was well received. With more than 50 participants and a high level of interest, there was an expressed need for this kind of seminar. The subject matter is relevant for many disciplines, and several of the Nordic countries are beginning or undergoing work to develop scenarios on use of nuclear weapons and civil contingency planning.

From the seminar, it is evident that many disciplines have an interest in scenarios of nuclear weapons use. The technical study on nuclear weapons effects, consequence assessments, dispersion modelling, political studies, non-proliferation and anti-terrorism etc. all represent different approaches to the subject matter, and it is valuable to have a greater understanding of the different approaches and exchange views between disciplines.

Different organisations in the Nordic countries have different responsibilities and approaches the subject matter differently. The seminar gave a greater understanding of the implications of these differences in how work on these scenarios are being done.

There was an expressed wish for a follow-up seminar on the findings from the work being done in the Nordic countries on scenarios related to use of nuclear weapons, and a wish for an informal network to be established.

8. References

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Bibliographic Data Sheet **NKS-454**

Title	Seminar on the use of nuclear weapons towards a Nordic country: Scenarios, impact assessments and protective measures
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Affiliation(s)	Norwegian Radiation and Nuclear Safety Authority, Radiation and Nuclear Safety Authority of Finland, Icelandic Radiation Safety Authority, Danish Emergency Management Agency
ISBN	978-87-7893-547-2
Date	January 2022
Project	NKS-B / NUCSEM
No. of pages	19
No. of tables	0
No. of illustrations	0
No. of references	4
Abstract max. 2000 characters	After the cold war, the use of nuclear weapons towards countries in Northern Europe has been seen as an increasingly unlikely scenario by policy makers and academics. In the last few years, however, there has been significant changes in the international security environment, and the view has now changed. Several Nordic countries have currently an interest in scenarios related to the use and detonation of nuclear weapons within their borders. In that regard, a Nordic seminar (NUCSEM) was held in Oslo 2-3 November 2021 with NKS funding. The purpose of the NUCSEM seminar was to coordinate efforts, and exchange knowledge and views in this work.
Key words	nuclear weapons, scenarios, assessments, Nordic countries

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