1. Electromagnetic Pulse – a Parcel from the Past

1.1. Introduction

High-Altitude Electromagnetic pulse (HEMP) addressed in this book is one of the damage effects of nuclear explosion, more specifically – high-altitude nuclear explosion, when the nuclear ammunition explodes at the altitude of 30-400 km, i.e. in the ionosphere or even in near space (The International Aeronautical Federation has set the altitude of 100 km (a so called Karman line) as the border line between atmosphere and space). Obviously, explosion performed at this altitude cannot result in serious destruction or people's death. So why would somebody use it as an affecting tool of war? Affecting what? Why do people talk about it after 70 years since the first trial of the nuclear weapon? Let us try to answer these questions and in order to do it, we shall need to begin with the history of HEMP discovery.

1.2. History of HEMP

The history of HEMP originates from the moment of the first test of the nuclear weapon.

Fig. 1.1. Delivery of the world's first nuclear bomb to the testing site

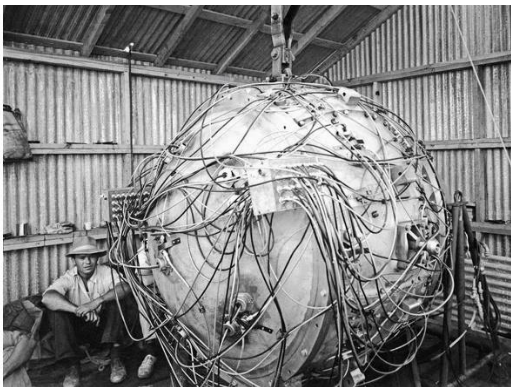


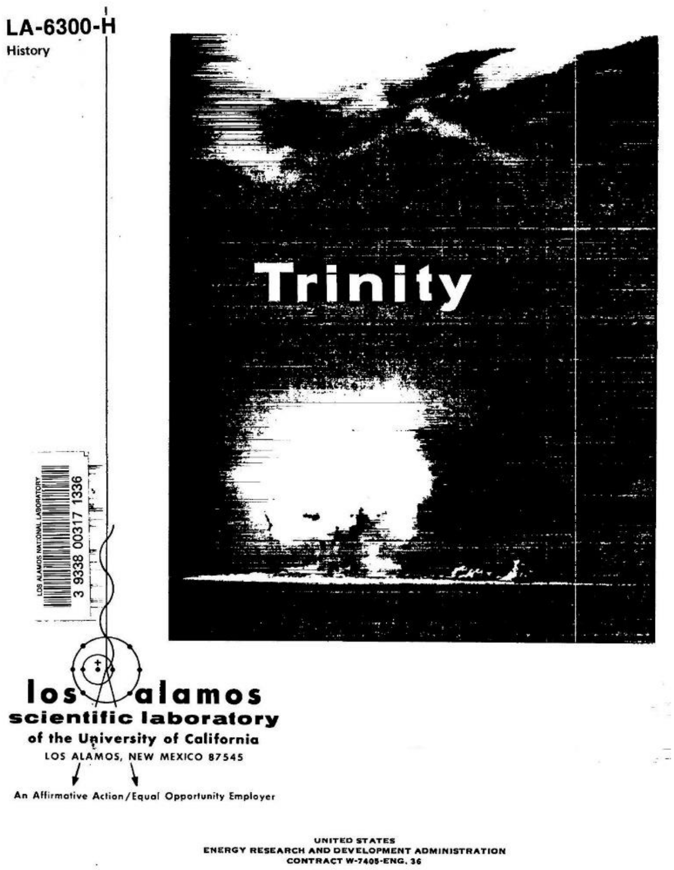
Fig. 1.2. Hoisting to a tower (left) and preparation of the nuclear explosive mounted on a tower (right) on Trinity range.

Fig. 1.3. Steel tower with a mounted "gadget"

Unlike other physical phenomena, it was not predicted in advance. It was rather discovered “with the point of the pen”. Furthermore, HEMP was not immediately understood and explained upon its discovery, and conclusions of some future theories turned out to be erroneous.

The first nuclear test explosion was performed within the frameworks of the famous ‘Manhattan project’ in USA on The Alamogordo range, 200 miles southward from Los-Alamos (New Mexico) on July 16, 1945. The 20 kt explosive (informally called “gadget”) made of Pu-239 (Fig. 1.1 and 1.2) was mounted on a steel 33-meter high tower (Fig. 1.3), while the administration and data collection center (Fig. 1.4) were located at a safe distance in a protected building.

Fig. 1.4. Administration and data collection center



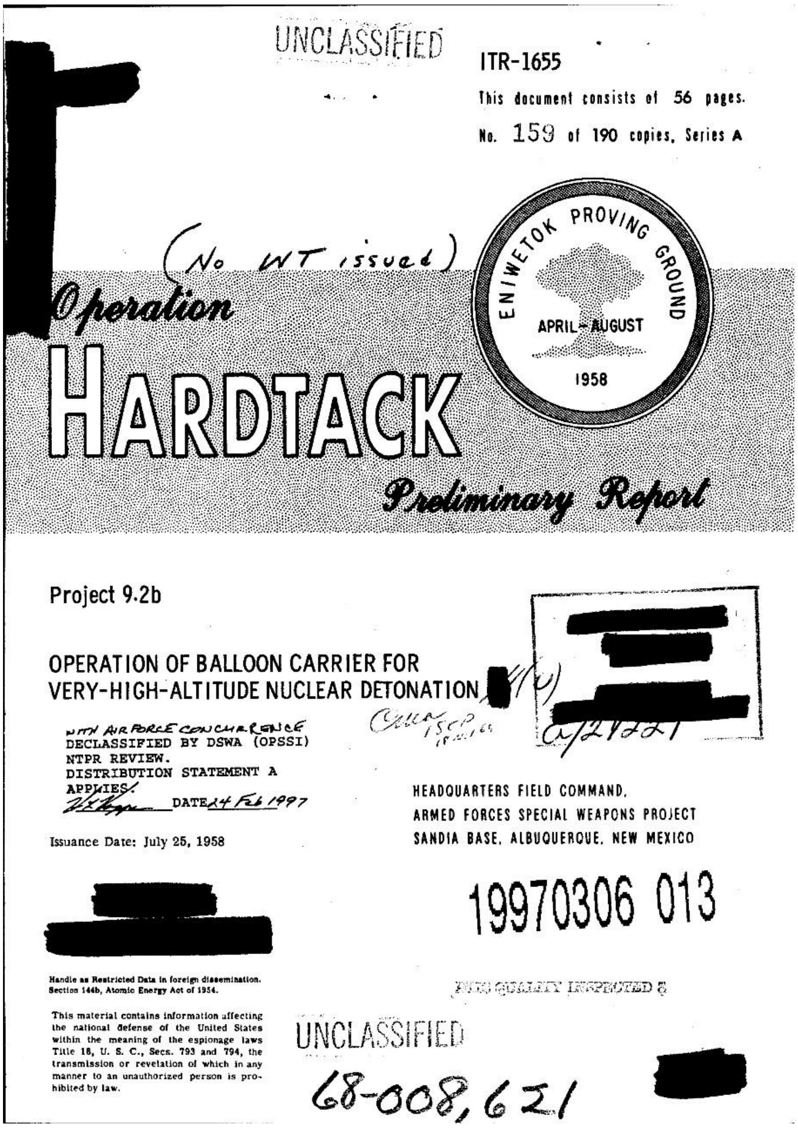
7. SUMMARY OF NUCLEAR PHYSICS MEASUREMENTS (ROBERT R. WILSON)

We can understand the difficulty of transmitting signals during the explosion when we consider that the gamma rays from the reaction will ionize the air and other material within hundreds of yards. Fermi has calculated that the ensuing removal of the natural electrical potential gradient in the atmosphere will be equivalent to a large bolt of lightning striking that vicinity. We were plagued by the thought that other such phenomena might occur in an unpredictable or unthought of manner. All signal lines were completely shielded, in many cases doubly shielded. In spite of this many records were lost because of spurious pickup at the time of the explosion that paralyzed the recording equipment.

Fig. 1.5. Declassified version of “Trinity” project’s report.

The word “Trinity” derives from the Latin word “trinitas”. This concept is used in Christian religion to denominate the triality of the Lord: the Father, the Son and the Holy Spirit. Thus, Robert Oppenheimer, (Fig. 1.6) the research advisor of the project and the manager of Los-Alamos laboratory, gave this name to the project under the influence of the religious poetry of John Donne (English poet of the 17th century).

Fig. 1.6 Robert Oppenheimer, research advisor of the project (left) and Leslie Groves, two-star general, Director of the project (right) near remnants of one of the tower’s supports, dissolved during the explosion.



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(No WT issued)

ENIWETOK PROVING GROUND

APRIL – AUGUST

1958

Operation

HARDTACK

Preliminary Report

Project 9.2b

OPERATION OF BALLOON CARRIER FOR
VERY-HIGH-ALTITUDE NUCLEAR DETONATION [redacted] (U)

[redacted]

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HEADQUARTERS FIELD COMMAND,
ARMED FORCES SPECIAL WEAPONS PROJECT
SANDIA BASE, ALBUQUERQUE, NEW MEXICO

Issuance Date: July 25, 1958

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[redacted]

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[redacted]

Fig. 1.7. Report on Yucca project within Hardtack-1 mission declassified in 1997

Simultaneously with this, the Conference of the Three Heads of Government was held in Potsdam. Upon receiving an encrypted notice with a coded phrase “Delivery was successful”, the US President Harry S. Truman suddenly saw himself as the Ruler of the World and informed J. Stalin that the USA invented a new type of weapon. The reason for such openness was clear: it was the USA’s habit to hold negotiations “from a position of strength”. However, this message did not impress Joseph Stalin as much as Truman may have expected. Truman could hardly imagine that Stalin had known that the Americans were prepared and rushed to test the first nuclear bomb, so he took corresponding measures.

In 1946, after the test, the Los-Alamos laboratory issued a secret report LA-1012, which remained classified for more than 30 years. It was not until May of 1976, when a declassified version of this report (LA-6300-Y, Fig. 1.5) was issued, even though some data were deleted. Yet, the initial and general information about HEMP was published in the disclosed version of the report. This information was published in Section 7 (Fig. 1.5) and consisted of only several lines. This Section suggested that the problems with sensor signal transfer were anticipated based on the theory of Enrico Fermi. Fermi determined that nuclear explosion affected by X-ray emission, leads to ionization of air over a large area resulting in a high difference of potentials in the atmosphere (similar to lightning discharge). That is why all signal cables were thoroughly shielded and dug into the ground. However, despite all preventive measures, many types of data-acquisition equipment were knocked out of service during the explosion by a high-voltage pulse. It should be noted that electronic equipment of that time was made of vacuum tubes (Fig. 3), i.e. it was rather primitive, unsophisticated and far less sensitive compared to modern micro-processor based measuring equipment.

This was the first ever registered impact of EMP onto electronic equipment.

Further missions (Crossroads, Sandstone, Greenhouse, Buster-Jangle, Tumbler-Snapper, Ivy, Upshot-Knothole, Castle, Teapot, Wigwam and Redwing) involved a series of explosions and allowed to research various aspects of ground surface, above-water and underwater nuclear explosions, including EMP registering. Upon explosion, the data-acquisition equipment was frequently knocked out of service, thus many parameters of the explosion remained unregistered. This was attributed to the inferiority of equipment and its low reliability.

Similar cases of equipment damage by a powerful electromagnetic pulse field were registered during nuclear weapon testing conducted by Great Britain in 1952-1953 (Maralinga range, South Australia). British physics called this phenomenon “radio-flash”. A concept similar to what we call electromagnetic pulse today was also used in some early publications of Soviet scientists.

In 1958, US scientists and military experts reverted to EMP research within the Hardtack-1 mission, which involved 35 nuclear explosions of various types. Some of those explosions were high-altitude explosions. The first high-altitude nuclear explosion in USA (Yucca project, Fig. 1.7) was performed using a large air balloon, launched from the Essex aircraft carrier (USS Boxer CVS-21), Fig. 1.8. It was a relatively low-capacity (1.7 kt) explosive weighing about 100 kg. In addition to the explosive, the air-balloon carried containers with data-acquisition equipment attached to it on a long rope. The total weight of equipment carried by the air-balloon was 346 kg. The explosive was demolished 26 km above ground between Eniwetok and Bikini atolls on April 28, 1958. This explosion was expected to offer possibilities of using nuclear explosive as a means capable of impacting missile and air defense electronic systems.

Fig. 1.8. Preparation (left) and launch (top right corner) of the air-balloon with nuclear explosive W-25 attached to it (from the deck of Essex aircraft carrier).

In addition to data-acquisition equipment placed in 5 evenly spaced containers under the nuclear explosive, (on the same rope) a US-army research laboratory also registered HEMP parameters from two tracking stations located in Wotho and Kusale towns (100 and 460 miles from Bikini, respectively). Moreover, two long-range B-36 bombers equipped with data-acquisition equipment remained in the air at a safe distance from the point of explosion. Initially, the plan was to launch the balloon from the ground. However, since even a light breeze could significantly impact such a large air-balloon, a decision was taken to re-locate the launch onto a ship. In order to avoid any shift of the balloon and its ballast at the time of launching, the ship was supposed to move in the windward direction with the wind’s speed. During the preparation stage, a total number of 76 air-balloons with ballast dummies were launched from different locations.

Hardtack mission involved two additional high-capacity high-altitude nuclear explosions coded as “Teak” and “Orange”. For the purpose of the “Teak” project, the thermonuclear explosive W-39 (3.8 Mt) was delivered to the altitude of 77 km above ground by a Redstone missile (Fig. 1.9), which started from one of Johnson Atoll’s islands on July 31, 1958. The outcome of this nuclear explosion was a powerful EMP, which could not be recorded in the testing area due to failure of data-acquisition equipment and errors in preliminary calculations and forecasts performed by Hans Bethe (famous theoretical physicist) regarding EMP.

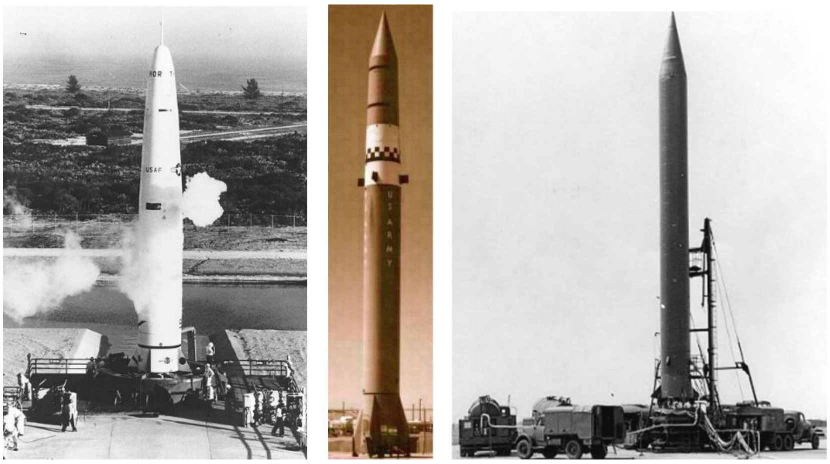
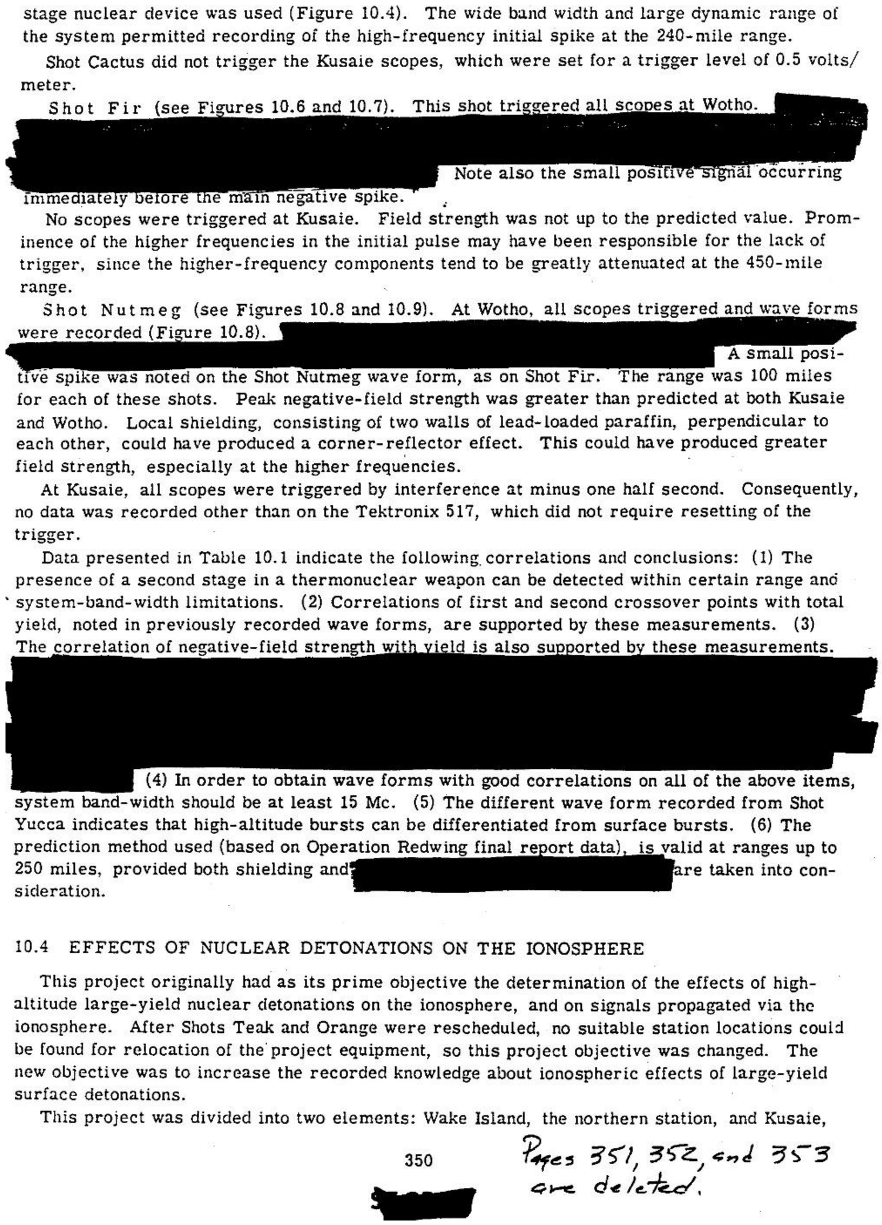


Fig. 1.9. Missiles (left to right): Thor, Redstone (USA) and Soviet missile SS-4 Sandal, which were used during the tests to deliver nuclear explosives to the altitude of the explosion.



stage nuclear device was used (Figure 10.4). The wide band width and large dynamic range of the system permitted recording of the high-frequency initial spike at the 240-mile range.

Shot Cactus did not trigger the Kusaie scopes, which were set for a trigger level of 0.5 volts/meter.

Shot Fir (see Figures 10.6 and 10.7). This shot triggered all scopes at Wotho. [redacted] Note also the small positive signal occurring immediately before the main negative spike.

No scopes were triggered at Kusaie. Field strength was not up to the predicted value. Prominence of the higher frequencies in the initial pulse may have been responsible for the lack of trigger, since the higher-frequency components tend to be greatly attenuated at the 450-mile range.

Shot Nutmeg (see Figures 10.8 and 10.9). At Wotho, all scopes triggered and wave forms were recorded (Figure 10.8). [redacted] A small positive spike was noted on the Shot Nutmeg wave form, as on Shot Fir. The range was 100 miles for each of these shots. Peak negative-field strength was greater than predicted at both Kusaie and Wotho. Local shielding, consisting of two walls of lead-loaded paraffin, perpendicular to each other, could have produced a corner-reflector effect. This could have produced greater field strength, especially at the higher frequencies.

At Kusaie, all scopes were triggered by interference at minus one half second. Consequently, no data was recorded other than on the Tektronix 517, which did not require resetting of the trigger.

Data presented in Table 10.1 indicate the following correlations and conclusions: (1) The presence of a second stage in a thermonuclear weapon can be detected within certain range and system-band-width limitations. (2) Correlations of first and second crossover points with total yield, noted in previously recorded wave forms, are supported by these measurements. (3) The correlation of negative-field strength with yield is also supported by these measurements. [redacted] (4) In order to obtain wave forms with good correlations on all of the above items, system band-width should be at least 15 Mc. (5) The different wave form recorded from Shot Yucca indicates that high-altitude bursts can be differentiated from surface bursts. (6) The prediction method used (based on Operation Redwing final report data), is valid at ranges up to 250 miles, provided both shielding and [redacted] are taken into consideration.

10.4 EFFECTS OF NUCLEAR DETONATIONS ON THE IONOSPHERE

This project originally had as its prime objective the determination of the effects of high-altitude large-yield nuclear detonations on the ionosphere, and on signals propagated via the ionosphere. After Shots Teak and Orange were rescheduled, no suitable station locations could be found for relocation of the project equipment, so this project objective was changed. The new objective was to increase the recorded knowledge about ionospheric effects of large-yield surface detonations.

This project was divided into two elements: Wake Island, the northern station, and Kusaie,

350

Pages 351, 352, and 353 are deleted. [redacted]

Fig. 1.10. Available pages of partially declassified ("sanitized") ITR-1660 report (some pages have been deleted completely) regarding Hardtack-1 mission.

Nonetheless, a powerful geomagnetic storm, much stronger than geomagnetic agitations caused by magnetic storms on the Sun and some flashes in the sky were registered far away from the explosion epicenter in the observatory of Apia town (Upolu island in the Pacific Ocean) – the capital of Samoa, located 3,200 km from Johnson Atoll.

During the "Orange" project, (August 11, 1958) a nuclear explosive of the same type was delivered by the same missile from the same range, but to the altitude of 43 km above ground. Unfortunately, the search of any additional data regarding the EMP effect in this project in published or declassified literature was unsuccessful. Some authors claim recurring problems with data-acquisition equipment, whereas others suggest that information about this project is still classified. However, fragmentary data published in partially declassified (1999), to be more precise – "sanitized" ("sanitized version" is what is written on the front page) report ITR-1660 regarding Hardtack-1 in 1959, (Fig. 1.10) suggest that many registered EMP parameters appeared to be different from what was expected or what can be derived from the theory.

In particular, EMP intensity upon a high-altitude explosion was three orders higher compared to ground surface explosion. Furthermore, some pieces of measuring equipment (similar to what happened during the very first testing of a nuclear explosion) were knocked out of service and all the obtained data were lost.

Since registered data did not comply with theoretical data, they were simply disregarded until new testing of nuclear explosives in 1962 (Fishbowl mission). These tests returned data similar to those obtained during the Hardtack-1 mission, which were initially disregarded as seemingly erroneous.

One of the most renowned projects within this mission was Starfish Prime, which was deployed on July 9, 1962. The mid-range missile GRM-17 ("Thor"), Fig. 1.9, delivered a thermonuclear explosive W49 (1,44 Mt) to 1,100 km altitude from Johnson Atoll in the Pacific Ocean. Upon detachment, the explosive descended to 400 km, where it was remotely triggered.

An unexpected outcome of this explosion was registered in Hawaii, located 1,445 km from the explosion epicenter: simultaneous failure of 30 lines of street lighting, actuation of multiple alarms and breakages in telephone systems. It took several tests, where obtained HEMP parameters did not comply with the theory to understand that there was something wrong with the theory.

1.3. The issues of theoretical physics

Arthur Compton from Cambridge University suggested the fundamentals of HEMP theory when studying scattering of X-rays on paraffin atoms. In 1923, he found that X-rays scattered in paraffin have higher wave length value compared to those falling onto them. Classical electrodynamics of D. Thompson could not explain this phenomenon. A new physical phenomenon was discovered: the effect of elastic scattering of a short-wave electromagnetic emission (X-rays and gamma rays) on unbound atoms' electrons, accompanied by elongation of a wave length and emergence of additional unbound electrons. In other words, Compton experimentally found that X-rays reflected from electrons act as though they consisted of separate particles (Fig. 1.11). Thus, he was the first to affirm Einstein's theory regarding the existence of light quantum.

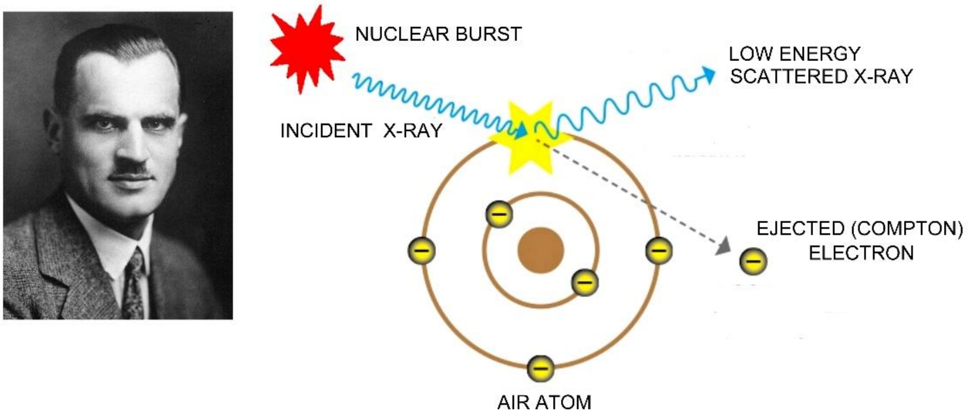


Fig. 1.11. Arthur Compton and illustration of his theory in relation to HEMP.

This discovery indirectly affirmed the corpuscular theory of electromagnetic emission, more specifically – light (which was earlier rejected by Max Planck and Niels Bohr). In 1927, A. Compton was awarded the Nobel Prize for this discovery. During World War II, A. Compton was a key person in the Manhattan project, developing the world's first nuclear weapon. He was the Director of a so-called Metallurgic Laboratory, which produced weapon-grade Plutonium for the first nuclear bombs. However, the disputes regarding quantum physics in general, and quantum theory of light in particular, do not subside. According to a prominent physicist, Academy Fellow, Yakov Borisovich Zeldovich [1.1], an experimental work suggesting that Compton's theory was incorrect appeared back in 1933. Physicists were confused. New, more thorough work was necessary (the first and the best in this list belongs to brothers A.I. and A.I. Alikhanov and L.A. Artsymovich) to restore the truth and rehabilitate Compton's formula.

Compton's theory was used to explain experimentally discovered powerful electromagnetic pulses near the ground surface during high-altitude nuclear explosions. According to this theory, interaction of powerful X-ray emission, occurring upon high-altitude nuclear explosion in the air, with unbound electrons of air atoms leads to the emergence of a large number of additional unbound electrons, (Compton's electrons) captured by the magnetic field of the Earth. This powerful stream of electrons rapidly descending towards the Earth's surface induces electric field upsurge near its surface.

However, when using Compton's effect for theoretical substantiation of HEMP parameters, some false theories were implemented. For example, in 1957 Hans A. Bethe, the famous American physicist and Nobel Prize winner (Fig. 1.12) published (in a secrete report, which is classified until now) a theory of electromagnetic pulse based on extrapolation of experimental data obtained during ground surface trials of nuclear explosives. Nuclear explosions of 1958 and 1962 described above showed that the values of electromagnetic field density of EMP during a high-altitude explosion, obtained using Bethe's theory, are 1,000 times lower than actual values.

In USSR, the HEMP theory was also addressed simultaneously with H. Bethe, but independently from him. While the theory of H. Bethe was based on experimental data, obtained during ground surface nuclear explosion, Soviet physicists did not have such an opportunity and their calculations were solely theoretical.

Fig. 1.12. Founders of HEMP theory: Hans A. Bethe, A.S. Kompaneets, V. Gilinskiy.

The first model was developed by Prof. Alexander Solomonovich Kompaneets, famous Soviet theoretical physicist, Doctor of Physics and Mathematics, (Fig. 1.12) representative of Kharkov physics school and a student of its founder – worldwide renowned L.D. Landau. Since 1946 and until the last day of his life, A.S. Kompaneets worked at the Institute of Chemical Physics of Academy of Science of USSR.

Due to the beginning of his work under the Soviet Nuclear project, the Council of Ministers of USSR approved a top-secret Decree No. 973-40ts dated April 30, 1946 "On assistance to the Institute of Chemical Physics of Academy of Science of USSR". One of the sections of this Decree was called "Establishment of a special sector on studying the theory of nuclear chain reactions and explosions at the ICP of Academy of Science of USSR". There were six departments within the Special Sector. A.S. Kompaneets was the Head of Theoretical Physics Department.

The "radio emission of a high-capacity explosion" (today – HEMP) was one of the principal fields of A.S. Kompaneets's activity. He developed a worldwide renowned equation, which was later named after him (Kompaneets's equation). The equation described changes of photon gas emission upon its Compton's scattering in low-density plasma [1.2]. That was a corner stone equation used by physicists all over the world. They used this equation until American physicist Victor Gilinski, Head of Physics Department of Rand Corp. (USA) proved [1.3] the erroneousness of Kompaneets's theory (Fig. 1.13).

I. INTRODUCTION

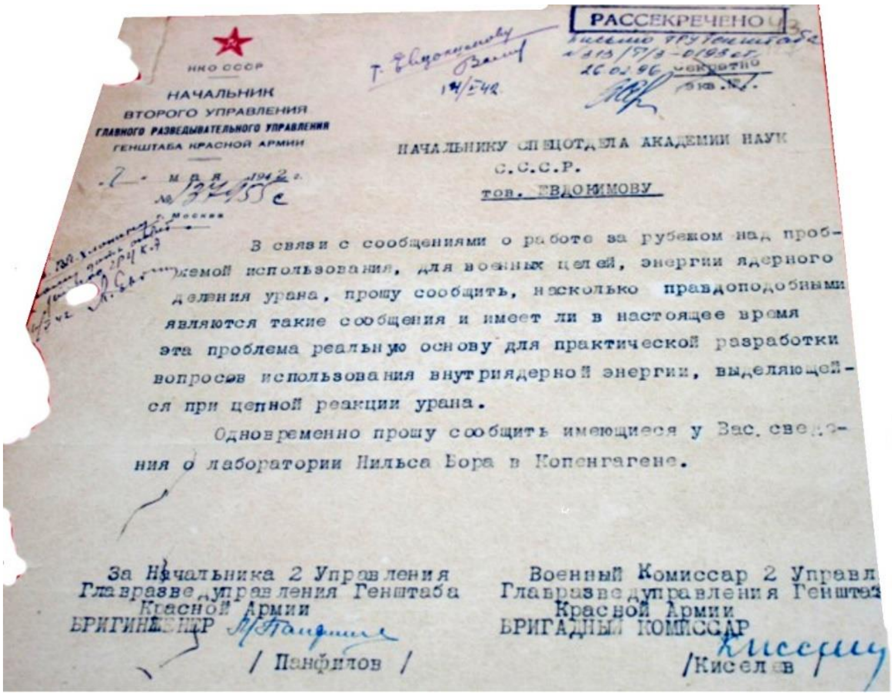
In a 1958 article in the Soviet literature Kompaneets(1) described the basic mechanism for radio emission from a nuclear explosion. This description, however, is incorrect at several points. The purpose of this paper is to show that a correct solution for the same model differs substantially from the solution presented by Kompaneets. In particular, he leaves out the important first half cycle of the signal so that the initial deflection is in the wrong direction.

Fig. 1.13. Introduction to V. Gilinski's work [3] with criticism of A.S. Kompaneets's theory.

1.4. People's Commissariat for Internal Affairs (NKVD) as the primary "designer" of the first Soviet nuclear explosive

Long before Americans started testing nuclear explosives, Soviet intelligence of NKVD started looking after any work in this field in all the countries, especially – USA and Great Britain. Soviet intelligence operation in the field of nuclear bomb was codenamed "Enormoz". This name was given to the project by the 1st Directorate of NKVD of USSR back in 1941. The overall management of the "Enormoz" operation was performed by the Head of the 1st Directorate (foreign intelligence) of NKVD-NKGB, 3rd rank Commissioner of homeland security, Pavel Fitin. The operation itself was developed by the Head of the 3rd (UK - USA) Department of the 1st Directorate, Commissioner of Homeland Security, Gike Ovakimian, who worked as a New-York spymaster until 1941 and involved the cooperation of the Rozenbergs. Major Leonid Kvasnikov, the deputy of the New-York spymaster, was appointed to perform the mission. It should be noted that he was one of the founders of Soviet scientific and technical intelligence, when he worked as the Head of the 3rd Division of the 3rd Department of the 1st Directorate in 1939.

While the office of L. Beria was fully involved into "procuring" of nuclear secrets, the Red Army's Intelligence Service (RAIS) has only had poor chances to hear about the nuclear issue. This is evidenced by a secret letter of the Head of the Second Directorate of Intelligence Service to the Head of Special Department of Soviet Academy of Science, M. P. Yevdokimov (Fig. 1.14).



РАССЕКРЕЧЕНО

НКО СССР

НАЧАЛЬНИК
ВТОРОГО УПРАВЛЕНИЯ
ГЛАВНОГО РАЗВЕДЫВАТЕЛЬНОГО УПРАВЛЕНИЯ
ГЕНШТАБА КРАСНОЙ АРМИИ

7 мая 1942 г.
№ 137955с
г. Москва

НАЧАЛЬНИКУ СПЕЦОТДЕЛА АКАДЕМИИ НАУК
С.С.С.Р.
тов. ЕВДОКИМОВУ

В связи с сообщениями о работе за рубежом над проблемой использования, для военных целей, энергии ядерного деления урана, прошу сообщить, насколько правдоподобными являются такие сообщения и имеет ли в настоящее время эта проблема реальную основу для практической разработки вопросов использования внутриядерной энергии, выделяющейся при цепной реакции урана.

Одновременно прошу сообщить имеющиеся у Вас сведения о лаборатории Нильса Бора в Копенгагене.

За Начальника 2 Управления
Главразведуправления Генштаба
Красной Армии
БРИГИНЖЕНЕР
/ Панфилов /

Военный Комиссар 2 Управл.
Главразведуправления Генштаба
Красной Армии
БРИГАДНЫЙ КОМИССАР
/Киселев/

Fig. 1.14. Letter of RAIS No. 137955s dated May 7, 1942 to the Special Department of Soviet Academy of Science. In this secret letter, Panfilov, Deputy Head of the 2nd Directorate of the Main Intelligence Directorate of the Red Army and Commissar General Kiselev, asked the head of the Special Department of the USSR Academy of Sciences Evdokimov about the plausibility of reports regarding the possibility of using uranium nuclear fission energy for military purposes and about Niels Bohr laboratory in Copenhagen.

The Special Department of Soviet Academy of Science was dealing with defense issues. The background of Mikhail Prokopiyevich Yevdokimov, the Head of the Department, was an engineer-metallurgist, so he was not familiar with atomic physics. That is why he forwarded the letter to Director of Radium Institute of Academy of Science, Academy Fellow, V.G. Khlopin. Two weeks later the Academy Fellow wrote the answer:

> "*The Academy of Science does not have any data regarding the work progress of foreign laboratories on the use of internal energy released upon uranium fission...Moreover, there were no publications on this issue in scientific literature (which we have access to) during the last year. This situation makes me think that the corresponding work is of top significance and thus, it is performed in absolute secrecy."*

Despite the passive attitude of the Intelligence Service and Academy of Science of USSR, the intelligence activity of NKVD was successful. In fact, in spite of the extremely difficult defense emergency of USSR during that time, the State Defense Committee issued the top secret Resolution No. 2352ts "Regarding uranium handling" in September of that year (Fig. 1.15).

In 1944, the State Defense Committee issued a "Top Secret/ Particular Importance" (ts/pi) Resolution No. GKO-7102 ts/pi (SDC-7102 top secret/particular importance) regarding extraction and processing of uranium (Fig. 1.16).

Management of extraction and processing of uranium was again entrusted to L. Beria and his department, including creation of a Research and Development Institute within NKVD, i.e. the Institute of Special Metals (InSpecMet of NKVD).

Two weeks later after the Hiroshima bombing, the State Defense Committee issued the Resolution No. GKO-9887ts/pi dated August 20, 1945 (Fig. 1.17). This Resolution stipulated creation of a Special Committee chaired by Lavrentiy Beria, which was supposed to be responsible for "management of all activities on the use of uranium's internal energy". The Committee was granted extraordinary powers and unrestricted financing. The First General Directorate (FGD) of NKVD became the executive body of the Special Committee. Two more bodies were established within FGD, i.e. Scientific and Research Council (SRC) and Bureau No. 2.

Department "S", established as part of P. Sudoplatov's team (Fig. 1.18) became the operational administration of Bureau No. 2. The most important strategic materials, including 200 pages from the "Enormoz" case were transferred to this department.

Сов.Секретно

РАСПОРЯЖЕНИЕ
ГОСУДАРСТВЕННОГО КОМИТЕТА ОБОРОНЫ
№ 2352сс

"28" сентября 1942г. Москва,Кремль

Об организации работ по урану

Обязать Академию Наук СССР (акад.Иоффе) возобновить работы по исследованию осуществимости использования атомной энергии путем расщепления ядра урана и представить Государственному Комитету Обороны к 1-му апреля 1943 года доклад о возможности создания урановой бомбы или уранового топлива.

Для этой цели:

1. Президиум Академии Наук СССР:

а) организовать при Академии Наук специальную лабораторию атомного ядра;

б) к 1-му января 1943 года в Институте радиологии разработать и изготовить установку для термодиффузионного выделения урана 235;

в) к 1-му марта 1943 года в Институте радиологии и Физико-техническом институте изготовить методами центрифугирования и термодиффузии уран 235 в количестве, необходимом для физических исследований, и к 1-му апреля 1943 года произвести в лаборатории атомного ядра исследования осуществимости расщепления ядер урана 235.

2. Академии Наук УССР (акад.Богомолец) организовать под руководством проф.Ланге разработку проекта лабораторной установки

Fig. 1.15. Resolution GKO-2352ts to resume work on nuclear energy research in order to build a U-bomb. This top secret document of the USSR State Defense Committee (GKO) is entrusted to the USSR Academy of Sciences (academician Ioffe) to resume work on nuclear energy; create a special laboratory; develop and create the necessary equipment. Submit by April 1, 1943 Report on the possibility of creating a uranium bomb.

Из Постановления ГКО № 7102 сс/ов «О мероприятиях по обеспечению развития добычи и переработки урановых руд»

8 декабря 1944 г.
Сов. секретно
(Особая папка)

Государственный комитет обороны
Постановление № 7102 сс/ов

От 8 декабря 1944 г. Москва, Кремль

О мероприятиях по обеспечению развития добычи и переработки урановых руд

Считая всемерное развитие добычи урановых руд и производства урана важнейшей государственной задачей, Государственный комитет обороны *постановляет*:

1. Возложить на НКВД СССР:

а) разведку урановых месторождений Табошар, Уйгур-Сай, Майли-Су, Тюя-Муюн и Адрасман, а также доразведку других урановых месторождений, которые будут передаваться НКВД СССР для эксплуатации в дальнейшем;

б) добычу и переработку урановых руд из указанных месторождений;

в) строительство и эксплуатацию рудников и обогатительных фабрик на существующих и вновь открываемых урановых месторождениях;

г) строительство и эксплуатацию заводов по переработке урановых руд и концентратов;

д) разработку технологии наиболее рационального передела урановых руд на химические соединения и технологии получения из них металлического урана.

2. Обязать Наркомцветмет (т. Ломако) не позднее 1 января 1945 г. передать НКВД СССР:

а) рудники и месторождения урановых руд Табошар, Уйгур-Сай, Майли-Су, Адрасман и Тюя-Муюн;

б) завод «В» и Ленинабадский завод;

в) геолого-разведочные партии Наркомцветмета на урановых месторождениях, передаваемых НКВД СССР, со всем наличным (к моменту выхода настоящего Постановления) персоналом, сооружениями, имуществом, оборудованием, транспортом, фондами, а также материалами и оборудованием (включая импортное и союзное), находящимися в пути или в изготовлении.

Передачу произвести по балансу на 1 января 1945 г.

3. Обязать НКВД СССР (т. Завенягина) к 1 февраля 1945 г. представить на утверждение Государственного комитета обороны предложения на 1945 год по планам добычи урановых руд, производства урана и строительства урановых рудников и заводов.

4. Поручить НКВД СССР (т. Завенягину) совместно с Наркомчерметом (т. Тевосяном) выяснить вопрос о возможности совместной добычи урана и ванадия, а также о размерах возможной добычи урана из месторождений Кара-Тау и представить в ГОКО к 1 февраля 1945 г. свои предложения.

Fig. 1.16 a. Extracts from Resolution GKO-7102 ts/pi regarding extraction and processing of uranium. In this top secret document of December 8, 1944 under the signature of I. Stalin, the NKVD is charged with organizing all the necessary work for the extraction and processing of uranium ores, including the erection of mines and factories in the USSR, the creation of a uranium research institute, the purchase abroad of the necessary equipment and technical literature. Separately indicated an increase of 50% of the nutritional standards of prisoners working in these mines and factories.

7. Обязать НКВД СССР (т. Берия):

а) организовать в системе НКВД СССР научно-исследовательский институт по урану, присвоив ему наименование «Институт специальных металлов НКВД» (Инспецмет НКВД).

Возложить на Инспецмет НКВД изучение сырьевых ресурсов урана и разработку методов добычи и переработки урановых руд на урановые соединения и металлический уран;

б) построить в районе Москвы завод по производству урановых соединений и металлического урана.

13. Поручить т. Микояну:

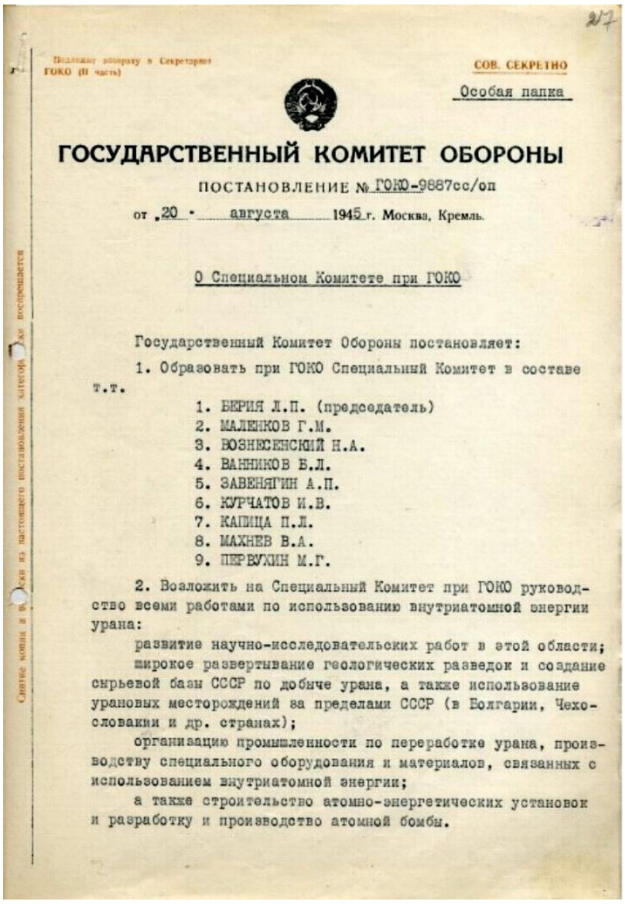
а) в месячный срок выяснить возможность дополнительного заказа по импорту и представить в ГОКО предложения о специальной закупке в первом полугодии 1945 г. лабораторного оборудования для урановых предприятий НКВД СССР по его спецификации;

б) обеспечить Спецметуправление НКВД СССР в 1945 году английской, американской, немецкой, итальянской и французской научной, справочной и технической литературой на общую сумму в 10 тыс. долларов (по спискам НКВД СССР).

25. Разрешить НКВД СССР увеличить на 50% нормы питания заключенных, работающих на предприятиях Спецметуправления НКВД СССР.

Председатель Государственного комитета обороны И. Сталин

Fig. 1.16 b. Continued. Extracts from Resolution GKO-7102 ts/pi regarding extraction and processing of uranium.


Подлежит возврату в Секретариат ГОКО (II часть)

СОВ. СЕКРЕТНО

Особая папка

ГОСУДАРСТВЕННЫЙ КОМИТЕТ ОБОРОНЫ

ПОСТАНОВЛЕНИЕ № ГОКО-9887сс/оп

от „20" августа 1945 г. Москва, Кремль.

О Специальном Комитете при ГОКО

Государственный Комитет Обороны постановляет:

1. Образовать при ГОКО Специальный Комитет в составе т.т.

1. БЕРИЯ Л.П. (председатель)
2. МАЛЕНКОВ Г.М.
3. ВОЗНЕСЕНСКИЙ Н.А.
4. ВАННИКОВ Б.Л.
5. ЗАВЕНЯГИН А.П.
6. КУРЧАТОВ И.В.
7. КАПИЦА П.Л.
8. МАХНЕВ В.А.
9. ПЕРВУХИН М.Г.

2. Возложить на Специальный Комитет при ГОКО руководство всеми работами по использованию внутриатомной энергии урана:

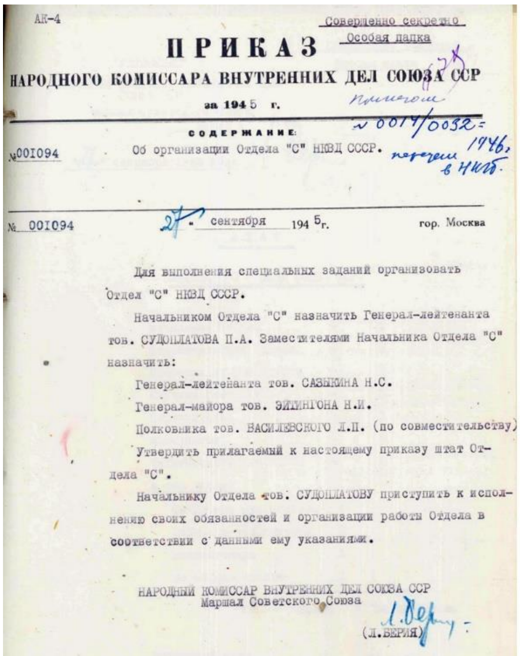
развитие научно-исследовательских работ в этой области;

широкое развертывание геологических разведок и создание сырьевой базы СССР по добыче урана, а также использование урановых месторождений за пределами СССР (в Болгарии, Чехословакии и др. странах);

организацию промышленности по переработке урана, производству специального оборудования и материалов, связанных с использованием внутриатомной энергии;

а также строительство атомно-энергетических установок и разработку и производство атомной бомбы.

Fig. 1.17. Extracts from Resolution of the State Defense Committee (GKO) No. GKO-9887ts/pi. In this top secret document of August 20, 1945 the USSR GKO decides to organize a special committee to supervise all work on the use of uranium atomic energy under the guidance of the NKVD Chairman L. Beria.



АК-4

Совершенно секретно
Особая папка

ПРИКАЗ
НАРОДНОГО КОМИССАРА ВНУТРЕННИХ ДЕЛ СОЮЗА ССР
за 1945 г.

СОДЕРЖАНИЕ:
№001094 Об организации Отдела "С" НКВД СССР.

№ 001094 27 сентября 1945 г. гор. Москва

Для выполнения специальных заданий организовать Отдел "С" НКВД СССР.

Начальником Отдела "С" назначить Генерал-лейтенанта тов. СУДОПЛАТОВА П.А. Заместителями Начальника Отдела "С" назначить:

Генерал-лейтенанта тов. САЗЫКИНА Н.С.

Генерал-майора тов. ЭЙТИНГОНА Н.И.

Полковника тов. ВАСИЛЕВСКОГО Л.П. (по совместительству)

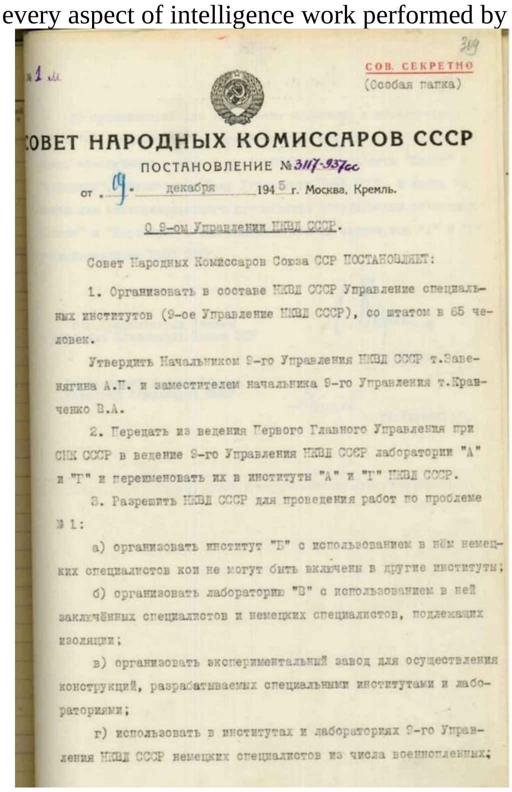
Утвердить прилагаемый к настоящему приказу штат Отдела "С".

Начальнику Отдела тов. СУДОПЛАТОВУ приступить к исполнению своих обязанностей и организации работы Отдела в соответствии с данными ему указаниями.

НАРОДНЫЙ КОМИССАР ВНУТРЕННИХ ДЕЛ СОЮЗА ССР
Маршал Советского Союза
(Л.БЕРИЯ)

Fig. 1.18. Top secret Order of NKVD No. 001094 ts/pi signed by L. Beria regarding establishment of Special Department “S” as part of NKVD chaired by two-star general P. Sudoplatov for perform special tasks on the uranium problem.

Among other things, it is interesting to review clause 13: “Comrade Beria shall endeavor to organize foreign intelligence work to obtain more comprehensive technical and economic information about uranium industry and nuclear bombs. Moreover, he is appointed to manage every aspect of intelligence work performed by intelligence agencies in this field.”



СОВ. СЕКРЕТНО
(Особая папка)

СОВЕТ НАРОДНЫХ КОМИССАРОВ СССР
ПОСТАНОВЛЕНИЕ №3117-937сс
от 9 декабря 1945 г. Москва, Кремль.

О 9-ом Управлении НКВД СССР.

Совет Народных Комиссаров Союза ССР ПОСТАНОВЛЯЕТ:

1. Организовать в составе НКВД СССР Управление специальных институтов (9-ое Управление НКВД СССР), со штатом в 65 человек.

Утвердить Начальником 9-го Управления НКВД СССР т.Завенягина А.П. и заместителем начальника 9-го Управления т.Кравченко В.А.

2. Передать из ведения Первого Главного Управления при СНК СССР в ведение 9-го Управления НКВД СССР лаборатории "А" и "Г" и переименовать их в институты "А" и "Г" НКВД СССР.

3. Разрешить НКВД СССР для проведения работ по проблеме № 1:

а) организовать институт "Б" с использованием в нём немецких специалистов кои не могут быть включены в другие институты;

б) организовать лабораторию "В" с использованием в ней заключённых специалистов и немецких специалистов, подлежащих изоляции;

в) организовать экспериментальный завод для осуществления конструкций, разрабатываемых специальными институтами и лабораториями;

г) использовать в институтах и лабораториях 9-го Управления НКВД СССР немецких специалистов из числа военнопленных;

Fig. 1.19. Resolution of Council of People’s Commissars No. 3117-937ts/pi. In this top secret document, the Council of People's Commissars of the USSR decides to create a Directorate of Special Institutions "on Problem No. 1" within the structure of the NKVD (Directorate No. 9) and transfer the laboratories "A" and "G" to subordinate this directorate, as well as organize new laboratories "B" and "C" in the structure of the NKVD, to use in them imprisoned specialists, as well as German specialists, who are subject to isolation from among the prisoners of war.

In December of that year the Resolution of the Council of People’s Commissars No. 3117-937ts/pi stipulated creation (again as part of NKVD) of a separate The Ninth Directorate of Special Institutes chaired by a two-star general A. Zaveniagin, and further subordination of laboratories and factories dealing with “Problem No. 1” to it (please note that the creation of the nuclear bomb was coded as "problem no. 1" even in the top secret document). Indeed, NKVD became the principal implementer of the nuclear project in the USSR (Fig. 1.19).

Lavrentiy Pavlovich Beria was a disciplined and pro-active performer; he was an excellent administrator so he became very involved in the work. Soviet intelligence has always watched this issue very closely. However, the intensity of their work increased significantly after Hiroshima and Nagasaki. The best spies were moved to this job. Yakov Terletsky, Doctor of Physics and Mathematics, lieutenant colonel, generalized all the incoming materials and reported during the Scientific Research Committee (SRC) meetings.

Initially, the chairman of SRC was the People's Commissar in charge of ammunition, one of the first triple Heroes of Socialist Labor, two-star general Boris Vannikov, while his deputy (and then the chairman) was Academy Fellow Igor Kurchatov, who chaired the SRC till the end of his life. Except for them, the following people were part of SRC: Beria's deputies Vasily Machnyov and Avraamiy Zaveniagin, as well as Academy Fellows Abram Ioffe, Abram Alikhanov, Isaac Kikoin, Vitaly Khlopin and Yuliy Khariton.

Fig. 1.20. Heads of the USSR's nuclear project, employees of NKVD: Commissar of Internal Affairs L. Beria; People's Commissar in charge of ammunition B. Vannikov (he was not NKVD's employee, but he worked with it very closely); Head of Directorate of Foreign Intelligence of NKVD P. Fitin; 3rd rank Commissar of Homeland Security (two-star general), Deputy of Commissar of Internal Affairs, Head of The Ninth Directorate of NKVD A. Zaveniagin; Head of Department "C" of NKVD P. Sudoplatov; Head of Department of Scientific and Technical Intelligence, colonel L. Kvasnikov; expert of Department of Scientific and Technical Intelligence, Doctor of Physics and Mathematics, Professor, lieutenant colonel Ya. Terletsky.

СССР

ПРОТОКОЛ
от 30 ноября 1945 года № 9

ПРОТОКОЛ ЗАСЕДАНИЯ СПЕЦИАЛЬНОГО КОМИТЕТА ПРИ СОВНАРКОМЕ СССР

Москва, Кремль

Сов. секретно
(Особая папка)
Хранить наравне с шифром

Члены Специального комитета при СНК СССР: тт. Берия Л.П., Маленков Г.М., Вознесенский Н.А., Ванников Б.Л., Завенягин А.П., Капица П.Л., Курчатов И.В., Махнев В.А., Первухин М.Г.

I. Об организации при Специальном комитете Инженерно-технического совета:

Ввиду того, что инженерно-технические вопросы в решении задачи практического использования внутрипромышленных ресурсов в настоящее время приобретают большое значение, Специальный комитет при СНК СССР ПОСТАНОВЛЯЕТ:

1. Организовать при Специальном комитете Инженерно-технический совет.
Поставить перед Инженерно-техническим советом в качестве главной задачи обеспечение инженерно-технического руководства проектированием и сооружением предприятий по использованию внутрипромышленных ресурсов, а также руководство конструированием и изготовлением специального оборудования для указанных целей.
4. Утвердить состав Инженерно-технического совета в 7 человек: тт. Первухин М.Г. (председатель), проф. Емельянов В.С. (заместитель), Малышев В.А., Завенягин А.П., Алексенко Г.В., проф. Касаткин А.Г. (члены Совета), Поздняков ВС. (ученый секретарь).
Для обеспечения связи между научной и инженерной разработкой сооружений ввести в состав секций Инженерно-технического совета следующих научных работников, ответственных за научно-исследовательскую разработку проектов сооружений: в состав первой секции - акад. Курчатова И.В, в состав второй секции - чл.-кор. Академии наук Кикоина И.К., в состав третьей секции - проф. Арцимовича Л.А., в состав четвертой секции - проф. Корнфельда М.О., в состав пятой секции - к.х.н. Правдюка Н.Ф.

II. О месте строительства заводов N° 813 и 817:
1. Принять предложение тт. Ванникова Б.Л., Курчатова И.В., Завенягина А.П. и Борисова Н.А. о строительстве завода № 817 на площадке "Т" (Южный берег оз. Кызыл-Таш Челябинской обл.).

Fig. 1.21a. Top Secret minutes of the Special Committee's Meeting No. 9. In this top secret order signed by L. Beria dated November 30, 1945, the creation of the Engineering and Technical Council for the design and construction of factories and special equipment for the use of "intraindustrial resources" (encrypted name for atomic energy) and for the production of "product 180" (encrypted name enriched uranium) is ordered. It was ordered to create a Commission to study the effects of the use of atomic bombs in Hiroshima and Nagasaki. It is ordered to limit the list of persons allowed to discuss the problem.

2. Принять предложение тт. Ванникова Б.Л., Кикоина И.К., Завенягина А.П. и Борисова Н.А. о строительстве завода № 813 на площадке строительства завода № 261 НКАП, для чего передать завод № 261 Первому главному управлению при СНК СССР.

3. Поручить Госплану СССР (т. Вознесенскому Н.А.) рассмотреть совместно с НКАП вопрос об использовании металлургического оборудования, вывозимого на завод № 261 из Германии, и свои предложения внести на рассмотрение Оперативного бюро Совнаркома СССР.

4. Поручить т. Чернышеву В.В. совместно с тт. Сергеевым В.А. и Борисовым Н.А. в 3-дневный срок проверить заявку на импорт материалов, товаров и оборудования, исходя из необходимости закупки только тех материалов и того оборудования, кои не могут быть поставлены отечественной промышленностью или подобраны из трофейных материалов и демонтированного в Германии оборудования.

IV. Об организации Лаборатории № 3 Академии наук СССР

Принять представленный тт. Ванниковым Б.Л., Борисовым Н.А. и Алихановым А.И. проект Постановления СНК СССР «Об организации Лаборатории № 3 Академии наук СССР» с дополнениями, внесенными т. Бенедиктовым И.А.

V. О строительстве полупромышленных установок по производству продукта 180

Принять в основном проект Постановления СНК СССР «О строительстве полупромышленных установок по производству продукта 180», внесенный Техническим советом Специального комитета при СНК СССР, поручив тт. Ванникову Б.Л. (созыв), Первухину М.Г., Борисову Н.А., Гинзбургу С.З., Паршину П.И. и Байбакову Н.К. в 3-дневный срок уточнить сроки выполнения технических и рабочих проектов, изготовления оборудования и строительства установок.

XII. Об организации Лаборатории № 4 при Первом главном управлении при СНК СССР17

Рассмотрение вопроса об организации Лаборатории № 4 перенести на следующее заседание Специального комитета с тем, чтобы одновременно заслушать доклад проф. Ланге о проводимых им работах.

XIV. Заявление т. Капицы П.Л. о выводах, сделанных им на основании анализа данных о последствиях применения атомных бомб в Хиросима и Нагасаки

Поручить комиссии в составе тт. Алиханова (председатель), Ландау, Харитона, Мигдала, Рейнберга, Садовского, Васильева и Закощикова проанализировать все имеющиеся материалы о последствиях применения атомных бомб в Хиросима и Нагасаки и определить эффективность фактора взрывной волны, фактора теплового и фактора радиоактивного излучения. Выводы комиссии обсудить на Техническом совете и доложить Специальному комитету.

Председатель Специального комитета при СНК СССР Л. Берия

Fig. 1.21b. Minutes of the Special Committee’s Meeting No. 9. Continued

Приложение к протоколу № 9

Сов. секретно (Особая папка)

ПОЛОЖЕНИЕ Об Инженерно-техническом совете Специального комитета при СНК СССР

5. Список лиц, приглашаемых на заседание совета, в каждом отдельном случае утверждается председателем совета или его заместителем.

Работники аппарата Инженерно-технического совета принимают участие в заседании совета только по тем вопросам, в разработке которых они принимают непосредственное участие.

Лица, приглашаемые для рассмотрения отдельных частных вопросов, присутствуют на обсуждении лишь того конкретного вопроса, к которому они имеют касательство (а не всего вопроса повестки дня). Протоколы заседания совета составляются секретарем совета в 3 экз., из коих один направляется председателю Специального комитета при СНК СССР, второй - председателю Научно-технического совета при Специальном комитете и третий хранится в секретном архиве Инженерно-технического совета. Ни в какие другие адреса протоколы совета и материалы его работы и работы секций не рассылаются.

6. Инженерно-технический совет ведет необходимую переписку только с председателем Научно-технического совета при Специальном комитете, с Первым главным управлением при СНК СССР (через начальника управления). Переписка совета со всеми другими организациями и учреждениями осуществляется через секретариат Специального комитета.

Fig. 1.21c. Appendix to Minutes of the Special Committee’s Meeting No. 9.

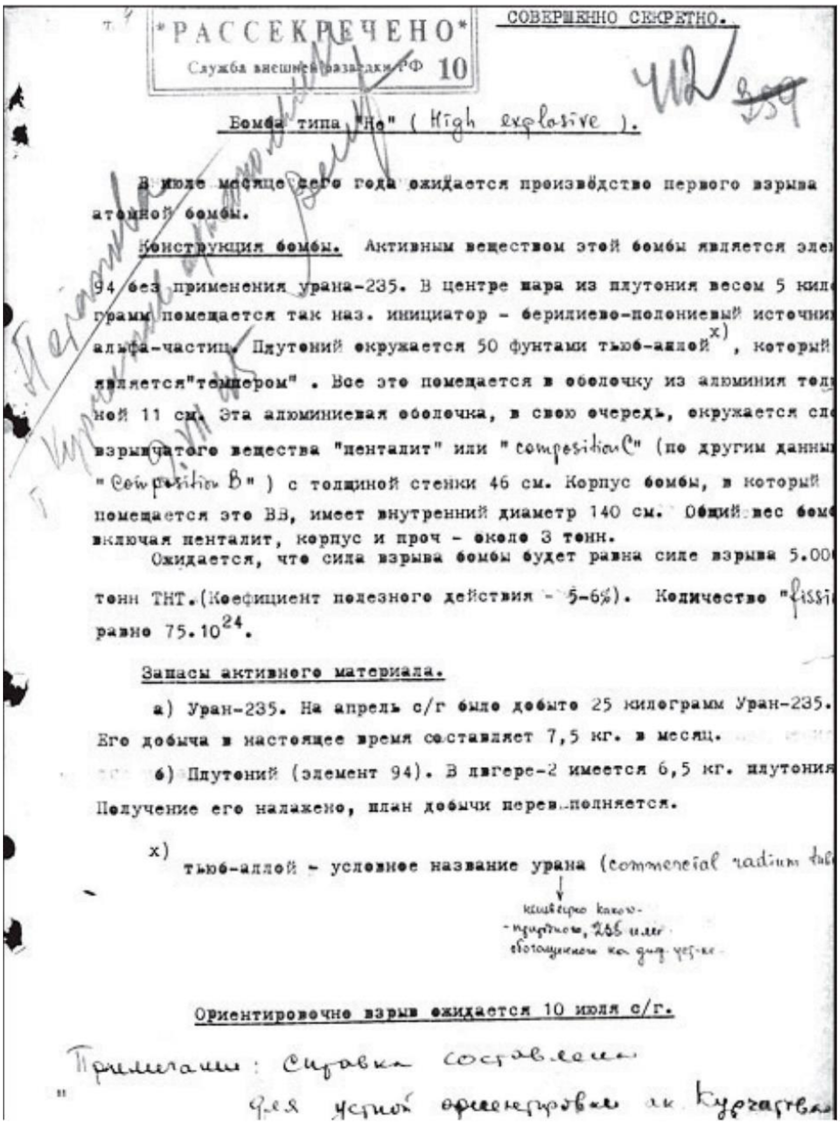
Leonid Romanovich Kvasnikov was called off from New-York at the end of 1945 to work on the project. In 1947 he chaired scientific and technical intelligence of NKVD and remained in this position till his resignation in 1966, regardless of various reforms and re-naming of agencies. Obviously, the Soviet Union was intensively working on the nuclear project, but it lagged behind the USA in terms of practical deployment.

Specialists from almost all the fields of science and industry (provided the issues addressed were within their competence) were invited to the meetings of the Special Committee.

Among other issues, the Minutes of the Special Committee No. 9 (Fig. 1.21) stipulated that the committee consisting of the leading nuclear scientists of the country is expected to analyze all the materials concerning the explosions in Hiroshima and Nagasaki.

In these Minutes, factory 813 means Production Facility “Mayak”, while factory 817 means “Ural Electrochemical Plant”.

Intelligence officers from NKVD took information from the leading physicists and nuclear experts, including those working at the National Laboratory in Los-Alamos, such as Klaus Fuchs, Ted Holl, Morton Sobell and David Greenglass. They were contacted by New-York spymasters of NKVD, Alexander Feklisov and Anatoliy Yatskov, as well as by Harry Gold and the Cohen couple (recruited US citizens).



РАССЕКРЕЧЕНО
Служба внешней разведки РФ 10

СОВЕРШЕННО СЕКРЕТНО.

Бомба типа "Не" (High explosive).

В июле месяце сего года ожидается произвёдство первого взрыва атомной бомбы.

Конструкция бомбы. Активным веществом этой бомбы является элем 94 без применения урана-235. В центре шара из плутония весом 5 кило грамм помещается так наз. инициатор – бериллиево-полониевый источник альфа-частиц. Плутоний окружается 50 фунтами тьюб-аллой x), который является "темпером". Все это помещается в оболочку из алюминия толщ ной 11 см. Эта алюминиевая оболочка, в свою очередь, окружается сл взрывчатого вещества "пенталит" или "composition C" (по другим данны "composition B") с толщиной стенки 46 см. Корпус бомбы, в который помещается это ВВ, имеет внутренний диаметр 140 см. Общий вес бомб включая пенталит, корпус и проч – около 3 тонн.

Ожидается, что сила взрыва бомбы будет равна силе взрыва 5.00 тонн ТНТ. (Коефициент полезного действия – 5–6%). Количество "fissi равно 75.10^{24}.

Запасы активного материала.

а) Уран-235. На апрель с/г было добыто 25 килограмм Уран-235. Его добыча в настоящее время составляет 7,5 кг. в месяц.

б) Плутоний (элемент 94). В лагере-2 имеется 6,5 кг. плутония Получение его налажено, план добычи перевыполняется.

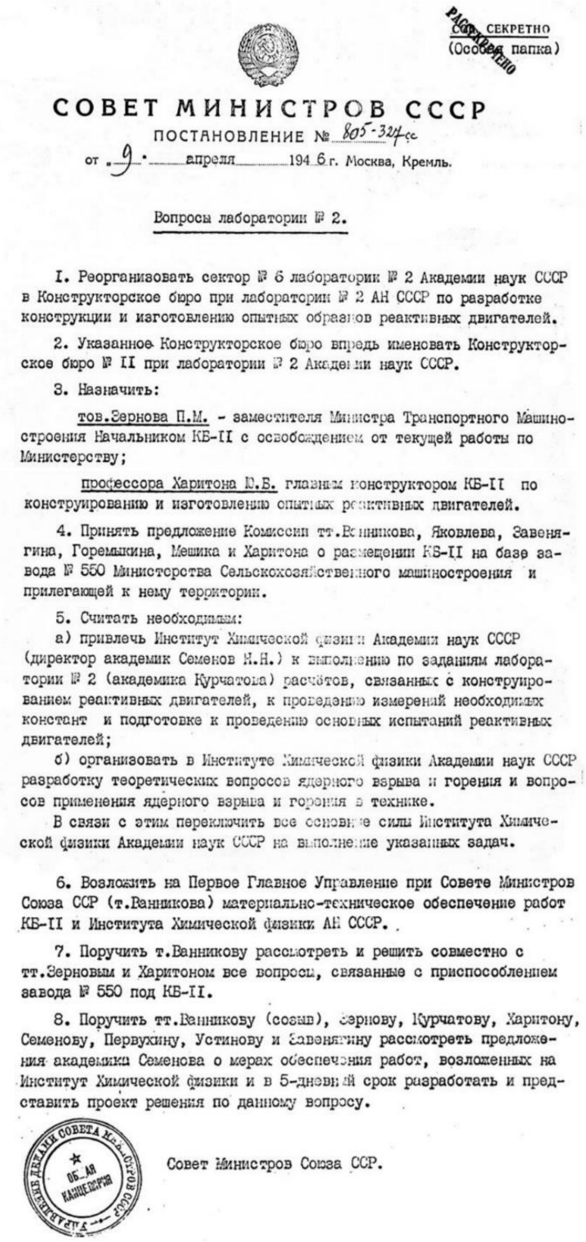
x) тьюб-аллой – условное название урана (commercial radium

Ориентировочно взрыв ожидается 10 июля с/г.

Fig. 1.22. A page from Soviet intelligence report. This is a top secret document intended for the scientific supervisor of works in the field of the atomic problem I. Kurchatov. The document presents technical information obtained by Soviet intelligence on the design of the American atomic bomb based on uranium-235.

Robert Oppenheimer, research advisor of the Manhattan project and Director of Los-Alamos laboratory, who sympathized to socialists and adhered to left-wing views, was an object of special attention for Soviet intelligence service. Grigory Heifets, spymaster of Soviet intelligence acting as a Vice-consul of USSR in San-Francisco, managed to establish a close contact with him. Simultaneously, the wife of Vasily Zarubin (Soviet spymaster in New-York), Yelizaveta Zarubina (Major of NKVD) got acquainted with Oppenheimer’s wife – Kathrine, who used to be a member of the US Communist party. Upon Zarubina’s request, Kathrine convinced the “fathers” of a nuclear bomb – Enrico Fermi and Leo Szilárd – to permit some specialists recruited by Soviet intelligence to participate in the Manhattan project. The profusion of Soviet spies around the “Manhattan Project” was remarkable. About 200 Soviet intelligence officers worked to collect data about the US nuclear bomb. Foreign intelligence involved 14 especially valuable agents, (foreigners) who participated in the US nuclear project and made a significant contribution into development of the Soviet nuclear bomb. The list includes renowned physicist Klaus Fuchs, the Rozenbergs, (sentenced to death on an electric chair) as well as deep covered agents Leontina and Morris Cohen. During the several-year mission Soviet intelligence officers scouted undoubtedly huge amounts of secret documents, which consisted of 12,000 pages in aggregate. Soviet scientists who developed a nuclear bomb in a so called “Laboratory No. 2” hardly imagined that all those pieces of information, and sometimes even research findings, (Fig. 1.22) were obtained by NKVD. They really thought that those bites of information came from some R&D centers within the country, who worked with them on the same problem simultaneously.

Shortly afterwards, nuclear experts received a rather clear assignment: replicate the US bomb with minimum changes and supplements. In order to do this, the Cabinet Council of USSR issued a Decree No. 805-327ts/pi dated April 9, 1946 to establish a special engineering department – Constructor Bureau "CB-11" (Fig. 1.23). It is fun to see today how they used vague terms, such as "jet engine", to denominate a nuclear bomb in a top secret document meant to be stored in a special folder, or "Plant 550 of the Ministry of agricultural machine-building", located in a detached village Sarov in Mordovia (since 1946 the name 'Ministry of agricultural machine-building' was assigned to former People's Commissariat in charge of ammunition). By the way, CB-11 was called "facility 550" in many further governmental documents. In fact, the first nuclear bomb was denominated in the documents as RDS-1 (meaning "jet engine named after Stalin"). Abbreviation RDS with different numbers was used for a long time and was assigned to multiple nuclear explosives developed by CB-11 (today this facility is called "All-Russian Research and Development Institute of Experimental Physics").



РАССЕКРЕЧЕНО

СОВ. СЕКРЕТНО
(Особая папка)

СОВЕТ МИНИСТРОВ СССР

ПОСТАНОВЛЕНИЕ № 805-327сс

от 9 апреля 1946 г. Москва, Кремль.

Вопросы лаборатории № 2.

1. Реорганизовать сектор № 6 лаборатории № 2 Академии наук СССР в Конструкторское бюро при лаборатории № 2 АН СССР по разработке конструкции и изготовлению опытных образцов реактивных двигателей.

2. Указанное Конструкторское бюро впредь именовать Конструкторское бюро № 11 при лаборатории № 2 Академии наук СССР.

3. Назначить:

тов.Зернова П.М. - заместителя Министра Транспортного Машиностроения Начальником КБ-11 с освобождением от текущей работы по Министерству;

профессора Харитона Ю.Б. главным конструктором КБ-11 по конструированию и изготовлению опытных реактивных двигателей.

4. Принять предложение Комиссии тт.Ванникова, Яковлева, Завенягина, Горемыкина, Мешика и Харитона о размещении КБ-11 на базе завода № 550 Министерства Сельскохозяйственного машиностроения и прилегающей к нему территории.

5. Считать необходимым:

а) привлечь Институт Химической физики Академии наук СССР (директор академик Семенов Н.Н.) к выполнению по заданиям лаборатории № 2 (академика Курчатова) расчетов, связанных с конструированием реактивных двигателей, к проведению измерений необходимых констант и подготовке к проведению основных испытаний реактивных двигателей;

б) организовать в Институте Химической физики Академии наук СССР разработку теоретических вопросов ядерного взрыва и горения и вопросов применения ядерного взрыва и горения в технике.

В связи с этим переключить все основные силы Института Химической физики Академии наук СССР на выполнение указанных задач.

6. Возложить на Первое Главное Управление при Совете Министров Союза ССР (т.Ванникова) материально-техническое обеспечение работ КБ-11 и Института Химической физики АН СССР.

7. Поручить т.Ванникову рассмотреть и решить совместно с тт.Зерновым и Харитоном все вопросы, связанные с приспособлением завода № 550 под КБ-11.

8. Поручить тт.Ванникову (созыв), Зернову, Курчатову, Харитону, Семенову, Первухину, Устинову и Завенягину рассмотреть предложения академика Семенова о мерах обеспечения работ, возложенных на Институт Химической физики и в 5-дневный срок разработать и представить проект решения по данному вопросу.

Совет Министров Союза ССР.

Fig. 1.23. Decree of the Cabinet Council of USSR of April 9, 1946. In this top secret decree ordered to organize a special constructor's bureau (CB-11) to create "jet engines" (the encrypted name of the atomic bomb) under the guidance of Professor Y. Khariton and organize research work on the nuclear explosion at the institute Chemical Physics Academy of Sciences of the USSR.

In February of 1947, a Resolution of the Cabinet Council of USSR granted CB-11 a status of a high security facility and converted its territory into a closed restricted-access area. The place-name Sarov was excluded from toponyms of the Mordovia Autonomous Soviet Socialist Republic and was deleted from all records (it was not mentioned on geographic maps and open mass media). Later on, this village (today this is a restricted-access area) existed under different fictional names, (even in secret documents) such as Base No. 112, Gorky-130, Arzamas-75, Kremlyov, Arzamas-16 and Moscow-300).

In 1945, simultaneously with intensive intelligence activity performed by NKVD, the office of A. Zaveniagin found German specialists (metallurgists, chemists and physicists) and delivered them to the USSR. The list included: Nikolaus Riehl, Manfred von Ardenne and others. In total 70 specialists were delivered to the USSR in 1945. This number increased to 300 people by 1948. Later on A. Zaveniagin was in charge of "German" laboratories. Simultaneously with this, P.Ya. Meshik and I.K. Kikoin were responsible for the search of technological equipment, ore reserves and excavated uranium raw material over the total territory of Germany controlled by the USSR. In total, 220 tons of uranium compounds (pure metal equivalent) were found by mid-1946. In the middle of 1946, a geologic exploration was performed by 320 geologic parties all over the USSR. As a result, in addition to the Taboshar uranium field, they started excavation of uranium compounds in the Krivoy Rog basin, the Estonia and Transbaikal region. They resumed excavation in Jáchymov (Czech Republic) and started development in Saxony in the mines of future SDAG Wismut.

By 1947, the USSR owned enough resources and scientific data to start building its own nuclear bomb. However, technical information stolen from the Americans was sufficient to start this job. That is why L. Beria insisted on simple copying of the "Fat Man" – the American bomb dropped on Nagasaki. Outraged Peter Kapitsa (who was involved into the nuclear project on the recommendation of I. Kurchatov) wrote a personal letter to J. Stalin, where he challenged Beria's opinion. As a result, P. Kapitsa was dismissed from the project and Beria's opinion became the law for bomb designers.

As Yu. B. Khariton (the research supervisor of Soviet nuclear project and chief engineer of a nuclear bomb) confessed: "the first Soviet nuclear explosive was built based on American sample." The Chief of NKVD's Department "S", who was responsible for procuring information regarding development of nuclear bomb in USA, two-star general P. A. Sudoplatov also wrote that "the first Soviet bomb (RDS-1) was a copy of American plutonium bomb dropped on Nagasaki to the smallest details." At the same time, Sudoplatov emphasized that "the design of the first US nuclear bomb was available in USSR 12 days after the bomb's assembly." As Academy Fellow Ya. Zeldovich joked, this bomb was "full drawn" from the Americans.

Thus, it can truly be said that the first Soviet nuclear bomb was developed (and here "development" means not only theoretical development, but all the issues related to construction of new factories, establishment of production of necessary parts, ore extraction, etc., as well as procurement of drawings and descriptions of the nuclear bomb) inside the belly of NKVD. I.V. Kurchatov had a separate office at NKVD Directorate in Moscow (Lubyanka Street, bldg. 2) to make his work more comfortable (Fig. 1.24).

Fig. 1.24. Building of NKVD (KGB) Directorate in Lubyanka Street (Moscow)

Of course, we should not belittle the role of the leading Soviet nuclear experts, who participated in building of the first nuclear bomb (Fig. 1.25), though it was NKVD's game and especially its Chairman Lavrentiy Beria.

Below is what Yu. B. Khariton (research supervisor of the project and Chief engineer of the first Soviet nuclear bomb) wrote in his book [1.4]:

> "*Beria quickly instilled the necessary amplitude and dynamism to the work. This person, regarded as embodiment of evil in the contemporary history of the country, possessed mega-energy and fitness to work simultaneously. Our specialists, who interacted with him, could hardly miss his intellect, will and motivation. They become convinced that he was the top orchestrator, who can get the job done. Surprisingly, but Beria, who sometimes manifested offensive behavior, could (depending on situation) be polite, tactful and just a normal human being.*
>
> *The meetings that he chaired were always efficient, business oriented and never exhaustingly long. He was a master of unexpected and extraordinary solutions.*
>
> *M. A. Sadovskiy found himself at an absolutely different meeting chaired by Beria. There were about 30 people in his Kremlin office in Moscow. They discussed preparation of the range for the first thermonuclear explosion. Speakers tried to explain, how machines will be located, which facilities need to be built and how as well as which experimental animals need to be brought to the field in order to study the outcomes of damage effects. Suddenly, Beria went unhappy getting more and more anxious. He was interrupting speakers, changed people that were supposed to report to him, asked strange questions, which were difficult to answer. Eventually, he blew up and (according to M. A. Sadovsky) being*

completely unsatisfied he shouted: I will do it myself!" Then Beria started talking nonsense. Step by step we understood the following from his monologue: he wants the explosion to destroy everything on the range. It had to be frightening! When the meeting was over, the participants left depressed. That was the first time, when Mikhail Alexandrovich understood that dealing with Beria is not a joke...

Beria worked quickly, he didn't neglect site visits and got familiar with the results of performed work personally. When we performed our first nuclear explosion, he was the Chairman of the State Commission. Despite his exceptional position in the Party and the Government, Beria managed to allocate time for personal communication with people he was interested in, even though they didn't have any official honors or top-notch titles. He met with A.D. Sakharov (PhD in Physics and Mathematics at that time) several times as well as with O. A. Lavrentyev (just demobilized sergeant from the Far East).

Fig. 1.25. Founders of Soviet nuclear physics, whose scientific efforts provided theoretical substantiation and deployment of the first Soviet nuclear bomb: Igor Vasiliyevich Kurchatov, Yuliy Borisovich Khariton, Yakov Borisovich Zeldovich, Lev Davidovich Landau, Abram Isaacovich Alikhanov, Georgy Nikolayevich Flerov, Konstantin Antonovich Petrzhak, Isaac Konstantinovich Kikoin.

Beria demonstrated tolerance and appreciation when he needed any specialist for any work, even though people from his department thought that person was suspicious. When the Security Service decided to remove L.V. Altshuhler (who explicitly favored genetics and disliked Lysenko) from the site as a security risk, Yu. B. Khariton called directly to Beria and said that this employee was very beneficial in his job. The conversation was short and the almighty person asked just one question after a long silence: "Do you really need him?" And having received a positive answer he said: "Alright" and hung up. The subject was closed.

According to many veterans of nuclear industry, should this project be under Molotov's control, it would have been difficult to expect any quick success in performing such tremendous work.

We can treat Beria's personality differently and there is no doubt that he is guilty of the deaths of millions of innocent Soviet people. At the same time, we should admit: his personal drive and organizational abilities, as well as severe reprimands during the meetings and far from idle threats to shoot dead in case of failure; thousands of prisoners building plants and laboratories for the nuclear project; powerful scientific and technical intelligence, allowed the prevention of perhaps an even larger global disaster. Indeed, the fact that USSR tested and built its nuclear bomb much earlier than it was expected in the USA and UK (1953-1954), cooled down some American war hawks and allowed to avoid deployment of multiple (totally 13) plans of preventive nuclear bombing of the USSR. For example, according to the "Dropshot" plan, 300 nuclear bombs (50 kilotons each) were supposed to be dropped on 100 large industrial centers of the USSR in order to demolish 85% of its industrial and military potential, including 25 bombs onto Moscow; 22 onto Leningrad; 10 onto Sverdlovsk; 8 onto Kiev; 5 onto Dnepropetrovsk; 2 onto Lvov, etc. In addition to that, the additional plan envisaged dropping of 250,000 tons of ordinary bombs. Estimates suggested that roughly 60 million Soviet citizens would have died in the event of such bombing.

Luckily, those plans were destined to remain on paper. In 1949 (summer), the finished product "501" (coded name of the first Soviet nuclear bomb) was dismantled, packed and sent from CB-11 to "training range No. 2" (former name of Semipalatinsk nuclear testing range) by a special train. Final elements of the bomb were mounted to its central part during the night of August 29 and at 7 a.m. it was successfully blown. The bomb's capacity equivalent to TNT was 22 kt, length – 3.7 m; diameter – 1.5 m; weight – 4.6 tons (Fig. 1.26). Similarly to the American "Trinity" project, the nuclear explosive was mounted on a steel tower of the same height (33 meters), Fig. 1.27.

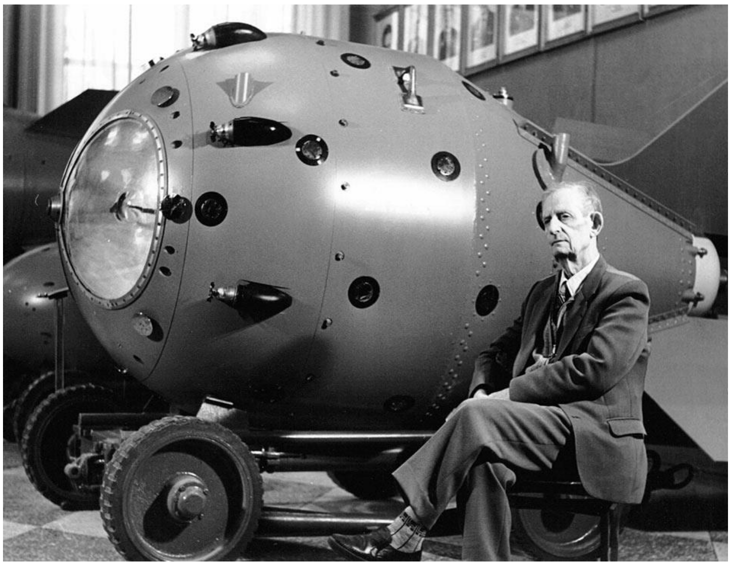


Fig. 1.26. Prototype of RDS-1 bomb displayed in All-Russian Research and Development Institute of Experimental Physics and Academy Fellow Yu. B. Khariton in 1993.

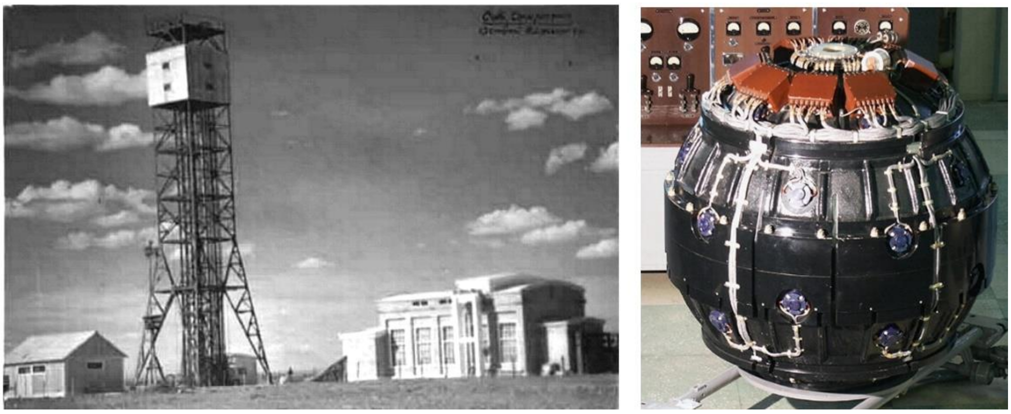


Fig. 1.27. Nuclear explosive RDS-1 and the tower where it was mounted for blasting

NY/LN #33 150 SQCMS 23/ 1656G DAILYMAIL 344
VIA PREWI COLLECT.

COMPLETE NEWS The Sun COMPLETE NEWS

TRUMAN SAYS RUSSIA SET OFF ATOM BLAST

New York World-Telegram S EXPLOSION TOOK E IN RECENT WEEKS

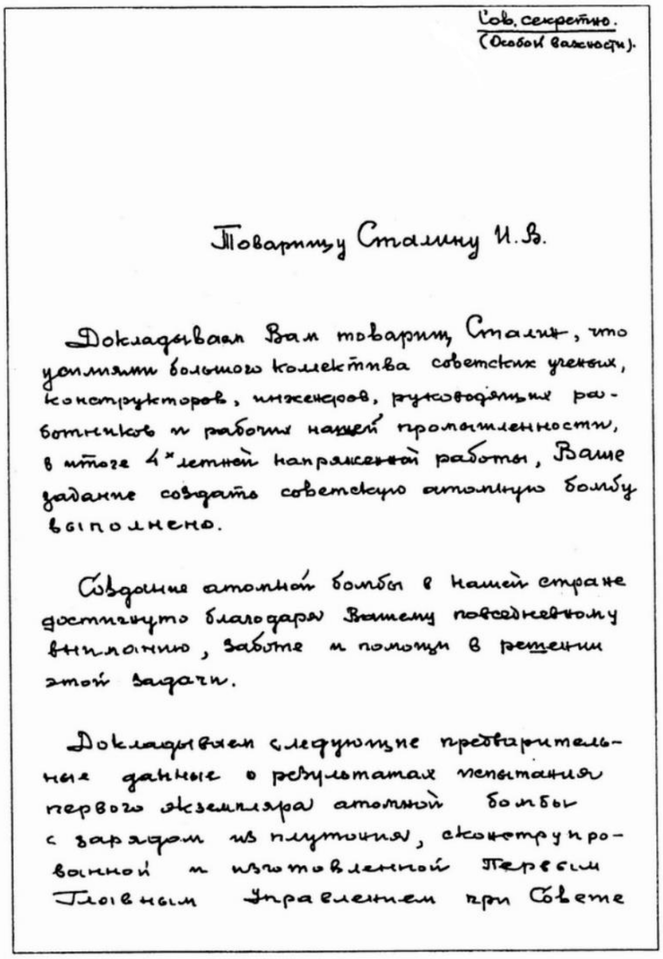
ATOMIC BLAST IN RUSSIA

Journal American Tells Cabinet Of Test in Russia EXTRA! Truman Makes Vital Disclosure

TRUMAN SAYS REDS HAVE EXPLODED ATOM!

AFTERNOON NEWSPAPER HEADLINES SHORTLY AFTER PRES. TRUMAN'S ANNOUNCEMENT-KEYSTONE.

Fig. 1.28. Headlines of American newspapers with a sensation about USSR’s testing of the nuclear bomb



Сов. секретно.
(Особой важности).

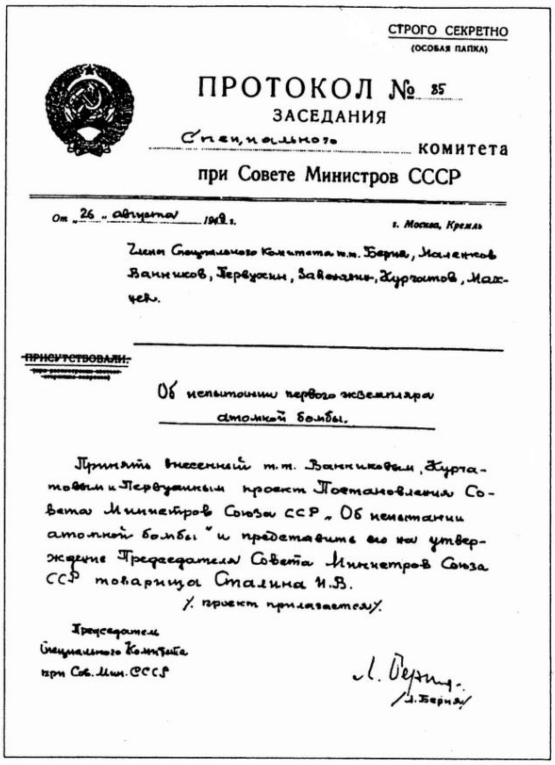
Товарищу Сталину И.В.

Докладываем Вам товарищ Сталин, что усилиями большого коллектива советских ученых, конструкторов, инженеров, руководящих работников и рабочих нашей промышленности, в итоге 4х летней напряженной работы, Ваше задание создать советскую атомную бомбу выполнено.

Создание атомной бомбы в нашей стране достигнуто благодаря Вашему повседневному вниманию, заботе и помощи в решении этой задачи.

Докладываем следующие предварительные данные о результатах испытания первого экземпляра атомной бомбы с зарядом из плутония, сконструированной и изготовленной Первым Главным Управлением при Совете

Fig. 1.29. Chirograph of L. Beria to J. Stalin. In this top secret letter from the head of the NKVD, L. Beria, reports to I. Stalin on the successful creation and testing of the first Soviet atomic bomb.



СТРОГО СЕКРЕТНО
(ОСОБАЯ ПАПКА)

ПРОТОКОЛ № 85
ЗАСЕДАНИЯ
Специального комитета
при Совете Министров СССР

От „26" августа 1949 г. г. Москва, Кремль

Члены Специального Комитета т.т. Берия, Маленков, Ванников, Первухин, Завенягин, Курчатов, Махнев.

~~ПРИСУТСТВОВАЛИ:~~

Об испытании первого экземпляра атомной бомбы.

Принять внесенный т.т. Ванниковым, Курчатовым и Первухиным проект Постановления Совета Министров Союза ССР „Об испытании атомной бомбы" и представить его на утверждение Председателя Совета Министров Союза ССР товарища Сталина И.В.

/проект прилагается/.

Председатель Специального Комитета при Сов. Мин. СССР

Л. Берия.
/Л. Берия/

Fig. 1.30. Minutes of the Special Committee's meeting regarding approval of the draft of Resolution of the Cabinet Council of USSR "Regarding testing of a nuclear bomb" signed by L. Beria

Upon successful testing of the bomb, L. Beria wrote a gleesome report to Stalin (Fig. 1.29). Afterwards, the Special Committee prepared a special Resolution of the Cabinet Council of USSR "Regarding testing of the nuclear bomb" (fig. 1.30). The majority of the scientists who engineered the bomb were granted governmental awards. The project supervisor I.V. Kurchatov received special laurels from J. Stalin (Fig. 1.31).

Successful testing of the Soviet nuclear bomb (which was named "Joe-1", derives from Josef Stalin in the USA) was a surprise for Americans and the US newspapers yelled about this sensation at the top of their voices (Fig. 1.28). When awarding Kurchatov after successful bomb testing, J. Stalin said: "If we delayed building of the nuclear bomb for 1-1.5 years, we would have "tried" its effect on ourselves."

Постановление Совета Министров СССР № 5070-1944 сс/оп
«О награждении и премировании за выдающиеся научные открытия и технические достижения по использованию атомной энергии» (выписка)

г. Москва, Кремль

29 октября 1949 г.
Сов. секретно
(Особая папка)

...Учитывая исключительные заслуги перед Советской Родиной в деле решения проблемы использования атомной энергиии в соответствии с Постановлением Совета Министров СССР от 21 марта 1946 года № 627-258, Совет Министров Союза ССР ПОСТАНОВЛЯЕТ:

1. КУРЧАТОВА Игоря Васильевича, академика, научного руководителя работ по созданию атомных реакторов и атомной бомбы:
— представить к присвоению звания Героя Социалистического Труда;
— премировать суммой 500 000 руб. (помимо выданной ранее части (50 %) премии в сумме 500 000 руб. и автомашины ЗИС-110).

Присвоить акад. Курчатову И.В. звание лауреата Сталинской премии первой степени.

Построить за счет государства и передать в собственность акад. Курчатова И.В. дом-особняк и дачу, с обстановкой.

Установить акад. Курчатову И.В. двойной оклад жалования на все время его работы в области использования атомной энергии.

Предоставить акад. Курчатову И.В. право (пожизненно для него и его жены) на бесплатный проезд железнодорожным, водным и воздушным транспортом в пределах СССР.

Председатель Совета Министров Союза ССР И. Сталин

Fig. 1.31. Extract from Resolution of Cabinet Council of USSR regarding awarding of Kurchatov I. V. for "outstanding merits to Soviet Motherland". This top secret decree of the Council of Ministers of the USSR of October 29, 1949 refers about awarding the atomic energy research supervisor I. Kurchatov with a considerable monetary prize, a personal house, a dacha, awarding him with honorary titles of the USSR, etc.

1.5 Thermonuclear bomb

Long before RDS-1 testing in 1945, NKVD started obtaining intelligence information about a new type of nuclear bomb – a so called "super-bomb" – which was under development in the USA. This lead to establishment of a small research group at the Institute of Chemical Physics of Academy of Science of USSR, chaired by Yakov Zeldovich. In the spring of 1948, Klaus Fuchs delivered an especially large and detailed file about the super-bomb to Soviet intelligence. To work on this, an additional group was formed, (intended to help Zeldovich's group) lead by Igor Yevgeniyevich Tamm at the Physics Institute of Academy of Science of USSR (PIAS) in the summer of 1948. Tamm's students – Andrey Dmitriyevich Sakharov and Vitaliy Lazarevich Ginzburg (Fig. 1.32) – were also part of this group.

Fig. 1.32. Founders of the theory of Soviet thermonuclear bomb Academy Fellows: Igor Yevgeniyevich Tamm, Andrey Dmitriyevich Sakharov and Vitaliy Lazarevich Ginzburg

After visiting CB-11 and getting familiarized with the design of RDS-1 (fall of 1948), D. Sakharov decided to add a layer of light-weight elements into a uranium container surrounding plutonium core. Thus, a scheme was utilized in which fission and fusion fuel were "layered", a design known as the "Sloika" (Russian layered cake). A similar design was much earlier theorized by Edward Teller in the USA. At the end of August 1946, Teller proposed a new bomb configuration, which he dubbed the "Alarm Clock." The scheme alternated spherical layers of fissionable materials and thermonuclear fuel (deuterium, tritium and possible their chemical compounds). In September 1947, Edward Teller proposed the application of a new thermonuclear fuel in the"Alarm Clock": lithium-6 deuteride, which was supposed to greatly enhance the production of tritium during explosion and thereby substantially increase the thermonuclear combustion efficiency. Still unbeknownst to the

American team, in March 1948 in London, Klaus Fuchs provided a Soviet agent with information on the progress of the ”Classical Super” (Klaus Fuchs departed from Los Alamos on June 15, 1946 but research and development on the hydrogen bomb continued on).

This design was expected to make significant increase in blast capacity. The other participant of the group – V. Ginzburg – offered to substitute heavy water (suggested by D. Sakharov) by a promising lithium-6 deuteride (as in” Alarm Clock”).

In 1949, Directors of PIAS, S.I. Vavilov and Yu. B. Khariton informed L. Beria about a so called Sakharov’s “sloika”, so a new R&D plan to build a thermonuclear bomb (RDS-6) during 1949-1950 was approved during the summer meeting of CB-11 in 1949. This plan envisaged putting efforts both into Sakharov’s “sloika” – RDS-6s and into “Tube” – RDS-6t (a so-called project “Classic Super”, stolen in the USA).

After Harry Truman announced that the USA would start working on a “thermonuclear or super-bomb” (January 31, 1950) as a response to successful testing of a nuclear bomb in USSR, the Special Committee called a meeting chaired by Beria, who resolved to accelerate the efforts on creation of its own super-bomb. In order to implement this solution, a group headed by I. A. Tamm, which consisted of A.D. Sakharov, Yu. A. Romanov and Tamm himself was moved to CB-11 to work on RDS-6s (“sloika”). Two members of his group jews: Vitaliy Ginzburg and Yefim Fradkin stayed at PIAS as they faced problems with getting access to top-secret jobs. Semen Belenkiy was also not moved, due to health issues.

The group of Ya. Zeldovich kept on working on foreign “Tube” at the Institute of Chemical Physics of Academy of Science of USSR till the end of 1953 (in other words, almost 6 years), when these efforts were recognized as meaningless. The Americans drew this conclusion 4 year earlier, based on calculations of American mathematician Stanislav Ulam, who proved unfeasibility of the “Classic Super” project using mathematical methods in 1950. Edward Teller (fig. 1.33), American physicist, used this conclusion to define new principles of the thermonuclear bomb’s design in 1951. This design of a thermonuclear bomb was called Ulam-Teller’s design. Overpressure for hydrogen-3 and deuterium in this design was achieved by focusing of reflected radiation after a preliminary blast of small nuclear explosive inside the bomb, rather than by a detonation wave caused by the explosion of ordinary chemical explosives.

On November 1, 1952, the USA tested Ivy Mike (Operation Ivy) – a thermonuclear device equivalent to 10 megatons in TNT, based on Ulam-Teller’s principle. The tests were conducted on Elugelab Island, Enewetak Atoll (Marshall Islands in the Pacific Ocean). However, “Mike” was not a bomb.

Fig. 1.33. The “fathers” of American thermonuclear bomb: Edward Teller, Stanislav Ulam and Richard Garwin.

Fig. 1.34. The world’s first high capacity thermonuclear explosive Ivy Mike based on Ulam-Teller’s principle

It was a huge unit (Fig. 1.34), developed by Richard Garwin. It was as big as a two-storey house and weighed 74 tons. In addition to that, it implemented liquefied deuterium in a cryogenic state, so it did not have any chance to become a real weapon.

After this test, the USSR streamed all its efforts to the thermonuclear bomb. Neither Stalin’s death, nor Beria’s arrest halted this work. Eventually, on August 12, 1953, the first Soviet thermonuclear bomb was tested in Semipalatinsk.

Fig. 1.35. The first Soviet thermonuclear bomb RDS-6s (“sloika”)

Its capacity was “just” 400 kilotons, much more than that of nuclear bombs, but it still fell short compared to American “Mike”. Of course, Soviet RDS-6s was a full-fledged bomb (fig. 1.35), rather than a fixed installation. Nonetheless, it did not have enough capacity (did not reach even 1 Mt) to comply with the set requirements.

A new era in Soviet thermonuclear bomb's history started at the onset of 1954 due to a situation of double dead-end: recognition of hopelessness of American "Tube" on the one hand, and impossibility to increase the capacity of Sakharov's "sloika" on the other. However, in order to establish a new focus area, it was necessary to prove hopelessness of the previous two and close both of them, even though a vast amount of time and financial resources were wasted. It was not so easily achievable even after Stalin's death and Beria's arrest and required collective efforts of many scientists, including the authority of Academy Fellow Lev Landau.

The new focus area, justified by D. Sakharov and Ya. Zeldovich, was about exploiting the idea of "nuclear crimping", i.e. use of an auxiliary nuclear bomb to crimp the "sloika", rather than using the ordinary chemical explosive, as was the case with RDS-6s. In fact, this idea was not new and was touched upon in Ulam-Teller's theory. Yet, it still needed to be deployed, and it actually was a new design of CB-11.

On November 22, 1955, Tu-16 bomber dropped a bomb with a design capacity of 3.6 Megatons over the Semipalatinsk range. There were some death losses caused by testing; the radius of destruction reached 350 km; Semipalatinsk itself was also damaged.

Постановление СМ СССР № 142-84сс
«О плане производства атомных и термоядерных бомб,
а также атомных зарядов к ракетам Р-5м на 1955 год»

г. Москва, Кремль — 22 января 1955 г.
Особой важности

Совет Министров Союза ССР ПОСТАНОВЛЯЕТ:

1. Утвердить на 1955 г. план производства *атомных* и *термоядерных бомб*, а также *атомных зарядов* к ракетам *Р-5м* в количестве *158* штук, в том числе:

а) *атомных бомб* всего — *125* шт.;

б) *термоядерных бомб* всего — *8* шт.;

в) *атомных зарядов* к *ракетам* в количестве — *25* шт.

2. Обязать министра среднего машиностроения т. Малышева:

а) в 10-дневный срок утвердить в пределах годового плана на 1955 г., установленного настоящим Постановлением, поквартальный выпуск *атомных* и *термоядерных бомб*, а также *атомных зарядов* к *ракетам* исходя из утвержденного плана выпуска *плутония* и *урана-235*;

б) представить на утверждение Совета Министров СССР себестоимость *плутония* и комплектных изделий *РДС* (без *зарядов*) на 1955 г.

Заместитель Председателя Совета Министров Союза ССР Н. Булганин
Управляющий делами Совета Министров СССР А. Коробов

Fig. 1.36. Resolution of Cabinet Council of USSR No. 142-84ts "Regarding plan of building of nuclear and thermonuclear bombs". In this top secret document of January 22, 1955, a plan for the production in the USSR of atomic and thermonuclear bombs and missile charges in 1955 is given.

It was the beginning of the nuclear arms race. The Resolution of Cabinet Council of USSR approved the plan of batch building of nuclear bombs in the country (Fig.1.36). Simultaneously, the second nuclear weapon center – Scientific and Research Institute 1011 – was established in order to speed up engineering and building of nuclear weapons. The new institute immediately received part of CB-11's work (Fig. 1.37) and the work schedule was established.

Постановление СМ СССР № 586-362сс
«О мероприятиях по организации работ
и ускорению ввода в эксплуатацию НИИ-1011»[1]

г. Москва, Кремль — 24 марта 1955 г.
Сов. секретно
(Особая папка)

В целях усиления работ по разработке новых типов *атомного* и *водородного* оружия и создания условий для дальнейшего роста научно-исследовательских и конструкторских кадров в этой области Совет Министров Союза ССР ПОСТАНОВЛЯЕТ:

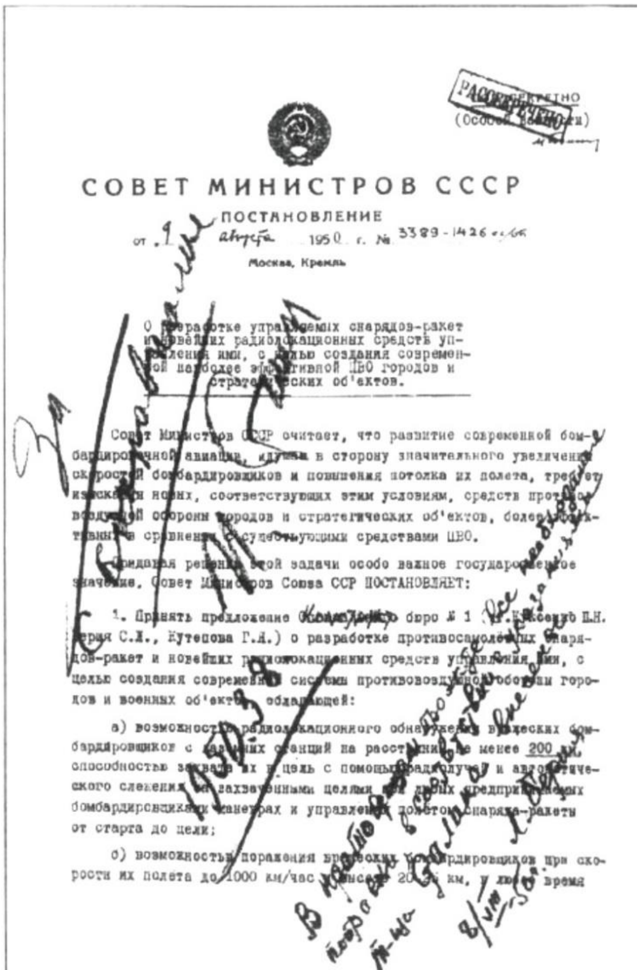
1. Определить основными задачами Научно-исследовательского института № 1011 Министерства среднего машиностроения разработку авиационных *атомных* и *водородных* бомб различных конструкций и специальных зарядов для различных видов *атомного* и *водородного* вооружения.

2. Утвердить на 1955 г. следующие основные задачи НИИ-1011:

а) разработать эскизный проект *атомной* бомбы с полным тротиловым эквивалентом *80–100* тыс. тонн в габаритах изделия *РДС-6* с новым экономичным *атомным* зарядом (с исключением этой темы из плана КБ-11 на 1955 г.);

Fig. 1.37. Extract from the Resolution of Cabinet Council of USSR No. 586-362ts "Regarding measures to set up operation and speed up commissioning of R&D Instituted-1011". In this top secret decree of the Council of Ministers of the USSR dated March 24, 1955 refers to the creation of a new research institute No. 1011 to accelerate the production of nuclear and thermonuclear weapons.

Fig. 1.38. Fishman David Abramovich, the Hero of Socialist Labor, Doctor of Technical Science, Professor, Prize Winner of Lenin's Award and two USSR State Awards, Honored Scientist and Engineer of RSFSR, the first Deputy of Chief Design Engineer of CB-11 and R&D Institute-1011



РАССЕКРЕЧЕНО
(Особой папки)

СОВЕТ МИНИСТРОВ СССР
ПОСТАНОВЛЕНИЕ
от 9 августа 1950 г. № 3389-1426 сс/оп
Москва, Кремль

О разработке управляемых снарядов-ракет и новейших радиолокационных средств управления ими, с целью создания современной наиболее эффективной ПВО городов и стратегических об'ектов.

Совет Министров СССР считает, что развитие современной бомбардировочной авиации, идущее в сторону значительного увеличения скоростей бомбардировщиков и повышения потолка их полета, требует изыскания новых, соответствующих этим условиям, средств противовоздушной обороны городов и стратегических об'ектов, более эффективных в сравнении с существующими средствами ПВО.

Придавая решению этой задачи особо важное государственное значение, Совет Министров Союза ССР ПОСТАНОВЛЯЕТ:

1. Принять предложение Специального бюро № 1 (тт. Куксенко П.Н., Берия С.Л., Кутепова Г.А.) о разработке противосамолетных снарядов-ракет и новейших радиолокационных средств управления ими, с целью создания современной системы противовоздушной обороны городов и военных об'ектов, обладающей:

а) возможностью радиолокационного обнаружения вражеских бомбардировщиков с наземных станций на расстоянии не менее 200 км, способностью захвата их в цель с помощью радиолучей и автоматического слежения за захваченными целями при любых предпринимаемых бомбардировщиками маневрах и управлением полетом снаряда-ракеты от старта до цели;

б) возможностью поражения вражеских бомбардировщиков при скорости их полета до 1000 км/час на высоте 20 км, в любое время

Fig. 1.39. Resolution of Cabinet Council of USSR No. 33389-1426ts/pi dated August 9, 1950, signed by J. Stalin and signing statement of L. Beria. In this top secret decree of the Council of Ministers of the USSR with I. Stalin's visa states the beginning of the development and creation of anti-aircraft missiles with atomic warheads.

The new institute was located in a small town – Snezhinsk – situated at the eastern foot-hills of the middle of the Urals, somewhere between Sverdlovsk and Chelyabinsk on the Sinara lake shores. Today, this institute is known as All-Russia R&D Institute of Technical Physics (ARRDITP) or Chelyabinsk-70. The area where it is located is called "Closed territorial and administrative division Snezhinsk"; there are 60,000 people living in this area. Some top-notch specialists from CB-11 were moved to the new institute. For instance, Fishman D. A., the first Deputy of Chief Design Engineer of CB-11 became the first Deputy of the Chief Design Engineer of R&D Institute-1011.

1.6. Nuclear test explosions

The first high-altitude explosions and the first measurement of their damage effect parameters, including those of HEMP, were conducted in USSR during testing of nuclear surface-to-air missile of air defense, developed in compliance with the Resolution of the Cabinet Council of USSR No. 33389-1426ts/pi dated August 9, 1950 (Fig. 1.39).

The first air defense system based on surface-to-air missile (SAM) equipped with nuclear war-head was S-25 “Berkut” (“SA-1 Guild” in NATO classification). One of modifications of these air defense systems used a missile type 215 (ZUR-215), Fig. 1.40, with a nuclear war-head fitted with RDS-9 explosive.

This nuclear explosive was also used in the battlefield missile system, Frog-3 (2K6) developed by R&D Institute-1 (Moscow Institute of Thermal Engineering). A missile launcher on an amphibian tank PT-76 was engineered by Artillery Central R&D Institute-58. A special war-head 3N14 with 901A4 (RDS-9) explosive was developed by CB-11 for the Frog-5 missile. Due to restrictions imposed by a nuclear explosive, the war-head featured increased maximum diameter and was shaped differently compared to the Frog-3 missile with an external-blast warhead (see Fig. 1.41).

Fig. 1.40. SAM ZUR-215 type of S-25 air defense system (“Berkut”)

Fig. 1.41. Missile launcher of battlefield missile system Frog-3 featuring external-blast warheads (left) and Frog-5 featuring nuclear warheads (right).

An explosive with a capacity of 10 kt was fitted into a body (maximum diameter – 540 mm) with cone fairing and a truncated cone-shaped tail part. The weight of 3N14 was 503 kg. Due to large over-caliber of the warhead, Frog-5 was 10.6 m long and its all-up weight was 2.3 tons.

This technical solution – increased diameter of the warhead (i.e. use of a so called over-caliber warhead) to fit a nuclear explosive – was copied from a similar class American missile, Honest John (MGR-1) equipped with a nuclear warhead W7 (20 kt), Fig. 1.42.

Fig. 1.42. Missile launcher with Honest John (MGR-1) with an over-caliber warhead for nuclear warhead option.

Obviously, "borrowing" of military secrets in the USA, both in the field of nuclear ammunition and in the field of missile engineering, was so much more efficient and beneficial that it keeps on going in the modern era. For example, it is worth mentioning the newest American supersonic missile, engineered by Defense Advanced Research Project Agency – DAPRA (US agency developing perspective ammunition). This missile is now being tested both in the USA and in Russia (Fig. 1.43) by the Central R&D Institute of Aerospace Defense Forces (CRDIADF), more specifically by its Air-Defense R&D Center in Tver town. It is known that modern radar facilities are equipped with recognizing systems based on both target's Doppler features and its so called "radar portrait". So, this R&D center is busy "drawing the portrait" of the newest American missile, which has not been commissioned yet, similar to many other samples of American missiles and military planes.

Fig. 1.43. The newest American supersonic missile at the R&D Air-Defense Center of Central R&D Institute of Aerospace Defense Forces in Tver town.

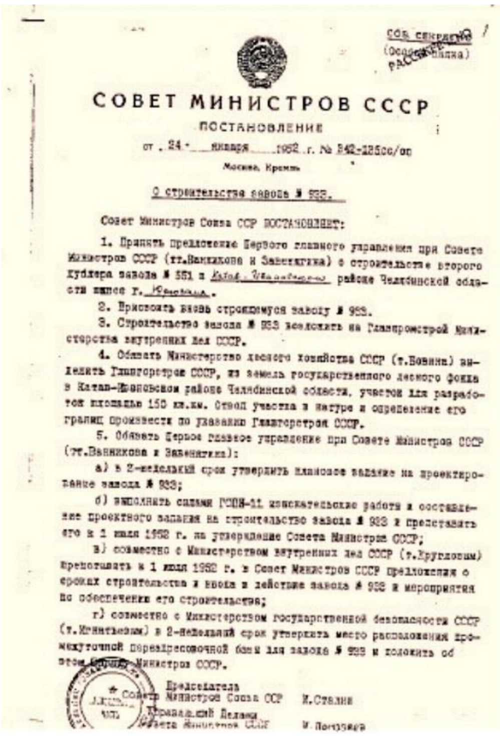
As for the above mentioned Frog-3, the author had a chance to study this system and subsequent 9K52 ("Frog-7") during military training when author was a student of Kharkov technical institutes. Later on, author was exposed to them during annual military field training at a missile battalion of the 25th division of the land forces named after Chapayev. The shape of Frog-3 was rather strange (Fig. 1.44): it featured a two-chamber solid-fuel engine 3ZH6 (like two missiles connected in series). This was a single-stage engine, but with two chambers placed one after the other inside a common body. The head chamber had a set of tube jets placed in the middle of the body at a certain angle to twist the missile along the axis, when in flight, while the tail chamber was equipped with ordinary jets.

Fig. 1.44. Unusual shape of Frog-3

In other words, the missile seemingly had two propulsion engines working simultaneously to increase the power. It was especially important for a heavier missile with a nuclear warhead. On the other hand, availability of two separate solid-fuel propellant sticks required additional pre-launch preparation of the missile in order to reduce scatter of the engine's parameters during its operation, i.e. reduction of circular error probable – CEB (measurement of target accuracy). In order to achieve this, it was necessary to raise the guide member with a missile into a vertical position and then return to a required position based on calculations.

Tube jets in the middle of the missile's body made it look like a fire ball when it was flying. Though two propellant sticks were working simultaneously, their capacity was still low for the start, thus once leaving the guide ways, the missile "sank" to about half a meter above the ground and then started its flight from this altitude. No wonder the CEB of this missile was up to 2 km with the flying range of up to 32 km.

Resolution of the Cabinet Council of USSR No. 342-135ts/pi, dated January, 1952 (Fig. 1.45), stipulated beginning of construction of plant No. 933. Later on it bore other names, such as: enterprise P. O. Box 17, then enterprise P. O. Box G-4146. This plant (contemporary name "Instrument Making Plant") located in Tryokhgorniy town, Chelyabinsk region (code names: "Zlatoust-20", then "Zlatoust-36") started building nuclear explosives, engineered by CB-11, including RDS-9.


Сов. секретно
(Особая папка)

СОВЕТ МИНИСТРОВ СССР
ПОСТАНОВЛЕНИЕ
от 24 января 1952 г. № 342-135сс/оп
Москва, Кремль

О строительстве завода № 933.

Совет Министров Союза ССР ПОСТАНОВЛЯЕТ:

1. Принять предложение Первого главного управления при Совете Министров СССР (тт.Ванникова и Завенягина) о строительстве второго куйлера завода № 551 в [illegible] районе Челябинской области вблизи г. [illegible].

2. Присвоить вновь строящемуся заводу № 933.

3. Строительство завода № 933 возложить на Главпромстрой Министерства внутренних дел СССР.

4. Обязать Министерство лесного хозяйства СССР (т.Бовина) выделить Главпромстрою СССР, из земель государственного лесного фонда в Катав-Ивановском районе Челябинской области, участок для разработок площадью 150 кв.км. Отвод участка в натуре и определение его границ произвести по указанию Главпромстроя СССР.

5. Обязать Первое главное управление при Совете Министров СССР (тт.Ванникова и Завенягина):

а) в 2-недельный срок утвердить плановое задание на проектирование завода № 933;

б) выполнить силами ГСПИ-11 изыскательские работы и составление проектного задания на строительство завода № 933 и представить его к 1 июля 1952 г. на утверждение Совета Министров СССР;

в) совместно с Министерством внутренних дел СССР (т.Круглова) представить к 1 июля 1952 г. в Совет Министров СССР предложения о сроках строительства и ввода в действие завода № 933 и мероприятия по обеспечению его строительства;

г) совместно с Министерством государственной безопасности СССР (т.Игнатьева) в 2-недельный срок утвердить место расположения промежуточной перевалочной базы для завода № 933 и доложить об этом [illegible] Министров СССР.

Председатель
Совета Министров Союза ССР И.Сталин
Управляющий Делами
Совета Министров СССР М.Помазнев

Fig. 1.45. Top secret Resolution of Cabinet Council of USSR No. 342-135ts/pi dated January 24, 1952 signed by I. Stalin, refers to the creation of special plants No. 933 for the production of atomic charges and auxiliary equipment.

The first missile launch with a real nuclear explosive was performed from the Kapustin Yar range (official name: The 4th State Central Cross-Branch Range of Russian Federation - the 4th CCBR; military unit 15644), located in the northwest part of the Astrakhan region, close to a small town called Znamensk (closed territorial and administrative division "CTAD Znamensk"). The range was established on May 13, 1946 as a central range for the Ministry of Armed Forces of USSR (former name of the Soviet Ministry of Defense) to test the first Soviet ballistic and SA missiles. On February 2, 1956, the missile type R-5M (8K51) (SS-3 Shyster in NATO classification) with a nuclear warhead was launched from this range. This missile was engineered at the Experimental Design Bureau (EDB) of R&D Institute-88 (today's name: Central Research and Development Institute of Machine Building, Korolyov town, Moscow region) chaired by S. P. Korolyov. Upon heading 1,200 kilometers eastwards, the missile delivered the warhead to a desert near Arkalyk town (Kazakhstan), where it exploded. The capacity of nuclear explosive was about 3 kilotons.

Fig. 1.46. Photo of the missile type R-5M (SS-3 Shyster in NATO classification) with a crossed-out "Top Secret" label during pre-launch preparation on Kapustin Yar range.

The first high-altitude nuclear explosion code named “ZUR-215” was performed in the USSR on January 19, 1957, (i.e. before a similar US test under “Yucca” project in April of 1958) upon blasting of a RDS-9 nuclear explosive with a capacity of 10 kt, mounted on SAM 215, (Fig. 1.40) launched from the Kapustin Yar range.

The purpose of this mission was to study damage effects of high-altitude nuclear explosion onto planes, flying in a tight formation (two radio-controlled targets – IL-28 bombers – as well as ground facilities were located 500 m and 1,000 m away from the point of explosion).

The plane’s radar beacon (transponder) was used as a target for missile aiming (the transponder’s signal was caught by the SAM aiming system’s radar). The transponder was previously dropped from the plane and was gradually descending on a parachute. Upon reaching the transponder, the warhead was blast at the altitude of about 10 km.

Instruments equipped with telemetry devices for data transfer, placed in 16 special cylinder-shaped containers, were used to acquire data of the nuclear explosion’s damage effects. These containers were previously dropped from planes in such a way as to have some of them approximately on the explosion’s altitude (at various distances away from it) and some of them – on other altitudes. The actual position of containers at the moment of nuclear explosion and position of the explosion point itself were determined by photo survey from ground facilities (from 4 directions). Additional ground facilities were established to measure parameters of impact wave, light emission, (spectrum, integrated flux and time) as well as direct nuclear radiation. Dummy models of wooden buildings were built close to the zero point and in some other locations.

Both target planes were downed by the explosion: the first plane, flying away from the burst point caught on fire, the other plane, which was flying almost directly towards the impact wave, lost a wing.

Instruments mounted on these planes did a good job and the data were transferred to the ground via telemetry. Later on, these results were used to determine criteria and damage area of planes in case of nuclear explosion.

Ground observation stations did not register any noticeable impact of the explosion on the wooden buildings and their windows.

Further nuclear tests, conducted on November 1 and November 3 of 1958, (supposed to be carried out at the altitude of 20-25 km) were a failure due to defects in safety and arming units (SAU) of the warheads. SAU is a system of arming, safeguarding (in case of emergencies) and self-destruction. SAU of nuclear warheads features multi-level arming. For example, in case of Frog-7A with ground-to-ground missiles (9M21B) equipped with 9N32 warhead, (which author studied) the first safeguarding stage is deactivated upon leaving the guide way and detachment of control cable; the second – upon reaching design conditions of the on-board power source (ampule battery); the third – upon reaching a certain velocity of the missile, (determined by the airstream pressure sensor) and the fourth – upon a signal from the Doppler radar altimeter. Other types of missiles may employ different control parameters of SAU’s safeguarding stages. For example, the SAM 215 type employs an air pressure transducer, which determines the altitude of a missile. Failures of tests carried out on November 1 and November 3 of 1958 were a result of fault actuation of these SAU sensors, which lead to warhead explosion at 12 km instead of 20–25 km, as designed.

The next successful high-altitude nuclear explosion was performed after 3 years (mission “Thunderstorm”). This long break is attributed to numerous negotiations between the USA and the USSR regarding conclusion of a test-ban treaty, as well a temporary unilateral obligation, which either the USA or the USSR accepted from time to time. After a collapse of talks, a new high-altitude nuclear explosion was performed above the Kapustin Yar range on September 6, 1961. The target for the guiding system’s radar of the SAM 215 type, which carried a nuclear explosive, was represented by a passive corner reflector, which was delivered to 20 km altitude (design point of explosion) by an air-balloon. This air-balloon also carried instruments containers to measure gamma rays and other parameters of the nuclear explosion. In order to conduct additional measurements of γ- and β-emissions, two SAM 207 type missiles (built by Tushinskiy Machine-Building Plant) were launched from an S-25 system (SA-1 Guild) into the atomic cloud, but they carried measuring instruments instead of explosives in their head parts.

The first tests of EMP-affected radar systems’ efficiency and that of electronic equipment placed into containers were carried out during this “Thunderstorm” mission. The tests were performed by tracking the “measuring” of 207 type missiles under EMP impact occurring upon nuclear explosion.

Another successful high-altitude nuclear explosion was performed above the Kapustin Yar range on October 6, 1961 (“Thunder” mission). This mission was carried out to study the damage effects of a high-altitude nuclear explosion for the benefit of Anti-Ballistic Missile Defense (ABM Defense). A middle range R-5M (SS-3 Shyster), Fig. 1.43, raised a nuclear explosive with a capacity of 40 kt to about 40 km, where it eventually burst. Four heat-resistant steel spherical containers (diam. 50 cm) with data acquisition equipment were used to record the damage effects. The containers were attached directly to the missile under special fairing. Upon actuation of separation charges, (after receiving a radio signal at the set time) the containers were discharged from the missile, stretching steel ropes with distance sensors mounted 20 m apart. These sensors measured the distance of the containers from the burst point (it was 140–150 meters at the moment of explosion). After explosion, the containers fell on the ground. Later on they were searched for using special devices. In addition to that, similarly to the above mentioned case, two 207 type missiles with data-acquisition equipment were launched into the atomic cloud. Similarly to the previous case, both main damage effects of nuclear explosion and EMP impact on electronic equipment placed into containers were studied.

Unlike the USA, all technical reports on the above mentioned tests are still classified in Russia. Thus, it is not possible to obtain any new findings regarding HEMP even today.

Trying to make up for the 3 years which were lost, the USSR carried out a series of additional high-altitude nuclear explosions (in addition to “Thunderstorm” and “Thunder”) during 1961–1962 (mission “K” - Kosmos).

Similarly to previous tests, missiles were launched from the Kapustin Yar range. However, the blast took place above the Sary-Shagan range in Kazakhstan (the State R&D and Testing Range No. 10 of the Ministry of Defense of USSR – SRDTR-10; administrative center – Closed territorial and administrative division CTAD Priozyorsk) rather than above Kapustin Yar. This means that the missiles with nuclear warheads were flying from the Astrakhan region (Russia) to Kazakhstan, literally above the heads of Soviet civilians.

Fig. 1.47. Placement of R-12 missile (SS-4 Sandal) on a launching cradle

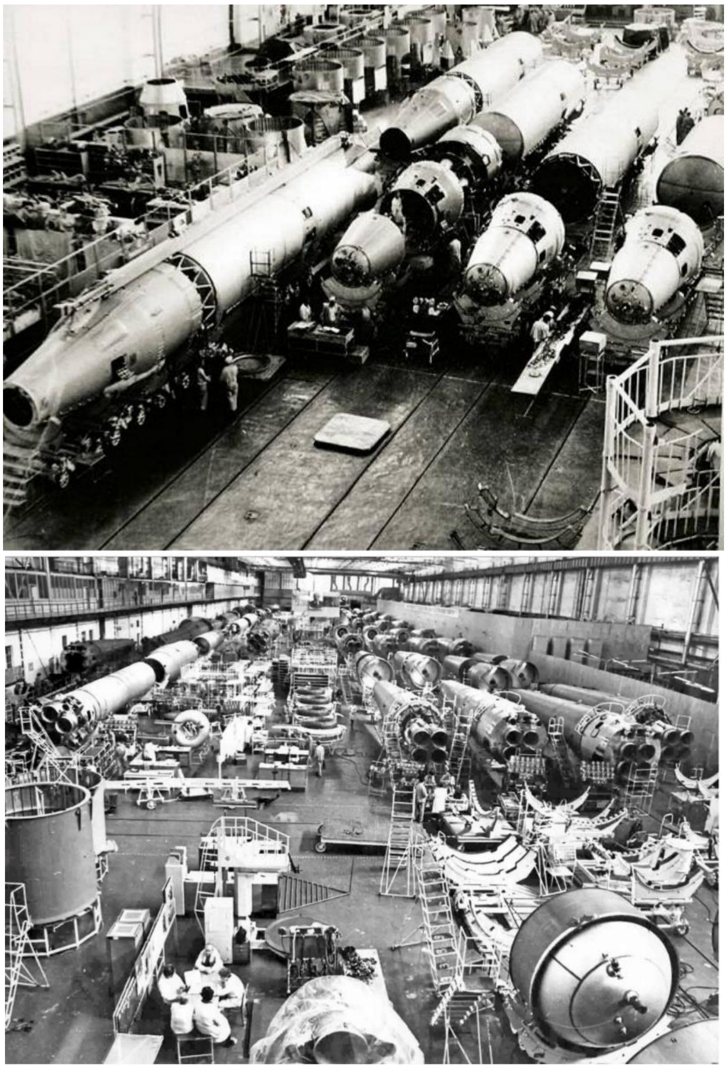


Fig. 1.48. Batch assembly of strategic R-9A (8K75) missiles (SS-8 Sasin) at Kuybyshev plant “Progress”.

On October 27, 1961, two middle-range missiles type R-12 (SS-4 Sandal), Fig. 1.47, with low-capacity nuclear explosives (1.2 kilotons) were launched from Kapustin Yar. These missiles were engineered at EDB-586 (CB “Yuzhnoye”, Dnepropetrovsk) under the direction of Chief Design Engineer M. K. Yangel. These explosives were blast at 150 km above ground (mission “K-1”) and 300 km above ground (mission “K-2”), i.e. almost in space. The purpose of these tests was to check the effect of space nuclear burst (including HEMP) impact on radio communication equipment and radars; to study physical processes accompanying space bursts and check possibility of their detection.

On October 22, October 28 and November 1 of 1962, three more high-altitude explosions were carried out: “K-3” – at 290 km; “K-4” – at 150 km and “K-5” – at 59 km. These bursts employed thermonuclear high-capacity explosives (300 kilotons).

Fig. 1.49. Map of Kazakhstan with trajectories of SS-4 Sandal (from Kapustin Yar), 207 missiles (from Sary-Shagan) and SS-8 Sasin (from Baikonur) launched within “K-3” project

On October 22, the plan envisaged launching of the R-9A (8K75) missile (SS-8 Sasin in NATO classification) in addition to SS-4 Sandal and “measuring” 207 type SAM, launched from Sary-Shagan towards it. The missile was engineered by EDB-1 of R&D Institute-88 under the direction of S. P. Korolyov, whereas the control system was developed and produced by Kharkov Scientific and Production Center “Electropribor” (EDB-692; P. O. Box 67; SPC “Khartron”).

The batch production of these missiles was set up at Kuybyshev (Samara town) plant “Progress” (now “Missile and Space Center “Progress”), Fig. 1.48.

SS-8 Sasin was expected to start from the Tyura-Tam range (other names: R&D and Testing Range of R&DIP-5; military unit 11284; “Taiga” facility; Baikonur) within the framework of the second stage of its flight development tests and to pass as close to the burst point as possible (Fig. 1.49).

The purpose of the test was to look into reliability of radio control equipment, evaluate accuracy of motion measurements and determine the impact of a nuclear explosion onto the level of incoming signals (both on on-board and ground receivers of missile radio control system). In other words, they researched HEMP impact on a missile’s control system. Thus, the test of October 22 served several purposes. Firstly, it was another check of reliability of the nuclear weapon carrier. Secondly, it was the check of the explosive itself. Thirdly, there was a need to explore the damage effects of a nuclear explosion and its effect on various types of military machinery, including missiles and military satellites. Fourthly, there was a need to check fundamentals of ABM Defense system “Taran”, offered by V. N. Chelomey. The system was expected to knock down enemy’s missiles by a series of nuclear explosions on their way. The development of the ABM Defense system “Taran” was stipulated by the Resolution of the Central Committee of CPSU and the Cabinet Council of USSR dated May 3, 1963. EDB-52 (chaired by V. N. Chelomey) and the Radio Engineering Institute of Academy of Science of USSR (chaired by Academy Fellow A.A. Mints) were appointed as principal engineering organizations. The system was supposed to employ long range UR-100 (8K84) missiles, (SS-11 mod. 1 SEGO in NATO classification) with thermonuclear warheads with a capacity equal or above 10 Mt. Later on, this project was severely criticized and thus had never been deployed. Calculations, offered by Director of Applied Mathematics Institute, Academy Fellow M.V. Keldysh, were among the reasons of failure. The calculations suggested that considering the stated specifications of the “Taran” system, it would waste countermissiles excessively. For example, in order to intercept 100 “Minuteman” missiles, (American intercontinental ballistic missile) the system would need 200 missiles of SS-11 mod. 1 SEGO type. A perspective of blasting hundreds of thermonuclear bombs with a capacity of 10 Mt each over your own country did not seem attractive either for scientists or for political elite of the country. However, back in 1962, i.e. before even taking a decision regarding development of the “Taran” system, there was an attempt to check the principal idea of V. N. Chelomey, whether or not it is possible to intercept long-range missiles by means of high-capacity high-altitude nuclear explosion. That is why the SS-8 Sasin missile was launched to the nuclear weapon burst point. But on October 22, the launch was a complete failure. The combustion chamber of the primary stage broke down 2.4 seconds after starting and the missile fell down 20 m away from the launching cradle.

Since the attempt to test interception of strategic missiles failed, another test was carried out a week later, i.e. on October 28 (K-4). This test was almost an exact copy of the previous one both in terms of its set up, (except for lower design altitude of nuclear explosion) and in terms of its results. The missile made it to several dozen meters and the combustion chamber of the primary stage broke down. The missile sank and fell down on the launching cradle resulting in severe damage. Nonetheless, other parts of the research ended up successfully, since interception of a missile by means of high-altitude nuclear explosion was not the only aim of the tests. In addition to studying damage effects of nuclear explosion, the aim of the tests was to obtain experimental data regarding geophysical phenomena accompanying high-altitude explosions, particularly, the explosions' impact on the ionosphere. Parameters of artificial van Allen belts occurring in space were also measured. In order to do this, "Kosmos-3", "Kosmos-5" and "Kosmos-7" satellites were launched before the tests. Another objective was to determine HEMP impact on radars, radio and cable communication systems. Some investigations were made as part of the objective to establish a system of nuclear explosion detection and control. Addressing of all those issues during "K" missions required significant ground and satellite observations and measurements to be carried out. For this purpose, a lot of various radio-technical aids were used. Up to twenty radar stations featuring various wave length ranges were observing the explosion area from different (up to 10) directions. Radio signals of satellites and missiles, scattered through ionized areas, were recorded by ground receiving facilities (some of them were duplicated). All permanent observation stations located in different regions of the country performed ionospheric observations. Observations of the impact of atmosphere ionization on performance of communications equipment of various wave lengths were conducted on specially developed radio waves, capable of passing through the ground zero of the nuclear explosion, as well as on multiple permanent radio lines of various lengths. Several permanent radar telescopes from various observatories were also involved into observation of space radio emission.

Additional explosion – "K-5" – was performed on November 1, 1962. The purpose of this explosion was to specify some previously obtained data, particularly, those of optical observations and measurements. Actually, development of "K-5" and parameters of its impact were close to what has been predicted (based on previous observations performed during "Thunder" and "Thunderstorm" missions). However, improved and more sophisticated investigation during "K-5" allowed to expand the pool of experimental data regarding explosion development at such altitudes.

A. N. Shchukin, two-star general, Academy Fellow, Deputy Chairman of the Military-Industrial Commission (MIC) of the Cabinet Council of USSR, performed scientific supervision of the whole bunch of full-scale and model experiments, as well as theoretic research related to these missions.

The research findings suggested that high-altitude nuclear explosions were accompanied by electromagnetic pulse (EMP) emissions in a broad range of frequencies with amplitude significantly higher than that of ground explosions of the same capacity. It was also found that registration of nuclear explosion's EMP was possible at higher (up to 10,000 kilometers) distances from the explosion epicenter. Performed geomagnetic measurements confirmed that an observer located almost anywhere on the globe could identify powerful nuclear explosions at 100-150 km altitudes.

However, it should be admitted that precise and consistent interpretation of many data was found to be more complicated than initially assumed, and required development of comprehensive models and calculation methodology for high-altitude nuclear explosions.

Unfortunately, technical reports with the results of tests and measurements of all these explosions are still classified in Russia. Some indirect data can be obtained from partially declassified multi-page CIA reports related to these tests (fig. 1.50). The label "Top Secret" is crossed out, but the sources of information have been deleted and nuclear explosives are marked with "JOE" plus corresponding figures. Missile types are denoted according to American classification (e.g. SS-1, SS-2, etc.).

The only source of technical information regarding HEMP (studied under "K" project as one of the damage effects of nuclear explosion) is represented by a report of the Principal (at that time) of the Central Physical and Technical Institution of the Ministry of Defense of Russian Federation (military unit 51105; CR&DI-12; Sergiyev Posad-7; facility "Ferma"; Federal State-Owned Enterprise "The 12th Central Research and Development Institute" of the Ministry of Defense of Russian Federation), Brigadier General Loborev V. M, which was made up subject to the direction of the USSR authorities during "Perestroyka" and "reset" 32 years later after completion of project "K" [1.5], as well as his article co-authored with other employees of the same Institute, published 36 years later after completion of project "K" [1.6].

Both the report [1.5] and the article of V. M. Loborev described the consequences of "K-5" nuclear explosion's EMP impact onto civil infrastructure of Kazakhstan, located within the area of exposure.

Some interesting factors are worth to be noted:

CR&DI-12 was founded in 1950 subject to the Directive of the General Staff of the Armed Forces of USSR No. 553343 dated April 26, 1950. Later on, the Institute became part of the 12th Chief Directorate of the Ministry of Defense of USSR (military unit 31600, Moscow, Znamensky Lane, 19) to research the damage effects of nuclear explosion and their impact on ammunition, military machinery, buildings and people; elaborate recommendations for armed forces to protect the staff and machinery from nuclear weapon effect and to provide scientific and methodological supervision of special weapon testing. One of the Institute's objectives was to provide scientific substantiation of the country's protection against nuclear attack. Looking at the Institute's building in Sergiyev Posad (Moscow region), the building of its branch office in St.-Petersburg (military unit 70170, Novoselskaya Street, 39E) as well as its experimental facilities featuring dozens of test benches, one can say that it's pretty large.

Fig.1.51c. Experimental and testing facility of CR&DI-12 (Moscow region)

The following test benches had to do with HEMP:

- pulse voltage generator PVG-10;
- simulators of electromagnetic pulse SEMP-B and SEMP-BM;
- "Arterit" unit intended for testing large-scale military machinery for the impact of powerful electromagnetic fields;
- "Zenith" unit to test military machinery and ammunition for the EMP impact;

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quently descended through the nuclear cloud. A missile, possibly an ABM, was probably launched about four minutes after burst time, and a second vertical firing through the cloud occurred about half an hour after burst time. In the JOE 109 operation, two possibly downrange firings were noted.

188. The 1962 high-altitude tests, JOE 157 on 22 October, JOE 160 on 28 October, and JOE 168 on 1 November, resembled those of 1961, but appeared to be more complex. All three involved the firing of three 1020 n.m. missiles from the Kapustin Yar rangehead; in each case the second missile was launched about fifty seconds after the first, and the third about six minutes after the first. As in 1961, the nuclear payloads are believed to have been carried by the first missiles.

189. JOEs 157 and 160 each had yields of 200 KT. The former was detonated at an altitude of about 160 n.m.; the latter, at an altitude of about 90 n.m. [ ] For the JOE 157 event, a missile, which probably had a purpose similar to the first vertically fired missile of the JOE 105 operation, was fired from a downrange location.

190. JOE 168 had a 1.8 MT yield and was detonated at an altitude of about 30 to 70 n.m. Unlike the other high altitude tests, JOE 168 was not one of an obvious pair of devices having identical yields but tested at different altitudes. The yield of JOE 168 was similar, however, to that of the US 9 July 1962 STARFISH device (1.45 MT) detonated 216 n.m. above Johnston Island in the Pacific. It is noted that Soviet scientific expeditionary ships were positioned both in the vicinity of Johnston Island and in the conjugate area probably to collect data from STARFISH. We believe that JOE 168, which was detonated on 1 November 1962 at 30–70 n.m., could have served along with STARFISH to give the USSR some data on high altitude effects from a pair of 1.5–1.8 MT tests at different altitudes.

191. A unique feature of all three 1962 high-altitude tests was the apparent planned use of a satellite to collect basic physical data. COSMOS XI passed over the burst point of JOE 157 within minutes of the detonation; it was at the antipodal point for the JOE 160 test at the time of detonation; and it was near the magnetic conjugate point of the JOE 168 detonation at time of burst. There is some question whether COSMOS XI was still transmitting at the time of JOE 168.

Nuclear Weapons and Systems

192. A small number of individually produced weapons for interim use could be fabricated within a few months after device testing. However, the time lag between nuclear test device and initial stockpile entry of serially produced weaponized versions is about two years at a minimum. On this basis some of the new devices tested in 1961 could be entering stockpile during the latter part of 1963 if a priority development requirement is assumed. It is estimated, however, that this could only be done on a limited scale, and that, in general, the devices tested in 1961–1962 would be stockpiled in 1964 and 1965.

Delivery Systems Information

193. [ ] indicate that the warhead assigned to the tactical SS–1a missile has a yield spectrum of 30 to 200 kilotons. [ ] data from which the warhead yield categories associated with other Soviet tactical missiles in the SS–1, SSC–1 and SS–2 categories can be generally derived. There is evidence [ ] that nuclear warheads for Soviet tactical missiles and

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Fig. 1.50. A page from CIA's report regarding high-altitude nuclear explosions performed in USSR under the "K" project.

Despite such facilities and resources, there is no word about the Institute's staff involvement and any significant achievements, either on the Institute's web-site or in scientific literature published in the USSR on the topic of nuclear testing, or in declassified documents on the nuclear project published in USSR, or in the memoirs of participants of those events. This cannot be explained by mere confidentiality. First of all, this topic was declassified long ago and secondly, employees of other scientific institutions (e.g. All-Russian R&D Institute of Experimental Physics from Saratov town) have long been publishing the articles on HEMP issues in the open domain [1.7, 1.8]. Publications of the Chief Research Fellow of CR&DI-12, Doctor of Engineering Science, Professor, Balyuk Nikolay Vasiliyevich are, perhaps the only exception to this rule. However, most of these publications regarding HEMP are not based on original research and development efforts of the Institute. They are rather a paraphrase of information previously published in old American reports. One of the typical examples is the book [1.9], published in 2013. The major portion of the text and illustrations are just a translation and paraphrase of some American 30-year old reports. Other examples include his articles in the EMC Technologies Journal co-authored with the Principle of CR&DI-12, Rear Admiral Pertsev S. F. and the first Deputy of the Chief of the General Staff of the Military Forces of Russian Federation, two-star general Burutin A. G. [1.10, 1.11]. Those are just general arguments and descriptions of equipment available at CR&DI-12 that are well known to the specialists in this field. Who will benefit from general arguments of generals and admirals, instead of specific recommendations and inventions on how to protect critical infrastructure of the country?

Fig. 1.51a. Panorama of the main building of CR&DI-12 in Sergiyev Posad (Moscow region)

Fig. 1.51b. Branch office of CR&DI-12 in St.-Petersburg

The only reference is made to the participation of the office staff in the Leningrad branch in measuring parameters of one of the underwater nuclear test explosions, as well as the above mentioned report and article of the Institute's Principal Loborev V. M. Quite a short list for 68 years, isn't it? The number of classified thesis papers accessible to a very limited circle of employees will hardly justify the existence of the Institute.

Official literature with research findings regarding HEMP impact on civil infrastructure was published by the Institute staff in English. Why? Soviet (and now Russian) civil specialists still lack information regarding HEMP impact on civil infrastructure. At the same time, one of the objectives of the Institute upon its foundation was to develop means of protection from nuclear weapons, meaning HEMP, for the country. Don't they have enough information to provide to civil specialists in the field of electric power industry, communication, water supply, as well as other specialists responsible for the country's infrastructure?

Reviewers from CR&DI-12, who review author's articles from time to time, say that it is prohibited to publish articles addressing the necessity to intensify work in the field of protection of civil infrastructure from HEMP and to offer specific technical solutions intended to ensure this type of protection. Why?

It seems that the Institute staff are afraid that civil specialists responsible for the country's infrastructure will find out about this serious problem and eventually ask why nothing has been done in this field in all these years! Eventually, somebody will have to answer this question...The Institute responsible for this matter for 68 years now will continue its cotton wool existence, while a minimum number of people are aware of the problem.

But, let us get back to the outcomes of HEMP impact onto civil infrastructure during "K-5" tests. According to data, published by V. M. Loborev [1.12] (Fig. 1.52), HEMP impact caused failures in the operation of Air Defense radar located about 1,000 km away. Breakdowns of ceramic insulators resulting in short-circuit were observed on 35 kV electric overhead power lines. Electromagnetic pulse caused fires due to short-circuit in electric appliances. A power generator was knocked out of service at one of power plants; relay protection was triggered resulting in switching the power generator off at another power plant. A slow geomagnetic component of HEMP induced a short current pulse with an amplitude of several thousand Amps, as well as a long (more than 20 sec) current pulse, rated 4 Amps. This lead to diesel-generator damage and triggering of protection devices mounted over a 570 km above-ground telephone line. There is also information about some breakages of electronic equipment, occurred at Baikonur Cosmodrome.

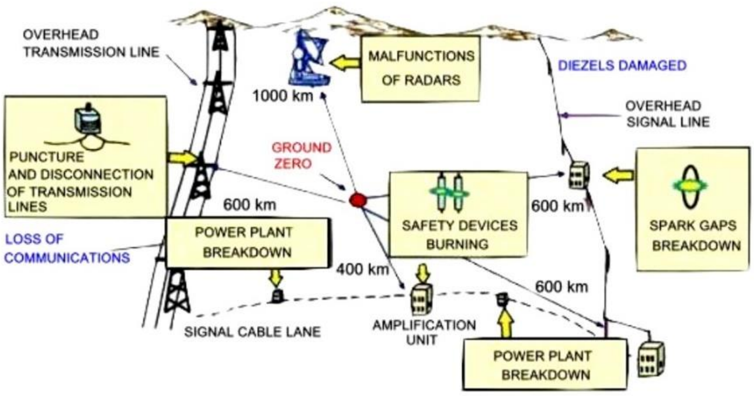
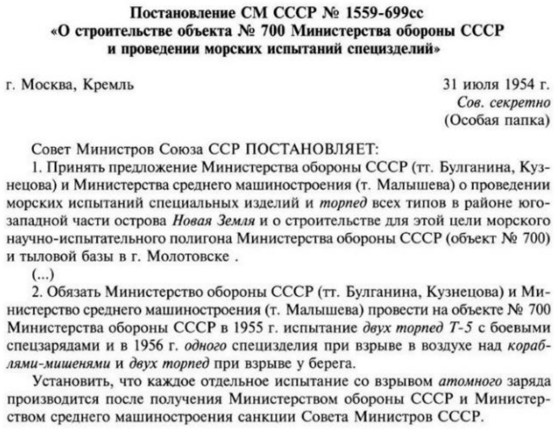


Fig. 1.52. Damaged electric equipment affected by HEMP during nuclear high-altitude test explosion performed under "K-5" project in Kazakhstan in 1962 (based on data published in V. M. Loborev's report presented at EUROEM International conference in France in 1994).

The US Nuclear Energy Agency took the advantage of the new policy of Soviet President, M. S. Gorbachyov and proclaimed principles of "perestroika", "reset" and "glasnost" (when the doors of previously well protected Soviet enterprises were opened both literally and figuratively, and when financing of many defense projects was seized). The Agency provided grant proceeds (in 1992, when the new President B. N. Yeltsin was in power) of $288,500 to prepare a technical report with analysis of effects occurred during underwater nuclear explosions, performed by USSR in the Arctic and during high-altitude nuclear explosions under the "K" project in Kazakhstan.This job was given to CR&DI-12, as its staff from Leningrad branch office were recording and measuring parameters of the Arctic nuclear explosions on the Novaya Zemlya islands (nuclear range established subject to Resolution of the Cabinet Council of USSR No. 1559-699ts dated July 1954, Fig. 1.52; other names: Facility-700; Range No. 6; Arkhangelsk-55 and Arkhangelsk-56). Whereas the staff from the Headquarter's (Sergiyev Posad) were responsible for high-altitude nuclear explosions performed under the "K" project. In fact, the report presented by V. M. Loborev and his article were a result of this job performed at the expense of American grant proceeds.



Постановление СМ СССР № 1559-699сс
«О строительстве объекта № 700 Министерства обороны СССР
и проведении морских испытаний специзделий»

г. Москва, Кремль — 31 июля 1954 г.

Сов. секретно
(Особая папка)

Совет Министров Союза ССР ПОСТАНОВЛЯЕТ:

1. Принять предложение Министерства обороны СССР (тт. Булганина, Кузнецова) и Министерства среднего машиностроения (т. Малышева) о проведении морских испытаний специальных изделий и *торпед* всех типов в районе юго-западной части острова *Новая Земля* и о строительстве для этой цели морского научно-испытательного полигона Министерства обороны СССР (объект № 700) и тыловой базы в г. Молотовске .

(...)

2. Обязать Министерство обороны СССР (тт. Булганина, Кузнецова) и Министерство среднего машиностроения (т. Малышева) провести на объекте № 700 Министерства обороны СССР в 1955 г. испытание *двух торпед Т-5* с боевыми спецзарядами и в 1956 г. *одного* специзделия при взрыве в воздухе над *кораблями-мишенями* и *двух торпед* при взрыве у берега.

Установить, что каждое отдельное испытание со взрывом *атомного* заряда производится после получения Министерством обороны СССР и Министерством среднего машиностроения санкции Совета Министров СССР.

Fig. 1.53. First page (partially) of the Resolution of Cabinet Council of USSR No. 1559-699ts regarding establishment of nuclear range on Novaya Zemlya islands.

In 1995, upon finishing work and preparation of the report, (17 paragraphs long) two executives of CR&DI-12 – the Principal, two-star general, Professor, V. M. Loborev and the Chief research worker, colonel, Doctor of Technical Science, V. M. Kondratyev – were invited to the leading nuclear centers: Lawrence Livermore National Laboratory and Los Alamos National Laboratory to lecture on the topic of electromagnetic effects of high-altitude nuclear explosions. Since neither V. Loborev, nor V. Kondratyev spoke any English, they were constantly accompanied by two interpreters. V. Kondratyev lectured about HEMP history and its recording, since he was a senior specialist in this field and his doctoral thesis was devoted to HEMP. He suggested that Soviet scientists registered HEMP (though many sensors were knocked out of service) during the very first ground testing back in 1949. This phenomenon was assumed to be used as the means of registration of remote nuclear explosions rather than a kind of weapon capable of ruining electronic equipment. Then, V. Kondratyev reported that since the USSR did not find any American data about HEMP, scientists thought that that topic was top secret in the United States. Later on, it became obvious that there were no such data in the USA. "Then, – Kondratyev said, – when we received your data, particularly the EMP formula, we noticed that they were in full compliance with ours and thus, we concluded that you took our data from our classified reports. We are familiar with calculation models of Radasky, Baum, and Longmeyer, but we couldn't check them as we didn't have high-capacity computers like those that you've got in the USA. So, our methods were different." According to V. Kondratyev, the HEMP theory was elaborated in the USSR back in 1961-1962. This was the merit of scientists from the Ministry of Communication of the USSR, who analyzed the results of HEMP impact onto communications systems. Later, V. Kondratyev listed damages of electric equipment and communication systems occurred as a result of high-altitude nuclear explosion in Kazakhstan in 1962 (see fig. 1.49). The question was how they protected communication lines after testing. He answered that subject to the initiative of the Ministry of Communication - aerial wire lines were substituted by cables, which ran in the ground. While answering further questions, V. Kondratyev mentioned breakages of military diesel generators and substations as a result of pulse overvoltage, as well as about actuation of relay protection on power lines. Answering the question about breakages of communication lines during other tests, V. Kondratyev mentioned that those breakages occurred during low-altitude explosions. As for breakages of power lines during other tests, he said that he was not aware of such data. Answering the question - whether the direction of wires (north – south; west – east) influences their susceptibility to breakages, V. Kondratyev said that it definitely does. Following, there was a series of questions regarding more general issues of nuclear testing and nuclear safety. Those were addressed by V. Loborev. Most of the answers were like this: "I am only the Principal of the Institute and not the President of the country", "Ask my government, not me"... One of the comments from the American side, which was given during one of the discussions is noteworthy: "We are not interested in protection of our national power system, since we think that any hurricane can create more serious problems in power industry". This phrase was articulated back in 1995. It is known that today this point of view of the USA is no longer shared (except for Dr. Saul Rabinowitz from Electric Power Research Institute).

1.7. The status of HEMP protection

So, what is the situation today? It should be acknowledged that nobody takes any serious steps towards protection of civil infrastructure from HEMP, either in Russia, or in any other post-Soviet country. The major institute in this field – CR&DI-12 – that has both equipment and staff, performs rare tests of some samples of military machines for HEMP resistance, ignoring critical types of civil infrastructure, such as power and water supply systems. It looks like this situation is comfortable and nobody cares about protecting Russia's infrastructure from HEMP.

The only exception is the attitude of the Ministry of Communications, who have always been interested in the HEMP impact onto civil communications systems since the onset of experiments with nuclear explosions. Several dissertations and reports on this topic emerged a bit later. There are also regulatory materials, e.g. "Provisions for resistance of common communication network's equipment, appliances and devices to IE and HEMP in Russia", approved by the decision of the State Commission for telecommunication of the Ministry of Communications of the Russian Federation No. 143 dated 31.01.1996 (not available in public domains) and others, as well as a set of Russian standards, such as: State Standard (GOST) R 52863-2007; Protection of Information; Protected automated systems; Testing for resistance to intentional powerful electromagnetic impacts; General requirements; GOST R 53111–208; Sustainability of operation of communication networks for general use.

Unfortunately, there is nothing similar in the field of electric power industry, which is as important as communication.

The opposite situation has come about in the USA. They have commercialized this issue and now it represents a well-functioning business. Dozens of professional consultants who frighten people with HEMP consequences appeared there during the last 10-20 years. Dozens of books, hundreds of reports (a list of major reports available in public domain is given in the Appendix) have been published on this topic. Dozens of private and state-owned organizations have received orders to conduct research in this field. Below is a non-exhaustive list of them:

- Metatech Corp.
- Department of Homeland Security (DHS)
- EMP Commission of Congress
- North American Electric Reliability Corp. (NERC)
- Department of Energy
- Department of Defense (DoD)
- Critical Infrastructure Partnership Advisory Council (CIPAC)
- Electric Infrastructure Security Council (EICS)

- Defense Science Board (DSB)
- US Strategic Command (USSTRATCOM)
- Defense Threat Reduction Agency (DTRA)
- Defense Logistics Agency (DLA)
- Air Force Weapons Laboratory
- FBI
- Sandia National Laboratories
- Lawrence Livermore National Laboratory (LINL)
- Oak Ridge National Laboratory
- Idaho National Laboratories
- Los Alamos National Laboratories
- Martin Marietta Energy Systems, Inc.
- National Security Telecommunications Advisory Committee
- Federal Emergency Management Agency (FEMA)
- National Academy of Science
- Task Force on National and Homeland Security
- EMPrimus
- SARA Inc.
- Neighborhood of Alternative Homes (NOAH)
- EMPact America
- Federal Energy Regulatory Commission (*FERC*)
- Electric Power Research Institute (EPRI)
- NASA
- U.S. Northern Command (NORTHCOM)
- SHIELD Act
- EMP Grid
- EMP Technology Holding
- Strategic National Risk Assessment (SNRA)
- Walpole Fire Department

It appeared that the EMP topic is nothing else than a wonderful "long-playing" tool of "bugging" the State budget. And it looks like nobody wants the "bugging" process to be finished by some certain actions aimed at protection of electric power supply systems. To support this, let me cite one of the former authorities of the US Ministry of Defense, Dr. Ashton Carter: "*Army, NAVY and Strategic command continue to think that they need to think about the problem*". Executive Director of Task Force on National and Homeland Security, Dr. Peter Vincent Pry, was more specific, when speaking on this topic: "*The problem is not the technology. We know how to protect against it. It's not the money, it doesn't cost that much. The problem is the politics. It always seems to be the politics that gets in the way*".

So, it becomes clear why nothing specific has been done anywhere in the world regarding protection of the infrastructure (and the electric power industry, specifically) from HEMP and why all the efforts are limited by multi-page reports about investigations, presentations, workshops, conferences and other types of pleasant leisure times in a circle of colleagues. The fact is that those multiple "participants of the process" are not interested in finishing the long-term investigation process, but prefer to keep the topic "afloat" in order to receive governmental financial proceeds. Author personally aware of the business and know the employees of one of such companies in the USA. The company makes hundreds of thousands of US Dollars on just frightening the executives of power companies with "bogeyman" about HEMP. Once the contract is concluded, they give specialists of power and water-supply companies (far away from HEMP problem) a song and dance about EMP and general information, which one can easily procure on the Internet free of charge.

Considering that there are hundreds of manufacturing companies all over the world that promote expensive (sometimes not necessary) HEMP protection aids, which do not always possess the declared features, (who can check?!) one can make a conclusion that HEMP is an excellent business today!

Many authors indirectly support this business as their books are nothing but "bogeyman", intended to frighten the laymen. They do not contain any technically significant information and thus, they are not interesting for specialists. Nonetheless, they create an atmosphere of fear and despair in society, while the problem can easily be resolved, provided those responsible for the country's infrastructure are willing to do something with it. Unfortunately, it is very common to hear (both in Russia and in the USA) that protection of the country and its infrastructure from HEMP is the army's domain and not of civil specialists. On the other hand, army specialists assume that their responsibility is to ensure HEMP protection of military equipment and ammunition and not of civil infrastructure. Moreover, they insist that the only efficient protection from electromagnetic pulses of a nuclear explosion is represented by the national Air and Missile Defense Systems (ADS and MDS), where more budget funds need to be invested. This attitude of Military-Industrial Commission (MIC) representatives becomes clear when comparing a relatively low cost of HEMP protection means for the most important elements and systems of the national infrastructure with the costs for development and production of an efficient multi-level missile shield, which protects the whole country. There is also lack of understanding (or unwillingness to understand) that military aids, such as ADS and MDS, are often incapable to ensure protection of the infrastructure from various types of modern nuclear explosive carriers. For example, modern strategic carriers are equipped with rather sophisticated aids to overcome existing and perspective ADS and MDS of an enemy.

Simpler, smaller-size and small-range missiles can be similarly “successful”. These missiles are fitted into standard sea containers on ships, near the coast line or even in ports, (Fig. 1.54) and are capable of carrying nuclear charges over hundreds of kilometers, while ascending to a dozen kilometer altitudes. They are the sources of EMP invulnerable to any MDS, both existing and potentially developed due to their capability of concealed approach to a target, unexpectedness of launch, ultra-low approach time and changing trajectory during cruising.

Fig. 1.54. Containers resting on ships and in ports where tactical ballistic nuclear warhead missiles can fit are invulnerable to MDS.

The possibility of concealed approach of tactical warhead missiles of a small action radius to a target in order to avoid its hitting by MDS, on the one hand, and to take it out of regulation of international treaties, on the other hand, has long been known to military specialists and the attempts to develop these systems started immediately upon creation of relatively small nuclear warhead missiles.

For example, in 1961 the US airborne units received "Little John" (MGR-3) missiles, which were equipped with free-flight missiles capable of carrying nuclear warheads. Light-weight launching units of this system could be delivered by CH-47 "Chinook" helicopters, both in the pit and on an external lift.

The Soviet Union quickly appreciated the perspectives of these systems, and based on the Decree of the Council of Ministers of USSR No. 135-66ts dated February 5, 1962, it started developing the tactical missile complex "FROG-7" (9K53) with 9M21B missiles, (nuclear warhead) and 9M21B1, (thermonuclear warhead) and the launching unit 9P114 represented by a light-weight self-propelled platform with a carburetor 45 h. p. engine M-407 from the "Mosckvich" car. Later on several modifications of such systems were introduced, which allowed transportation by MI-6 and MI-10 cargo copters. The helicopter was expected to deliver the missile with its launching unit behind enemy lines. The rest of the way, where necessary, could be covered on wheels and then it could suddenly strike a missile from a position which the enemy did not think of, which converts it from tactical complex into strategic. The efforts of the "FROG-7" development reached the stage of experimental samples testing. However, this resulted in many obstacles including high "windage" of a helicopter carrying a launching unit and consequently a high drifting rate, as well as inappropriate flying range of fully loaded helicopters. As a result, the efforts on development of this complex were stopped in 1965.

Fig. 1.55. Container-based launching units of missile complexes Club-K (above) and LORA (below).

Modern technological levels made it possible to return to this idea and deploy it successfully. For example, let us take Israeli missile system LORA ((LOng Range Attack) manufactured as a container with four missiles (Fig. 1.55). Its shape is reminiscent of containers of the Russian system Club-K, with the similar number of missiles 3M54K (SS-N-27 Sizzler in NATO classification), (Fig. 1.55).

Club-K is a Russian container-based missile unit, which can fit into a standard 20- or 40-foot sea container.

This unit is intended for targeting the above-water and ground targets. The unit can be installed on the coast lines, different classes of vessels, railway and truck platforms. The complex can be used with ground launching units as well as sea, rail-way and truck platforms. It can use different anti-ship missiles, as well as missiles for hitting ground targets. All the missiles included in the complex are cruising, flying at a relatively low altitude of 5-50 m and are not intended to be equipped with nuclear warheads, while LORA is equipped with a tactical ballistic missile, which can fly as high as 45 km and can carry a high capacity nuclear weapon to a distance of up to 300 km.

Today, there are hundreds of millions of standard containers circulating all over the world, Fig. 1.50. Who knows which of them are just containers and which of them carry missiles... Despite the fact that Israeli LORA is actually the only full-fledged container system, which can secretly approach to the coast line of a country on a container ship and hit its territory with an electro-magnetic pulse, the fact of existence of this system allows to conclude that the statements of MIC representatives about efficient protection of advanced MDS against HEMP, and that they should continue to receive additional investments are not true, and in fact are a way of deception of a public opinion. In practice an army will not be able to ensure efficient protection of power systems of cities and settlements from HEMP and thus, electric engineers should take the leading role and take care of such protection.

References to Ch. 1.

1.1. Zeldovich Ya. B. Interaction of unbound electrons with electromagnetic emission. – Success of Physics-related science, 1975, vo. 115, issue 2.

1.2. Kompaneets A.S. Radio emission of nuclear explosion. – Experimental and Theoretical Physics Journal, 1958, vol. 35, issue 6(12), pp. 1538-1544.

1.3. Gilinsky V. Kompaneets Model for Radio Emission from a Nuclear Explosion. - Memorandum RM-4134, Rand Corporation, August 1964.

1.4. Khariton Yu.B., Smirnov Yu.N. Myths and reality of Soviet nuclear project. – Arzamas-16: ARR&DIEP, 1994. p. 72.

1.5. Seguine, Howard, "Memorandum for Record, Subject: US-Russian Meeting" at Lawrence Livermore National Laboratory, February 14-15, 1995.
1.6. Greetsai V.N., Kozolovsky A.H., Kuvshinnikov V.M., Loborev V.M., Parfenov Y.V., Tarasov O.A., Zdoukhov L.N. Response of Long Lines to Nuclear High-Altitude Electromagnetic Pulse (HEMP) - IEEE Transactions on Electromagnetic Compatibility, 1998, Vol. 40, Issue 4, pp 348-354.
1.7. Bashurin V.P., Gaynullin K. G., Golubev A.I. et. al. Some theoretical computation models and software to study electrodynamic effects, accompanying nuclear explosions. – Collection of research papers The issues of mathematic modeling, numerical mathematics and informatics. Arzamas-16: ARR&DIEP, 1994, pp. 117-130.
1.8. Boriskin A.V., Zolotov V.A., Kravchenko A.S., et. al. Mobile simulators of electromagnetic pulses employing magnetic cumulation generators. – Applied mechanics and technical physics, 2000, v. 41, No. 3, pp. 6 – 12.
1.9. Akbashev B.B., Balyuk N. V., Kechnev L.N. Protection of telecommunication facilities from electromagnetic impacts. – M.: Griphon, 2013. p. 472.
1.10. Burutin, A.G., Pertsev S.F., Balyuk N. V. Experimental and testing facilities of the Ministry of Defense of Russian Federation. – EMC Technologies, 2010, No. 1, pp. 33 – 37.
1.11. Burutin A.G., Pertsev S.F., Balyuk N.V. Weapon and electromagnetic factors. “Voyenny Parad” (Military Parade) Magazine, 2009, No. 6, pp. 14 – 16.
1.12. Loborev V. V. Up to Date State of the NEMP Problems and Topical Research Directions. - Electromagnetic Environments and Consequences: Proceedings of the EUROEM 94 International Symposium, Bordeaux, France, 30 May – 3 June 1994, pp. 15-21.