Cold War and Proliferation

After Trinity, Hiroshima, and Nagasaki and the defeat of Germany, the US believed to be in the absolute lead in nuclear weapon technology, US even supported Baruch plan for a short period of six months. But proliferation had started even before the Trinity test and developed rapidly to a whole set of Nuclear Powers over the following decades.
Spies and Proliferation

At Potsdam conference 1945 Stalin was informed about US bomb project. Efficient Russian spy system in US had been established based on US communist cells and emigrant sympathies and worries about single dominant political and military power.

Klaus Fuchs, German born British physicist, part of the British Collaboration at the Manhattan project passed information about Manhattan project and bomb development and design Plans to Russia. Arrested in 1949 in Britain and convicted to 14 years of prison. He served 9 years - returned to East Germany as Director of the Rossendorf Nuclear Research center.

Fuchs case caused panic and enhanced security in US. Fear of communist take-over was fired by McCarthy propaganda. Numerous subsequent arrests and trials culminating in Rosenberg case!
The Spy Story
Fat Man Design

Copied by Klaus Fuchs and forwarded to Russian courier person (Harry Gold).
Spy Scare

SILENCE MEANS SECURITY

SILENCE MEANS SECURITY
Value of Spy Work,
Information on trends not detail of design

It is unknown whether Fuchs' fission information had a substantial impact. Considering that the pace of the Soviet program was set primarily by the amount of uranium they could procure, it is hard for scholars to accurately judge how much "time" this saved the Soviets. Some former Soviet scientists said they were actually hampered by Fuchs' data, because Beria insisted that their first bomb ("Joe-1") should resemble the American plutonium bomb ("Fat Man") as much as possible, even though the scientists had discovered a number of improvements and different designs.

The information Fuchs passed on the hydrogen bomb was too early to be of much material use: the key methods of making a hydrogen bomb work had not yet been discovered in the United States during the time Fuchs was working on the project (the Ulam Teller mechanism was not proposed until 1951). Soviet physicists would later note that they could see as well as the Americans could that the early designs by Fuchs and Teller were useless.
Outstanding and leading Soviet discoveries and scientists:

1934 first European cyclotron at the Radium Institute in Leningrad
1938 discussion of chain reactions for energy production
1940 Georgy Flerov (1913-1990) discovered spontaneous fission
1940 “underground” experiments in Moscow Metro for Cosmic Ray reduction
1940 Yakov Zeldovich (1914-1987) predicted chain reaction & $^{235}\text{U}$ fission bomb
1940 Formation of Uranium Commission to identify Soviet Uranium mines
1940 Yakov Zeldovich & Yuly Khariton predicted critical mass for $^{235}\text{U}$ as 10kg.
1942 Flerow submitted first Uranium Bomb design to Kurchatov

Initially Soviet Bomb program was driven by competition with presumed British bomb program, the “Tube Alloys project” (triggered by the Frisch prediction of 1kg critical mass). The “Tube Alloys project” subsequently merged with the Manhattan Project in 1943. Information came from British spy circles.

Main handicap of Soviet Program was lack of Uranium until 1949.
Start of Soviet Weapons Program

Program was ordered by Stalin in 1943 after being informed about US efforts. The administrative head of the program was Lavrenti Beria.

Scientific director was Igor Kurchatov, who headed the Russian nuclear research program and built the first Russian cyclotron in 1934.

Program was initially limited, ~100 people, 25 physicists.

**Lavrenty Pavlovich Beria** (1899-1953), Soviet politician and police chief, is remembered chiefly as the executor of Stalin’s Great Purge of the 1930s. His period of greatest power was during and after WW-II. After Stalin’s death, he was removed from office and executed by Stalin’s successors.
The second race for the bomb
Citizen Kurchatov
(1903-1960); head of the Soviet Nuclear physics program. He developed the big Russian Cyclotron 1934, built the first Russian reactor 1946, developed the first Russian fission Bomb 1949, and the first fusion bomb 1955. Named after him are the Kurchatov Institute and element 104 Kurchatovium.

Kurchatov managed to build with full support of Stalin and Beria a competitive nuclear research program from 1943 to 1945, stimulated by successful Trinity test. He built entire weapons research laboratory structure called Arzamas-16, taking Manhattan project structure as a guide. Arzamas-16 was often referred to as Los Arzamas (since 1993 sister city of Los Alamos). Arzamas-16 represented a network of “secret cities” and research labs.
The old Sarov Monastery is seen in this reproduction of an old print (courtesy of German Goncharov). Sarov is where the Soviet “Los Alamos” was built, the closed city known variously as Arzamas-16, KB-11 and Kremlev. Today, once again, the city is called Sarov.
Arzamas-16

In 1946 little monastery town Sarov disappeared from Russian official maps. The town became the site for the first Russian nuclear weapons laboratory.

Presently home of two weapons facilities: The VNIEF nuclear weapon design institute and AVANGARD warhead assembly facility.
Secret Cities

Arzamas-16: 29 km² about 82,000 population, fenced off from surrounding area. Has been center for Soviet and Russian nuclear research for 50 years. Besides Arzamas-16 there existed nearly 50 additional nuclear weapon research, production and test sites distributed over area of former Soviet Union. Privileged workers and researchers under heavy KGB surveillance. The camps and facilities were all build by GULAG workers and POWs.
GULAG work force

~116 GULAG camps, ~18 camps for nuclear bomb related projects (mines)
~3,000,000 prisoners, ~60,000 inmates working on nuclear bomb related projects
~3,400,000 German POWs, last 10,000 released in 1955 (~2,000,000 missing)

~ 1500 cal/day: 600 grams of black bread every day, spaghetti, a little meat, sugar, vegetables, and rice.
Nuclear Facilities in Russia today
The Soviet first bomb was called by the Americans "Joe 1", Joe-1 was an exact copy of "fat man" based on Intelligence from Klaus Fuchs and other US-based scientists. The copy approach was made on insistence of Beria to warrant quick success. The explosion at the Semipalatinsk test site in Kazakhstan was successful.

Plutonium based 22KT bomb; the plutonium was generated at Cheliabinsk-40 breeder reactor built by Kurchatov in 1947.

Yuli Khariton (1904-1996)

Leading Russian weapon designer, last living pupil of Rutherford

First Lightening/Joe 1
August 29, 1949
New Sloyka design by Sakharov

Layer Cake: alternate layers of light (liquid deuterium and tritium) & heavy ($^{235}$U) nuclear fuel to trigger a fission fusion reaction.

In 1950
As “father” of the Soviet Hydrogen Bomb

First design study by Andrei Sakharov

1989, as regime dissident
The RDS-6s used a $^{235}$U fissile core surrounded by alternating layers of fusion fuel ($^6$Li deuteride with tritium), and fusion tamper (natural uranium) inside a high explosive implosion system. The small $^{235}$U fission bomb acted as the trigger (about 40 kt). The total yield was 400 Kt, and 15-20% of the energy was released by fusion, and 90% due to the fission reaction.

"The earth trembled beneath us, and our faces were struck, like the lash of a whip, by the dull, strong sound of the rolling explosion. From the jolt of the shock wave it was difficult to stand on one's feet. A cloud of dust rose to a height of eight kilometers. The top of the mushroom reached a height of twelve kilometers, while the diameter of the dust of the cloud column was approximately six kilometers. For those who observed the explosion from the west, day was replaced by night."

August 12, 1953
At Semipalatinsk