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SUBJECT Turbojet and Turboprop Engine Development at Zavod [redacted] in Upravlencheskiy Near Kuybyshev 25X1

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SUPPLEMENT TO REPORT NO. [redacted]

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THIS IS UNEVALUATED INFORMATION

[redacted]

25X1 1. Opytnyy Zavod [redacted] in Upravlencheskiy Gorodok (53-12N, 50-09E) was directly assigned to the Ministry for Aviation Industry in Moscow. The abbreviation of the plant designation is [redacted] 25X1 Zavod [redacted] was composed of four OKBs (Opytnoye Konstruktsionnoye Byuro = Experimental Design Bureau) and the production department.

2. Until 1 July 1949, Colonel Olekhnovich (fnu) was Soviet plant manager, and only Germans were in charge of the developing activities. On 1 July 1949 Colonel Kuznetsov (fnu), who with seven assistants had come from the Ufa/Chernikovka (54-45N, 56-00E) aircraft engine plant, took over the plant management and also became technical director of the plant.

3. After the war, the Soviets requested the Stassfurth BMW Plant to improve the BMW-003 C engine from 900 to 1,250 kg/p. This project was completed by late 1946. A second order given in March 1946 for further development of the BMW-018 was not carried out, as 257 BMW employees, about 12 percent of the total work force, were deported to Upravlencheskiy on 22 October 1946. Together with 375 Junkers experts and with the help of about 2,500 Soviet convicts, the BMW experts installed dismantled German machinery [redacted] 25X1 Development activities were started on 15 November 1946 and were in full swing by May 1947. The production department started operation in May 1947. Up to the summer of 1948 the four individual OKBs worked separately. The teams were from the BMW, Jumo, and Askania plants, and the group of Engineer Alfred Mueller, who, with about eight experts, constructed oscillographs. Coming from Moscow/Tushino, where they had worked on the development of Diesel engines, Graduate Engineer Manfred Gerlach and 48 experts arrived at Upravlencheskiy at a later date. Dr. Manfred Christian and seven German experts were the last group 25X1 to arrive at Zavod [redacted] They came from an aircraft engine plant in

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Kazan (55-51N, 49-06E). In the summer of 1948 [redacted] i.e., the BMW and Junkers groups, were consolidated into one group. 25X1

25X1 4. [redacted] functioning as an experimental plant for jet engines, controlled the entire mass production of such engines, directed the activities of the delivery plants, and improved their efficiency. [redacted] 25X1 a plant producing control devices was located in Moscow, a propeller plant in the Ural mountains, a plant for airscrew controls in Moscow, and a roller bearing plant in Kuybyshev. The Ministry for Aviation Industry in Moscow was in charge of the practical evaluation of the designs and transmitted requests for mass production to the plants. Experts
25X1 from these plants were briefed [redacted] 25X1

The TsIAM Institute in Moscow checked the designs coming from Zavod
25X1 [redacted] and submitted in return research requirements on performance
25X1 data to [redacted] However, as TsIAM frequently made mistakes, there was only an exchange of correspondence between the two plants since 1949
25X1 Zavod [redacted] was assigned to the Ministry for Aviation Industry. Only the reconstruction section for aircraft engine models was supervised by the regional sub-headquarters of the Ministry for Aviation Industry, department for aircraft engine construction in Kirov.[1]

5. The Soviets requested a BMW-003 engine to be designed with a take-off power of 1,250 kg/p. The dimensions and the weight of the engine were to be those of the BMW-002 A-2. The fuel consumption was not prescribed. In the fall of 1947 the improved version of the BMW-003 C successfully passed the State test. Dr. Manfred Christian stated that the engine has been in mass production in Kazan since that time.

6. Improvements to achieve a higher output included the increase of revolutions from 9,500 to 9,700 rpm, ± 50 rpm. An entirely new turbine with a new type of mounting was designed. The outer and inner coating of the burner cans were connected by an overlap fastening in order to increase the tensile strength and to avoid warping. Turbine blades were designed with a greater angle of pitch. The cooling air duct to the turbine was enlarged. To prevent the internal cooling jackets in the turbine blades from turning loose, they were reduced in length to two-thirds of the blade length, and the insert section of the blade root was enforced. The BMW type root fixing of turbine blades by means of two wedges was replaced by a mounting with one wedge with conical shaped sides. Cover lids were to keep the wedges from falling out after cooling down. The number of turbine blades was increased by 11. Cooling air funnels in the burner cans were placed more to the rear of the can and reduced in length, so their ends would not project into the combustion zone and burn. The new increased fuel flow achieved by a higher injection pressure at the nozzles enlarged the flame and subsequently the flame core, which had a temperature of more than 1,400°C. An adjustable exhaust pipe with new exhaust area was required for the increased thrust. Although the exhaust area was considerably reduced for the starting performance, in order to avoid the installation of additional parts, the engine started smoothly.[2]

7. The Soviets requested an increased output of the Jumo-004 engine. This project was completed by late 1947 after previous efforts had failed to
25X1 achieve an output even higher than requested. [redacted]

8. Development activities on the Jumo-012 were carried on until the summer of 1948, when the engine failed the State test because the target date for completion was not met. This project was then cancelled. The Soviets stated that requirements for this class engine were filled by other types; therefore, the Jumo-012 was no longer of any interest. It was not known whether the engine was in quantity production in spite of
25X1 the stated facts. [redacted]

9. Developments on the BMW-018 were cancelled at the end of 1947 and the engine was further utilized for preliminary experiments for turboprop developments. The Soviets stated that requirements for an engine of this class were filled by the Nene engines. About five BMW-018s were completed. They were projected for a rating of 3,600 kg/p and had a two-stage turbine. Experiments on the test stand revealed that the requested output was achieved. Design records were kept [redacted] for research purposes.[5] 25X1

10. During the fall of 1947 Major General Makar Mikhailovich Lukin requested a new turboprop engine to be designed on the basis of the Jumo-022 and BMW-028 engines. He submitted performance data of turboprop developments by the western powers and demanded an engine with higher ratings be constructed. Three months of studying these records revealed that the information was incorrect. Since the German scientists refused to continue the project on the basis of this incorrect data, Moscow requested the development of an entirely new turboprop engine. Colonel Olekhnovich was personally assigned to supervise and control the development activities. He was later replaced by Colonel Kuznetsov (fnu).

11. The engine was to be designed on the basis of the following data: The total power of about 5,400 hp was to include 85 to 90 percent shaft power. The overall dimensions were widely tolerated. Maximum fuel consumption was to be 380 g/hp/h. Fuel: kerosene. All other specifications were to be discussed in conferences. The engine was projected for a bomber and for a twin-engine long-range escort aircraft. It was to be started by a ground starter engine or by a 50 hp pneumatic board engine, which was being developed in Moscow. The compressed air cylinders of this starter unit were to be kept on the ground. However, as the development of the pneumatic starter was apparently unsuccessful and proved impracticable for tactical operations, a 75 hp turboprop starter unit developed at [redacted] was installed.[6] 25X1

12. Preliminary design plans were completed by the winter of 1947/1948 and the following specifications were approved by Moscow: Two four-bladed counter-rotating propellers with a diameter of 4.20 cm. The propellers were adjustable to gliding position and were to be used as landing brakes. The engine was to be equipped with a 14-stage axial compressor. The first third of the combustion chambers were to be 16 individual Junkers burner cans leading into one annular BMW combustion chamber. The turbine was designed with three stages and the thrust nozzle with a rigged exhaust cone. The engine was to run at 7,700 rpm at a compressor air mass flow of 30 kg/sec, with a maximum fuel consumption of 380 g/hp/h for the take-off performance, and a maximum weight of 3,500 kg. A new type of monocoque turbine casing composed of two welded shells was designed. During the first experimental runs gasoline was used as the starter fuel; later the engine was started with kerosene. In long conferences it was decided to use nimonic steel, a fire-resistant material, for the turbine blades. The cruising speed of a bomber at an altitude of 8,000 meters was to be more than 800 km/h. The development of a 10,000 hp hydraulic brake test stand was approved in order to facilitate the correct measurement of shaft power on engines of this size.

13. The following data were recorded during the first State test of the engine in August 1950: (All data refer to sea level.)

a. Take-off power	5,400 hp	(These figures were obtained at the new hydraulic brake test stand and at the propeller test stand.)
b. Shaft power	4,800 hp	
c. Thrust (counted in shaft power)	600 hp	
d. Fuel consumption	296 g/hp/h	
e. Revolutions of turbine	7,500, ± 25 rpm	
f. Oil pressure (engine)	4.8, ± 0.3 atmospheres	

g.	Oil consumption	1.5 to 2 kg/h (an oil consumption of 4.5 kg was requested according to the test regulations)
h.	Oil circulation	6,200 kg/h
i.	Compressor air mass flow	31 kg/sec
j.	Landing brakes adjusted to	2.2 tons
k.	Maximum gas temperature	540° C measured in the exhaust pipe just behind the third turbine stage.
l.	Fuel (incl. starter fuel)	kerosene
m.	Acceleration period from idling to full power performance	14 seconds
n.	Acceleration period requested by the Soviets	18 seconds

Test runs were also successful at a temperature of up to 40° C. However, because of damage in the combustion chambers, the engine was not accepted after the first and two additional State tests. [redacted] 25X1 the fact that a great number of German experts were released by the end of September 1950, indicating that no further basic complications with the engine were expected by the Soviets.

14. Most target dates set for the development of the engine were met. Work on the plans started on 1 March 1948 and the first sketches were completed by 1 May, so that requests for materials and measuring equipment could be made and the first shipments of semi-finished products could be delivered to the plant. The construction plans for the first turboprop test stand were also completed by this time. On 20 November 1948 the first engine performed an experimental run, and by January 1949 the improved engine was running at a speed of 5,000 rpm.

15. Because of the following difficulties, the first State test scheduled 1 October 1949 was postponed: About 150 to 200 hps were required to accelerate the compressor to 2,800 rpm. (The hps were counted by means of an electric dynamometer.) This problem was solved with experimental model No. 3 by constructional alterations and the installation of blow-off flaps behind the fifth and sixth compressor stage. These hydraulically controlled flaps opened and closed automatically with the engine running at about 6,000 rpm. This number of revolutions was not final but referred to these particular tests. An entirely wrong cooling system and an incorrectly controlled mass flow of cooling air caused an oil loss of 180 to 200 kg per hour. By May 1949 the oil consumption, including these losses, was reduced to 30 kg/h. The critical number of revolutions, ranging between 5,200 and 5,800 rpm, caused vibration cracks in the compressor unit. The critical speed was completely eliminated by altering the over-all length of the engine. Major problems arose with the development of combustion chambers. After extensive modifications of the entire unit and the designing of about 38 different versions, the burning ratio was finally increased from less than 60 percent to 95 percent by August 1950. An elongation of blades at the first and second turbine stage was prevented by air cooling. The strength of turbine blades was increased by altering the shape, and the life-time was prolonged by eliminating the exhaust flame of the turbine during the take-off. The fuel consumption of 420 g/hp/h was reduced to 296 g/hp/h on experimental models Nos. 12 to 16. Difficulties in the control system, the propeller adjustment, and the fuel control had been overcome by August 1950. Starting in the fall of 1949, useable bearings were delivered by the Kuybyshev ball bearing plant. These bearings were manufactured on the basis of directions issued [redacted] 25X1 [redacted] 25X1 cracks in the propeller reduction gear were prevented by altering the teeth profiles and by treating the surface of the gears. The engine was to be automatically started and accelerated by one throttle arm operated by the pilot.

16. In addition to the development of the reported turboprop engine, the research activities in Upravlencheskiy included after-burning, icing problems, fuel and lubrication experiments, projects designing the utilization of gas

turbines for the generation of electric power, the full automatic control of engines at all altitudes by one lever, and the heating of the cockpit by the engine; the latter field included research on gas components contained in the air.

17. There was cooperation between Aircraft Engine [redacted] in Kuybyshev [redacted] with regard to purchasing machinery, helping out with materials, delivery of jigs and fixtures, and training of personnel. Fifty Nene combustion chambers were produced [redacted] and issued to Aircraft Engine [redacted] with directions for the material to be used and two detailed manufacturing plans for these units. 25X1 25X1 25X1 25X1

18. [redacted] three Stalin awards were given to [redacted] the Askania Group, and that in 1950 the first oscillographs were delivered by [redacted] the expert team under Engineer Alfred Mueller. Material difficulties arose with the BMW-003 C. When the engine was subjected to the State test, blades manufactured of Soviet material proved to be less heat resistant than German blades. Furthermore, the sheets were not evenly rolled. Although these shortcomings were eliminated in long conferences and with technical directions worked out by [redacted] the quality and quantity of the blade material only approximately met the requirements. There were further bottlenecks in measuring instruments, tools, silumin castings, and heat resistant steels. Stocks of these materials were hardly sufficient for a two months requirement. 25X1 25X1 25X1 25X1

19. The plant employed about 3,500 workers, including a group of 750 German experts. The German group was composed of about 60 outstanding theorists, about 220 scientists, about 250 foremen working as experts in the development plant, and about 200 skilled laborers. Soviet specialists included about 18 elderly experts from scientific institutes; about 120 graduate engineers from the Moscow and Leningrad universities who, in teams of 35 engineers, were attached to [redacted] for half a year after their graduation; there were also about 100 technicians and graduates from technical institutes; and finally 120 to 150 Soviet technicians who were transferred to Zavod [redacted] from aircraft plants in Leningrad, Ufa, Kazan, Bezymyanka, etc.[7] About 20 percent of the work force were Soviet women, who worked in offices, as guards, in the transport section, on construction projects, and on material tests. Soviet personnel was gradually assigned to positions previously held by German experts. After the formation of the state of Israel, Soviet citizens of the Mosaic faith applied for emigration or repatriation to Israel. Subsequently, all Jews were removed from their leading positions in the plant. Since the most qualified Soviet scientists, especially those in the experimental field, were Jews, this action was a serious blow to technical progress. 25X1 25X1

20. At the test stands, work was done in four six-hour shifts. The assembly and manufacturing sections worked in one eight-hour shift, and several other departments in three eight-hour shifts. The design and administration section worked an average of eight hours per day but, in order to meet the required target dates, they frequently had to work overtime. Failures of the new turboprop engine were investigated. The design department worked overtime and also consulted experts from other departments.

21. [redacted] protected by a wooden fence with barbed wire and was surrounded by a raked restricted area. The plant was guarded by female plant police, patrols within the plant area, and sentries in the workshops. Individual plant sections within the area were separately fenced in. The Germans were allowed to move unrestrictedly within a radius of six kilometers around the plant. A special application which was required for a trip to Kuybyshev had to be requested three days in advance. 25X1

22. A copy of all design plans, sketches, and studies was kept in fire-proof shelters. Since the beginning of the Korean war, precautionary measures were increased, and more sand boxes, fire extinguishers, and other tools were placed all over the plant. There were three modern fire trucks available. AA gun emplacements were neither reconstructed nor occupied since hostilities started in Korea.

23. The construction project of a large reservoir reaching from Krasnaya Glinka to Kazan was cancelled in order to prevent floods in the Stavropol (53-27N, 49-24E) oil fields along the Volga valley. In a new project, water was to be dammed up, probably in six individual stages, with the first stage being located near Stavropol. Compared with the first project, with an output of two million kws, not more than one million kws would be produced by the six-stage power plant. Construction was to start in the spring of 1951. Aircraft plants in Kuybyshev [redacted] were the only factories excluded from the draft of personnel for this project. 25X1

25X1 [redacted] Comments:

1. The Kirov regional sub-headquarters, department for aircraft engine construction, is reported for the first time. The information indicates a break-down into regional sub-headquarters which are in charge of the fulfillment of the district armament program. The Kirov sub-headquarters are assumed to be located in an aircraft accessory plant at the southern border of the Kirov airfield.

2. In 1945 the BMW-003 engine was developed with a thrust of 800 kg and installed in type 162 aircraft, the so-called Volksjaeger. During the first flights the speed of this fighter proved to be inadequate. BMW subsequently designed an improved version with 900 kg thrust, which was not mass produced. These facts explain 900 kg thrust as being basic for further developments of this engine in the USSR. An increase to 1,250 kg static thrust, to be achieved by means of the reported improvements, is believed possible. Dr. Christian, who with his small expert team had worked in Aircraft
25X1 Engine Plant [redacted] in Kazan, stated that the BMW-033 (sic) was being produced there.

3. According to a previous report, the improved version of the Jumo-004 with a static thrust of 1,500 kg was completed in mid-1947.

25X1 4. The Jumo-012 passed the State test by the fall of 1948. [redacted] Having a thrust of 2,500 kg, the Jumo-012 belongs to the same group of aircraft engines as the Nene, which by that time was being manufactured in quantity at Plants [redacted] in Moscow. The Red October Plant in Leningrad was allegedly also converted to the production of Nene engines. 25X1

5. Developments of the BMW-018 started during the war. The engine was designed with a 12-stage axial compressor, a three-stage turbine, and for an output of 3,500 kg. A slightly altered version developed in the USSR could actually be utilized as a preliminary experimental model for turboprop.

25X1 6. See [redacted] for a report on research on the turboprop Jumo-022 and the TS turbo starter engine.

7. This refers to the aircraft engine plants Red October in Leningrad, Zavod
25X1 [redacted] in Ufa/Chernikovka, Zavod [redacted] in Kazan, and Zavod [redacted] in Kuybyshev/Bezymyanka. In addition to these plants, confirmed as being engaged in the production of turbo engines, there were the gas turbine 25X1
25X1 plants [redacted] in Moscow/Tushino and [redacted] located in an eastern section of Moscow. 25X1

Attachments: Two

25X1 1. [redacted]

25X1 2. Layout sketch of Zavod [redacted]

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Attachment 2

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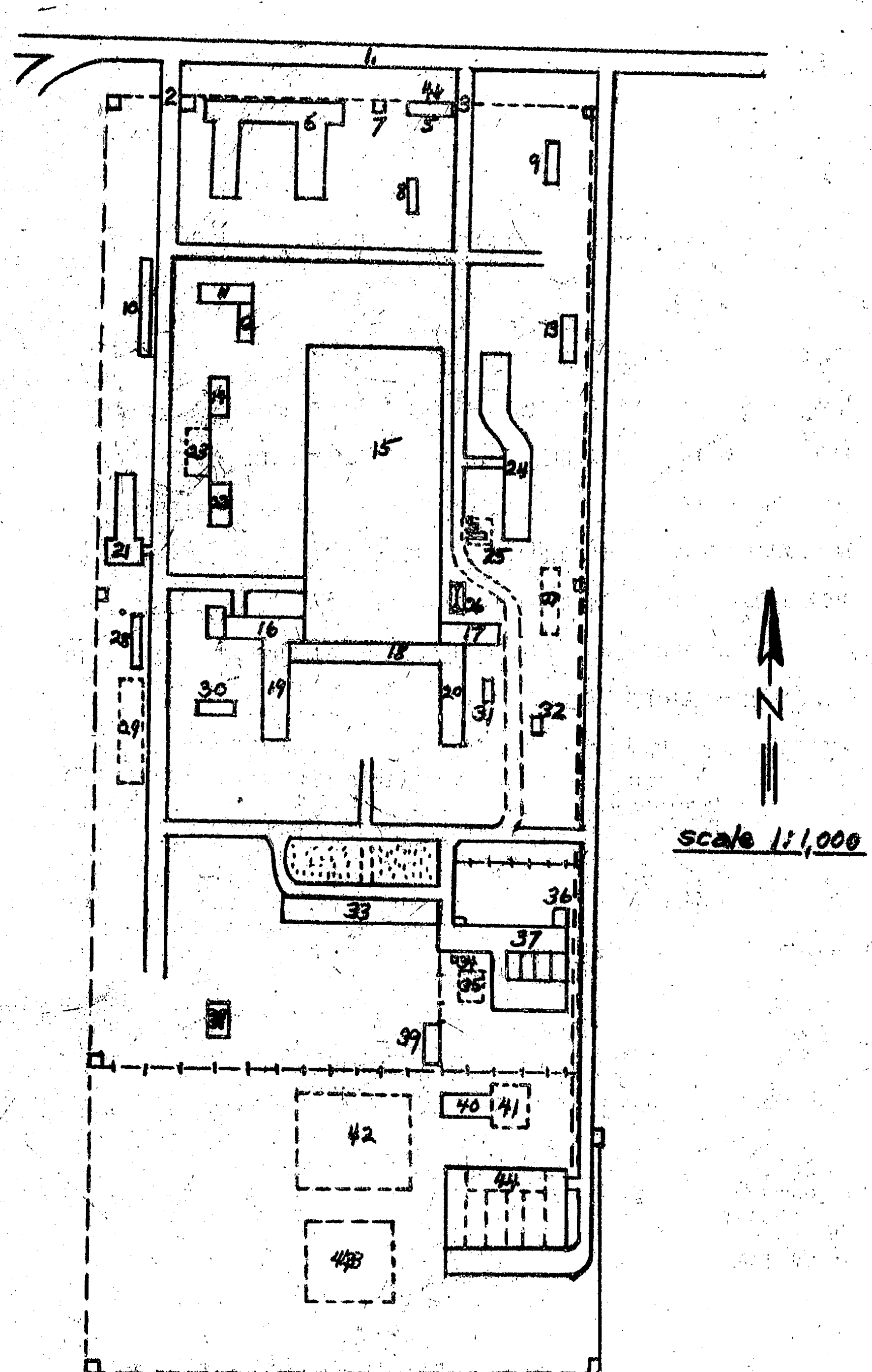
Zavod [redacted] in Upravlencheskiy, Plant Layout



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Legend:

1. Asphalt road.

2. Entrance for trucks.

3. Entrance for trucks.

4. Entrance for laborers.

5. Gatekeeper's house.

6. Workshop 17: Material research institute with a chemical laboratory, a physical laboratory, and a testing room for tensile strength of materials. The section also included an electric measuring department, book printing shop, and a photographic laboratory. The institute was equipped with installations from the BMW and Junkers Plants.

7. Detainment barracks for German specialists.

8. Aerodynamic test stands: Brick building with a flat roof covered with roofing paper; two wind tunnels with measuring channel and generators for aerodynamic blade profile tests.

9. Gas plant: Flat brick building covered with roofing paper, produces gas for autogenous welding.

10 to 12. Material stores.

13. Pressing plant for steel shavings.

14. First aid station.

15. Large building: Brick structure with an arched steel structure roof with sky lights, covered with roofing paper. The building housed the following:

   a. Workshop 1 a, production of blades.
   b. Workshop 1 b, mechanical manufacturing shop.
   c. Workshop 2, mechanical manufacturing shop.
   d. Workshop 4, construction of jigs and fixtures. The workshops were equipped with about 400 metal processing machines; semi-finished products were supplied from the stores, and processed parts were returned there.

16. Assembly test stands.

17. Workshop housing the surface treatment section, carpenter shop, and pattern making carpenter shop. The workshop was equipped with lathes. Cyanide of potassium was not available, as it had to be delivered to Bezymyanka.

18. Preliminary assembly shop, construction section, and storage for electric parts. The two-story building was covered with roofing paper. The basement housed stored electrical parts, and the ground floor housed the assembly shop, which was equipped with auxiliary machines processing single parts. The second floor housed the construction section, technological section, and offices.

19. Workshop housing the hardening shop, which was equipped with electric furnaces on the ground floor and the plant management on the second floor.

20. Brick building with a forge equipped with two or three electric annealing furnaces and steam hammers, two of which were large. The second floor housed offices and a switchboard from the Junkers Plant.

25X1 21. [redacted] the Askania Group: T-shaped, two-story brick building housing offices, mechanical workshops, and assembly shops. [redacted] 25X1
25X1 [redacted] believed that starter units were being produced here and probably also in the ARM Plant. [redacted] 25X1
25X1 [redacted] the Askania Group was transferred to Moscow
25X1 [redacted] 1950, taking all machinery along with them. The building was presumably to be used for the installation of additional assembly test stands or as a construction shop for control devices.

22. Apprentices school and small store with electric engines.

23. Fire station, was being torn down.

24. Workshop 5: Sheet metal processing shop, old building, about 15 x 80 m, constructed of bricks, wood, and clay. The workshop was equipped with gas and electric welding apparatus and presses; the sheets were hand formed.

25. Air mixing chamber for compressed air equipment: One small chamber was constructed in 1947 and a large chamber was constructed in 1949. Outdoor installation erected on foundations.

26. Compressor shop: The steam-powered compressor installation was dismantled and compressor engines driven by electric engines were installed. Operational pressure was 4.5 atmospheres.

27. Store with construction materials, dismantled.

28. Boiler house: Old brick building, 8 x 15 m, with sheet metal smokestack, equipped with coal fueled steam boilers for heating.

29. Coal dump: The crane with trolleys connecting the coal dump to Krasnaya Glinka was dismantled in 1948.

30. Fitting shop working for plant requirements, i.e., parts for laying of pipes.

31. Blasting installation: Flat brick building, 6 x 10 m, covered with roofing paper. The shop was equipped with one multiple blasting machine and one sand-blasting machine.

32. Store.

25X1 33. [redacted] Theoretical development of turboprop engines, three-story brick building, the roof covered with roofing paper, housing designing offices, blueprint section, and secret archives. Previously, [redacted] 25X1
25X1 [redacted] had worked in this building.

34. Fuel station: Constructed in 1947; equipped with filler necks, and measuring instruments for the fuel supplied to the station.

35. Fuel and lubrication dump: Constructed in 1947. The lubrication dump was an above-ground installation and fenced in, while the fuel tanks
25X1 were underground. [redacted] one tank with a capacity of 50,000 liters and another tank with a capacity of 80,000 liters. It is possible that there were more tanks [redacted] Fuel was shipped to 25X1
the dump by means of tank trucks. There was an underground fuel line to the test stands. (See item 37 on attached sketch.)

36. Workshop 14: Small fitting shop for the test stands.

37. Workshop 14: Test stands constructed in 1946 and 1947, 8 x 12 x 13 m wooden structure building with slake fillings. There were four test stands for completed engines. They were assembled from parts of dismantled Junkers and BMW test stands. Three were remodeled for the

testing of turboprop engines from 1948 to 1950; and one GT 2 test stand was used for measuring individual compressor stages.

38. Store with construction tools.

39. Electric workshop of workshop 14: Adjusted the test stands for high and low voltage current. In 1950 this section was transferred to No. 44 on attached sketch.

40. Large transformer station, completed in 1950.

41. Switching area: Surrounded by a wire fence, belongs to No. 40 on attached sketch. Mast area for outdoor power lines. The main feeder line on wooden masts had a tension of 15,000 volts and was laid in 1949 and 1950. Power was supplied by the Kuybyshev power plant on the eastern bank of the Volga River, north of the junction of Samara River. The branch-off point of the line was not known.

42. Half-finished foundation for a high altitude test stand. Construction was started in 1947 and discontinued in the fall of 1948. The high altitude testing equipment came from Junkers; parts of it were shipped to Moscow in the fall of 1950.

43. Large fuel dump: Under construction since the spring of 1950 to be completed by the summer of 1951. The size of the installation had not been determined.

44. Testing grounds of workshop 14: Construction was started in the fall of 1947 and the bare structures of the stone buildings were completed by August 1950. The whole project was to be completed by 1 January 1951, a target date which, [redacted] could not be met. The northern front wing housed one high hall with four test stands, while the side wings had one ground floor and a second floor. The four test stands were designed for large engines and had exhaust channels with a cross section 8 x 8 meters. There were high separating walls lined with sound absorber plates. The section was provided with its own reassembly shop and all workshops required for the testing. One test stand was put into operation on 15 August 1950. 25X1