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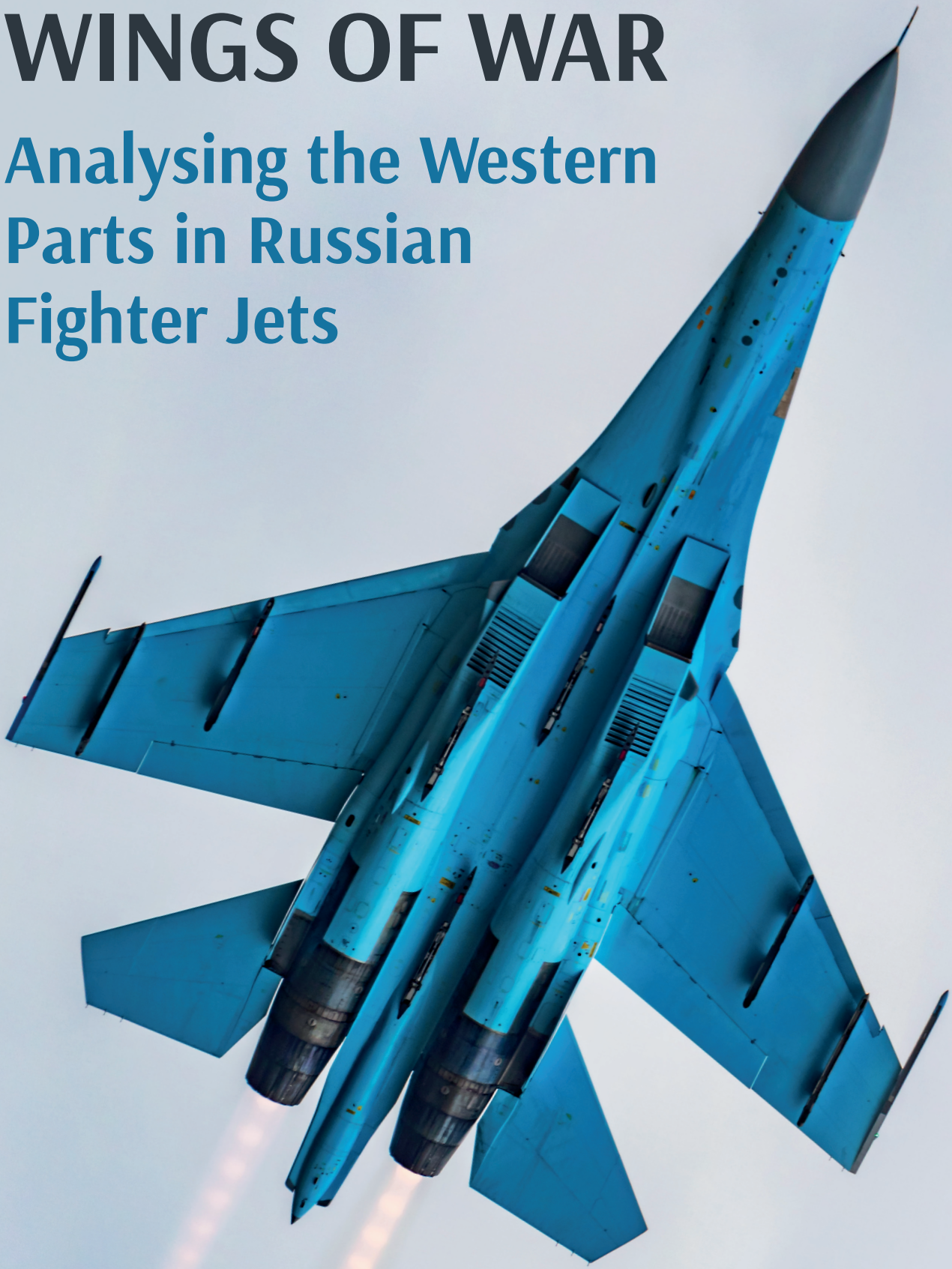
WINGS OF WAR

Analysing the Western Parts in Russian Fighter Jets



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LEGAL DISCLAIMER

This report identifies companies that are believed to be involved in the manufacturing of components that have been acquired by the Russian military-industrial complex and used in its military aircraft.

To avoid doubt, we do not allege any legal wrongdoing on the part of the companies that manufacture the components and do not suggest that they have any involvement in any sanctions evasion-related activity.

Furthermore, we do not impute that the companies that make the components are involved in directly or indirectly supplying the Russian military or Russian military customers in breach of any international (or their own domestic) laws or regulations restricting or prohibiting such action. This report is released for the sole purpose of highlighting moral and ethical concerns, encouraging further discussion, and calling for better business due diligence and risk assessment.

ACRONYMS

AD	Analog Devices
ADC	Analog-to-Digital Converters
ADP	Automatic Data Processing
AESA	Active Electronically Scanned Array
BIS	Bureau of Industry and Security
CCL	Commerce Control List
CMOS	Complementary Metal–Oxide–Semiconductor
CNC	Computer Numerical Control
CPLD	Complex Programmable Logic Device
DAC	Digital-to-Analog Converter
DRAM	Dynamic Random-Access Memory
EAR	Export Administration Regulations
ECCN	Export Control Classification Number
ECM	Electronic Countermeasures
EDM	Electrical Discharge Machining
ELINT	Electronic Intelligence
EU	European Union
FPGA	Field-Programmable Gate Array
GBPS	Gigabyte Per Second
GDP	Gross Domestic Product
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HS	Harmonised System
IAZ	Irkutsk Aviation Plant
IC	Integrated Circuit
IDT	Integrated Device Technology
JSC	Joint-Stock Company
KM	Kilometre
KnAAZ	Komsomolsk-on-Amur Aircraft Plant
KNIRTI	JSC Kaluga Research Institute of Radio Engineering

KTRV	JSC Tactical Missile Weapons
KYC	Know Your Customer
LLC	Limited Liability Company
LLP	Limited Liability Partnership
LTD	Limited
LVDS	Low Voltage Differential Signalling
NACP	National Agency on Corruption Prevention
NAKO	Independent Anti-Corruption Commission
NGO	Non-governmental Organisation
OFAC	U.S. Office of Foreign Assets Control
onsemi	ON Semiconductor
OSJI	The Open Society Justice Initiative
PJSC	Public Joint-Stock Company
PLL	Phase-Locked Loop
PROM	Programmable Read-Only Memory
RF	Radio Frequency
RSP	Receive Signal Processor
RUSI	Royal United Services Institute
SoC	System-on-Chip
TI	Texas Instruments
TTL	Transistor Transistor Logic
UAC	United Aircraft Corporation
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America
USB	Universal Serial Bus
USD	United States Dollar

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EXECUTIVE SUMMARY

Russia maintains an undoubted advantage in aviation despite significant losses. As of the end of February 2024, the estimated losses count over 345 aircraft and 325 helicopters.[1] Yet even despite the losses and sanctions, Russia continues expanding its production capabilities.

The Independent Anti-Corruption Commission (NAKO) analysed over 2,000 components found in the six aircraft pieces used by the Russian Air Forces: **MiG-31I, Su-27SM3, Su-30SM, Su-34, Su-35S, and Su-57**. We also identified via open-source information the central plants and several pieces of equipment used to produce these jets.

The Air Forces of Ukraine require 40-50 F-16 aircraft for its short-term needs, while a long-term perspective makes five aviation brigades: 180 aircraft. The cost estimates, therefore, vary from over $1 billion to $10 billion. At the same time, **in 2023, Russia spent at least $4 billion purchasing electronics for various military purposes, including maintaining and producing its fighter jets**.

This report is another part of NAKO's efforts to weaken Russia's capability to wage war against Ukraine, preventing its military-industrial complex from gaining essential Western technologies, and ensuring Russia is held accountable for its war crimes.

We highlight over 200 companies around the world that are or can be of potential interest to the Russian Federation and its military-industrial complex. Therefore, we strongly recommend the manufacturers, mentioned in this report ensure they are compliant while exporting to counties outside the Global Export Controls coalition and/or intermediaries in the risky jurisdictions. For more information on enhanced due diligence and advanced know-your-customer policies, we recommend consulting with the guide NAKO co-authored in partnership with The Royal United Services Institute (RUSI), The Open Society Justice Initiative (OSJI), and the Heartland Initiative.[2]

[1] The report of the General Staff of the Armed Forces of Ukraine. March 1, 2024. https://x.com/defenceu/status/1763443179611636094?s=46&t=yqsAutIWRcUsq3QFu3IoqA

[2] Managing risks created by Russia's invasion of Ukraine: enhanced due diligence and advanced know your-customer policies. RUSI, OSJI, NAKO< Heartland Initiative. https://nako.org.ua/en/research/managing-risks-created-by-russias-invasion-of-ukraine-enhanced-due-diligence-and-advanced-know-your-customer-policies

KEY FINDINGS

- Among at least 244 companies from 22 countries, **most components traditionally come from Western countries, mainly the U.S.: 64%**. The list of other top manufacturing countries includes **Japan, Switzerland, Germany, France, the UK, Taiwan, and The Netherlands**.

- **54.45%** of components were identified as **essential for Russian weaponry requirements**, according to the Highest Priority Items List.[3]

- The absolute majority of components could be classified as **EAR99** according to the U.S. export control classification. At the same time, **161 components were identified as ones that require export licenses when destined for Russia or Belarus**.

- In 2023, Russia imported the prioritised goods identified in this report worth at least **$4.2 billion**. They reached Russia mainly through third countries.

- The list of leading manufacturing companies includes Texas Instruments, Murata Manufacturing, Analog Devices, Kemet, Micron, Maxim, IDT, AVX, Holt Integrated Circuits, Linear Technology, Cypress, Intel, and ON Semiconductor. In 2023, **Russia imported electronics from these companies worth at least $962.6 million, which is 19.7% less than in 2022, yet still 69.69% more than in 2021**.

- Despite export control restrictions and requirements, **Russia's imports of goods made by the leading manufacturing companies only increased**. In particular, the main growth is seen for:
  - Linear Technology – 894.26%
  - Holt Integrated Circuits – 614.46%
  - Analog Devices – 399.12%
  - Maxim – 136.00%
  - Texas Instruments – 121.95%

- **The only leading manufacturers whose supply to Russia decreased in 2023 are Micron (34.56%) and IDT (-45.07%)**, making these companies the only ones to sell less production to Russia in 2023 than before the full-scale invasion. Texas Instruments, Cypress, and Intel **also had a decrease in 2023 sales, yet it is still insufficient to reach the 2021 numbers**.

- **At least 58 major Russian companies** import the most critical items to Russia via third

[3] Best Practice: Certification to Prevent Diversion to Russia of Highest Priority Items. BIS. September 14, 2023. https://www.bis.doc.gov/index.php/documents/policy-guidance/3339-tent-final-best-practice-customer-certification-v4/file

countries. The supply-chain-related companies need to be better and more consistently covered with sanctions.

- At least 18 different Russian military complex enterprises work on producing the analysed fighter jets. There is evidence of production chain use of **machinery originating from 52 companies from at least 17 countries:** Germany, Japan, the U.S., Italy, China, Czechia, Sweden, Austria, Belgium, Brazil, Lithuania, Spain, Switzerland, Taiwan, Thailand, Turkey, and the UK.

- The network of the main supplier companies includes at least 119 entities in different countries, mainly **China and, specifically, Hong Kong ($905.5 million, 80.4%)**. Apart from these, the list of suppliers includes **entities registered in Europe** (the UK, Serbia, Cyprus and Hungary) and **Canada, UAE, Taiwan, Thailand, Turkey, Singapore, and Seychelles**.

- There is evidence of a Kyrgyz company supplying British optics to one aircraft plant described in the report. Several other companies from different countries carry signs of being shell companies.

METHODOLOGY AND LIMITATIONS

This report analyses the composition of six Russian aircraft that are a part of the Russian Air Force and used in the war against Ukraine. This analysis of more than 2,000 components is based on documents the Independent Anti-Corruption Commission (NAKO) obtained from military and government sources. The aggregated statistics of companies and companies' main headquarter jurisdictions are given in raw form, as the initial investigators put it. NAKO also analysed the majority of the components via open sources to identify approximate type, Harmonised System (HS) code, and the U.S. export control classification.

NAKO did not intend to identify unique pieces of components exclusively. Thus, apart from purely unique ones, the overall list of electronics analysed contains repetitive components found in the aircraft or its subsystems.

The information on the analysed Russian Air Force pieces came to the initial researchers and investigators in different states and under different circumstances. Thus, NAKO's data may be insufficient compared to other publications on this matter. Due to the lack of visual confirmation and physical presence, the components were not fully identified and verified. Due to the complexity of such an investigation and the peculiarities of the context, NAKO had no opportunity to conduct thorough and continued research.

Generally, this report is about companies' head office jurisdictions. The exception, however, includes several products identified as regional in nature (e.g., American and Swiss offices of STMicroelectronics). In addition, as our analysis relies on raw data, we assume that the initial investigators could misidentify or misinterpret some of the components and their origin.

Note that the components described in this report may not necessarily come to the final beneficiary directly from the manufacturer. Such supplies, both before and after February 24, 2022, might also result from trade between intermediaries, certified resellers, and distributors. However, we used customs data to understand how similar components reached Russia in 2023. In particular, we relied on Russia's customs data on incoming products from the main component manufacturers, general information on incoming products prioritised by the U.S. government according to the Bureau of Industry and Security (BIS) (see *Critical Components and Components under U.S. export control*), key exporting and importing countries and companies, and approximate aggregated value of the contracts (see *Supply Chain*).

Given the complexity of the customs data, the somewhat opaque nature of this information, and potentially incorrect monetary indicators, the contracts' aggregated value may not necessarily reflect the actual sum of imports. Additionally, the lists of key importers and exporters do not automatically imply the company supplies directly for the needs

of the Russian Federation Armed Forces or respective plants engaged in producing military aircraft.

NAKO also conducted an open-source investigation of the main plants based in the Russian Federation that are engaged in the production cycle of the analysed pieces. Considering a wide range of plans that provide products, maintenance, and services important for aircraft cycle production, we choose to focus only on the most prominent plants.

This report highlights over 200 companies around the world that are or can be of potential interest to the Russian Federation and its military-industrial complex. Therefore, we strongly recommend the manufacturers mentioned in this report ensure they are compliant while exporting to counties outside the Global Export Controls coalition and/or intermediaries in risky jurisdictions. For more information on enhanced due diligence and advanced know-your-customer policies, we recommend consulting the guide NAKO co-authored in partnership with The Royal United Services Institute (RUSI), The Open Society Justice Initiative (OSJI), and Heartland Initiative.[4]

[4] Managing risks created by Russia's invasion of Ukraine: enhanced due diligence and advanced know your-customer policies. RUSI, OSJI, NAKO< Heartland Initiative. https://nako.org.ua/en/research/managing-risks-created-by-russias-invasion-of-ukraine-enhanced-due-diligence-and-advanced-know-your-customer-policies

AIRCRAFT CHARACTERISTICS

The Russian Federation Aerospace Forces have been the central part of Russia's full-scale invasion of Ukraine since the first days. As the full-scale war began, Russian Su-34 bombers, Su-30SM fighters, and Su-35S fighters reportedly flew around 140 sorties in the first few days and struck targets all over Ukraine. Within the first couple months of the full-scale invasion, Russia had fired more missiles against Ukraine than any country had employed in a war since World War II.[5]

Su and MiG fighter and multirole aircrafts are the backbone of the Russian Federation Aerospace Forces. According to RUSI research, Russia's Su-30SM and Su-35S completely outclass Ukrainian Air Force fighter aircraft on a technical level, especially shoot-down performance of their N011M Bars and N035 Irbis-E radars, and the much longer reach and active-radar guidance capability of the R-77-1 air-to-air missile compared with the semi-active R-27R/ER available to Ukrainian fighters.[6]

Exhibit 1. Russian Federation Aerospace Forces Aircraft

Model	NATO Designation	Type	Production years	Est. amount[7]	Estimated losses[8]
MiG-31	Foxhound	Fighter aircraft	1981 - 1994 (ongoing modernisation)	129	-
Su-27	Flanker-B	Fighter aircraft	1985 - 2010 (ongoing modernisation)	359	-
Su-30	Flanker-C	Multirole aircraft	2012 - ongoing	110	11 Su-30SM
Su-34	Fullback	Multirole aircraft	2006 - ongoing	149+	24 Su-34, 1 Su-34M
Su-35	Flanker-E	Multirole aircraft	2013 - ongoing	118+	7 Su-35S
Su-57	Felon	Multirole aircraft	2020 - ongoing	21+	-

[5] How Ukraine Fought Against Russia's Air War. Lawfare. January 22, 2023. https://www.lawfaremedia.org/article/how-ukraine-fought-against-russias-air-war

[6] The Russian Air War and Ukrainian Requirements for Air Defence, Bronk with Reynolds and Watling (RUSI) https://static.rusi.org/SR-Russian-Air-War-Ukraine-web-final.pdf

[7] As of 2022, according to the National Agency on Corruption Prevention (NACP)

[8] According to Oryx https://www.oryxspioenkop.com/2022/03/list-of-aircraft-losses-during-2022.html

MiG-31 is a long-range, two-seat supersonic interceptor aircraft, based on the earlier MiG-25.[9] It works in all weather conditions, no matter the time of the day. Of 500 MiG-31 aircraft produced, 370 serve in the Russian Federation Air Force and 30 are in the Kazakhstan Air Force.[10] The others were upgraded, including to MiG-31BM.

This aircraft has four Vympel R-33E air-to-air missiles that allow it to shoot large, high-speed targets at extreme ranges, four short-range R-60MK missiles, and two Bisnovat R-40TD1 medium-range missiles.[11] The MiG-31 aircraft is equipped with N007 Zaslon phased array radar with a 200-kilometre (km) scanning distance that can search and target various objects in the air and on the ground.

Su-27 is a highly manoeuvrable fighter with long range, heavy armament, and modern sensors. The aircraft is equipped to operate autonomously in combat over hostile territory, in escort of deep-penetration strike aircraft and in the suppression of enemy airfields. The aircraft provides general air defence in cooperation with ground-based and airborne control stations.

The Su-27 is equipped with a Phazotron N001 Zhuk coherent pulse-Doppler radar with track-while-scan and look-down / shoot-down capability. The range of the radar against 3m^2 targets is more than 100 km in the forward hemisphere and 40 km in the rear hemisphere. The radar has the capacity to search, detect, and track up to 10 targets with automatic threat assessment and prioritisation. The Su-30M, Su-33, and Su-35 are all advanced versions of the Su-27 fighter aircraft.[12]

[9] Aircraft. Military Today. https://www.militarytoday.com/aircraft.htm

[10] MiG-31 Foxhound Interceptor Aircraft. Aircforce Technology. February 18, 2021. https://www.airforce-technology.com/projects/mig-31/

[11] Ibid.

[12] Su-27 Flanker Front-Line Fighter Aircraft, Russia. Airforce Technology. July 16, 2021. https://www.airforce-technology.com/projects/su27/?cf-view

Su-30 is a 2-seat multi-role fighter variant of the Su-27 with new avionics and had an added ground attack capability. Some versions of the Su-30 use canards and thrust-vectoring engines for improved manoeuvrability. This aircraft also has a long-range phased-array radar. In terms of capabilities, the Su-30 is broadly similar to the U.S. F-15E Strike Eagle.

Su-34 is one of the derivatives of the Su-27, retaining the basic layout and construction of the Su-27 airframe along with conventional high-wing configuration and onboard equipment.

The Su-34 is equipped with an electro-optical fire control system, supplied by the Urals Optical and Mechanical Plant, and a Geofizika FLIR pod, with forward-looking infrared. Leninetz of St. Petersburg supplies the passive phased array radar system and TsNIRTI supplies the electronic countermeasures suite.

Su-35 is a significantly developed version of the Su-27 with a number of improvements in engines, aerodynamics, avionics, and construction methods.

The Su-35 is a very fast and highly manoeuvrable fighter with very long-range, high-altitude capability, and heavy armament. The aircraft's electronic warfare suite includes a radar warning system, radar jammer, cooperative radar jamming system, missile approach warner, laser warner, and chaff and flare dispenser.

Su-57 is a 5th-generation, stealth, multi-role fighter jet developed to destroy various land, airborne, and maritime targets. The fighter jet has advanced onboard radio-electronic equipment, including the electronic second pilot, which is a powerful onboard computer, and other innovative solutions, such as placing the armament inside the fuselage. The onboard avionics systems include active electronically scanned array (AESA) radar and ELINT systems.

Delivery of the Su-57 fighter jets with the second-stage engine began in 2022. The Russian Federation Air Force is expected to receive 22 Su-57 fighter jets by late 2024, which is expected to increase to 76 by 2028.[13]

As the war unfolds, fighter and multirole aircraft continue to play pivotal roles in Russia's military effort. To overcome its losses (which are estimated around 6-8% of its active tactical combat aircraft inventory, reaching 10-15$ for some pre-war active multi-role and ground-attack aircraft fleets in 2022[14]), Russia focuses its efforts on rebuilding and increasing its military capacity. According to the UK Ministry of Defence Intelligence update on the situation in Ukraine as of 01 October 2023, Russia's defence spending is set to surge to approximately 30% of total public expenditure in 2024 (10.8 trillion roubles, which is 6% of GDP and 68% increase over 2023).[15]

United Aircraft Corporation (UAC), part of Rosteh corporation, would be the focal point of these efforts as a company that, together with its affiliate companies, controls 100% of Russia's military aircraft production.[16] In March 2021, financial difficulties forced the merger of RSK MiG and Sukhoi under the UAC umbrella. UAC also subsumed Tupolev, Ilyushin, and Irkut Corporation. The many legacy design bureaus were brought under a single Moscow-based centre, but engineering functions survived mostly without significant restructuring.[17]

UAC has five subsidiary plants. All Russian combat aircraft production is now at the Novosibirsk Aviation Plant (Su-34[18] [19]), the Komsomolsk-on-Amur Aviation Plant (Su-27, Su-35[20], Su-57 [21]), Irkutsk Aviation Plant (Su-30[22]), and Nizhniy Novgorod Sokol Aircraft Manufacturing Plant (MiG-31 [23]).

UAC delivered 27 new-build combat aircraft in 2022: four Su-30SM2s, 10 Su-34Ms, seven Su-35Ss, and six Su-57s. The historic average from 2008 to 2022 is 40 aircraft per annum, so the 2022 total is somewhat below the

[13] Sukhoi Su-57 Felon Fighter Jet, Russia. Airforce Technology. January 20, 2023. https://www.airforce-technology.com/projects/sukhoi-su-57-felon-fighter-jet-russia/?cf-view

[14] Russian Air Force 'Has Lot of Capability Left' One Year On From Ukraine Invasion. Air&Space Forces Magazine. February 15, 2023. https://www.airandspaceforces.com/russian-air-force-lot-of-capability-left-ukraine-invasion/

[15] UK Ministry of Defence. https://twitter.com/DefenceHQ/status/1708365567998988596/photo/1

[16] ПАО "ОАК" https://www.rusprofile.ru/id/3398605

[17] Russian combat aircraft production sustained despite sanctions. February 17. WavellRoom. https://wavellroom.com/2023/02/17/russian-combat-aircraft-sanctions/

[18] UAC handed over Su-34 aircraft to the Russian Air Force. November 22, 2023. https://rostec.ru/news/oak-peredala-vks-rossii-samolety-su-34/

[19] UAC handed over another batch of Su-34 bombers to the Russian Aerospace Forces. October 9, 2023. https://rostec.ru/news/oak-peredala-vks-rossii-ocherednuyu-partiyu-bombardirovshchikov-su-34/

[20] Russian aircraft manufacturers manufactured and handed over Su-30SM2 aircraft to the Ministry of Defense. July 3, 2023. https://rostec.ru/news/rossiyskie-aviastroiteli-izgotovili-i-peredali-minoborony-samolety-su-30sm2/

[21] Aircraft manufacturers from Komsomolsk-on-Amur handed over serial Su-57 and Su-35S to the Russian Ministry of Defense. September 28, 2023. https://rostec.ru/news/aviastroiteli-iz-komsomolska-na-amure-peredali-minoborony-rf-seriynye-su-57-i-su-35s/

[22] Russian aircraft manufacturers manufactured and handed over Su-30SM2 aircraft to the Ministry of Defense. July 3, 2023. https://rostec.ru/news/rossiyskie-aviastroiteli-izgotovili-i-peredali-minoborony-samolety-su-30sm2/

[23] "They really have no analogues": the Russian Ministry of Defense received a batch of modernized MiG-31 fighter-interceptors. RussiaToday. August 1, 2023. https://russian.rt.com/russia/article/1181747-rossiya-mig-31-modernizaciya

average.[24] UAC continued combat aircraft production in 2023, however the precise number of aircraft delivered is unknown.

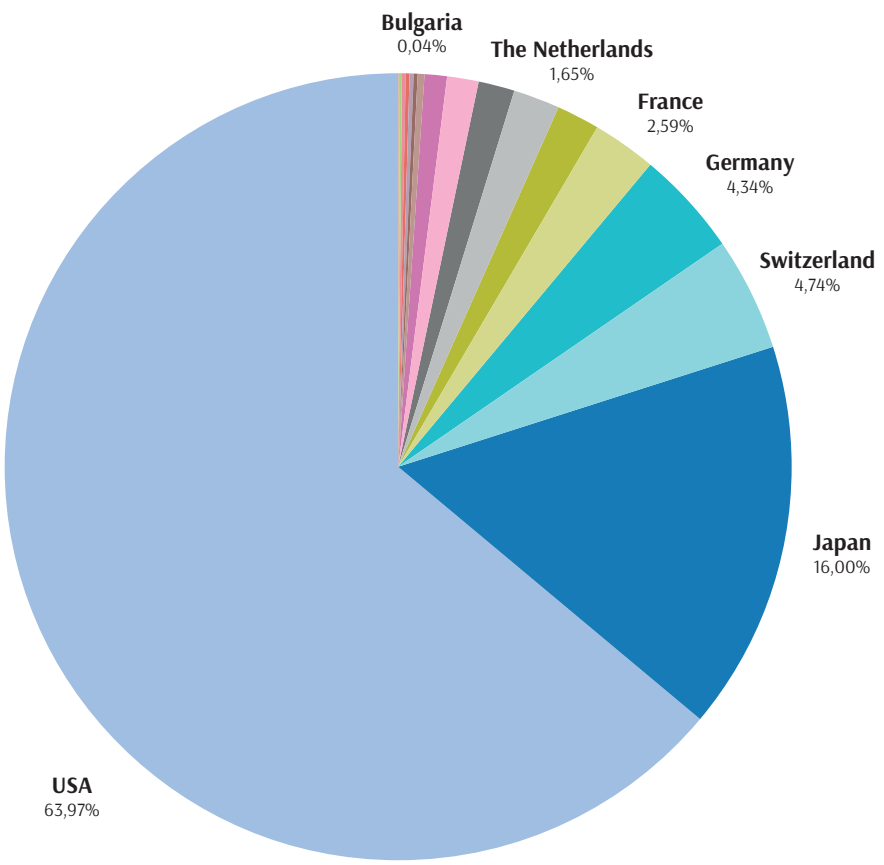
UAC not only relies on its own producing capacities but also uses a wide range of foreign components, despite being sanctioned by the U.S., European Union (EU), UK, Canada, Switzerland, Japan, Australia, New Zealand, and Ukraine.[25]

FOREIGN COMPONENTS

Out of more than 2,000 components found in all six fighter bombers studied, there is evidence of at least 22 countries of manufacturing. **The majority of components come from U.S. companies**, either by headquarters' jurisdiction or territorial origin of manufacturing.

In addition to the U.S., the list of top manufacturing countries includes **Japan, Switzerland, Germany, France, the UK, Taiwan, and The Netherlands**.

Exhibit 2. Components and their presumable origin, by headquarters of the manufacturers' jurisdiction



Additionally, some of the components' origins can be traced back to:

- **Europe** – Belarus, Belgium, Bulgaria, Czechia, Finland, and Spain;
- **North America** – Canada;
- **Middle East** – Israel;
- **Asia** – China, India, Singapore, South Korea, and Kyrgyzstan.

[24] Russian combat aircraft production sustained despite sanctions. WavellRoom. February 17, 2023. https://wavellroom.com/2023/02/17/russian-combat-aircraft-sanctions/

[25] United Aircraft Corporation. War & Sanctions. https://sanctions.nazk.gov.ua/en/sanction-company/24/

Exhibit 3. Components Found in Six Aircraft by Country

Country	MiG-31I	Su-27SM3	Su-30SM	Su-34	Su-35S	Su-57
Belarus					1	
Belgium		1				
Bulgaria					1	
Canada			1	1		
China		1	3	1	17	3
Czechia		1				1
Finland						1
France	1	23	10		8	16
Germany	11	7	14	12	39	14
India		2				
Israel					1	
Japan	17	35	29	37	164	76
Kyrgyzstan					4	
Philippines		1				
Singapore					5	
South Korea		2	1	2	13	4
Spain				1		
Switzerland		10	20	10	45	21
Taiwan		9	5	4	14	8
The Netherlands	5		6	3	20	3
UK		20		1	14	6
USA	70	233	177	157	545	249

Source: ***NAKO***

CRITICAL COMPONENTS

On September 14, 2023, BIS issued a list of highly prioritised items essential for Russia's weaponry requirements, the **Highest Priority Items List**.[26] Considering alternative supply via third-party countries outside the Global Export Controls Coalition, BIS recommends that local manufacturers seek the assurance of compliance with the U.S. export control when exporting the goods from the Highest Priority Items List to companies from non-Coalition countries.

Exhibit 3. Components Found in Six Aircraft by Country

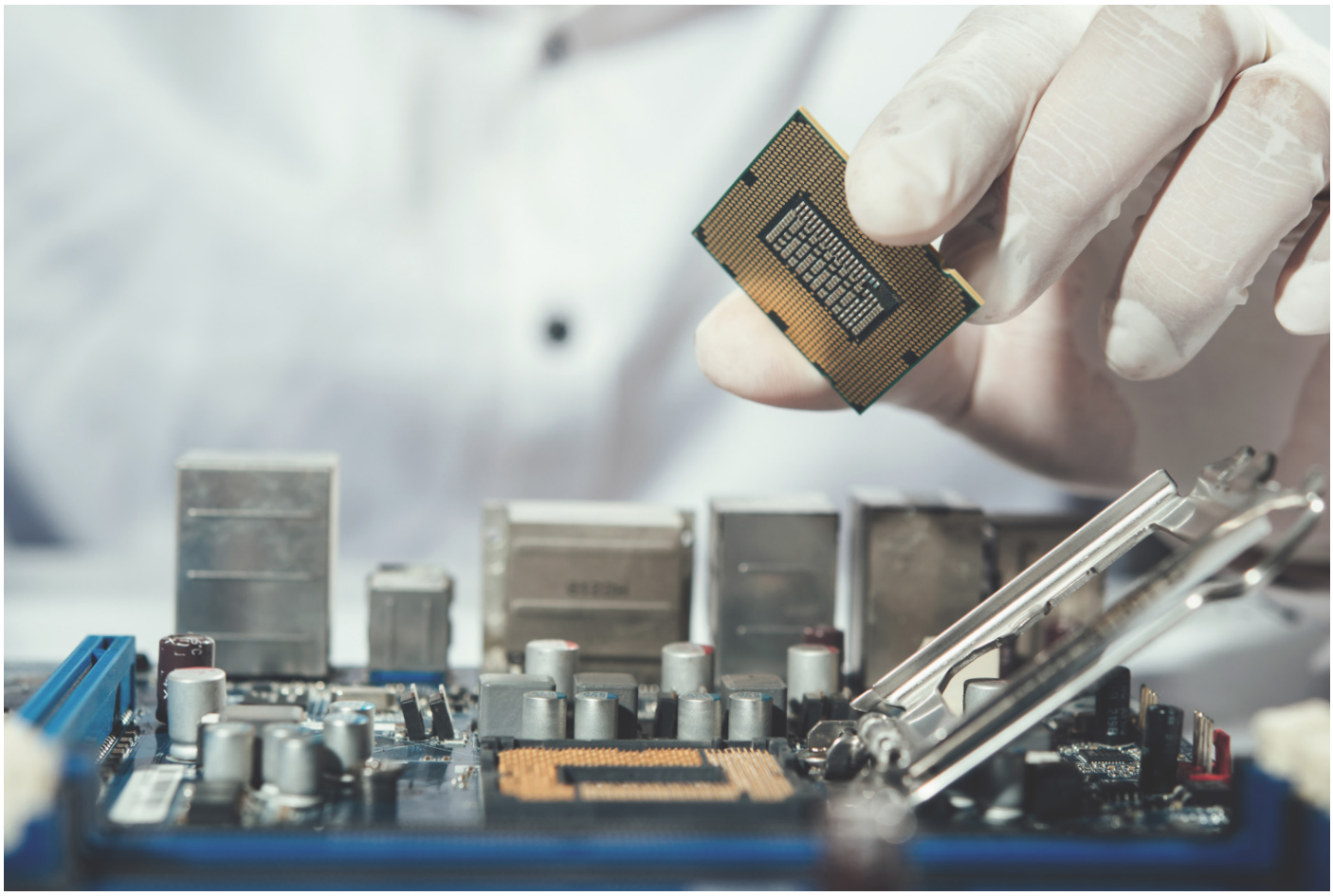
№	HS Code[27]	Identification	Number of components found
1	8542.39	Electronic Integrated Circuits	559
2	8532.24	Fixed Capacitors, Ceramic Dielectric, Multilayer, Chips	277
3	8536.69	Electrical Plugs And Sockets For A Voltage Not Exceeding 1,000 V	202
4	8548.00	Waste and scrap of primary cells, primary batteries and electric accumulators	139
5	8542.32	Memories, Electronic Integrated Circuits	136
6	8541.10	Diodes, Other Than Photosensitive Or Light-emitting Diodes	103
7	8542.33	Amplifiers, Electronic Integrated Circuits	75
8	8541.29	Transistors, Other Than Photosensitive, Others	67
9	8504.50	Other Inductors	57
10	8533.21	Fixed Resistors, Others, For A Power Handling Capacity Not Exceding 20 W	49
11	8531.21	Electric sound visual signalling apparatus products	48
12	8538.90	Parts For Electrical Apparatus For Electrical Circuits, Boards, Panels Etc	37
13	8542.31	Printed Circuit Board Assembly	30
14	8504.40	Electrical Static Converters; Power Supplies For Adp Machines	28
15	8541.41	Light-emitting diodes (LED)	28
16	8536.49	Relays For A Voltage Exceeding 60 V But Not Exceeding 1,000 V	26
17	8541.49	Other semiconductor devices	25
18	8504.90	Parts For Electrical Transformers, Static Converters And Inductors	24
19	8541.21	Transistors Other Than Photosensitive, With A Dissipation Rate Of Less Than 1 W, Operating Frequency Less Than 100 Mhz	21
20	8536.90	Electrical Apparatus For Switching, Protecting Or Making Connections To Or In Electrical Circuits, For A Voltage Not Exceeding 1,000 V, Others	18

[26] Best Practice: Certification to Prevent Diversion to Russia of Highest Priority Items. BIS. September 14, 2023. https://www.bis.doc.gov/index.php/documents/policy-guidance/3339-tent-final-best-practice-customer-certification-v4/file

[27] HS Codes highlighted in yellow indicate the codes that had been identified and prioritised as the most significant to the Russian weaponry requirement, according to the BIS. *See more:* **the Highest Priority Items List**.

21	8533.40	Other variable resistors, including rheostats and potentiometers	18
22	8536.41	Relays For A Voltage Not Exceeding 60 V	18
23	8532.25	Dielectric of paper or plastics	16
24	8504.31	Electrical Transformers Others, Having A Power Handing Capacity Not Exceeding 1 Kva	11
25	8414.59	Fans, Centrifugal, Not Suitable For Use With Motor Vehicles	11
26	8541.60	Mounted Piezoelectric Crystals, Quartz, Designed For Operating Frequencies Exceeding 20 Mhz	9
27	8473.30	Parts And Accessories For Automatic Data Processing Machines And Units Thereof, Magnetic Or Optical Readers, Transcribing Machines, Etc., Others	8
28	8532.29	Fixed electrical capacitors (excluding tantalum, aluminium electrolytic, ceramic, paper, plastic and power capacitors)	7
29	8529.90	Parts (except Antennas And Reflectors) For Use With Radio Transmission, Radar, Radio Navigational Aid, Reception And Television Apparatus, Others	7
30	8536.10	Fuses For Electrical Apparatus For A Voltage Not Exceeding 1,000 V	6
31	8536.50	Electrical Switches For A Voltage Not Exceeding 1,000 V, Others	5
32	8506.50	Primary Cells And Primary Batteries, Lithium	5
33	8543.70	Electrical Machines And Apparatus, Having Individual Functions, Others	4
34	8531.20	Indicator panels incorporating liquid crystal devices (LCD's) or light emitting diodes (LED)	4
35	8544.42	Electric Conductors, For A Voltage Not Exceeding 1000 V, Fitted With Connectors, Others	3
36	8542.90	Electronic Integrated Circuits And Microassembly Parts	3
37	8532.22	Aluminum electrolytic	2
38	8536.30	Electrical Apparatus For Protecting Electrical Circuits For A Voltage Not Exceeding 1,000 V, Others	2
39	8532.23	Fixed Capacitors, Ceramic Dielectric, Single Layer, Chips	2
40	8517.62	Machines For The Reception, Conversion And Transmission Or Regeneration Of Voice, Images Or Other Data, Including Switching And Routing Apparatus	2
41	8523.51	Solid-state Non-volatile Storage Devices For The Recording Of Sound Or Other Phenomena	2
42	8541.30	Thyristors, diacs and triacs, other than photosensitive devices	2
43	8471.80	Control Or Adapter Units For Automatic Data Processing Machines	1
44	8501.10	Electric Motors Of An Output Not Exceeding 37.5 W	1
45	8535.90	Electrical Apparatus For Switching, Protecting Or Making Connections To Or In Electrical Circuits, For A Voltage Exceeding 1,000 V, Others	1
46	9027.10	Electrical Gas Or Smoke Analysis Apparatus	1
47	8544.49	Electrical Slip Rings	1
48	9030.33	Instruments And Apparatus, For Measuring Or Checking Voltage, Current, Resistance Or Power, Without A Recording Device, Others	1
49	8524.91	Liquid Crystals	1
50	8541.40	Photosensitive Semiconductor Devices, Including Photovoltaic Cells; Light-emitting Diodes	1

Source: ***NAKO***



COMPONENTS UNDER U.S. EXPORT CONTROL

U.S. export control measures concern any high-technology item listed as subject to the Export Administration Regulations (EAR) administered by BIS, which is part of the U.S. Department of Commerce.

The **Commerce Control List (CCL)**, an EAR subset, identifies particular items, technologies, and software that require an export licence before moving out of the U.S. If a certain good is listed in the CCL, it is therefore assigned with a specific **Export Control Classification Number (ECCN)**. Since April 2021, ***all items from the CCL require export licences when destined for Russia or Belarus***.[28] The licence requirements also apply to in-country transfers within Russia and Belarus.

The other items under the jurisdiction of the EAR, yet out of the CCL, are designated **EAR99** and considered low-technology consumer goods and do not require licensing. ***These items do require licences while exporting to Russia or Belarus if they pertain specifically to the BIS's Entity List***.

The absolute majority of the components analysed and identified in this report are EAR99, while 161 more can be designated as part of the CCL with respective ECCNs attributed.

[28] Russia-Belarus. BIS. https://www.bis.doc.gov/index.php/policy-guidance/country-guidance/russia-belarus

Exhibit 5. List of components from the CCL found in the analysed aircrafts

ECCN	# of Components	Interpretation	Reasons for Control[29]
3A991	112	**Electronic devices and components** not controlled by 3A001[30]	Anti-Terrorism
5A991	39	**Telecommunication equipment** not controlled by 5A001[31]	Anti-Terrorism
3A001	4	**Electronic Items**[32]	National Security, Regional Stability, Missile Technology, Nuclear Proliferation, Anti-Terrorism
5A002	3	**"Information security" systems, equipment, and "components"**[33]	National Security, Regional Stability, Anti-Terrorism, Encryption Items
3A992	1	**General-purpose electronic equipment** not controlled by 3A002[34]	Anti-Terrorism
4A994	1	**Computers, "electronic assemblies",** and related equipment not controlled by 4A001 or 4A003[35]	Anti-Terrorism
7A994	1	**Other navigation direction-finding equipment, airborne communication equipment,** and all aircraft inertial navigation systems not controlled under 7A003 or 7A103[36]	Anti-Terrorism

[29] Compliance with the Export Administration Regulations (EAR) in AES EEI Filings. https://www.bis.doc.gov/index.php/documents/compliance-training/export-administration-regulations-training/377-ear-compliance-pdf/file

[30] Commerce Control List. Supplement No. 1 to Part 774. Category 3. https://www.bis.doc.gov/index.php/documents/regulations-docs/442-category-3-electronics-design-development-and-production/file

[31] Commerce Control List. Supplement No. 1 to Part 774. Category 5. https://www.bis.doc.gov/index.php/documents/regulations-docs/2336-ccl5-pt1-3/file

[32] Commerce Control List. Supplement No. 1 to Part 774. Category 3.

[33] Commerce Control List. Supplement No. 1 to Part 774. Category 5.

[34] Commerce Control List. Supplement No. 1 to Part 774. Category 3.

[35] Commerce Control List. Supplement No. 1 to Part 774. Category 4. https://www.bis.doc.gov/index.php/documents/regulations-docs/2335-ccl4-5/file

[36] Commerce Control List. Supplement No. 1 to Part 774. Category 7. https://www.bis.doc.gov/index.php/documents/regulations-docs/2339-category-7-navigation-and-avionics-2/file

Exhibit 6. List of product types with components from the CCL Intel

ECCN	Type of Product	Number of components found
3A001	AC/DC	1
	Bus Line Transceivers	2
	FPGA	1
3A991	ADC	5
	Configuration PROMs for FPGAs	2
	CPLDs	1
	DC/DC	2
	FPGAs	21
	FPGA Memories	9
	Memories	68
	Microcontrollers	3
	Unidentified	1
3A992	Programmers, Emulators, and Debuggers	1
4A994	Memory	1
5A002	FPGAs	2
	Microprocessors	1
5A991	Amplifiers	3
	Clock Generators, PLLs, Frequency Synthesizers	3
	Controllers	1
	DAC	1
	Drivers, Receivers, Transceivers	14
	Ethernet ICs	1
	Ethernet controllers	2
	Mixer	1
	RF Amplifiers	2
	RF PLL Frequency Synthesizers	1
	Signal Buffers, Repeaters, Splitters	1
	Special Purpose ICs	6
	Specialized ICs	1
	Telecom	2
7A994	RF Amplifiers	1

Source: ***NAKO***

COMPONENT MANUFACTURERS

Texas Instruments (TI) products are traditionally widely present in the Russian Army's weapons and equipment. TI's production is also in one of the leading positions in the case of the fighter bombers studied. The components used generally consist of electronic integrated circuits and printed circuit board assemblies. The identified integrated circuits are predominantly used for power management: voltage regulators, references, and power current converters. Yet, it also contains the components that are considered more critical. For instance, Ethernet transceivers, Low Voltage Differential Signalling (LVDS) repeaters, GBPS transceivers, and CMOS/TTL to LVDS transmitters (5A991), high-speed ADCs (3A001), and flash microcontrollers (3A991).

TI

5A991	
	8542.39
3A991	
	8542.31
3A001	

Japanese **Murata Manufacturing** is known for its ceramic passive electronic components, particularly the capacitors. Most of Murata's components are in the Highest Priority Items List as they represent many capacitors and filters. Mainly, the two most recurring products are ceramic capacitors or ferrite beads and chips, which are used for high-stability performances and cleaning the differential mode noise, respectively.

Murata Manufacturing

8532.24
8548.00

The list of components identified as **Analog Devices (AD)** demonstrates various types of integrated circuits, including RF ones. The most common items include microcircuits, amplifiers, converters, voltage regulators, analogue switches, multiplexers, and demultiplexers. Among them, specific AD products fall under stricter U.S. export controls: mixers, digital RSPs, frequency synthesisers (5A991), and several ADCs (3A991).

Analog Devices

5A991	
	8542.39
3A991	
	8542.31

A subsidiary of Taiwanese Yageo Corporation, American **Kemet** manufactures passive electronic components and various capacitors. This analysis identifies three main types of capacitors: ceramic, tantalum, and film.

Kemet

8532.24
8542.39

A large producer of computer memory, **Micron Technologies** specialises in different sorts of data storage: DRAM, flash, and USB flash memories. The analysed fighter bombers contain the following types of Micron memories: NOR flash (MT25, PC28 series) and NAND Flash Memory (MT29, MTFC Series eMMC), which can be identified as 3A991.

Micron

3A991	
	8542.32

Analog Devices subsidiary **Maxim Integrated** produces a broad selection of integrated circuits and microcontrollers: power management, analogue, interface, digital, etc. The components used in aircraft manufacturing include converters, multiplexers, drivers, receivers, transceivers, voltage regulators, PLLs, frequency synthesisers, and a variety of amplifiers, particularly GPS/GNSS low-noise amplifiers (7A994).

Maxim

- 7A994
- 8542.39

Integrated **Device Technology (IDT)**, a company acquired by Renesas Electronics, produced mixed-signal semiconductors. The identified integrated circuits consist of buffers, drivers, receivers, multiplexers, bus transceivers, frequency synthesisers, and PLLs.

IDT

- 8542.39

Currently, **AVX Corporation** is a subsidiary of Kyocera Electronics Corporation. Its primary speciality within the context of this report revolves solely around capacitors, mainly ceramic and tantalum.

AVX

- 8532.24

Holt Integrated Circuits' primary field of expertise is electronic components for the avionics industry. It offers different types of integrated circuits (ICs), including CMOS, protocol, interface, and specialised ones. Holt's systems (ARINC 429) are used in aircraft's navigation systems, communications, and flight control. Some of the components identified are used to support the MIL-STD-1553, a U.S. Department of Defense standard used in U.S. Air Force fighter jets.

Holt

- 8542.39

Linear Technology, acquired by Analog Devices, manufactured semiconductors for data conversion, power management, interface, signal conditioning, radio frequency, and space and military purposes. The analysed fighter bombers contain Linear's surge suppressors, programmable timers and oscillators, power management ICs, regulators, radio frequency (RF) detectors, and DC/DC converters that fall under 3A991 of ECCN.

Linear Technology

- 3A991
- 8542.39

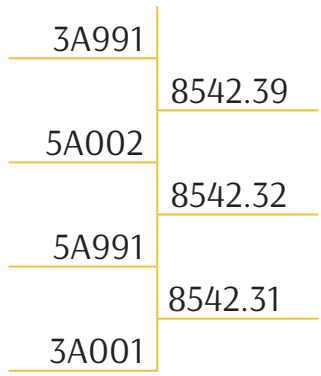
Cypress Semiconductor, acquired by Infineon Technologies, produced computer memory storage, microcontrollers, system-on-chips, power management ICs, etc. Its buffers, drivers, receivers, transceivers, PLLs, frequency synthesisers and memories were identified in the analysed pieces of Russian Federation Air Forces. Cypress' numerous memories from S25, S29, CY7, and FM18 series represent the 3A991 classification, while HOTLink IITM transceiver, telecom interface ICs, and a set of interface receivers fall under the 5A991 category.

Cypress

- 3A991
  - 8542.32
- 5A991
  - 8542.39

Intel is one of the world's largest semiconductor chip manufacturers. Intel's production is actively used in the Russian defence industry, especially its FPGAs and memories.[37] This report has counted a few types of products both under more and less strict restrictions. For instance, some of Intel's memories, especially FPGA memories (EPCS64, EPCS128, StrataFlash® Embedded Memory), were identified as 3A991. The same classification category is shared with Cyclone® V and Cyclone® 10 families of FPGAs. Intel's Arria® 10 SoC FPGA is classified as 3A001, while its Stratix® 10 is 5A002. Its Ethernet controller falls under 5A991. The other parts include special-purpose, voltage, and DC/DC controllers.

Intel



ON Semiconductor (onsemi) offers a great variety of products in power management, logic ICs, signal management, and passive devices. Particularly, onsemi's bridge rectifiers, diodes, switches, multiplexers, buffers, drivers, receivers, transceivers, registers, decoders, voltage regulators, optoisolators, several types of transistors, including phototransistors, interface, and logic ICs are present in the analysed pieces of Russian Air Forces.

ON Semiconductor

[37] FOREIGN COMPONENTS IN RUSSIAN MILITARY DRONES. https://kse.ua/wp-content/uploads/2023/08/230828%20Drones%20for%20KSE%20site.pdf?_t=1693243181

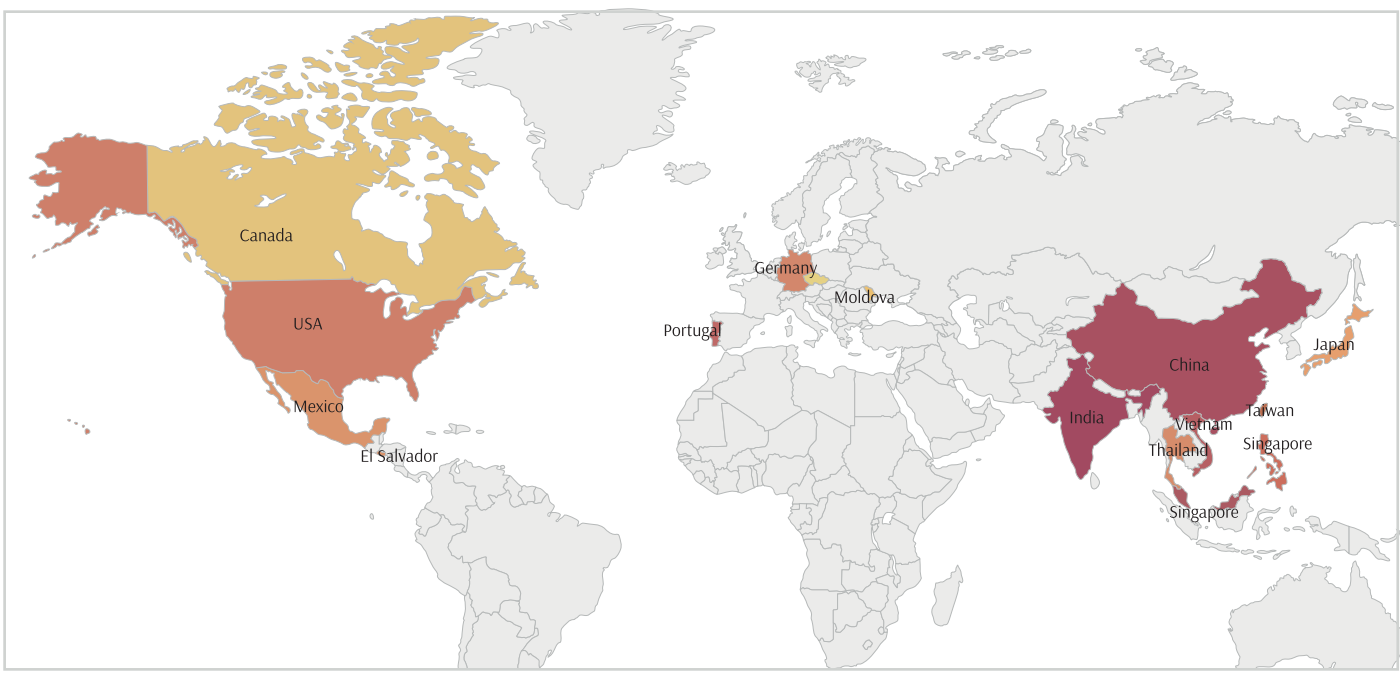
SUPPLY CHAIN

The involvement of third parties – countries and companies – has become the typical strategy to evade sanctions. As data from numerous countries, including European ones, demonstrate, there is an alarming tendency for rapid and rather sudden growth of exports into the countries bordering the Russian Federation in Central Asia: Armenia[38], Kazakhstan[39], Uzbekistan[40], etc. Apart from Russia's neighbours, export growth is also seen in Turkey, China, and the United Arab Emirates (UAE).[41]

Top 5 Countries of Origin (by total USD, 2023)	
China	$311,856,763
Malaysia	$231,302,807
Vietnam	$114,762,549
Taiwan	$90,745,231
Philippines	$46,515,127

Source: NAKO

The existing customs data on 2023 imports allows for identifying the leading countries that originate the components supplied to Russia under the brand of the key companies described in the previous section. The list also includes the USA, Thailand, Mexico, Japan, El Salvador, Singapore, Moldova, Canada, Czechia, India, Portugal, and Germany.



[38] U.S. Says Armenia Helping Russia Evade Sanctions
https://caspiannews.com/news-detail/us-says-armenia-helping-russia-evade-sanctions-2023-6-9-21/

[39] How Kazakhstan Helps Russia Bypass Western Sanctions
https://thediplomat.com/2023/10/how-kazakhstan-helps-russia-bypass-western-sanctions/

[40] "We must avoid using Uzbekistan as a platform for circumventing sanctions imposed on Russia", urges EU Sanctions Envoy
https://daryo.uz/en/2023/12/06/david-osullivan-the-eu-international-envoy-on-sanctions-draft

[41] U.S. Sanctions China, Turkey, UAE Firms for Supporting Russia
https://www.bloomberg.com/news/articles/2023-12-12/us-sanctions-china-turkey-and-uae-firms-for-supporting-russia

Compared to before the full-scale invasion, the supply of items made by the manufacturers above **increased**. In particular, the overall change demonstrates a rapid increase in 2022 with a moderate decrease in 2023.

2021	2022	2023
$567,390,275.45	↗ **111.83%** $1,198,740,339.46	↘ **–19.70%**[42] $962,603,097.78

Source: NAKO

Among the analysed companies, **the absolute majority of sales through third-countries tends to decrease.** However, in case of several manufacturers this tendency is the opposite:

- Albeit rapid growth in 2022, Micron's and IDT's production was imported *34.56%* and *45,07% less* in 2023 than before the full-scale invasion;
- The sales of TI, Cypress, and Intel decreased in 2023, yet still not enough to reach 2021 figures.

Overall, the companies that showed **the biggest growth** between 2021 and 2023 are:

1. Linear Technology, 894.26%
2. Holt Integrated Circuits, 614.46%
3. Analog Devices, 399.12%
4. Maxim, 136.00%
5. Texas Instruments, 121.95%

In general, the main trends in the key companies' components supply are [43]:

Company	2021	2022	2023	Country of Origin (2023)	Total USD (2023)
Texas Instruments	$65 368 894,08	↗ **137.88%** $154 873 412,32	↘ **–6.32%**[44] $145 056 001,05	China Malaysia Taiwan Philippines Thailand	$58 414 040,29 $30 317 319,34 $13 843 146,86 $11 382 841,13 $16 209 102,74
Murata Manufacturing	$6 195 720,57	↗ **38.02%** $8 541 775,24	↗ **12.68%** $9 624 630,07	Japan China Thailand Malaysia Taiwan	$5 456 738,74 $3 313 256,98 $185 682,40 $226 143,69 $42 254,87

[42] Compared to the previous year (2022).

[43] Source: NAKO

[44] Ibid.

Company	2021	2022	2023	Country of Origin (2023)	Total USD (2023)
Analog Devices	$52 610 138,31	↗ 229.99% $173 189 892,74	↗ 51.62% $262 563 997,65	China Malaysia Philippines Taiwan USA	$99 908 618,28 $55 873 468,12 $28 146 978,19 $21 103 981,73 $22 705 109,69
Kemet	$4 496 083,76	↗ 54.97% $6 969 675,28	↗ 23.86% $8 634 284,86	Mexico China USA Taiwan Portugal	$3 823 683,04 $2 458 762,56 $739 128,91 $362 979,08 $91 033,47
Micron	$49 490 294,57	↗ 37.12% $67 812 928,31	↘ −52.25% $32 414 137,80	China Malaysia Mexico Singapore Taiwan	$13 016 803,58 $7 738 793,60 $1 935 466,30 $1 655 285,36 $2 952 571,10
Maxim	$11 129 861,33	↗ 82.09% $20 271 067,57	↗ 29.56% $26 274 268,34	China Philippines Thailand Taiwan Malaysia	$9 312 362,37 $3 303 508,69 $3 809 105,52 $4 361 334,35 $3 198 068,86
IDT	$1 475 569,43	↗ 72.43% $2 546 821,64	↘ −68.09% $811 247,78	Moldova Taiwan China Germany USA	$1 647 178,90 $90 243,21 $259 506,69 $30 184,18 $40 041,30
AVX	$9 196 788,40	↘ −5.62% $8 679 769,97	↗ 35.76% $11 781 999,26	Czechia China El Salvador USA Taiwan	$1 252 665,50 $3 336 111,74 $1 972 948,58 $1 639 009,45 $1 739 660,41
Holt	$2 125 414,38	↗ 153.94% $5 401 917,15	↗ 181.57% $15 209 831,28	China Taiwan Thailand USA India	$6 718 153,93 $5 151 925,20 $864 336,55 $1 467 359,97 $313 448,38
Linear Technology	$1 100 808,62	↗ 330.98% $4 728 952,72	↗ 130.95% $10 947 258,44	Malaysia China Thailand USA Taiwan	$3 460 416,88 $2 634 295,63 $2 462 097,87 $1 111 197,97 $506 408,76
Cypress	$6 811 399,96	↗ 131.48% $15 740 712,21	↘ −27.56% $11 385 326,38	Taiwan China Thailand USA Philippines	$2 440 474,50 $3 418 823,03 $3 158 934,74 $610 454,13 $812 784,92

Company	2021	2022	2023	Country of Origin (2023)	Total USD (2023)
Intel	$346 181 236,15	↗ 106.03% $713 043 246,69	↘ –42.60% $409 714 832,10	Vietnam Malaysia China Taiwan USA	$114 762 549,56 $127 032 441,87 $101 367 940,12 $38 150 251,05 $13 309 143,55
ON Semiconductor	$11 208 065,89	↗ 51.13% $16 940 167,62	↗ 7.32% $18 185 282,77	China Malaysia Philippines Thailand Canada	$7 698 088,53 $3 456 155,60 $2 869 014,23 $1 209 025,30 $1 312 203,30

MAIN SUPPLIERS

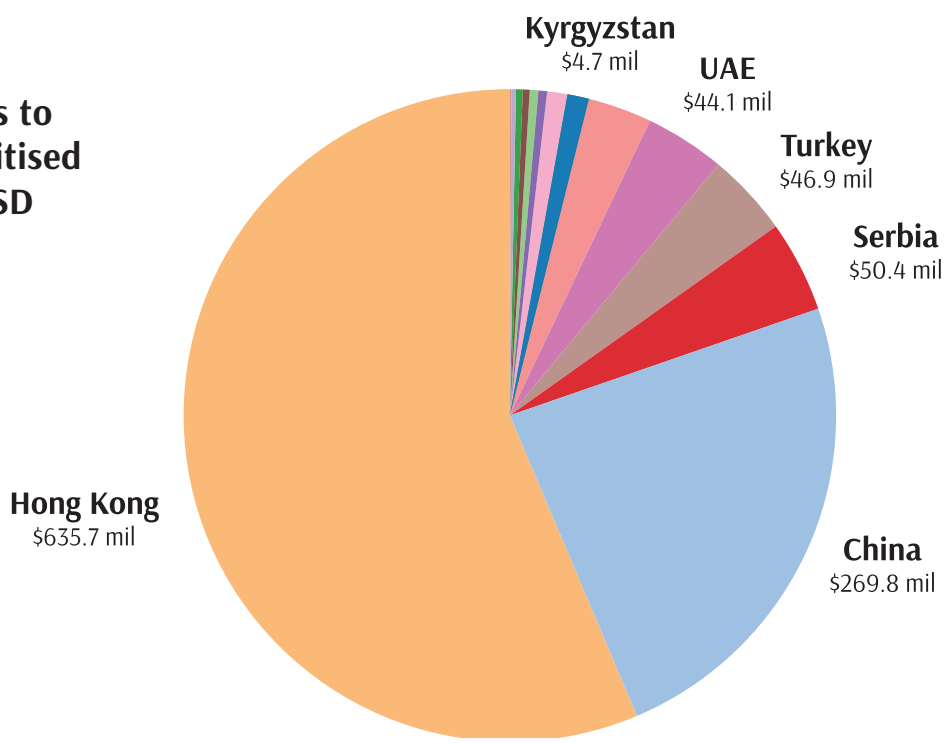
Due to the export control restrictions in the U.S., American companies whose goods possess potential interest and value in producing Russian weapons and military equipment must ensure they are compliant while exporting to counties outside the Global Export Controls coalition.

According to the 2023 Russian Federation customs data, the prioritised goods identified within this report **worth at least $4.2 billion reached Russia mainly through non-coalition countries.**

Exhibit 7. Russian import of prioritised goods in 2023, million USD

8542.39	8532.24	8548.00	8542.32	8542.33	8542.31	8517.62
987	56	11	124	123	906	2,053

Exhibit 8. Top companies to supply Russia with prioritised goods in 2023, million USD



Source: ***NAKO***

An analysis of the main suppliers of the components identified as one of seven HS Codes from the Highest Priority List shows there are **14 central countries** that enabled Russia receiving the goods in 2023. Particularly, almost 120 companies supplied various prioritised products **worth at least $1.1 billion**.[45]

At the same time, **the products' origins predictably differ,** both due to natural industrial and market reasons and other unknown or opaque factors. For instance, it is reasonably expected to see Asian states (China, Hong Kong, Taiwan, Malaysia, Vietnam, Philippines, Thailand, South Korea, and Japan) in the list of the countries that presumably originated the goods due to the peculiarities of the production cycle. It is also expected that the U.S. will be listed as one of the top countries of origin, as well as several EU countries (Czechia, Slovenia, Germany, and France) being on the list.

However, the nature of the origin of some prioritised semiconductor goods raises questions as to a) data reliability and b) potentially intentional misindication.

Specifically, the list includes **Costa Rica, Morocco, Mexico, and Malta** as the countries that seemingly originated some of the goods shipped to Russia in 2023 with **a cumulative worth of over $12 million**.

Aside from the products' origins, **the supplier companies** are also worth looking at. As expected, most companies come from China, whether it be a specific province or Hong Kong, its special administrative region. Overall, 95 Chinese and Hong Kongese companies supplied Russia with prioritised semiconductors of different origins **worth at least $905.5 million**.

The origin of top companies to supply Russia with prioritised items *(by total USD, 2023)*

Hong Kong	$635 683 949,27
China	$269 808 971,96
Serbia	$50 363 299,11
Turkey	$46 931 994,02
UAE	$44 081 072,32
Seychelles	$36 344 121,22
Canada	$11 367 221,79
UK	$11 156 601,26
Singapore	$5 090 162,21
Kyrgyzstan	$4 670 965,71
Thailand	$4 040 691,03
Hungary	$3 609 657,12
Taiwan	$2 585 374,46
Cyprus	$419 763,29

Source: ***NAKO***

Apart from the Chinese, there is also evidence of **four Serbian companies** whose only international customer in 2023 was Russia, predominantly private LLCs, some of which were sanctioned due to sanction circumvention. Several UAE and Turkish companies also tend to work with Russia and

[45] NAKO analysed only 700 top suppliers by each of seven HS Codes from the Priority List.

have already been covered by journalists[46] and partly sanctioned by the respective U.S. authorities.[47] [48]

The only British company on the top list, **Mykines Corporation LLP**, has already been mentioned in the context of Russia's supply chain and ties with Russia.[49] Established and run by Ukrainians, the company is tied to two companies in the British Virgin Islands: Emerette Investments Limited and Ventrax Trade Limited.[50] While the company's website states it is positioned as "a solar energy company"[51], customs data show that Mykines profits mainly from smartphones and laptop supplies with only a few Russian companies, one of which has been sanctioned by the U.S[52], while the other one is closely tied to Russian governmental contracts.[53]

Saldor Corporation is another interesting example. According to customs declarations, the company is registered in **Seychelles** and shares an address with numerous other entities, some of which can be linked to companies leaked in the Panama Papers.[54] Notably, Saldor shares some customers with the British Mykines: already-sanctioned Marsala LLC and Silkway LLC.

Although the interest in exports from countries bordering the Asian part of Russia is rapidly growing, only one Kyrgyz company was on the top list. Bishkek-based Shisan LTD mainly works with private companies of unknown affiliation. Yet one of its 2023 customers was **JSC Production Association Ural Optical and Mechanical Plant**, part of **Shvabe Holding** within Rostec (*mentioned on page 43*), which produces bomb aiming systems, laser distance measuring systems, and optical laser systems for military aircraft, including Su-27. In 2023, **Shisan supplied this plant with British optics worth more than $380,000, using Thailand as a third country**.

Generally, there were 119 main companies supplying Priority List items to Russia in 2023.[55]

[46] Media expose scheme of import of sanctioned goods to Russia, in particular for military-industrial complex. July 31, 2023. https://www.pravda.com.ua/eng/news/2023/07/31/7413632/

[47] BLIKSEM COMPUTERS & REQUISITES TRADING COMPANY LLC. OFAC Sanctions List Search. https://sanctionssearch.ofac.treas.gov/Details.aspx?id=45980

[48] Taking Additional Sweeping Measures Against Russia. U.S. Department of State. December 12, 2023. https://www.state.gov/taking-additional-sweeping-measures-against-russia-3/

[49] The UK business that shipped $1.2bn of electronics to Russia. April 7, 2023. https://www.ft.com/content/bdd8c518-bf10-4c9c-b53b-bfbe512e2e92

[50] Companies House - GOV.UK https://find-and-update.company-information.service.gov.uk/company/OC413685/officers

[51] Mykiness Solar. About Us. https://mykinessolar.com/about-us.html

[52] SILKWAY LIMITED LIABILITY COMPANY. OFAC Sanctions List Search. https://sanctionssearch.ofac.treas.gov/Details.aspx?id=44721

[53] Failure in the program: a former top manager of the Merlion Group of Companies warned the West against working with Oleg Karchev. February 2, 2022. https://ruscrime.com/failure-in-the-program-a-former-top-manager-of-the-merlion-group-of-companies-warned-the-west-against-working-with-karchev/

[54] Offshore Leaks Database. https://offshoreleaks.icij.org/nodes/14079335

[55] Source: NAKO

Exhibit 9. Top 25 companies supplying Priority List items to Russia, 2023

№	Company	Est[56]. value of the contracts	Country
1	Win Key LTD	$88 665 163,69	Hong Kong
2	Time Art International LTD	$62 902 278,85	Hong Kong
3	Agu Information Technology Co LTD	$48 668 230,42	China
4	Dexp International LTD	$46 764 719,96	Hong Kong
5	Saldor Corporation	$36 344 121,22	Seychelles
6	Imaxchip Technology Co LTD	$31 870 755,41	China
7	Tordan Industry LTD	$31 824 717,04	Hong Kong
8	Union Tech Inc LTD	$31 475 958,12	UAE
9	Yiwu Vortex Import And Export Co LTD	$31 260 426,25	Hong Kong
10	Kominvex Doo	$28 608 933,15	Serbia
11	Grants Promotion Service LTD	$20 561 226,85	Hong Kong
12	Abingo Distributors LTD	$19 769 213,45	Hong Kong
13	Asay Ic Ve Dis Ticaret LTD Sti	$19 162 933,68	Turkey
14	Guangzhou Chiphome Information Technology LTD	$17 608 731,36	China
15	TTS Logistics DOO	$15 881 320,02	Serbia
16	Yiwu Weishuo Import And Export Co LTD	$15 352 700,23	China
17	Align Trading Co LTD	$14 820 152,97	Hong Kong
18	Etop Electronics Hk Co LTD	$14 783 184,35	Hong Kong
19	Piraclinos LTD	$14 332 273,97	Hong Kong
20	Hytera Communications LTD	$13 962 489,52	China
21	Xin Quan Electronics Hongkong Co LTD	$13 759 525,22	Hong Kong
22	Most Invest LTD	$13 474 021,78	Hong Kong
23	Asialink Shanghai Int L Logistics Co LTD	$13 168 550,61	China
24	Clf Global LTD	$12 752 626,65	Hong Kong
25	Lett Tronic Group Limited O B Asay Ic Ve Dis Ticaret LTD Sti	$12 393 620,99	Hong Kong

[56] This section demonstrates the estimated cumulative sum of contracts within the analysed period and is based on the USD parameter in the customs data. It is important to acknowledge: the original data might contain potential discrepancies in the USD parameter due to the peculiarities of transactions, the actual currency of the contracts, and their respective display in the customs database.

MAIN IMPORTERS

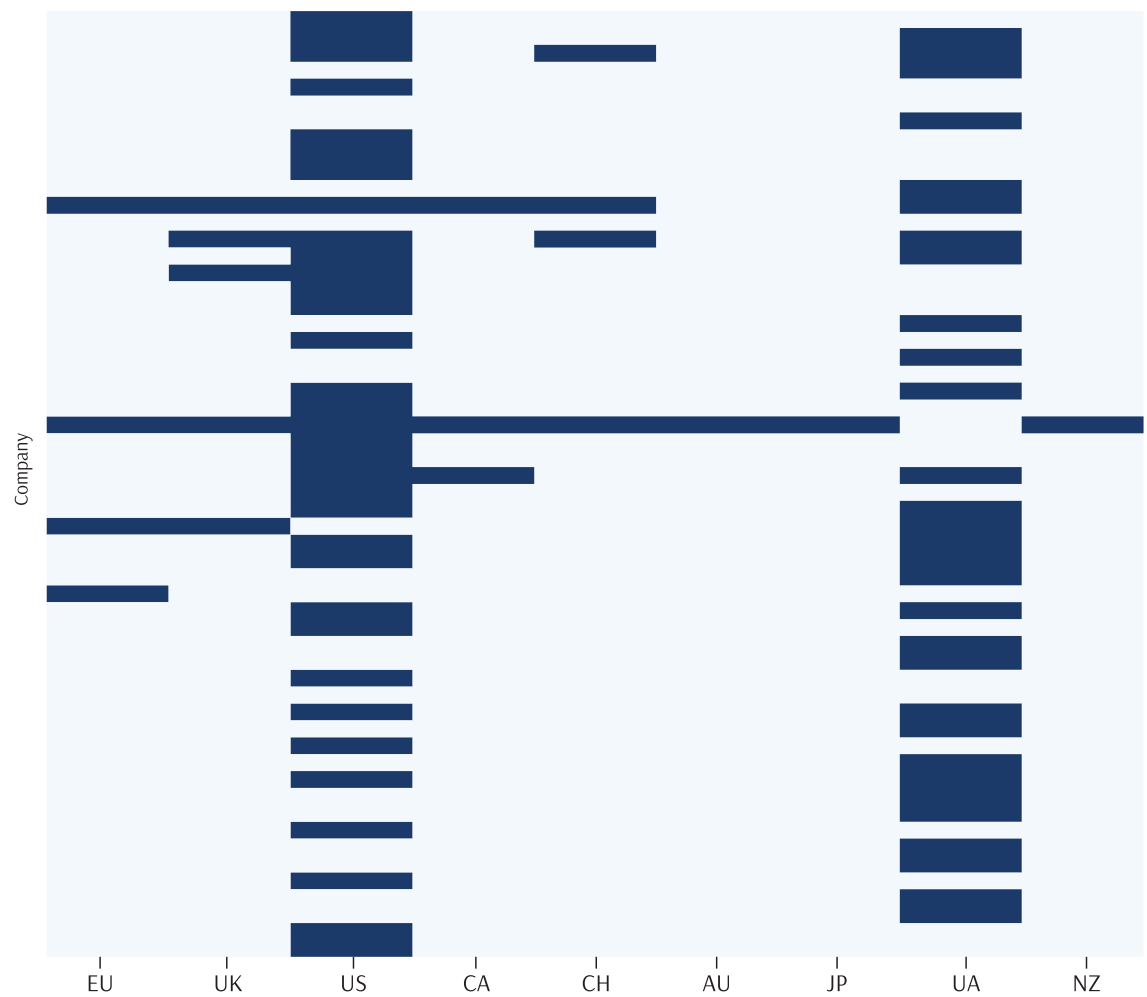
At least 58 major Russian companies import the most critical items to Russia via third countries for proven or potential military use (see Exhibit 11). This assessment is based on the following criteria:

- The company has to be present in the top importer list by at least two of seven main HS Codes in 2023;
- The company has already been sanctioned by at least one leading jurisdiction for sanctions evasion.

Although different countries certainly pursue sanctioning the supply-chain-related companies, **the following list of intermediary importers needs to be better covered**[57]: the U.S. sanctioned 34 of them, Ukraine sanctioned 30; the UK sanctioned five, while the EU and Switzerland took actions against four entities. Canada imposed restrictions against only three entities. Australia, New Zealand, and Japan sanctioned only one entity.

Exhibit 10 demonstrates how each analysed entity was or was not sanctioned by the nine leading jurisdictions. The intense blue indicates that a company has been sanctioned, while the remaining light blue shows the lack of action.

Exhibit 10. Comparison of sanctioning between jurisdictions, by companies



[57] According to the War & Sanctions database. https://sanctions.nazk.gov.ua/en/

Exhibit 11. Major Russian companies that import the most critical items to Russia via third countries for proven or potential military use

№	Company[58]	Est[59]. Import value	TIN
1	Tascom	$115 956 000,04	4025422770
2	NPP Itelma LLC	$85 737 309,55	7724685256
3	VMK LLC	$51 149 764,82	6450104152
4	TMI LLC	$42 803 353,01	9717000138
5	Silkway LLC	$37 426 784,10	9717089129
6	Atlas LLC	$37 255 890,57	2543069263
7	MT Systems LLC	$33 361 155,01	7805550962
8	Trialcom LLC	$31 178 563,16	7805791446
9	Velesstor LLC	$31 029 296,85	7838098822
10	Istern Trade LLC	$27 130 783,73	9728061541
11	EMC Expert LLC	$23 497 368,39	7107551966
12	SMT Aylogik LLC	$21 821 620,10	7804552300
13	Setuntel LLC	$19 463 566,96	7730246560
14	Testkomplekt LLC	$18 728 693,65	5029208152
15	New It Project LLC	$17 789 262,11	7724338125
16	Stout LLC	$17 763 861,28	7811401214
17	Trialcom LLC	$15 354 965,69	
18	Chipdevice LLC	$15 115 327,69	7806598766
19	Bitteria LLC	$15 051 883,41	9715297229
20	Snabinter LLC	$14 303 965,39	7743254512
21	Saturn EK LLC	$13 723 463,91	7806525158
22	Modern Digital Technologies LLC	$13 228 872,48	1655424901
23	Epsilon JSC	$12 164 828,86	5402015817
24	Lanprint Llc	$12 163 190,03	
25	Kvazar LLC	$10 333 706,11	7805753313
26	TD Kyutek LLC	$9 811 455,90	7729490282
27	SPC Topaz LLC	$9 267 972,66	5008011331

[58] The names, spellings and abbreviations of the companies can slightly differ in other sources due to translation and transliteration issues.

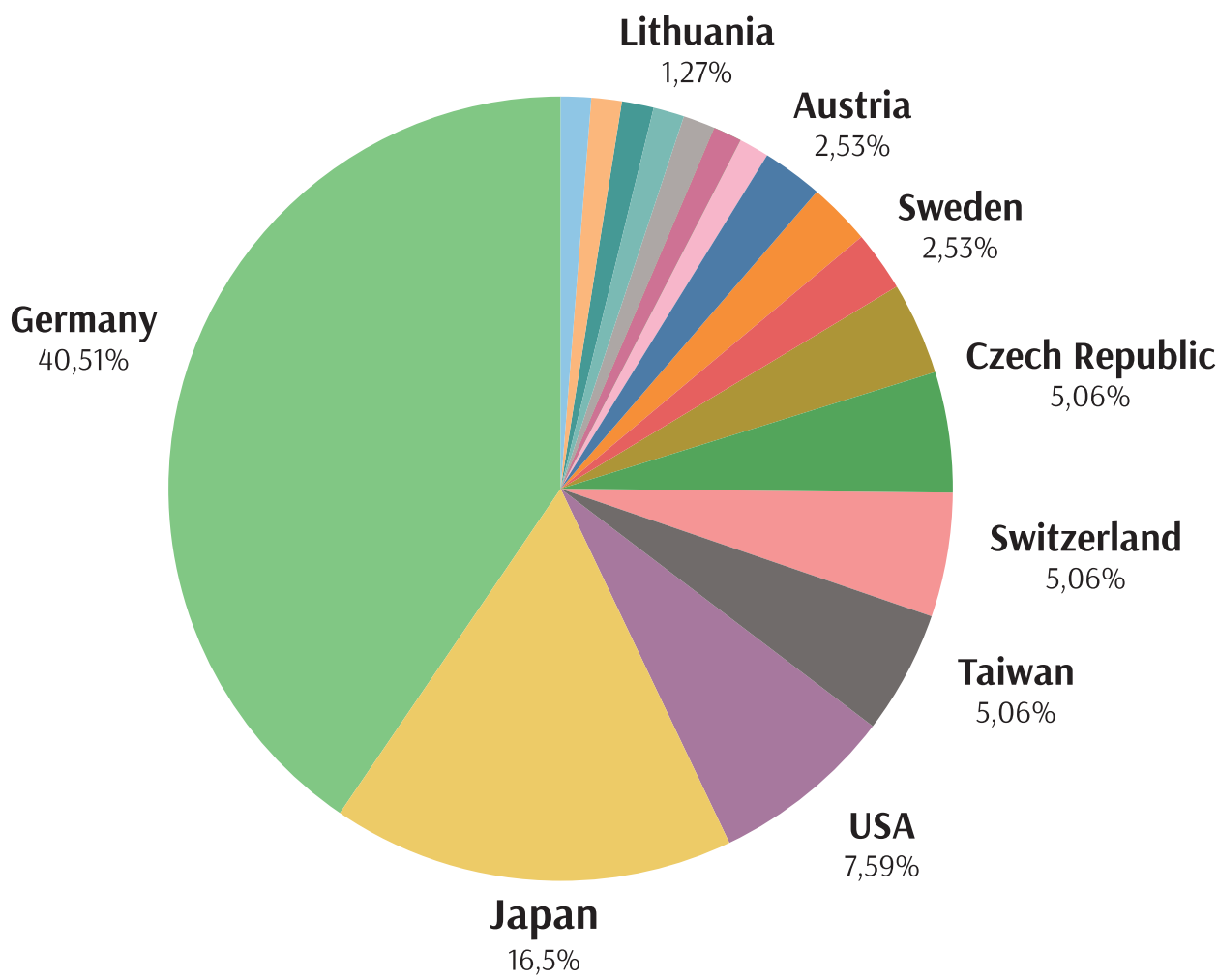
[59] This section demonstrates the estimated cumulative sum of contracts in the analysed period and is based on the USD parameter in the customs data. It is important to acknowledge that the original data might contain potential discrepancies in the USD parameter due to the peculiarities of transactions, the actual currency of the contracts, and their respective display in the customs database.

№	Company[58]	Est[59]. Import value	TIN
27	SPC Topaz LLC	$9 267 972,66	5008011331
28	Matrix Electronics LLC	$7 732 336,15	5402035309
29	Streloy E Commerce LLC	$7 649 738,51	7840068335
30	Katreyd LLC	$7 092 783,94	6731071061
31	NTC Rotek LLC	$6 759 171,14	7703545018
32	Microsan LLC	$6 678 935,31	5407216683
33	Radiotehkomplekt JSC	$6 444 048,29	7713122621
34	Titan Micro LLC	$5 429 728,28	6230119259
35	Macro Tim LLC	$4 904 071,21	7720134018
36	Exiton LLC	$4 583 123,44	2635063350
37	Spark TT LLC	$3 636 275,74	2130183574
38	Logide LLC	$3 475 471,33	7721831364
39	PIT Logistics LLC	$3 385 909,80	7810639510
40	Elkom LLC	$3 260 467,42	7328076275
41	Altex JSC	$3 228 857,96	7735141970
42	Baltelectron LLC	$3 227 353,50	7714417321
43	Vector LLC	$3 095 445,70	9718180638
44	Trading House Simmetron Electronic Components LLC	$3 059 684,97	7806296652
45	Favorit EK LLC	$2 914 145,31	7723349886
46	Sibelkom Logistic LLC	$2 722 205,84	5404462899
47	Arteks LLC	$2 363 590,73	7702815751
48	Kompel JSC	$2 150 699,26	7713005406
49	PK Electronics LLC	$2 020 578,81	4025409882
50	Alfa Komplekt Si LLC	$802 754,24	7733298937
51	Tellur Electronics LLC	$796 641,24	7720355306
52	Radiodetal Supply LLC	$704 543,83	7735187358
53	Scan Engineering Prof LLC	$496 205,66	7720767469
54	Altrabeta LLC	$459 950,99	7802646313
55	Avtek Group LLC	$374 101,64	7813196271
56	Imotek LLC	$267 548,95	7802428700
57	NPK Fotonika LLC	$228 766,46	7813547434
58	Radiotechsnab LLC	$172 794,74	7813257380

AIRCRAFT PRODUCTION: MACHINERY AND EQUIPMENT

Available open-source information allows the identification of numerous computer numerical controls (CNCs) and equipment used to produce the analysed aircraft of the Russian Federation Air Forces. In general, there is evidence of using the machinery of **52 companies from at least 17 countries:** Germany, Japan, USA, Italy, China, Czechia, Sweden, Austria, Belgium, Brazil, Lithuania, Spain, Switzerland, Taiwan, Thailand, and Turkey, and the UK.

Exhibit 12. Origin of machinery identified in aircraft production



Source: NAKO

Many machine tools are CNC with a wide variety of uses: machining centre, sharpening, digital guidance, press break, portal unit, measuring, milling, or turning machines. There is also evidence of foreign filters and dust controllers for large-scale machinery, lathes, bending, broaching, riveting, optical equipment, plastic moulding, pipe, and processing machines. Rotary engraver, water-jet cutting installation, welding station, and wire electrical discharge machining (EDM) are also present.

There is evidence of Russian enterprises involved in producing the analysed fighter bombers (see Exhibig 13).[60]

Exhibit 13. Key Russian plants engaged in aircraft production

- Irkutsk Aviation Plant
- JSC Hydromash
- JSC Kaluga Research Institute of Radio Engineering
- JSC Kizlyar Electromechanical Plant
- JSC ODK-STAR
- JSC Production Association «Ural Optical and Mechanical Plant»
- JSC Tactical Missiles Corporation
- JSC Ulyanovsk Instrument Manufacturing Design Bureau
- JSC Zavod Radiopribor
- Komsomolsk-on-Amur Aircraft Plant
- Lytkarino Machine-Building Plant
- NAZ im. Chkalova
- PJSC Holding Company “Leninets”
- PJSC ODK-Saturn
- PJSC ODK-Ufa Motor Manufacturing Association
- Salyut Machine-Building Association
- Scientific and Production Corporation “Precision Instrumentation Systems”
- Stavropol radio plant “Signal”

Source: NAKO

[60] This list, however, is incomplete as it is based solely on the evidence of manufacturing and the presence of the foreign machinery.

Exhibit 14. Identified CNC manufacturers

Austria	Engel
	STM Waterjet Group
Belgium	Donaldson Company
Brazil	Romi
China	Isel
Czech Republic	Kovosvit MAS
	Tajmac-Zps
	Walter Maschinenbau GmbH
Germany	Broetje-Automation
	Chiron Group
	DMG Mori
	Emco
	Eroglu
	Fooke GmbH
	Heidenhain
	Hermle
	Hoffmann Räumtechnik GmbH
	Index Group
	Modler
	Pipe Bending Systems
	Schroff
	Siemens
	Spinner Group
Italy	Fagima
	Jobs
	TWS Automation
Japan	Amada
	Fanuc
	Kitamura
	Matsuura
	Mazak
	Mitsubishi Machine
	Muratec
	Roland DGA
	Sodick
	Tsugami
Lithuania	Standa
Spain	MTorres
Sweden	Seco Tools
	WJS AB
Switzerland	Agie Charmilles
	Tornos
Taiwan	FEELER
	Honor Seiki Co., LTD
	Tongtai
Thailand	Anca
Turkey	Baykal
UK	Duguard
USA	Haas
	Keysight
	Rogers Corporation
	Weller

Source: NAKO

Komsomolsk-on-Amur Aircraft Plant (KnAAZ)

Комсомольский-на-Амуре авиационный завод имени Ю. Гагарина

Komsomolskiy-na-Amure aviatsionnyi zavod imeni Y. Gagarina

Sanctioned by

TIN
2703019760

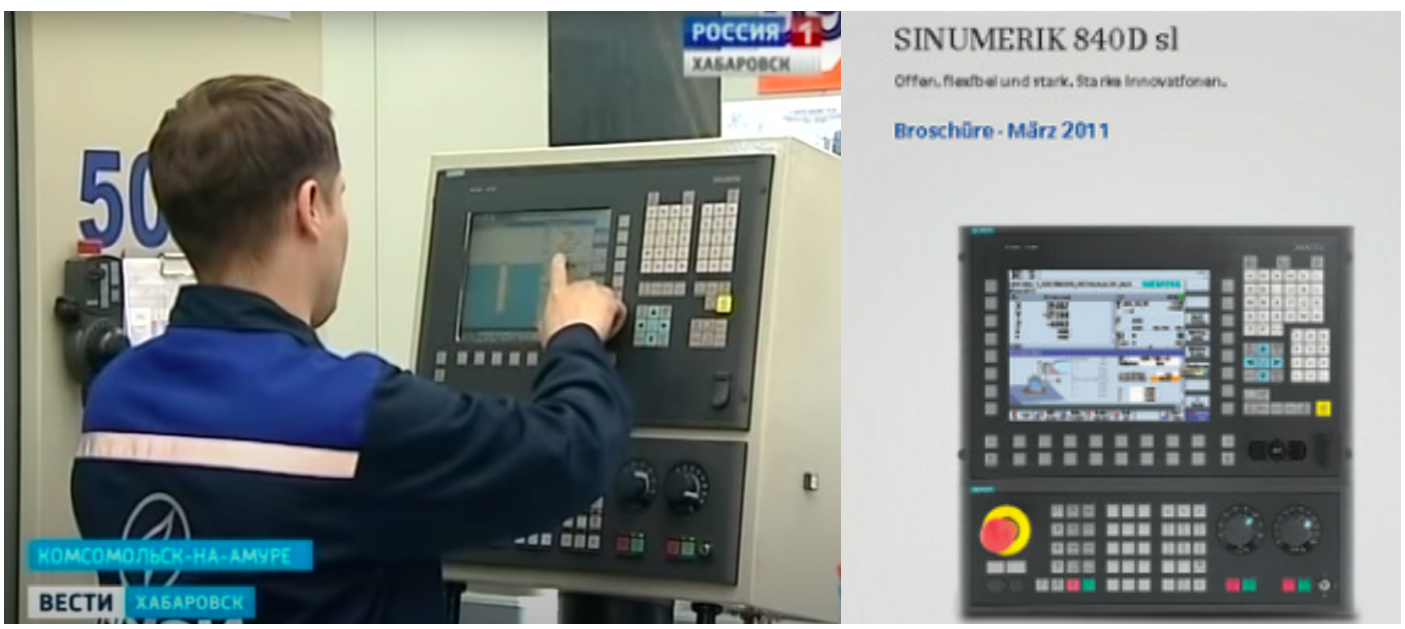
Subsidiary of
- JSC Sukhoi Aviation (7740000090)
- PJSC United Aircraft Corporation (7708619320)

KnAAZ is the leading manufacturer of JSC Sukhoi Aviation and a manufacturer of the Su brand aircraft.

According to the news broadcast, KnAAZ was supplemented with new milling machines in 2018, presumably Russian-made.[61] The machines are claimed to be manufactured in Sterlitamak, where the leading manufacturer of Russian milling and turning machines is located.

The operator's screen of these machines **resembles SIEMENS' Sinumerik 840D** for metalworking equipment. The Siemens label has the same shape, colour, and size as the one on the side of the milling machines installed at KnAAZ.

Exhibit 15. Screenshot from a 2018 news broadcast showing 'Russian-made' milling machine manufactured in Sterlitamak[62]



Another video for a kids' show, shot in 2020, demonstrates a machining centre with 'DMG' and 'Heidenhain iTNC 530' on it, which indicates **DMG Mori's origin**.[63] Notably, it can be identified as **DMU 60T** (see Exhibit 16).

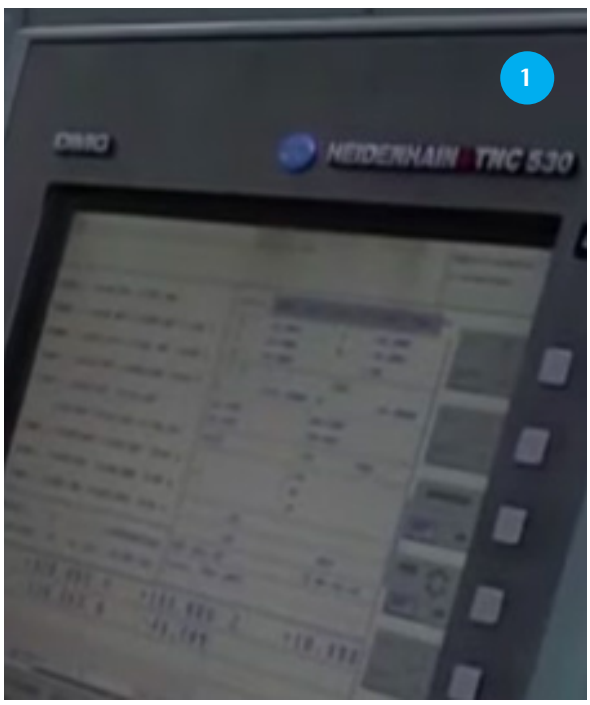
[61] Вести-Хабаровск. Новый цех механообработки на КнААЗ. https://www.youtube.com/watch?v=WRyM6vv2znY

[62] Brochure Siemens Sinumerik 840 D https://wtp.hoechsmann.com/ru/lexikon/22974/siemens_sinumerik_840_d

[63] ДСТВ в Комсомольске-на-Амуре: КНААЗ! https://www.youtube.com/watch?v=e71hNpK776c

Exhibit 16. Screenshot from the video

Exhibit 17. Closer look to the marks on the tool (1) and a photo of used DMU 60 for purchase with the same handles and doors, published on Russian marketplace (2)[64]



[64] DMG DMU 60 T Вертикальный обрабатывающий центр https://www.exapro.ru/dmg-dmu-60-t-p90225069/

Irkutsk Aviation Plant

Иркутский авиационный завод

Irkutskiy aviatsionnyi zavod

TIN
3807002509

Subsidiary of
- PJSC United Aircraft Corporation (7708619320)

Currently labelled as a branch of PJSC United Aircraft Corporation, Irkutsk Aviation Plant (IAZ) manufactures numerous multi-purpose jets, including **Su-30SM modifications**.

Photos from the plant made by a livejournal user indicate at least two foreign companies present: **German EROGLU and Belgian Donaldson Company**.[65] Particularly, EROGLU's tool rack and precision tool holders can be seen in the photos and Donaldson's filtering units installed on large-scale machines of unknown origin (assumingly, CNC milling machines).

Exhibit 18. Photos from inside IAZ

Apart from the visual evidence, IAZ's tender announcements in 2017-2022 indicate the presence of the following machines:

AgieCut[66]	Wire EDM	Agie Charmilles	Switzerland
Deckel Maho DMU 200P[67]	CNC Machine center	DMG Mori	Germany

[65] Производство самолетов Су-30 и Як-130. Иркутский авиационный завод. https://gelio.livejournal.com/200901.html

[66] https://rostender.info/region/irkutskaya-oblast/irkutsk/58277298-tender-postavka-zapasnyh-chastej-na-stanok-firmy-agie-agiecut-dlya-nujd-iaz

[67] https://rostender.info/region/irkutskaya-oblast/irkutsk/58154267-tender-postavka-zapasnyh-chastej-na-stanok-traub-tne-300-2002-g-dlya-nujd-iaz

TRAUB TNE 200[68]	Turn-mill centers	Index Group	Germany
TorresMill[69]	Heavy milling machine	MTorres	Spain
Jomax 265[70]	Milling Machine	Jobs	Italy
MCFV 1260[71]	Vertical machining centre	Tajmac-Zps	Czechia
RX7 2006 [72]	CNC Sharpening Machine	Anca	Thailand

JSC Ulyanovsk Instrument Manufacturing Design Bureau

АО Ульяновское конструкторское бюро приборостроения | АО УКБП

AO Ulyanovskoe konstruktorskoe byuro priborostroeniya | AO UKBP

This plant develops and manufactures avionics systems, aircraft and helicopter automatic control systems for ground vehicles and hydroelectric engineering, car components, and medical equipment.[73] Particularly, it is said to be one of the systems manufacturers for **Su-27 (SM3 including), Su-30SM, Su-37, Su-38, and Su-39**.

Sanctioned by

TIN
7303005071

Subsidiary of
- JSC Concern Radio-Electronic Technologies (7703695246)
- Rostec (7704274402)

The information on specific foreign-made machinery the plant uses is available on its website.[74] It consists of the following pieces:

Motorum	Bending Machine	Muratec	Japan
Unknown Model	Bending Machine	Baykal	Turkey
Unknown Model	Plastic Molding Machine	Engel	Austria

[68] Ibid

[69] https://rostender.info/region/irkutskaya-oblast/irkutsk/56808703-tender-postavka-reduktora-osi-x-c-komplektom-predvaritelnogo-natyajeniya-na-stanok-jomax-265

[70] https://rostender.info/region/irkutskaya-oblast/irkutsk/56808703-tender-postavka-reduktora-osi-x-c-komplektom-predvaritelnogo-natyajeniya-na-stanok-jomax-265

[71] https://rostender.info/region/irkutskaya-oblast/irkutsk/30933055-tender-postavka-zapasnyh-chastej-dlya-remonta-tehnologicheskogo-oborudovaniya-razlichnyh-firm-stanok-mcfv-1260-zav-v290c0243

[72] https://rostender.info/region/irkutskaya-oblast/irkutsk/28605281-tender-zapros-predlojenij-813132postavka-zapasnyh-chastej-dlya-remonta-tehnologicheskogo-oborudovaniya-stanok-anca-rx7-2006-g-sn-800140

[73] Ulyanovsk Instrument Manufacturing Design Bureau (UIMDB). https://centreforaviation.com/data/profiles/suppliers/ulyanovsk-instrument-manufacturing-design-bureau-uimdb

[74] Механическая обработка и аддитивные технологии. УКБП. https://www.ukbp.ru/index.php?id=12

Exhibit 19. A screenshot from the plant's website

Обработка листового материала

Обработка листового материала как стального, так и алюминиевых сплавов производится на прогрессивных станках с ЧПУ:
КПП – MOTORUM (Япония);
Лазерная установка – ТЕГРА (РФ);
Листогиб – BAYKAL (Турция)
Параметры деталей:
Размеры, мм 10-2000
Толщина материала, мм 0,5-6,0
Точность, ± мм 0,5

JSC ODK-STAR

АО ОДК-СТАР
AO ODK-STAR

Sanctioned by

TIN
5904100329

Subsidiary of
- JSC United Engine Corporation (7731644035)
- Rostec (7704274402)

According to its official web-page, this factory might be producing electric and other digital supplements (including fuel control systems) for the wide range of modifications of the **AL-31 engine. This engine is equipped on the Su-27, Su-30, and Su-34 with different modifications**.

A database on public procurement provides information that back in 2019, this factory was procuring a miniature **Siemens engine of an unknown model** to repair its **Modler machine** of an unknown model.[75]

JSC Tactical Missiles Corporation

АО Корпорация «Тактическое ракетное вооружение»
AO Corporatsiya "Takticheskoe raketnoe vooruzhenie"

Sanctioned by

TIN
5904100329

Owned by
Federal Agency for State Property Management

Known as **KTRV**, this entity is a major holding company for the manufacturers of military weapons, especially missiles. In particular, it manufactures a wide range of guided rocket weapons for the analysed fighters: anti-aerial P-27 rockets, guided air-to-ground X-38 missiles, etc.

A public procurement database provides information that back in 2011[76], this factory purchased the following industrial equipment of foreign manufacture:

[75] https://clearspending.ru/contract/75904100329190000950000/

[76] https://clearspending.ru/contract/15099000013150000005/

Kitamura-Fanuc 16iMB	Milling Machine	Kitamura	Japan
Unknown Model	Lathe	Romi	Brazil
Siemens 802 dl	CNC system	Siemens	Germany
Unknown Model	Allegedly cutters	Seco Tools	Sweden

JSC Hydromash

НОАО «Гидромаш» имени В.И. Лузянина
NOAO "Hydromash" imeni V.I. Luzyanina

Sanctioned by

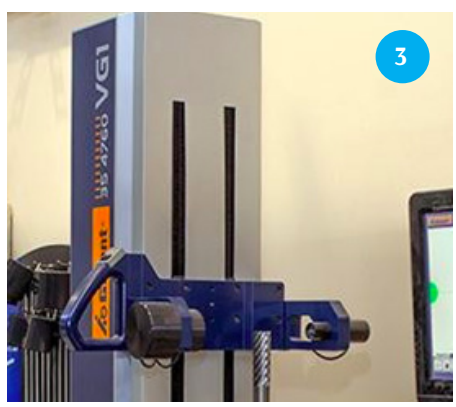
TIN
5262008630

Hydromash is a leading manufacturer of hydromechanical mechanisms for both civil and military aircraft and helicopters: gears, wing mechanisation, landing gears etc.

A photo with these machines in the plant is available on the factory's page within a Russian factories aggregator website[77] and indicate the existence of the following machinery:

MU 150 P DuoBlock	Wire EDM	Agie Charmilles	Switzerland
5-axis	Mill-Turn machine	DMG Mori	Germany
Garant VG1	Milling Machine	Hoffmann Räumtechnik GmbH	Germany

Exhibit 20. Photos from the plant showing the machinery made by DMG Mori (1), Mazak (2), and Hoffman (3)



[77] https://productcenter.ru/producers/33522/nao-gidromash-im-v-i-luzianina#main-photos-7

JSC Production Association "Ural Optical and Mechanical Plant"

АО «Производственное объединение „Уральский оптико-механический завод" имени Э. С. Яламова» | АО УОМЗ

AO "Proizvodstvennoe obedinenie 'Uralskiy optiko-mekhanicheskiy zavod' imeni E. S. Yalamova" | AO UOMZ

Sanctioned by

TIN
6672315362

Subsidiary of
- JSC Shvabe (7717671799)
- Rostec (7704274402)

Historically, the plant is said to specialise in bomb aiming systems, laser distance measuring systems, and optical laser systems for military aircraft such as **MiG-29 Fulcrum, Su-27 Flanker, and Tu-160 Blackjack**.[78]

The manufactured systems also include optical-electronic complex **101KS Atoll for Su-57**.

According to the job offers in 2022-2023[79] [80], the plant's future employees are required to know the following controls and machines:

Heidenhain 530, 540	Controls	Heidenhain	Germany
C32	CNC Machining Center	Hermle	Germany
DMS 60U, OMS-100U, DMS-635, OMS-1035	CNC Machining Center	DMG Mori	Germany
Maxxturn 25	CNC Machining Center	Emco	Germany
Schaublin 180, 125, 225	CNC Machining Center	Tornos	Switzerland
PD	CNC Machining Center	Spinner Group	Germany
Unknown Model	Controls	Fanuc	Germany
Unknown Model	Controls	Siemens	Japan

Exhibit 21. Screenshot of job requirements in 2022

Требования:

- среднее профессиональное образование;
- обязателен опыт работы на станках токарной группы - EMCO MAXXTURN 25, SRM16, SPINNER PD-CNC, TORNOS SCAUBLIN180-CCN, SCAUBLIN125 -CCN, SCAUBLIN225 TMI-CCN.
- **фрезерные - стойка Heidenhain - 530**/ станки DMS - 60U, OMS - 100U, DMS - 635, OMS - 1035
- **фрезерные - стойка Heidenhain - 540**/ станки HERMLE - C32

[78] Russian Defense Business Directory. https://nuke.fas.org/guide/russia/industry/docs/rus95/y_list.htm

[79] https://ekb.zarplata.ru/vacancy/card/id55606990/operator-stankov-s-pu-tokarnaya-frezernaya-gruppa

[80] https://m.rabota66.ru/vacancy/id82778562?position=10

JSC Zavod Radiopribor

ПАО «Завод “Радиоприбор”»
PAO “Zavod ‘Radiopribor’”

Sanctioned by

TIN
1659034109

Subsidiary of
- JSC Concern Radio-Electronic Technologies (7703695246)
- Rostec (7704274402)

Radiopribor is one of the largest Russian optical companies that develops and produces a wide range of optical-electronic and optical-mechanical instruments.[81] In particular, according to local media, the plant has been actively developing radiolocation systems for numerous aircraft.[82]

The Russian Federation public procurement database provides information on this plant purchasing spare parts, software, and CNCs for Radiopribor throughout the years. The list includes:

Siemens 840d[83]	CNC systems for metalworking machines	Siemens	Germany
Deckel Maho DMU 80P[84], DMC 635 V Ecoline	CNC Machining Center	DMG Mori	Germany
Roland EGX-600 Industrial Engraver[85]	Rotary engraver	Roland DGA	Japan
Tsugami B074-II	CNC Precision Automatic Lathe	Tsugami	Japan

Exhibit 22. Screenshot of 2015 contract details

Предмет контракта:

#	Наименование товара, работ, услуг	Код продукции
1	Поставка Автоматизированных рабочих мест, на лицензионном Программном обеспечении (ПО) CAD/CAM, по разработке управляющих программ для станков DMU 80 P duoBLOCK, система ЧПУ Siemens 840 D, DMC 635 V Ecoline, система ЧПУ Siemens 840 D, Tsugami B074-II для нужд ОАО «Радиоприбор»	7260000

[81] Russian Defense Business Directory. https://nuke.fas.org/guide/russia/industry/docs/rus95/k_list.htm

[82] КРЭТ выиграл конкурс на поставку “Сухому” системы госопознавания для Су-34. https://sdelanounas.ru/blogs/38959/

[83] https://clearspending.ru/contract/6165903410915000035000/

[84] https://clearspending.ru/contract/6165903410917000425000/

[85] https://clearspending.ru/contract/6165903410920000003000/

JSC Kaluga Research Institute of Radio Engineering

АО Калужский научно-исследовательский радиотехнический институт | КНИРТИ

AO Kaluzhskiy nauchno-issledovatelskiy radiotekhnicheskiy institut | KNIRTI

Known as KNIRTI, this institute produces systems, complexes, and other means of electronic warfare: reconnaissance and suppression systems for various bases, including aviation and space. In particular, the institute makes electronic countermeasures (ECM) **Khibiny (L-265 / L-265M10) for Su-35** and electronic warfare station **SAP-14 Tarantula for Su-34**.[86]

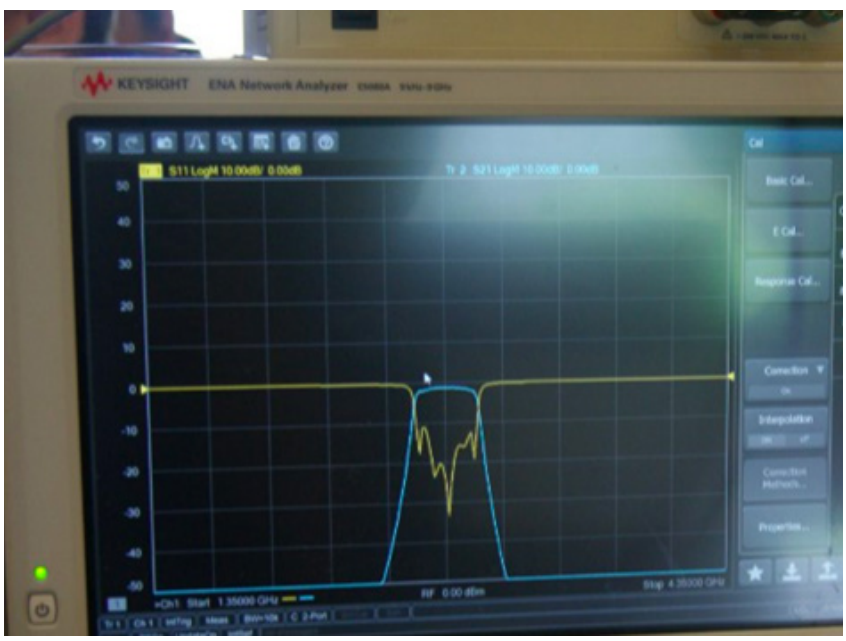
Photos from the plant's social media[87] indicate the presence of at least two pieces of machinery: an **American Haas** CNC machine of unknown model and **Keysight's** ENA Network Analyser.

Sanctioned by

TIN
4007017378

Subsidiary of
- JSC Concern Radio-Electronic Technologies (7703695246)
- Rostec (7704274402)

Exhibit 23. Photos from KNIRTI's social media group



[86] Бомбардировщик Су-34 получил «Тарантула». https://sdelanounas.ru/blogs/89781/

[87] https://m.vk.com/club59476018?z=photo-59476018_456239063/wall-59476018_304

JSC Kizlyar Electromechanical Plant

АО «Концерн Кизляярский электромеханиический завод» | КЭМЗ
AO "Kontsern Kizlyarskiy elektromekhanicheskiy zavod" | KEMZ

This electromechanical plant specialises in developing and manufacturing operational and diagnostic monitoring and onboard equipment for aircraft and helicopters.

As seen in a 2023 news broadcast[88], the plant is equipped with a vertical machine centre by **Taiwanese FEELER** (U-800), **Tongtai's** TMV 1050A, an unknown **American HAAS** machine, a cutting machine by **Austrian STM Waterjet Group**, and a Quattro laser cutting machine by **Amada GmbH**.

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TIN
0547003781

Subsidiary of
- JSC PT-Project Technology (7724804619)
- Rostec (7704274402)

Exhibit 24. Screenshots from a news broadcast show Taiwanese machinery (1,2), Austrian Waterjet and American HAAS (3,4), and German Quattro by Amada (5)

[88] Сделано в Дагестане. Концерн КЭМЗ. https://www.youtube.com/watch?v=zJJzRemxsBc

JSC NAZ im. Chkalova

ПАО Новосибиирский авиационный завод имени В. П. Чкалова

PAO Novosibirskiy aviatsionnyi zavod imeni V.P. Chkalova

Sanctioned by

TIN
5402112867

Subsidiary of
- JSC Sukhoi Aviation (7740000090)
- PJSC United Aircraft Corporation (7708619320)

Novosibirsk Aircraft Production Association Plant is one of the largest aerospace manufacturers in the Russian Federation. Mainly, it takes part in manufacturing several Su series aircraft, including Su-34 bomber aircraft upgrades.[89]

Numerous open-source photographs throughout the years show different parts of the plant, which enables identifying several pieces of machinery used for production there. For instance, photos from the plant's 2016 anniversary show several **German Broetje** (Automation, IPAC, MPAC) and **American Haas machines**.[90] Another social media post by a Russian reporter in 2014 shows the **German CHIRON** machine.[91]

Exhibit 25. Photos from the plant: Haas machine (1), Broetje IPAC (2), and Chiron (3)

[89] Russian defense chief inspects Siberian manufacturer of Su-34 bombers. October 6, 2023. https://tass.com/defense/1685755

[90] Новосибирский авиационный завод имени В. П. Чкалова. 85-летие и сотый Су-34.https://bmpd.livejournal.com/2094252.html

[91] Чкаловская «Тридцать четверка» Сухого. https://army-reporter.livejournal.com/179658.html

Additionally, the plant's tender announcements in 2014[92], 2018[93], and an unknown date[94] indicate the following machines:

Fooke Endura 908	Milling Machine	Fooke GmbH	Germany
Isel FB2 500/530	CNC Portal Unit	Isel	China
Turbograt 48	Pipe and processing machines	Pipe Bending Systems	Germany

PJSC ODK-Ufa Motor Manufacturing Association

ПАО «ОДК-Уфимское моторостроительное производственное объединение»
PAO "ODK-Ufimskoe motostroitelnoe proizvodstvennoe obyedinenie"

The plant produces aircraft engines, gas turbine drives for gas pumping units, power plants, and helicopter components. According to its website, the association is affiliated with United Engine Corporation, which manufactures turbo-reactive engines for **Su fighters**, helicopters, and gas turbine units.

Several tenders reveal the plant's purchases of the following machinery: **German** HELITRONIC MINI and Helicheck Pro[95] CNC-based measuring machines by **Walter Maschinenbau GmbH** and VL-156CM and VL-160C[96] turning-and-boring lathes made by **Taiwanese Honor Seiki**.

Sanctioned by

TIN
0273008320

Subsidiary of
- JSC United Engine Corporation (7731644035)
- Rostec (7704274402)

[92] https://rostender.info/region/habarovskij-kraj/komsomolsk-na-amure/33506435-tender-stanok-dlya-izgotovleniya-pechatnyh-plat

[93] https://rostender.info/region/habarovskij-kraj/komsomolsk-na-amure/33091535-tender-stanok-dlya-snyatiya-faski_

[94] https://rostender.info/region/habarovskij-kraj/komsomolsk-na-amure/33506435-tender-stanok-dlya-izgotovleniya-pechatnyh-plat

[95] https://clearspending.ru/contract/?productsearch=Walter+Maschinenbau&search-submit=&grbs=&regnum=&daterange=&price_gte=&price_lte=&customerregion=&address=&budgetlevel=&okdp_okpd=&sort=&fz=None&customerinn=&customerkpp=&supplierinn=&supplierkpp=&filter=True

[96] ОДК-УМПО возьмет в лизинг станки на сумму €2,4 млн и $3,2 млн. January 10, 2020. https://fedleasing.ru/articles/novosti/ufimskiy-motorostroitelnyy-zavod-odk-vozmet-v-lizing-obrabatyvayushchie-stanki-na-summu-2-4-mln-i-3-/

PJSC Holding Company 'Leninets'

ОАО «Холдинговая компания «Ленинец»

OAO "Kholdingovaya kompaniya 'Leninets'"

Sanctioned by

None

TIN 7810221748

Leninets is a private holding owned by the **Turchak family** [97]**:**

- **TURCHAK Andrey** (781002279818), First Deputy Chairman of the Federation Council, sanctioned by all main jurisdictions except for Japan;
- **TURCHAK Anatoliy** (781009507816), Andrey's father, former head of Leninets and current President of the non-governmental organisation (NGO) Union of Manufacturers and Entrepreneurs of St. Petersburg, not sanctioned;
- **TURCHAK Kira** (780619285009), Andrey's wife and a shareholder, not sanctioned;
- **TURCHAK Boris** (781014437770) Andrey's brother and a director of Leninets, not sanctioned.

The company mainly specialises in producing radar and navigation equipment for the army and navy.[98] For instance, Leninets produces **Zaslon multimode airborne radar for the supersonic interceptor of Mig-31**.

According to its website[99], the company uses these types of machinery:

HFT Series	CNC Press Break Machines	Amada	Japan
Unknown Model	CNC Press Break Machines	Mitsubishi	Japan
NC 251525	Water-jet cutting installation	WJS AB	Sweden
TWS-850	Convection oven	TWS Automation	Italy
WX1	Welding station	Weller	USA

Exhibit 26. Photo from the company's website showing Amada machinery

[97] Рассказ о том, как семья патриота Андрея Турчака построила особняки и бизнес-центры на месте оборонных заводов. https://www.proekt.media/narrative/andrey-turchak/

[98] Ibid

[99] http://www.npo-leninetz.ru/proizvodstvo/industrial-services/listoobrabotka/

Salyut Machine-Building Association

Научно-производственный центр газотурбостроения «Салют»
Nauchno-proizvodstvennyi tsentr gazoturbostroeniya "Salyut"

Salyut is the largest enterprise for manufacturing and maintenance of aircraft engines, including the Su series. One such engine, an axial flow turbojet engine **AL-31F-M1**, is used in the **Su-27SM3**.

A 2017 article in the factory's corporate magazine mentions the new broaching machine installed at the plant.[100] Although the machine's manufacturer is unclear, it resembles the **Siemens' Sinumerik 840D** machines mentioned earlier. A 2020 article in the same magazine article also mentions using **Siemens NX software** in projecting and modelling turbofan engines.[101]

Sanctioned by

TIN
7719409437

Subsidiary of
- JSC United Engine Corporation (7731644035)
- Rostec (7704274402)

Exhibit 27. Photo from 2017 article with, allegedly, Siemens Sinumerik 840D (left) and 2020 article mentioning Siemens software (right)

[100] Продолжается перевооружение станочного парка АО «НПЦ газотурбостроения «Салют». https://sdelanounas.ru/blogs/95780/

[101] Вертикаль. Корпоративное издание производственного комплекса "Салют" АО "ОДК". March 2020. https://advengineering.ru/media/filer_public/d1/5f/d15f5c79-db86-47ae-9309-2707cb9b696f/vertikal_1_mart_2020_na_sait.pdf

PJSC ODK-Saturn

ПАО «ОДК-Сатурн»

PAO "ODK-Saturn"

Saturn develops and produces gas turbine engines for military aviation. Since 2010, it has been making **AL-41-F1**, a variable-bypass ratio turbofan engine (Item 117) used in the **Su-35**. According to its brochure, it uses **Siemens PLM Software** for production.[102]

Sanctioned by

TIN
7610052644

Subsidiary of
- JSC United Engine Corporation (7731644035)
- Rostec (7704274402)

Exhibit 28. Company brochure mentioning the use of Siemens PLM Software

Stavropol radio plant "Signal"

ПАО «Ставропольский радиозавод «Сигнал»

PAO "Stavropolskiy radiozavod 'Signal'"

Signal specialises in electronics and produces active jamming stations for aviation, land and sea-based. In particular, the plant co-produces the L402 **Himalayas** airborne defence complex, which is used in fighters, including the **Su-57**.

Sanctioned by

TIN
2635000092

Subsidiary of
- JSC United Engine Corporation (7731644035)
- Rostec (7704274402)

The plant's 2018 tender announcements include the spare details and maintenance services for CNC machines produced by[103]:

- **Japan** – Mazak, Matsuura, Sodick, Fanuc;
- **Italy** – Fagima;
- **UK** – Dugard;
- **Czechia** – Kovosvit MAS.

[102] НПО Сатурн разработало двигатель SaM146 в рекордно короткие сроки, используя технологии Siemens PLM Software. https://www.plm-ural.ru/sites/default/files/2018-10/saturn.pdf

[103] Журналист «Блокнота» проник на предприятие оборонной промышленности. Блокнот Ставрополь. September 28, 2020. https://rostender.info/category/tendery-oao-signal-11590?page=18&scrollto=table-constructor

A local media video on the plant's activities confirms the presence of **Fagima** machinery and shows a **Japanese Tsugami** machine of unknown purpose.[104]

Exhibit 29. Screenshots from a 2020 news broadcast about the plant, showing a Tsugami machine (1) and Italian Fagima (2)

Scientific and Production Corporation "Precision Instrumentation Systems"

АО «Научно-производственная корпорация "Системы прицизиозного приборостроения»

АО "Nauchno-proizvodstvennaz korporatsiya 'Sistemy pritsioznogo priborostroeniya'"

Sanctioned by

TIN
7722698108

Subsidiary of
- JSC United Rocket and Space Corporation (7722692000)
- Roscosmos (7702388027)

A part of Roscosmos, this corporation manufactures high-tech equipment, quantum optical systems, and hardware and software systems, including **OLS-35** optical location station for **Su-35**.[105]

According to the company's 2021 tender announcements, it uses chassis details made by **German Schroff** and optical equipment of **Lithuanian origin** produced by **Standa**.[106]

[104] https://www.youtube.com/watch?v=N8A1WgabgME

[105] Оптико-локационная станция ОЛС-35. VPK.name. https://vpk.name/library/f/ols-35.html

[106] https://rostender.info/region/moskva-gorod/56746676-tender-postavka-oborudovaniya-standa-ili-ekvivalenta

CONCLUSIONS AND RECOMMENDATIONS

While Ukraine is waiting to receive any fighter jets able to surpass Russian Su and MiG aircraft in technical and combat performance, Russian Federation Aerospace Forces continue to perform effective operations against military and civilian targets, including extensive bombardments with cruise and ballistic missile barrages.

The Russian Federation has shown the ability to uphold its air force capabilities by both maintaining and producing new aircrafts. Research shows that components of foreign origin are widely used in fighter and multirole aircrafts operating on the battlefield. Some of those components are subject to export control measures, thus the precise supply routes and schemes should be properly investigated.

Domestic military air force producing capacities also rely on foreign technologies, namely CNC tools. Even though the main producer, UAC, is sanctioned in all key jurisdictions, other companies involved in Su and MiG production fall out of sight.

Recommendations:

1. Conduct a proper investigation of the supply chains of CNC machines or key foreign components subject to export control measures.
2. Ensure consistency of sanctions against Russian military complex companies involved in military aircraft production and supply processes.
3. Introduce systematic and continuous monitoring of compliance with the sanctions and export restrictions.
4. Encourage businesses to establish robust compliance and Know Your Customer (KYC) systems and conduct comprehensive red flag assessments.
5. Enhance the role of authorities responsible for detecting, investigating, and ceasing sanction and export control violations in key jurisdictions.
6. Create mechanisms for information exchange with governments and civil society groups to better investigate existing illicit networks and paths for components or CNC machines and equipment re-export to Russia and identify ways to disrupt them.
7. Investigate and target intermediaries responsible for sanctions regime violations and illicit procurement of CNC machines and critical components for the Russian Federation military complex.

APPENDIX 1: FULL LIST OF COMPANIES BY COUNTRIES AND PRESENCE IN THE AIRCRAFT

Country	Company	MiG-31I	Su-27SM3	Su-30SM	Su-34	Su-35S	Su-57
Belarus	NPO Integral					1	
Belgium	Clare		1				
Bulgaria	LEM					1	
Canada	DEI				1		
	Mitel			1			
China	BM					2	
	Connfly		1	3		1	1
	Elma					3	
	Loxford					1	1
	Multicomp					1	
	Ningbo Jietong Electronic					1	
	North China Research Institute of Electrooptics					3	
	NXU					2	
	Pico					2	
	WinBond				1		
	Wuhan						1
	Yangjie					1	
Czech Republic	TEMEX		1				
	TESLA Electric						1
Finland	Beneq						1
France	Exxelia					5	
	C&K					1	
	Exxelia			5		2	
	Jauch						1
	Lynred						1
	Photonis						2
	Radiall						1
	Rakon			1			2
	SAFT	1		3			
	Souriau		23				9
	United Monolithic Semi			1			

Country	Company	MiG-31I	Su-27SM3	Su-30SM	Su-34	Su-35S	Su-57
	ANDANTA						1
	Binder		1				
	DIOTEC	2					
	Ebm-papst		1			2	2
	Epcos	2					
	First Sensor					1	
	Geyer Electronic	1			1		
	Harting			6	4	2	2
	Infineon	3	2	7	5	22	4
	Klauke					1	
	Landmark					1	
Germany	Neosid				2		
	OSRAM					4	1
	Peak Electronics					1	
	Phyzik Instrumente					1	
	Powersem					1	
	Schaffner	1					
	Siemens			1		1	
	Sumida		2			1	
	Tepro		1				
	Tyco Electronics	2					
	Vishay					1	1
	Wurth Elektronik						3
India	Radisys		2				
Israel	Lambda					1	
	Citizen					1	
	Hamamatsu					1	
	Hirose			2	2	3	4
	Hitachi					1	1
	JST						1
	Mitsubishi	1					1
	Murata	15	27	23	22	107	39
	NEC		1			4	4
Japan	Nichia					6	4
	Nichicon		1				
	Omron				2	1	
	Panasonic		1	2	1	3	3
	Renesas	1					
	ROHM Semiconductor					2	1
	Sanyo Denki					1	
	Sharp					1	

Country	Company	MiG-31I	Su-27SM3	Su-30SM	Su-34	Su-35S	Su-57
Japan	Sony		2		2	2	
	Sumida			1			
	Taiyo Yuden				1	4	1
	TDK		3	1	5	18	15
	Torex Semiconductor					5	
	Toshiba				2	4	2
Kyrgyzstan	Aynur					4	
Philippines	Lattice Semiconductor		1				
Singapore	Broadcom					5	
South Korea	Hynix					1	
	i3 system					2	
	LG					1	1
	Samsung		2	1	2	9	3
Spain	Fag or				1		
Switzerland	TE Connectivity		7	18	3	33	17
	Elma						1
	Huber+Suhner			1			
	Littelfuse					3	
	STMicroelectronics		3	1	7	8	
	TRACO Power					1	3
Taiwan	Appointed!		1				
	Coretek Opto Corp						1
	Crown Ferrite					1	
	ECS						1
	FOCI					2	1
	Hitano						1
	InnoDisk					1	
	Jamicon		2			2	
	JMicron				2		
	Kingbright			1		3	1
	KLS						1
	Macronix		3			2	
	Optoway		1				
	Pan Pacific Electronics						1
	Transcend		1				
	TWH					2	
	Won-Top Electronics		1		1		
	Yageo			4	1	1	1

Country	Company	MiG-31I	Su-27SM3	Su-30SM	Su-34	Su-35S	Su-57
The Netherlands	LiteOn	4					
	Nexperia				1	12	1
	NXP			6	2	8	2
	Philips	1					
UK	TT Electronics		1			1	
	XP Power		2		1	1	
	e2v		2				
	FTD1		1				
	Harwin		8			5	3
	Laird					3	
	Memcon						1
	Micross Components		4				
	Smiths Connectors		2			4	1
	SST Sensing						1
USA	3M						2
	ATC				2		10
	Abracon	1					
	Agilent			1	1		1
	AirBorn		9			1	1
	Allegro Microsystems						2
	Alliance Memory			1			
	Alliance Semiconductor		2	1			
	Altera		3				1
	AMD		2	1	1	1	3
	Amphenol	1	13	2		6	8
	Anadigm					1	
	Analog Devices	5	9	33	39	62	20
	Apex Microtechnology					3	
	Applied Concepts					1	
	ATC			1	3	3	
	Atmel		1	4	1	3	
	Auilent				1		
	Avago	2	1		2		2
	AVX		8	3	3	26	10
	Bel Fuse					2	
	Beta Transformer					1	
	BH Electronics					1	
	Bourns		8	7		2	4
	Broadcom			5			
	C&D					1	

Country	Company	MiG-31I	Su-27SM3	Su-30SM	Su-34	Su-35S	Su-57
	C&K						1
	Caddock					1	
	Carlisle Interconnect Technologies			5			
	CEL			1			
	Coilcraft		5		1	1	
	Compound Photonics			1			
	Cosmo Electronic Corporation					1	
	CREE					1	
	CRYDOM					2	
	Crystek						1
	CTS			4	1		
	Cypress		9	5	2	13	7
	DDC					1	2
	DDC (National Hybrid)						2
	Dielectric Laboratories			1			
	Digilent, Inc					1	
	Diodes Incorporated	3	1		1	5	2
	Diotec					1	
USA	Dow-Key Microwave						1
	EMC Technology				6		
	Enpirion		1				
	Esterline Power Systems		3	1		17	5
	Everspin Technologies		1			2	3
	Exar					3	
	Fair-Rite		1				
	Fairchild Semiconductor	3	1				
	Fortasa Memory Systems		2				
	Fox / Abracon						1
	FOX Electronics	1					
	Frontier Electronics						1
	Habia Cable						1
	Haydon Kerk Motion Solutions						1
	Hewlett-Packard			1	1		
	Hittite				1		
	Holt Integrated Circuits				3	19	5
	Honeywell					2	2
	Hypertronics					1	
	IDT		9	6	4	14	3

Country	Company	MiG-31I	Su-27SM3	Su-30SM	Su-34	Su-35S	Su-57
	Integra				4		
	Intel			6	10	7	18
	Intersil					3	1
	IRF	6					
	ITT Cannon		1		1		
	Kemet		43	11	2	20	15
	Laird						1
	Lifasa						2
	Linear Technology		6		7		9
	Lippert		2				
	Littelfuse			2		7	6
	MACOM			8	3	3	
	Magnetics					2	
	Marvell		1		1		
	Maxim		6	9	4	36	5
	Measurement Specialties						1
	Micro-Coax					1	
	Microchip	1		4		6	3
	Micrometals						3
USA	Micron		5	3	7	23	17
	Microsemi				1	2	
	Mini-Circuits		1	10	3	2	1
	Molex		6			20	10
	Moog Protokraft		1				
	Motorola			2	1	4	
	Newhaven Display International	1					
	NIC Components		7			1	
	NorComp			1			
	Novacap						1
	NXP	2					
	OhmCraft					2	
	ON Semiconductor	18	3	6	8	14	1
	Orion Fans			1			
	Pericom					1	
	Pletronics						1
	Power Integrations	1			1	2	
	Pulse		4			7	1
	Qorvo			3	1	1	
	QuickLogic						1

Country	Company	MiG-31I	Su-27SM3	Su-30SM	Su-34	Su-35S	Su-57
USA	Ramtron	1					
	RECOM International Power					1	2
	Renishaw						2
	Riedon		10				8
	RUICHI						2
	Samtec		2	5		8	2
	Silicon Labs			1		2	
	Staco Systems					6	
	Standex Electronics				1		
	STMicroelectronics	9					
	Synergy Microwave				2		
	Teledyne						1
	Texas Instruments	8	21	11	17	104	23
	TSC				2		
	Tusonix				1		
	Vicor		7		1	39	7
	Vishay	7	10	1	6	16	3
	Voltage Multipliers					1	
	VPT					1	1
	Wolfspeed					1	
	Xilinx		7	8		3	
	YSI		1				1
	Z-Communications			1			

APPENDIX 2: FULL LIST OF THIRD-PARTY SUPPLIER COMPANIES

№	Company	Est. value of the contracts	Country
1	Win Key LTD	$88 665 163,69	Hong Kong
2	Time Art International LTD	$62 902 278,85	Hong Kong
3	Agu Information Technology Co LTD	$48 668 230,42	China
4	Dexp International LTD	$46 764 719,96	Hong Kong
5	Saldor Corporation	$36 344 121,22	Seychelles
6	Imaxchip Technology Co LTD	$31 870 755,41	China
7	Tordan Industry LTD	$31 824 717,04	Hong Kong
8	Union Tech Inc LTD	$31 475 958,12	UAE
9	Yiwu Vortex Import And Export Co LTD	$31 260 426,25	Hong Kong
10	Kominvex Doo	$28 608 933,15	Serbia
11	Grants Promotion Service LTD	$20 561 226,85	Hong Kong
12	Abingo Distributors LTD	$19 769 213,45	Hong Kong
13	Asay Ic Ve Dis Ticaret LTD Sti	$19 162 933,68	Turkey
14	Guangzhou Chiphome Information Technology LTD	$17 608 731,36	China
15	TTS Logistics DOO	$15 881 320,02	Serbia
16	Yiwu Weishuo Import And Export Co LTD	$15 352 700,23	China
17	Align Trading Co LTD	$14 820 152,97	Hong Kong
18	Etop Electronics Hk Co LTD	$14 783 184,35	Hong Kong
19	Piraclinos LTD	$14 332 273,97	Hong Kong
20	Hytera Communications LTD	$13 962 489,52	China
21	Xin Quan Electronics Hongkong Co LTD	$13 759 525,22	Hong Kong
22	Most Invest LTD	$13 474 021,78	Hong Kong
23	Asialink Shanghai Int L Logistics Co LTD	$13 168 550,61	China
24	Clf Global LTD	$12 752 626,65	Hong Kong
25	Lett Tronic Group Limited O B Asay Ic Ve Dis Ticaret LTD Sti	$12 393 620,99	Hong Kong
26	Shenzhen Comnect Technology Co LTD	$12 225 219,77	China
27	Financial Center Electronics LTD	$12 144 346,55	Hong Kong
28	SSP LTD	$11 877 272,77	Turkey
29	Claire Hk LTD	$11 770 770,49	Hong Kong

30	Alburton Enterprises Inc	$11 367 221,79	Canada
31	Mykines Corporation Llp	$11 156 601,26	UK
32	Chips Resources LTD	$11 112 236,16	Hong Kong
33	Robotronix Semiconductors LTD	$11 036 547,09	Hong Kong
34	Shenzhen Sieryou Technology Co LTD	$10 866 397,58	China
35	Achieve Trade LTD	$10 771 273,52	Hong Kong
36	Yw Nl E Commerce Company	$10 176 613,42	China
37	Siliborn Technology LTD	$9 972 469,77	Hong Kong
38	Incomp LTD	$9 945 481,59	Hong Kong
39	Makewell Industrial Trading Co LTD	$9 923 989,87	China
40	Hongkong Chip Line International Co LTD	$9 802 857,23	Hong Kong
41	Ace Electronic Hk Co LTD	$9 688 619,99	Hong Kong
42	Afox Corporation LTD	$9 618 989,42	Hong Kong
43	Leostar Hong Kong LTD	$8 956 138,11	Hong Kong
44	Shandong Ki Forest New Advanced Co LTD	$8 918 519,94	China
45	Allparts Trading Co LTD	$8 910 158,84	Hong Kong
46	V&P Power Systems LTD	$8 559 338,55	China
47	Bliksem Computers & Requisites Co LLC	$8 312 013,58	UAE
48	Shenzhen One World International Logistics Co LTD	$8 117 171,91	China
49	Shanghai Ip3 Information Technology Co LTD	$7 783 295,80	China
50	Wellgo International Industrial LTD	$7 780 563,02	Hong Kong
51	Margiana Insaat Dis Ticaret Limited Sirketi	$7 342 577,41	Turkey
52	Mt Industrial Technologies LTD	$6 985 910,16	Hong Kong
53	Fujian Electronics Import And Export Corporation	$6 952 213,82	China
54	Superchip LTD	$6 499 050,55	Hong Kong
55	Farteco LTD	$6 442 597,62	Hong Kong
56	Most Development LTD	$6 404 772,96	Hong Kong
57	Most Technology Company LTD	$5 826 561,43	Hong Kong
58	China Xilin Group LTD	$5 727 738,29	Hong Kong
59	Zixis LTD	$5 539 383,93	Hong Kong
60	Shenzhen Blue Hat International Trade Co LTD	$5 193 127,15	China
61	Pako International Trading LTD	$5 084 378,85	Hong Kong
62	Shisan LTD	$4 670 965,71	Kyrgyzstan
63	Woeroon Electronic Sourcing LTD	$4 638 904,79	China

64	Luxwing Enterprise LTD	$4 593 611,33	Hong Kong
65	Huizhou Ysl Electronic Tech LTD	$4 439 077,55	China
66	Ix Elektronik Ic Ve Dis Ticaret Limited Sirketi	$4 425 903,22	Turkey
67	Rama Group LLC	$4 140 258,21	Hong Kong
68	Nit Group Co LTD	$4 123 322,22	Hong Kong
69	Signal Optica Elektronik LTD Sti	$4 123 306,94	Turkey
70	Thai Electronics Co LTD	$4 040 691,03	Thailand
71	STK Electronics Co LTD	$3 962 519,32	China
72	New Wally Target International Trade Co LTD	$3 892 088,09	Hong Kong
73	Benico Limited C O Kobi International Company	$3 843 085,12	Hong Kong
74	Zeyuan Technology LTD	$3 754 451,98	China
75	Matrix Metal Group Kft	$3 609 657,12	Hungary
76	Jove Hongkong LTD	$3 593 315,97	Hong Kong
77	Univelco Dmcc	$3 577 775,21	UAE
78	LL Electronic LTD	$3 513 125,60	Hong Kong
79	Mei Xin Electronic Hk Co LTD	$3 469 029,41	Hong Kong
80	Corp Link International Forwarding LTD	$3 420 758,44	Singapore
81	Stk Electronics Hk Co LTD	$3 328 821,65	Hong Kong
82	Hongkong Yayang Trading LTD	$3 321 504,68	Hong Kong
83	Group Yeoh LTD	$3 211 928,08	Hong Kong
84	Kominvex Doo C O Atc Air Service LTD	$3 039 536,42	Serbia
85	Online Chip Electronic Co LTD	$3 025 644,98	China
86	Cargo Marketing Logistics Hk LTD	$2 947 881,55	Hong Kong
87	Shenzhen One Wolrd International Logistics Co LTD	$2 867 095,87	Hong Kong
88	Richboom Ningbo Supply Chain Management Co LTD	$2 839 694,30	China
89	Avala Informatic Doo	$2 833 509,52	Serbia
90	Shenzhen Pengzexiang Technology Co LTD	$2 641 993,16	China
91	Wizmart Technology Inc	$2 585 374,46	Taiwan
92	Cloudmax Tech Co LTD	$2 541 776,62	China
93	Shenzhen Giec Digital Co LTD	$2 466 628,27	China
94	Great Share International Trade LTD	$2 450 859,03	China
95	Wargos Industry LTD	$2 450 080,65	Hong Kong
96	Finder Technology LTD	$2 444 937,97	Hong Kong

97	Hengye Tech LTD	$2 353 008,86	China
98	Lother Trading Pte LTD	$1 669 403,77	Singapore
99	Izzition E Technology Co LTD	$1 240 560,28	China
100	LL Electronics LTD	$1 062 029,99	China
101	Gigaflex Asia LTD	$1 053 678,01	Hong Kong
102	Inner Mongolia Asia Europe International Logistics Co LTD	$1 013 376,54	China
103	Hong Kong Chum Call International LTD	$823 386,78	Hong Kong
104	Rg Solutions LTD	$694 528,29	Hong Kong
105	Rc All Electronics Group Co LTD	$569 226,31	Hong Kong
106	Retronic Technology LTD	$549 093,05	China
107	Cargo Linkedin International LTD	$541 395,32	Hong Kong
108	ICTC LTD	$516 526,22	Hong Kong
109	Shanghai Welltech Electronic Trading Co LTD	$508 932,27	Hong Kong
110	E Chips Solution Co LTD	$455 413,79	China
111	Yusha Group Co LTD	$451 307,21	China
112	Lett Tronic Group LTD	$437 153,97	Hong Kong
113	Noratec Holdings LTD	$419 763,29	Cyprus
114	Huayuanshitong Technology Co LTD	$388 857,50	China
115	Laserchips FZCO	$370 713,16	UAE
116	Saril Overseas LTD	$359 969,17	Hong Kong
117	Tecgr Co LTD C O All The Way Espress LTD	$355 068,94	Hong Kong
118	Resolute Machinery Trading LLC	$344 612,25	UAE
119	Shanghai Alexander Trading Co LTD	$186 429,38	China

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