METHODOLOGICAL RECOMMENDATIONS
on the identification of cruise missiles

м. Kyiv - 2022

Compilers:

Dmytro Ramshov - Deputy Head of the Center for Research of Trophy and Advanced Weapons and Military Equipment.

O. M. Surkov is the Head of the Department of Research of Air Force Armaments and Military Equipment of the Center for Research of Trophy and Advanced Armaments and Military Equipment.

Bondarenko S.O. is an officer of the Air Force Research Department of the Center for Research of Trophy and Advanced Weapons and Military Equipment.

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Based on the monitoring of open sources of information and the study of cruise missile crash sites, the author summarizes the technical characteristics and characteristic features that can be used to identify cruise missiles at the crash sites.

The methodological recommendations use materials from the manual "Identification of Missile and Rocket Weapons of the Russian Federation" developed by the Dnipro Research and Forensic Center of the Ministry of Internal Affairs of Ukraine and the State Enterprise "Yuzhnoye Design Bureau named after M.K. Yangel".

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SECTION I
BASIC INFORMATION ON THE FORMATION OF THE EVIDENCE BASE FOR THE USE OF DESTRUCTION MEANS AGAINST CIVILIAN OBJECTS AND PROHIBITED MEANS OF WARFARE

The Center for Research of Trophy and Advanced Weapons and Military Equipment (hereinafter referred to as the Center) was established in May 2022.

The Center is entrusted with the following tasks to form evidence database:

organization interaction з representatives authoritiesof the prosecutor's office and

law enforcement agencies in conducting investigative actions at the scene; inspection of the scene;

interviewing persons who witnessed the use of munitions (prohibited means of warfare);

collection and preservation of remnants (elements, fragments) of munitions (prohibited means of warfare) at the scene;

detection of prohibited means of warfare among the trophy weapons and military equipment (hereinafter - WMH), recording cases of their use;

informing the General Staff of the Armed Forces of Ukraine about the detected cases of violations of international humanitarian law and other international treaties;

transfer to law enforcement agencies of documented facts and remnants (elements, fragments) of munitions (prohibited means of warfare) that may be material evidence in cases specified in this Temporary Procedure.

The purpose of these methodological recommendations is to inform about the results of the work of the Center for Commands of the types and branches of the Armed Forces of Ukraine and scientific institutions of the Armed Forces of Ukraine on the identification of cruise missile remnants as a set of objective data on alleged crimes committed during the armed aggression against Ukraine.

SECTION II

X-35U CRUISE MISSILE IDENTIFICATION GUIDE

Tactical and technical characteristics cruise missile X-35U CRUISE MISSILE, wobbly for identification are shown in Table 1.

Table 1 - Tactical and technical characteristics of the X-35U cruise missile

Name of the characteristic, unit of measurement	**Meaning.**
Length, m	3,85 (4,4)
Housing diameter, m	up to 0.42
Wing span, m	1,33
Weight of the warhead, kg	145
Launch range, km	7-260 (7-130 for X-35)
Minimum flight altitude, m: -on the marching section - in the homing area	 10-15 4
The variable angle of turn from the heading line, deg.	± 130 (± 90)
Guidance accuracy, m	4-8
Flight speed, m/s	270-280

The appearance of the X-35U cruise missile is shown in Figure 1.

Figure 1 - General view of the X-35U missile with open derechers

The X-35U differs from the basic X-35 modification in the model of the main engine and the shape of the missile's tail section. In the X-35U, the engine is located in the nose of the extreme section of the body, protruding beyond the fuselage's main section, which is why the support frames have a characteristic figure-eight shape (Figure 2).

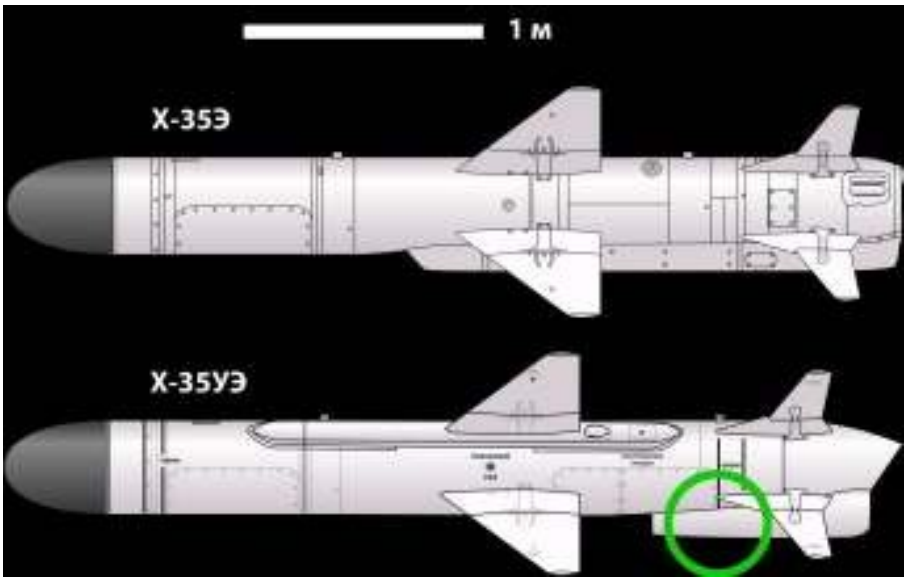


Figure 2 - Differences between X-35U and X-35

After a rocket crash and especially an explosion, the wreckage of its tail section remains in the best condition, as massive fastening assemblies, support frames, stiffeners of the rocket body, engine fragments, and, in particular, turbofan blades made of heat-resistant alloys.

Locks for fastening the fins, plating, service hatches and markings on the rocket's tail section, in particular: "Support", "Safety Connector 64M", "Safety Connector", "Control Connector", "Tackle Assembly", "Traverse Support", a five-digit serial number on the rocket's fins with a series and product number ("06002" is the second product of the sixth series), and on the fins of the one-piece rudder with the inscription in red dye "Do not touch!", support frames in the location of the engine with a characteristic figure-eight shape, a suspension assembly (bolted tow bar).

The X-31 also has five-digit numbers on the hull surfaces and on the one-piece rudder feathers with the inscription in red dye "No

touch!", however, the surfaces of X-31 have a natural metal color, while the surfaces of X-35 and X-35U are painted white.

The X-59MK has an elongated, rounded tail fairing, while the engine is mounted on a pylon under the tail section of the missile fuselage. The missile uses a different type of serial number, beginning with the digits "426". The tailplane of this missile is larger and has ailerons; the front plumage, made in accordance with the aerodynamic duck pattern in the latest modifications, has a flared rectangular shape. The missile body is marked "Keyway Control", which is not present on the X-35U.

Long-range cruise missiles ("Kalibr", "Iskander-K", X-101) have more significant differences, starting with a much larger hull diameter (514-742 mm)

The marking "Safety Connector 64M" is specific to the X-35U, as this modification uses the "product 64M" engine developed and produced by the RKBM HPO "Saturn" (Rybinsk, Russia) with the "SARD-64M" control system, while other models of medium- and long-range cruise missiles use different modifications of the TRDD-50 ("product 36", "product 36M", "product 36MT", "product 37-01"). The data and the name of the engine model "product 64M" are classified; open sources mention only the fact that a new engine, half as light and one-third shorter, manufactured by the Rybinsk-based Saturn Research and Production Enterprise, is used, and there is some information on the manufacture and testing of its components, including turbine blades. The numerical markings on the engine parts mostly begin with the digits "64". The inscription "VERX 640511300" with individual markings is hand-carved near the edge of the engine's outer contour; this inscription was found in at least two cases of X-35U identification. The serial number of the engine on the outer cowling begins with the digits "52".

Unlike the TRDD-50 modifications of other cruise missiles, the X-35U engine has a cut-off cone in its rear end with a round flat cap with 8 bolts.

The serial number of a metering device most likely consists of 13 digits. In an episode of the Russian television program "Military Acceptance" titled "Ball. Locking the Banks", a copy with a non-standard 7-digit serial number "1020022" is used to shoot close-ups, which is obviously a means of misinforming the viewer.

Characteristic components and parts of the X-35U that are regularly found at the site of a missile hit or crash are shown in Figures 3-13.

Figure 3 - The last five digits of the missile serial number indicating the series and product number

Figure 4 - Fragment of the support frame fastening with the inscription "Support"

Figure 5 - a fragment of the inscription "Takelah knot"

Figure 6 - Support frames with an octagonal shape

Figure 7 - Support frames with an octagonal shape

Figure 8 - Mounting of the missile's front fin

Figure 9 - Example of marking on the motor "Product 64M"

Figure 10 - Example of marking on the motor "Product 64M"

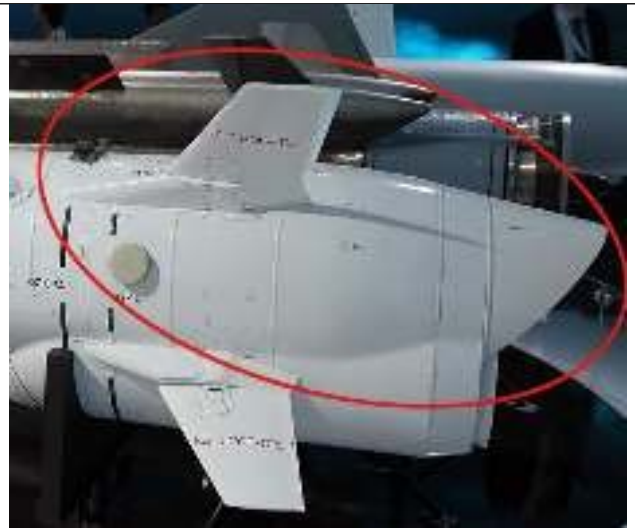
Figure 11 - Rear part of the engine "Product 64M"

Figure 12 - Product 64M engine - side view

Figure 13 - Fragment of the board labeled "SERD-64M" (the name of the engine control system "Product 64M")

The characteristic markings and design fragments that allow identification of the specimen by visual details in the public domain are shown in Table 2 and Table 3.

Table 2 - Characteristic markings and structural fragments that allow identification of the specimen by visual references in the public domain

Snippet description	Localization by visual cues	An example of an identified fragment
Plating and plumage of the missile tail section		
Technological hatch of the "Izdeliye 64M" marching engine		

Snippet description	Localization by visual cues	An example of an identified fragment
Plumage fastening locks and a tow bar (suspension unit)		
Technical reference information on the rocket body		

Snippet description	Localization by visual cues	An example of an identified fragment
The serial number on the missile body (in the open source - non-standard disinformation)		
Inscription on the case "TRAVERSE SUPPORT"		

Table 3 - Instruments of the X-35U cruise missile, their functional purpose and brief description

Labeling	Description.	Photo.
78.0058.1100.00 SB **MR-1GATS-1 10343**	Balloon inflating Weight 0.904 kg, volume 0.6118 l Working pressure 350 Atm, marginal - 525 Atm. The term of hearing 11 years old	
AG-9-ZHZ-7M	No information is currently available	
78.0058.0100.00 SB **MR-23AC-1-** **10343**	Balloon inflating Volume 0.2667 liters Working pressure 250 atm, marginal - 375 atm	

Labeling	Description.	Photo.
BUC-U	Angle stabilization unit	
95H6	Markings on the warhead	
06.0.0053	Markings on the rocket	No information is currently available
02.10.15.201	Markings on the rocket	No information is currently available
02.06.21.012	Markings on the rocket	No information is currently available
00.04.21.017	Markings on the rocket	No information is currently available
TG-4R **190411**	Generator	No information is currently available
__RD-64M-3	No information is currently available	
ElTom	Module tilt.	

Labeling	Description.	Photo.
MPSHV0515VOG	Manufacturer of BAT "HPP "ElTom, Tomilino. This is used in the X-101	
78.0058.0130.07	Pneumatic-hydraulic system gearbox (PGS)	
PC-10M **862-1-21**	At present information is not available at this time	No information is currently available
PPM-080	Radio altimeter receiver-transmitter module	No information is currently available
CN-99	Satellite navigation equipment	
BA-9-ZHZ-1665M	Marking on the rocket	

Labeling	Description.	Photo.
4184 №549011510174	At present information is not available at this time	No information is currently available
ECH-411 0390451	At present information is not available at this time	
UB-1-07M	Missile control unit	
SNP336-67RP127	Low-frequency electrical connector	

SECTION III

X-101 CRUISE MISSILE IDENTIFICATION GUIDE

The tactical and technical characteristics of the X-101 cruise missile that are important for identification are shown in Table 4.

Table 4 - Tactical and technical characteristics of the X-101 cruise missile, important for identification

Name of the characteristic, unit of measurement	Meaning.
Length, m	7,6
Housing diameter, m	0,742
Wing span, m	4,3
Weight of the warhead, kg	400
Launch range, km	Up to 5500
Flight height, m	From 30-70 to 10000
Effective scattering area, m^2	0,01
Guidance accuracy, m	6
Flight speed, m/s	190-270

General appearance cruise cruise missile X-101 behind open are shown in Figures 14-18.

Figure 14 - X-101 on the suspension of a Tu-95MC bomber

Figure 15 - Moment of launching the X-101 from a Tu-160 bomber

Figure 16 - X-101 and X-55CM in front of a Tu-160 bomber

Figure 17 - Suspension of the X-101 on the Tu-160 launcher

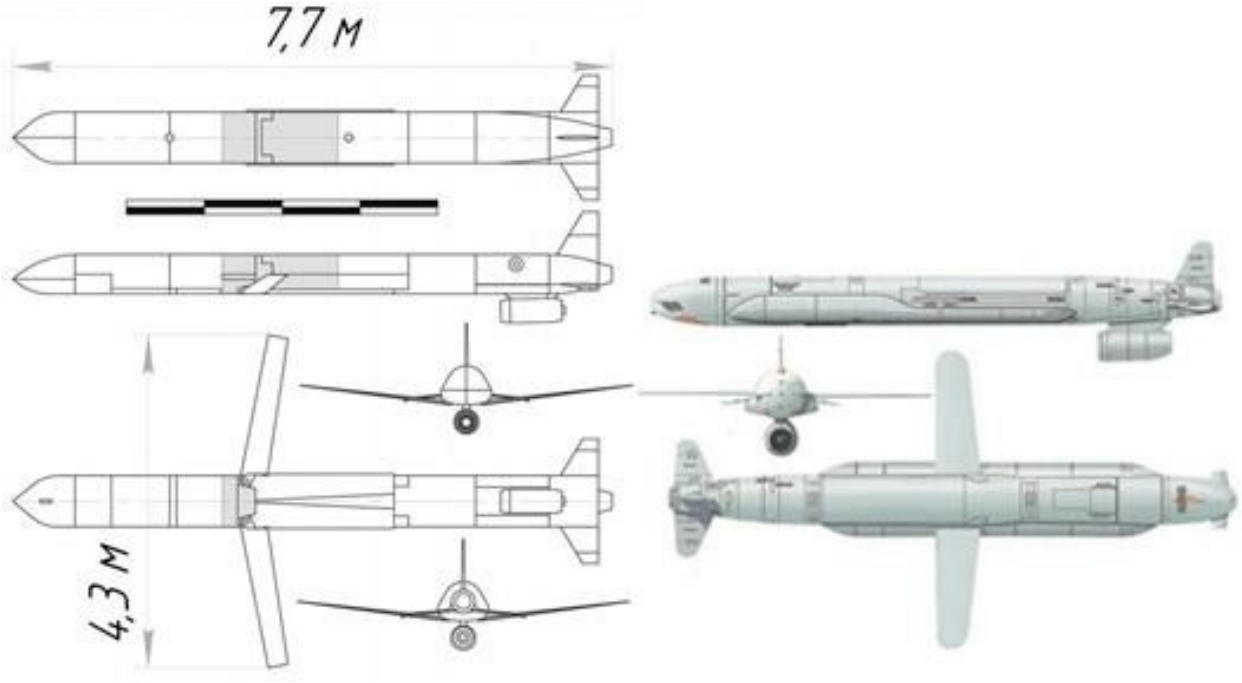


Figure 18 - Exterior of the X-101 (left) and X-555 missiles

The X-101 strategic subsonic cruise missiles are armed by the Tu-160 and Tu-95MCM long-range bomber aircraft of the Russian Aerospace Forces, which can carry up to 12 and 8 missiles, respectively. After launching, the X-101, unlike the 3M-14 Kalibr, 9M727 and 9M729 Iskander, X-35U, etc. cruise missiles, can have a variable altitude flight profile from 30 to 6000 m, as the missile design and radio-absorbing skin coating reduce the effective scattering area, according to open Russian data, to 0.01 m^2 .

Since February 24, 2022, the X-101 has been predominantly employing standard cruise missile tactics with a route flight at low and ultra-low altitudes (30-150 m), with final targeting without the use of a distinctive "slide" maneuver.

The missile has full autonomy: electronic components with a flight mission using data from the precision weapons information bank are entered into the BCOM during preflight preparation. The missile's complex flight path is based on control points where the missile's attitude is corrected according to the data from the inertial navigation system, satellite guidance, radio altimeter, optoelectronic correction system and final guidance.

The X-101 missile is a continuation of the development of the Soviet strategic cruise missile X-55 and its modifications - X-55CM and X-555. It generally borrowed from them the layout and the rudder plumage, which includes one vertical ("upper") and two horizontal ("left", "right") plumage planes. The rudder actuator unit, marked "K-005", is located at the extreme rear point of the rocket, with only a tail fairing in the form of a cut-off cone with ventilation holes behind it.

In the starting flutter, the rudder planes are folded to the side, straightened and locked at the moment of launch. At the same time, the TRDD-50A(M) turbojet engine (Product 36M) is retracted from the fuselage under the hull. After that, the wings with a wingspan of up to 4.3 meters are released into flight.

The missile differs from the X-55CM and X-555 in its fuselage profile (a triangle-like shape that fits the standard diameter of the X-101 predecessor missiles, with a flattened cross-section and side surfaces). The maximum width of the missile is significantly larger, reaching 0.745 m; its length is also greater (7.6 m versus about 6 m for the X-55 and X-55CM).

The X-101 has a larger wingspan and a distinct arrow-shaped wingtip compared to the X-55 modifications, which makes it easier to recognize visually. The X-101 is a low-altitude missile, with the wings positioned at the bottom of the fuselage before launch; previous models were mid-altitude, with their wings folded into the middle of the body.

The 3M-14 "Kalibr" missile is similar in size to the X-55 and in general layout to the X-101. Unlike the X-101, it has a cylindrical body, the engine is located inside the tail section of the missile, receiving airflow through an air intake in the lower part of the fuselage. At the rear, the missile ends not with a fairing, but with a turbojet engine nozzle, around which there are not three, but four smaller rudder fin planes, smaller than those on the X-101, which are made of black composite material.

The X-101's skin is made of aluminum-magnesium alloy and painted in light gray colored paint, with a distinctive purple in the tail section.

shade. The front part of the body, wing plating and rudder plumage are painted gray-violet or gray-blue and made of a textolite-like composite material. The central part of the fuselage is painted in a darker green-gray color, making it stand out from the rest of the missile (Figures 14-17). In the tail section of the missile, the metal skin of the body is covered with a layer of radio-absorbing material that looks like rubber.

Figure 19 - Rubber-like insulating coating of the skin is a characteristic feature of

the X-101"

The serial number on the X-101 is 13-digit and is affixed in at least two places on each side of the body, on the vertical rudder and on the wing surface, i.e., it is duplicated at least 8 times. An example of the number is shown in Figure 20.

Figure 20 - Serial number of the X-101 missile "3156484515003" The decoding of the serial number is shown in Table 5.

Table 5 - Decoding the serial number on a piece of casing

Missile marking 315 648 4 5 15 003					
315	648	4	5	15	003
plant manufacturer	code product	quarter of the year production	year production	series	product number in the series
	(X-101)		2015		

The last five digits, which indicate the serial and product number, are also found inside the case, in particular in stencil font on the back of the process hatches, and are also applied by hand on other surfaces (Figure 21).

Figure 21 - Last 5 digits of the serial number "3156484515003"

Other distinctive markings found on the X-101 enclosure include:

an inscription in red ink in the central part of the case, where the head of the optical-electronic correction system "OEC" is located: "WARNING", "PRODUCT OF A HOT PYROLYTIC MEDIUM";

inscriptions in black paint in the tail section of the rocket: "LEVELING PLACE," "ENGINE STOPPER," "ENGINE LIFT AND RELEASE," "MAJORITY PROCESSING."

inscriptions in black paint on the technological hatches in the tail section of the rocket "BVPR4C KRD"; "K005", "GAS HEATER 577-3-1 ZAZEMLEH"; "RB1 (A2E-X7) RB2 (A2E-X6) RB3 RBT";

"ZAMKI" inscriptions on the locks of the steering wheel flats;

production numbers on internal parts starting with the digits "84", index "504E".

As with other subsonic cruise missiles, the X-101 is characterized by a compact turbojet (turbofan) twin-circuit engine. Elements and turbine blades made of heat-resistant alloys have an increased chance of being destroyed by explosion and fire.

A feature that distinguishes the X-101 model from the X-555 and other cruise missiles is a red-colored kohukh with a 13-digit serial number beginning with the digits "52." An example is shown in Figure 22.

The wing of the X-101 has a longer main and tail spar than the 3M-14 Caliber, and it is a single rotationally driven molded part.

The length of the X-101 is about 170 cm (Figures 23-36).

Figure 22 - Engine cowling with serial number "52808431902052"

Figure 23 - Support spar of the Kalibr cruise missile

Figure 24 - Support spar of the X-101 cruise missile

Figure 25 - Support spar of the X-101 cruise missile

Figure 26 - K-005 rudder actuator unit

Figure 27 - K-005 rudder actuator unit

Figure 28 - K-005 rudder actuator unit

Figure 29 - Rocket's main engine - TRDD-50A(M) / "Product 36M"

Figure 30 - Rocket's main engine - TRDD-50A(M) / "Product 36M"

Figure 31 - Example of "504E" marking - a fragment of the fuel supply system

Figure 32 - Example of labeling with the digits "84" at the beginning of the number

Figure 33 - Rudder tail fin attachment lock

Figure 34 - Fastening lock, swivel mechanism labeled "A22" and a fragment of the left horizontal plane of the rudder

Figure 35 - Fastening lock, swivel mechanism labeled "A22" and a fragment of the left horizontal plane of the rudder

Figure 36 - Characteristic feature of the X-101 - cloth insulation of wiring

The characteristic markings and design fragments that allow identification of the specimen by visual details in the public domain are shown in Table 6 and Table 7.

Table 6 - Characteristic markings and structural fragments that allow identification of the specimen by visual features

Description. fragment	Localization by visual cues	An example of an identified fragment
Plating and plumage of the rocket's tail section - technological hatch		

Marking the engine compartment	 (port side)	 (starboard side)
"WARNING" labeling		

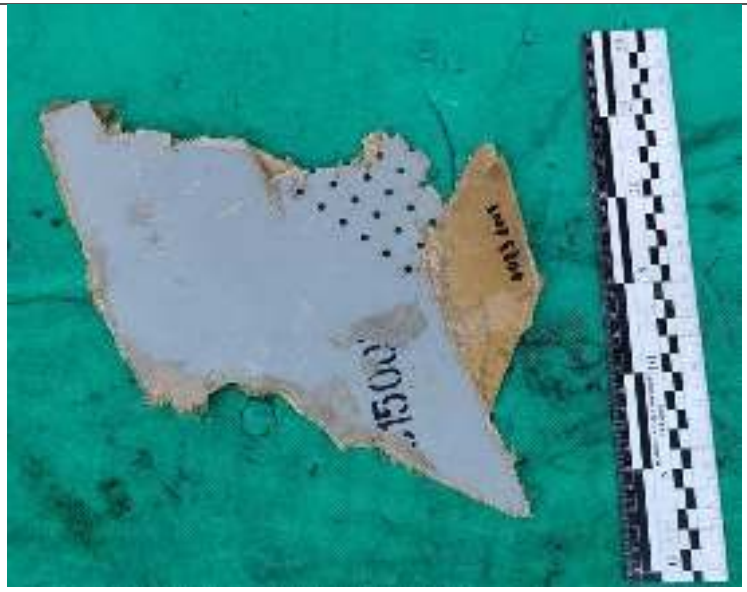
Tail section of the rocket with fairing		
Ventilation holes and serial number on the front of the rocket		

Table 7 - Instruments of the X-101 cruise missile, their functional purpose and brief description

Labeling	Description.	Photo.
504	Index of the X-101 missile	No information is currently available
BA-080-01	The unit automation unit. Production BAT "UPKB "Detail"	
BVK-15M	At present information is not available at this time	No information is currently available
BDG-1M	Damping gyroscope unit	No information is currently available
BK-59 series 1M	Correction unit	No information is currently available
BU-36 series 1M	Amplifier unit	No information is currently available
BCC-1	No information is currently available	
BP-45-1M	The tilting unit	No information is currently available

Labeling	Description.	Photo.
PGI-2M	Inertial gyroscopic platform	 
T-37M	Thermostat	No information is currently available
VIDEO.	Air pressure measurement system	
FRP-2M	No information is currently available	No information is currently available

Labeling	Description.	Photo.
MP-3A3-A	Instrument frame	  
MP-0.75C2	High-speed electric motor for hydraulic fluid supply	

Labeling	Description.	Photo.
9-E-2648	Combat unit	
BK-66A	Switching unit for tilting devices	
UVK-208	Index of height, code	

Labeling	Description.	Photo.
IRCU.468173.008 with optical and mechanical unit	Data collection sensor in the gimbal. Developed by the Central Research Institute of Agricultural Economics, Moscow. Manufacturer "ZOOHTZLISH", м. Moscow, Zelenograd	 
BT33-205 **UCCU 687265.370**	Processor module. Developed by FSUE NIISI RAH, Moscow. Moscow	
WE ARE THE CHP 468354.001	An element of the terrain navigation system. The developer and manufacturer is CJSC HTC LHC, м. Moscow, Zelenograd	

Labeling	Description.	Photo.
MKR CHP 467415.001	Element of the terrain navigation system The developer and manufacturer is CJSC HTC LHC, м. Moscow, м. Zelenograd	
	On-board computer of the control system	
A11C	Container with hydraulic fluid	
	Steering wheel drive unit	

Labeling	Description.	Photo.
	General view of the rudders	
Monoblock L	Doppler speed and wear meter	No information is currently available
AG-080-01	Radio altimeter element "Kalina"	No information is currently available
Antenna 62045093	Satellite navigation antenna	 

Labeling	Description.	Photo.
UMSH-M	Low-noise amplifier	
L3-MG-2	Hydraulic oil	No information is currently available
SCFA-12-0.5	Ignition unit	
TRDD-50A (product 36M)	A turbojet twin-circuit engine. Developed by the Saturn Research and Production Enterprise, м. Rybinsk	No information is currently available
KRD-36M	Integrated motor controller	
MPSHV 0505 VOG	The tilting module. Manufacturer BAT "ElTom", c. Tomilino village	No information is currently available

Labeling	Description.	Photo.
MPSV 0515 VOG	Tilting module. Manufacturer BAT "ElTom", c. Tomilino village	
BVPR-4CM **BVPR-4C**	Straightening and tilt distribution unit	 
2x25NKM-5-B	Nickel-cadmium battery. Manufactured by HIIXIT JSC, м. Saratov	
577-3-1	Gas generator	No information is currently available
518-2C	Gas generator	No information is currently available

Labeling	Description.	Photo.
РЕМ-5В	Electromechanical converter	
ЕМ-40МР-1 (IRTSU.436431.007)	Electric drive. Developed by the Central Research Institute of Agricultural Engineering, м. Moscow, Russia	No information is currently available
51Л	Doppler velocity and wear meter antenna	
52Л	Markings on the Doppler speed and wear meter	

Labeling	Description.	Photo.
	General view of the tail section	

SECTION IV

GUIDE TO IDENTIFICATION OF CRUISE MISSILES 3M-14 CALIBER, 9M727, 9M729

The tactical and technical characteristics of the 3-M14 cruise missile that are important for identification are given in Tables 8 and 9.

Table 8 - Tactical and technical characteristics of the 3-M14 cruise missile

Name of the characteristic, unit measurement	**Meaning.**
Length (including the starting stage), m	6,2 - 7,1 (8,09 - 8,2)
Diameter of the body (launch capsule), m	0,514 (0,533)
Wing span, m	3,08
Starting weight, kg	1400 - 1770
Weight of the warhead, kg	450
Launch range, km	2600
Flight altitude, m: -over the sea - overland - at the end of the line versus offshore goals	 20 50-150 10
Angles of approach to the target, deg.	± 180
Guidance accuracy, m	5
Flight speed, m/s	180 - 240

For reference. Tactical and technical data of packages 9M729 and 9M727 (9M728) with the closest possible match to 3M-14. The length of the found samples of the main stage of 3M-14 was about 7.1 m. The length of the 9M729 package together with the starter stage was calculated by the open jets by the method of comparison and was 8.09 m, the maximum possible length of the package was determined by the length of the transit and nose cup and the top aerial and was 8.22 m.

Table 9 - Technical characteristics of the engine "Product 37-01E" / TRDD-50B

Name of the characteristic, unit of measurement	**Meaning.**
Maximum thrust, kgf	450
Specific fuel consumption at maximum rehydration, kg/kgs*h.	0,71
Diameter, m	0,33
Length, m	0,85
Dry weight, kg	82
Types of fuel used	T-1, TC-1, RT, T-6, T-10 (decilin)

For reference. Listed are the types of fuel with options for aviation kerosene for turbojet (turbofan) and direct-drive jet engines:

T-1 is a density of at least 0.800 g/cm³ , one of the standard types of kerosene for subsonic speeds;

TC-1 ("tonic sulfur-1") - density not less than 0.775 g/cm³ , one of the standard types of kerosene for subsonic speeds; presumably, it can be used to fill 3M-14 packages for impact at a distance significantly less than the maximum distance to reduce operating costs;

PT - density of at least 0.775 g/cm³ , universal fuel for flying at subsonic speeds with a short-term transition to supersonic speed;

T-6 - density of at least 0.840 g/cm³ , fuel for flight at supersonic speeds, used in particular for P-800 Onyx rockets;

T-10 (decylene, $C_{10}H_{16}$) - density 0.941 g/cm³ , a high-calorie toxic synthetic fuel developed for the P95-300 engine and its Russian equivalent TPDD-50, is most likely to be used to fuel 3M-14 packages for subsonic flight at all sections of the route to hit ground targets, especially at close to the maximum distance.

The general view of the 3M-14E Kalibr cruise missile is shown in the figures 37, 38.

Figure 37 - General view of the 3M-14E Kalibr cruise missile (mockup)

Figure 38 - General view of t h e Iskander-K rocket at the launch site

The solid-propellant rocket stage, which launches the rocket to the standard altitude and speed for the route, separates in the first minutes of flight and is not detected at the site.

The 3M-14 samples examined did not contain a warhead engine, typical of anti-ship modifications of the Kalibr family of missiles, which can accelerate the missile to supersonic speed before engaging a target.

According to open sources of Russian origin, the 3M-14 missile has a high-explosive (fragmentation) warhead, which can be fired by contact or airborne explosion. Some sources report the availability of a cluster warhead for the 3M-14 to accommodate ground targets. No information on a thermobaric warhead for the 3M-14 missile is available in open sources.

Submarine and surface warship deployment is the main option for the 3M-14 missile, with the former obviously prevailing. Less common is the "3M-14T" designation instead of the standard "3M-14" designation for the missile's main body. According to open sources, this is the designation for the modification that uses a transport and launch cup as part of the Kalibr-HK complex, which is installed on surface ships.

On the tail section of 3M-14 "Caliber" missiles 9M727, 9M728, 9M729, there is a marking of the model and serial number of the missile. At the same time, 3M-14 missiles have two serial numbers, for example: "3M-14.1.0000 #0XXX",

"3P-14.0000 №0XXX". Their number is always lower, obviously indicating a modification or production series (Figures 39, 40).

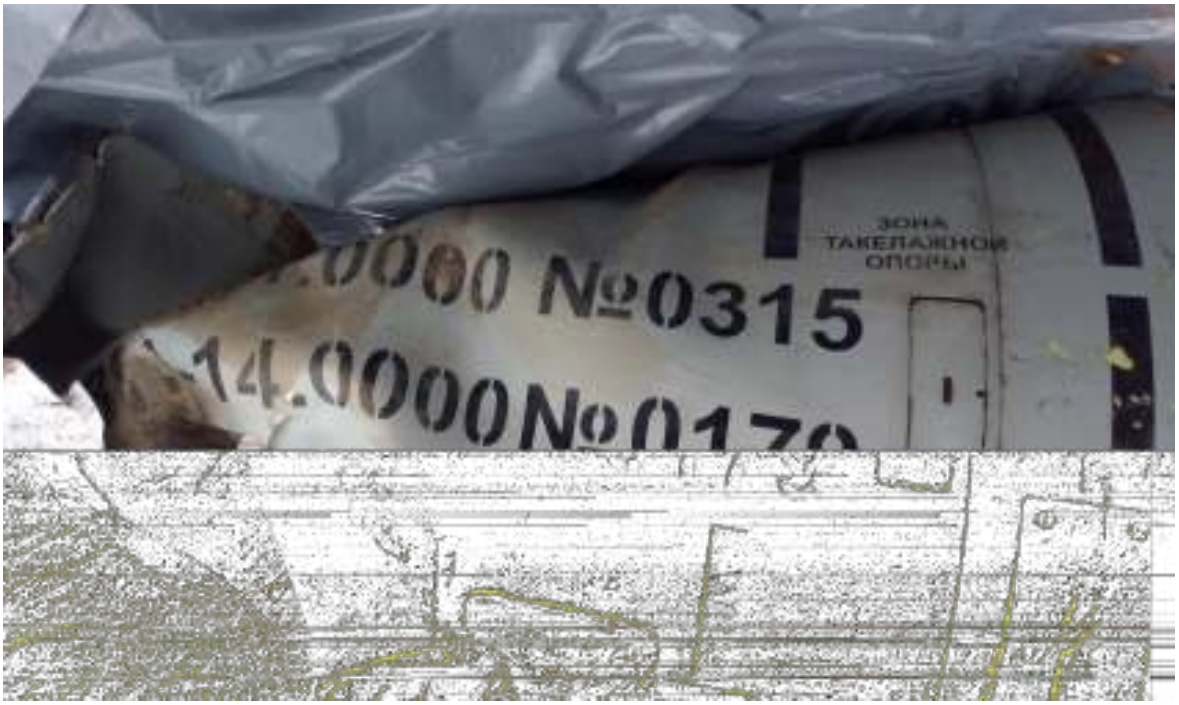


Figure 39 - Serial number of the 3M-14 missile

The 9M727 and 9M729 missiles have only one line of marking: "9M727.0000 No. 0XXX" or "9M729.0000-0 No. 0XXX" (Figure 40).

Figure 40 - Serial number of the 9M729 missile

There is a different font style for the 3M-14 and Iskander cruise missile markings, in which the lines have rounded ends (Figures 41, 42).

Figure 41 - Serial number of the 3M-14 missile

Figure 42 - Iskander cruise missile serial number

Serial numbers in a "rounded" font have larger numbers, and missiles marked with them are likely to have a later production date.

The most distinctive element of the 3M-14 missile is the "shank," or the nozzle ring of the missile with the four rudder planes mounted on it. It is often the first large fragment of the missile to be seen at the site. Most of the engine tail parts are marked "3P-51" (Figures 43-52).

Figure 43 - Typical circumstances of a hit

An engine is buried in the wall of the main crater or next to it; the rocket's "tail" with a nozzle and rudder actuators is visible.

Figure 44- Tail section of the 3M-14

The shank, rudder plane supports, engine, and current control unit BVPR 3 of the GWP3 power generator are arranged in a ring around the front of the engine. The diameter of the nozzle opening is about 24 cm.

Figure 45 - 3M-14 rocket nozzle

Figure 46 - Composite rudder fins on the 3M-14 shank

Figure 47- Damaged composite rudder fins on the 3M-14 shank

Figure 48 - Typical 3M-14 rudder markings

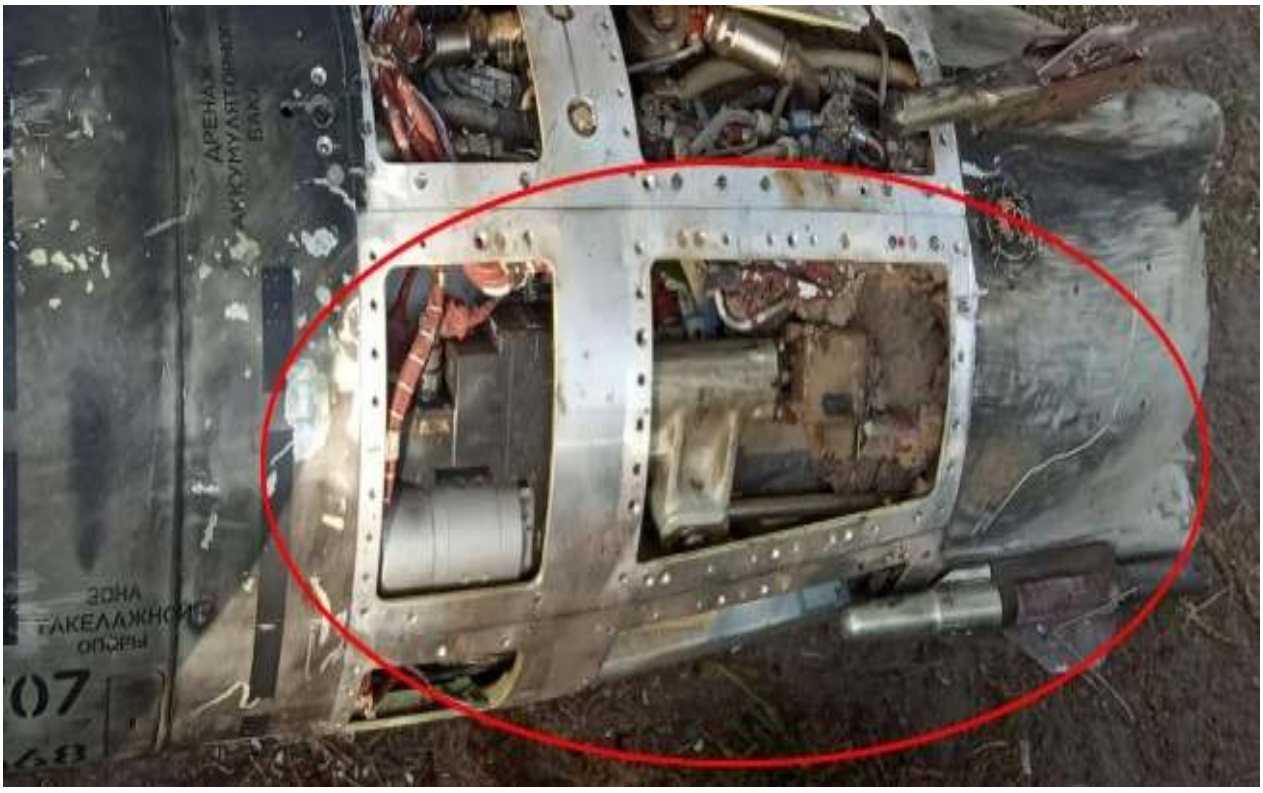


Figure 49 - Location of the rudder actuator and rudder linkage

Figure 50 - 3M-14 rudder linkage and mechanical transmission

The FT-1 filter container is often stored intact, with the markings on the hatch cover i n t a c t .

Figure 51 - Filter FT-1

Figure 52 - Typical markings of individual components of the missile tail section

The 3M-14 Kalibr and 9M727, 9M728 and 9M729 missiles of the Iskander-K (Iskander-M) complex are close modifications of the same cruise missile model. The early series of Iskander and Kalibr missiles are distinguished by an additional layer of light brown insulating (radio-absorbing) material around the air intake opening on the missile's tail. The nose fairing and wing leading edge are also brown (Figures 53-62).

Figure 53 - Material of the insulating lining of the air inlet edge

Figure 54 - Material of the insulating lining of the air inlet edge

Figure 55 - characteristic element of the fuel system

Figure 56 - Transparent silicone tanks - an element of the fuel system

Figure 57 - The Caliber and Iskander wing spar is 61 cm long, as opposed to 170 cm for the X-101

Figure 58 - Attachment of the wing support spar

Figure 59 - Exhibition model of the TRDD-50B engine ("Product 37-01")

Figure 60 - Exterior view of the TRDD-50B engine

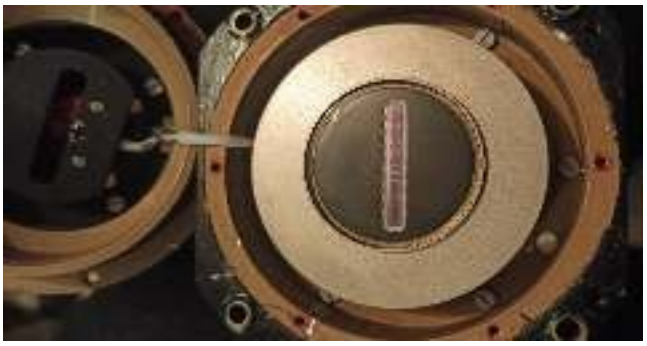
Figure 61- Remote unit marked "GTT" - a distinctive feature of the TRDD-50B engine that distinguishes it from the TRDD-50A (X-101) and "Product 64M" (X-35U)

Figure 62 - TRDD-50B serial number on the gray background, X-101 on the red

Instrument cruise missile 3-M14, their functional purpose and

A brief description is provided in Table 10.

Table 10 - Instruments of the 3-M14 cruise missile, their functional purpose and brief description

Labeling	Description.	Photo.
9M727 (9M728, 9M729)	Rocket index	No information is currently available
10KCU.466225. **(00.8-04)** Elements: MKR TEC.467415.001 MC TEC.468354.014	Computer "Baguette-62-04"	 
9Э437 IRCU.203332.006	Optical (blink infrared) collection sensors information	 
PMZHI.464426.010	Monoblock treatments	

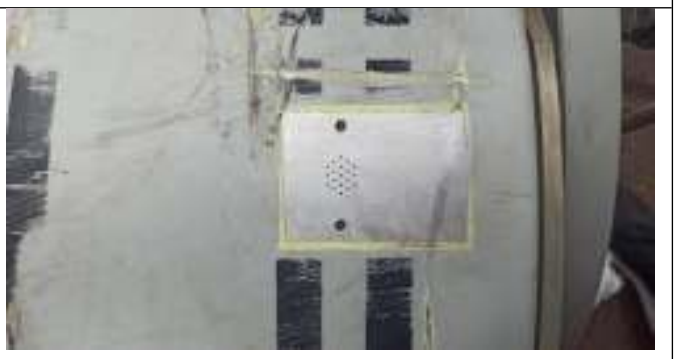
Labeling	Description.	Photo.
	information from radar antennas	
GIB-123-4 **MT-401M-1TA**	Gyro inertial unit	 
AB-60IC	Autonomous inertial navigation unit	

Labeling	Description.	Photo.
A-079-01L Elements: A-079-03 PZP-080-02 AR-080-01	Radio altimeter	
BU-152	Control system unit	
RR-97	Relay tilt distributor	
9Б705	Missile control system unit	

Labeling	Description.	Photo.
Zarya-61M **Proc.034** **BT62-045M** **BT62-408M** **BT62-406M**	On-board digital computer	 
9Б914	Secondary tilting unit	 

Labeling	Description.	Photo.
GTT-37.000 №15.147	Unit. Produced by BAT "High Technologies (Omsk Aggregate Plant) for JSC OMKB.	
TRDD-50B (product 37)	Marching engine	
SCF-12-05M	Turbojet ignition unit	

Labeling	Description.	Photo.
KRD-36M	Integrated motor controller	
CN-99	Satellite navigation	
CN-60	Satellite navigation	
VIP-60	Secondary source of tilting of onboard instrumen ts	
3П-51.5531	Wing opening drive	

Labeling	Description.	Photo.
	Appearance of the tail section	
	Ventilation element on the housing	
ZP-14.1.0000-70	Compartment connection ring	 
	Combat unit	

Labeling	Description.	Photo.
EMV-558	Electromechanical igniter	
Device A3	Altimeter antenna	
TV **9M727.7273**	Heat batteries	
	General view of the nose compartment	

Conclusions.

1. These methodological recommendations allow for the identification of X-35U, X-101, 3M-14 Caliber, 9M727 and 9M729 cruise missiles by their debris left after the explosion.

2. The methodological recommendations proposed by the experts of the Center for the Study of Trophy Weapons and Military Equipment should be used:

personnel of mobile groups that record and investigate the use of X-35U, X-101.3M-14 Caliber, 9M727 and 9M729 cruise missiles of the Russian Federation against Ukraine;

scientific and pedagogical staff of higher military educational institutions that train specialists in the field of missile forces and artillery;

personnel participating in the elimination of the consequences of the use of X-35U, X-101.3M-14 Caliber, 9M727 and 9M729 cruise missiles;

by investigators of law enforcement agencies' operational groups in order to form an evidence base for violations of international humanitarian law by the Russian Federation on the territory of Ukraine.

3. The methodological recommendations will be supplemented and deepened as statistical information from the crash sites of other types of cruise missiles is generalized.