

[Underwater Acoustic Modem](#)

Aquacomm: Highly reliable low cost underwater data communications link
www.dspcomm.com

[Online panels in Russia](#)

CPX - access to Russia from your PC 30 more markets. 5 yrs experience.
www.cint.com/

[Camplin Dive Services](#)

construction and maintenance welding, cutting, ROV, surveys
www.diveservices.com.au



Ads by Google

[FAS](#) | [Military](#) | [DOD 101](#) | [Systems](#) | [Missiles](#) | [ROW](#) ||||
[Index](#) | [Search](#) | [Join FAS](#)



VA-111 *Shkval* underwater rocket

In 1995 it was revealed that Russia had developed an exceptionally high-speed unguided underwater missile which has no equivalent in the West. Code-named the *Shkval* (Squall), the new weapon travels at a velocity that would give a targeted vessel very little chance to perform evasive action. The missile has been characterized as a "revenge" weapon, which would be fired along the bearing of an incoming enemy torpedo. The *Shkval* may be considered a follow-on to the Russian BGT class of evasion torpedoes, which are fired in the direction of an incoming torpedo to try to force an attacking to evade (and hopefully snap the torpedo's guidance wires). The weapon was deployed in the early 1990s, and had been in service for years when the fact of its existence was disclosed.

Development began in the 1960s, when the Research Institute NII-24 (Chief Designer Mikhail Merkulov) involved in the artillery ammunition research was instructed to launch the development of underwater high-speed missile to fight nuclear-powered submarines. On 14 May 1969, pursuant to a government resolution, NII-24 and GSKB-47 merged into the Research Institute of Applied Hydromechanics (NII PGM), which formed the basis of the present day 'Region' Scientific Production Association. Advances in the development of jet engines and fuel technologies, as well as outstanding results in the research of body motion under cavitation made it possible to design a unique missile with a dived speed much greater than that of conventional torpedoes.

When the suction on the low-pressure side of the propeller blade dips below ambient pressure [atmospheric plus hydrostatic head] the propeller blade cavitates -- a vacuum cavity forms. There is water vapor in the cavity, and the pressure is not a true vacuum, but equal to the vapor pressure of the water. High-speed propellers are often designed to operate in a fully-cavitating (supercavitating) mode. A high speed supercavitating projectile, while moving in the forward direction, rotates inside the cavity. This rotation leads to a series of impacts between the projectile tail and the cavity wall. The impacts affect the trajectory as well as the stability of motion of the projectile. The present paper discusses the in-flight dynamics of such a projectile. Despite the impacts with the cavity wall, the projectile nearly follows a straight line path. The frequency of the impacts between the projectile tail and cavity boundary increases initially, reaches a maximum, and then decreases gradually. The frequency of impacts decreases with the projectile's moment of inertia.

Apparently fired from standard 533mm torpedo tubes, *Shkval* has a range of about 7,500 yards. The weapon clears the tube at fifty knots, upon which its rocket fires, propelling the missile through the water at 360 kph [about 100 m/sec / 230 mph / 200-knots], three or four times as fast as conventional torpedoes. The solid-rocket propelled "torpedo" achieves high speeds by producing a high-pressure stream of bubbles from its nose and skin, which coats the torpedo in a thin layer of gas and forms a local "envelope" of supercavitating bubbles. Carrying a tactical nuclear warhead initiated by a timer, it would destroy the hostile submarine and the torpedo it fired. The *Shkval* high-speed underwater missile is guided by an auto-pilot rather than by a homing head as on most torpedoes.

There are no evident countermeasures to such a weapon, its employment could put adversary naval

forces as a considerable disadvantage. One such scenario is a rapid attack situation wherein a sudden detection of a threat submarine is made, perhaps at relatively short range, requiring an immediate response to achieve weapon on target and to ensure survival. Apparently guidance is a problem, and the initial version of the *Shkval* was unguided. However, the Russians have been advertising a homing version, which runs out at very high speed, then slows to search.

A prototype of the modernised "Shkval", which was exhibited at the 1995 international armaments show in Abu Dhabi, was discarded. An improved model was designed with a conventional (non-nuclear) warhead and a guided targeting system, which substantially enhances its combat effectiveness. The first tests of the modernised Shkval torpedo were held by the Russian Pacific Fleet in the spring of 1998.

The 'Region' Scientific Production Association has developed an export modification of the missile, 'Shkval-E'. Russia began marketing this conventionally armed version of the Shkval high-speed underwater rocket at the IDEX 99 exhibition in Abu Dhabi in early 1999. The concept of operations for this missile requires the crew of a submarine, ship or the coast guard define the target's parameters -- speed, distance and vector -- and feeds the data to the missile's automatic pilot. The missile is fired, achieves its optimum depth and switches on its engines. The missile does not have a homing warhead and follows a computer-generated program.

On 05 April 2000 the Russian Federal Security Service [FSB] in Moscow arrested an American businessman, Edmond Pope, and a Russian accomplice, on charges of stealing scientific secrets. A FSB statement said it confiscated "technical drawings of various equipment, recordings of his conversations with Russian citizens relating to their work in the Russian defense industry, and receipts for American dollars received by them." Pope, a retired US Navy captain who spent much of his career working in naval intelligence, was at the time of his arrest the head of a private security firm. On 20 April 2000 the FSB revealed that Pope had been seeking plans for the *Shkval* underwater missile. Pope was detained during an informal contact with a Russian scientist who had participated in the *Shkval's* creation.

The arrest of Daniel Howard Kiely, deputy head of the Applied Research Laboratory at Pennsylvania State University, came almost simultaneously. The laboratory led by Mr. Kiely has for many years been developing torpedoes for US warships and submarines. Professor Kiely had joined Pope in Moscow to offer technical advice and determine the tasks for Pope's further activity. Kiely was interrogated as a witness. His testimony and objects confiscated during the search proved his involvement in Pope's activities. Later the 68-year-old professor was released and allowed to return to the United States.

The objective of the High-Speed Undersea Weaponry project at the US Office of Naval Research is to develop the vehicle guidance, control and maneuvering capabilities for the quick reaction weapons. High-speed weapons could offer an advantage for Anti Submarine Warfare (ASW) "close encounter" scenarios. The overall system response of a high-speed weapon for breaking off engagements with enemy submarines would be measured in seconds, rather than minutes. The High-Speed Undersea Weapons project has three tasks; Vehicle Guidance, Vehicle Control, and Test Bed Development. Vehicle Guidance deals with homing sensors, signal processing, waveform design, and autopilot commands that are used to guide (either autonomously or with external interaction) the weapon to its target. Vehicle control deals with control and maneuvering of the high-speed weapon with emphasis on stabilizing the supercavitating bubble cavity, and optimizing the flow for low drag. Technical issues include instability due to vehicle planing and tail slap, interaction between cavity with propulsion exhaust, and propulsion system transients, including startup. Test Bed Development is an ongoing effort that develops a test platform to test and evaluate S&T candidate systems such as homing systems, vehicle control, and propulsion systems.



Sources and Methods

- [REGION ENTERPRISE: EXPERT IN HIGH-PRECISION GUIDED WEAPONS](#) Yevgeny Shakhidzhanov, *Military Parade* Issue 33. May - June 1999
- [CONCRETE SUBMARINES](#) BY JIM WILSON *Popular Mechanics* DECEMBER 98

[FAS](#) | [Military](#) | [DOD 101](#) | [Systems](#) | [Missiles](#) | [ROW](#) ||||
[Index](#) | [Search](#) | [Join FAS](#)

<http://www.fas.org/man/dod-101/sys/missile/row/shkval.htm>

Maintained by [Ivan Oelrich](#)

Originally created by John Pike

Updated Sunday, September 03, 2000 9:30:10 AM