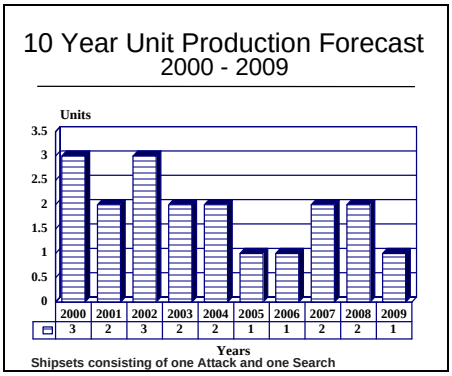
Kollmorgen Model 76 Periscopes - Archived 8/2000

Outlook

- 43 Model 76 shipsets to be produced through 2000
- Production tied to orders for submarines and upgrades
- Indian Navy upgrade pending



Orientation

Description. A family of submarine attack and search periscopes.

Sponsor

Kollmorgen Corporation
Electro-Optical Division
347 King Street
Northampton, Massachusetts (MA) 01060
USA
Tel: +1 413 586 2330
Fax: +1 413 586 1324
Web site: www.kollmorgen.com

Contractors

Kollmorgen Corporation
Electro-Optical Division
347 King Street
Northampton, Massachusetts (MA) 01060
USA
Tel: +1 413 586 2330
Fax: +1 413 586 1324
Web site: www.kollmorgen.com

Licensee. No known production licenses have been granted.

Status. Production and service.

Total Produced. An estimated 40 shipsets (a pair consisting of one Attack periscope and one Search periscope) produced through 1999.

Application. Used for surveillance and attack fire control. The modular construction allows for variation and mission specialization for attack as well as search.

Platform. Model 76 is suitable for installation on most types of small, medium and large submarines (especially diesel-electric submarines), and has been sold mainly to non-US markets.

Price Range. Kollmorgen periscopes are generally very competitively priced, suggesting that the unit price is comparable with those of known systems at roughly US$9.5 million and $10 million.

Technical Data

Specifications:

Magnification:	1.5x and 6x
Field of view:	32º and 8º
Elevation (search):	+60 to -10º
Elevation (attack):	+72 to -10º
Minimum range:	50 meters

Image Intensifier Ranges (against corvette-sized target):

Illumination	**Detection**	**Recognition**	**Identification**
Starlight:	1.5 km	0.7 km	0.5 km
Quarter moon:	2.5 km	1.3 km	1.0 km
Full moon:	4.5 km	2.4 km	1.7 km
FLIR ranges:	15 km	5.0 km	1.9 km

	Metric	**US**
Dimensions		
Tube diameter:	190 mm	7.5 in

Design Features. The Kollmorgen Model 76 periscope is produced in both search and attack versions. Both versions have binocular eyepieces with split optics. The periscope is modular and uses common parts, which allows it to include LLLTV, laser rangefinder, image intensifier or thermal imager, among other functions. The optical system has line-of-sight stabilization. A 35 mm camera coupling is standard, and the rotation drive is electrical. A data transmission/combat system interface is also included to facilitate sharing of that information with other tactical functions.

The attack periscope carries a broad-band radar warning receiver (RWR) with a display on the control unit of the periscope. The periscope head contains a stadiameter control. The optical system can be focused down to a minimum range of 50 meters. Optional features include a 12/6/1.5-time magnification telescope; power rotation; a video camera feeding a remote unit; an image intensifier; and a video, laser or radar rangefinder.

The search version has the same powers of magnification as the attack scope. Higher magnification, in the form of a 2x Galilean telescope mounted in the inner structure of the mast, is available as an option. The search periscope also contains an optical stadiameter which transmits data electronically to a submarine fire-control system. The same range of options as listed for the attack scope is available. In addition, the search scope carries a sextant, a satellite navigation antenna and an LF communications antenna.

When adopted, the image intensifier is mounted in the mast. For night use, the module is rotated by 90 degrees to place the intensifier in the direct optical path of the periscope. The operator can observe the output at the eyepiece, or it can be photographed or viewed though the TV system. A FLIR can also be mounted between the periscope's optical head and the RWR. This is a serially scanned SPRITE unit with a 12/4 degree field of view and a 0.2 mrad beamwidth. It is cooled by a split Stirling/closed cycle refrigerator.

The radar rangefinder uses a slotted waveguide antenna below the optical window of the periscope. This radar can also be used to track surface ships. The laser rangefinder can be mounted at the base of the periscope, opposite the viewing optics; a swinging mirror will bring the beam into the main optical path.

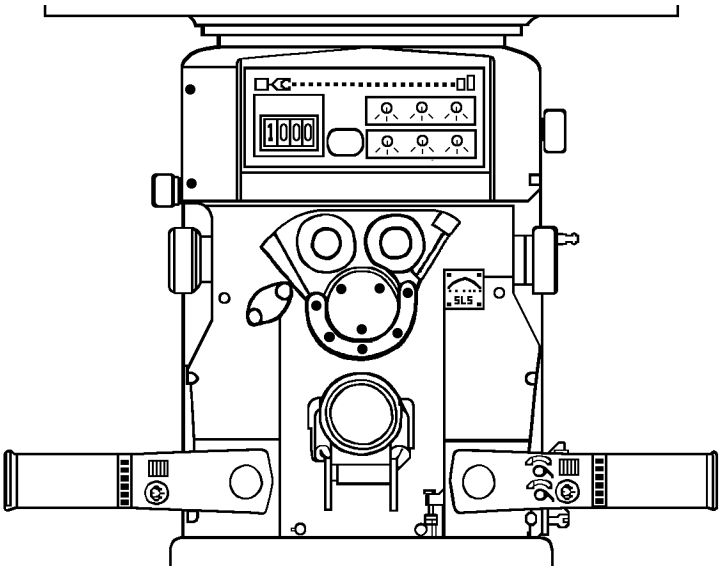
The periscope is also fitted with microphones, which allow the user to communicate within the submarine while making observations without having to move away from the periscope.

Operational Characteristics. The television video rangefinder performs split-field ranging. When the operator presses the INIT button, the image doubles vertically. The operator then moves the upper image so as to place the mast of the lower image on the waterline of the upper one. After entering the masthead height of the target, the range is automatically computed and presented in the eyepiece.

The RWR offered by Kollmorgen is an omnidirectional unit covering the E-band to J-band with a sensitivity of -35 dBm. Indication is by visual display (giving the band, and whether the radar is continuous wave or

pulse) and audio alert. An alternative installation is a more massive system that covers the same frequency range but provides either quadrant warning or 10-degree bearing cuts.

The sextant uses the periscope synchro to read off its line of elevation from the deck plane. The target bearing transmitter measures the target's bearing relative to the submarine and a built-in vertical and horizontal reference determines tilt and cross-tilt angles so that the periscope can display (and print) the star altitudes and bearings relative to the true horizon.



MODEL 76 PERISCOPE, DRY END

Source: Forecast International

Variants/Upgrades

Attack Series/Search Series. The Model 76 periscope is available in both Search and Attack versions. Normally, both are included in the shipset, so as to facilitate most effective operations according to the situational requirements.

The Attack Series periscopes have a small profile head for maximum stealth in covert situations.

The Search Series periscopes, in contrast, have a large profile, multipurpose reconnaissance sensor head for maximum search capability. Both types of heads are of modular build and share common parts and units under the installation surface, while the parts and assemblies above the surface are unique to each model.

The Model 76 periscopes sold to different customers have separate model numbers to distinguish them. Some of these are as follows:

Type 322. Installed on Italy's Salvatore Pelosi class; has a radar rangefinder.

Type 323. Installed on Primo Longobardo class; is equipped with a laser rangefinder.

Type 324. Installed on second pair of Nazario Sauro class.

Type 374. Installed on the Turkish Navy's Type 209s.

Several optional functions can be fitted on the periscope, thanks to its modular construction. These options include the following:

Image Intensifier. As explained in the Design Features section above, the image intensifier feature can be mounted on the mast section and can be viewed through various media, including TV. Detecting, recognizing and identifying a corvette size vessel in starlight conditions, is claimed to be possible at distances of 1.5, 0.7 and 0.5 kilometers, respectively.

Low Light Level Television (LLLTV). This feature allows viewing at lower illumination levels, with the TV

camera mounted in the space that has been designed into the display and control unit of the system. A monitor is part of the system and a VCR can be supplied as well, so that low light viewing can be shared with capacities at other stations, and video recordings and remote control of the unit are possible.

Thermal Imaging (Search Version only). An optional thermal imaging camera, when fitted on the periscope, covers the spectral band of 8-12µm. It is completely contained within the head of the periscope. Typical performance for detection, recognition or identification of a frigate (46 m x 6 m) is stated at 22, 9 and 5 kilometers, respectively, even in total darkness.

Video Rangefinder. An optional video rangefinder, containing a thermal camera or TV camera, can be fitted to the video monitor. The system uses an ordinary TV screen modified to perform split-field ranging and to display the calculated target range.

Laser Rangefinder. A single, integrated unit, mounted in the display and control unit of the attack periscope. The system utilizes a common aperture with the periscope visual system for both transmitting and receiving.

ESM Omni Directional Warning. Remote Control Console. Periscope Fairing. Monochrome, or Intensified Monochrome TV Camera. GPS/VPA Antennas (Search Version only). These are some additional optional features available for the Model 76 periscopes. Some but not all may be implemented concurrently, depending on the periscope version.

Integration with Other Periscope Types. The Model 76 Attack Periscope can also be integrated with a Model 90 Penetrating Optronic Periscope or with one of the more recent Model 86 family of Non-Hull Penetrating Optronic Periscopes.

The system can utilize a Kollmorgen Imaging Center or a Combat System Standard Console in such an application.

Program Review

Background. Kollmorgen Corporation first began manufacturing periscopes for the US Navy in 1916. In 1918, the company received a contract to provide periscopes for all the S class submarines. Since that time, Kollmorgen has been the dominant supplier of submarine search and attack periscopes to the US Navy. The company has been responsible for all new periscope designs used by the US Navy, and the only non-Kollmorgen periscopes procured by the US Navy since the 1930s have been small numbers of Kollmorgen-designed systems that were ordered from Sperry to establish a second source of supply. These included Type 2 periscopes in the 1950s and Type 18B systems in the late 1980s.

In the late 1930s, Kollmorgen developed the Type 2 periscope, a classic design which remains in production even today. The current version was first introduced in 1959 and differs from the pre-World War II version. It has been redesigned for deeper diving and features improved and treated optics. More recently, the company has produced the Type 8 and Type 18 periscopes which are used on current US Navy nuclear-powered attack and ballistic missile submarines.

In the 1970s, Kollmorgen decided to diversify its operations away from the US Navy market and develop a family of periscopes intended for the export market. This became the Model 76 periscope family. Launch orders were obtained from Argentina (in 1976), Sweden (for the Näcken class) and Turkey (Type 209-1200). The program took a major step forward when the Model 76 was specified for installation on the second pair of Italian Sauro class submarines, displacing the Pilkington periscopes of the first two boats. All Italian submarines have since been equipped with Kollmorgen Model 76s.

The Italian orders in particular established a series of contracts which have remained in place to the present. The **Timetable** section of this report shows the smooth succession of hulls being ordered with Kollmorgen periscopes as specified equipment. Although exact contract information for the last few years is lacking, there is every indication that previous activity will continue.

There are three significant periscope manufacturers in the world: Zeiss in Germany; Kollmorgen in the US; and Pilkington Optical Systems in the UK. Other, less significant players include SAGEM in France and Nikon in Japan, but these compete in a market dominated, for all intents and purposes, by the German, US and UK companies.

Zeiss owes its position in the market largely to its inclusion in the German Submarine Consortium and its status as the baseline equipment for the Type 209. Whenever a navy specifies other than baseline equipment, the choice is usually one of the other two competitors.

In the case of Kollmorgen, the US Navy does not and will not operate diesel-electric submarines. Kollmorgen, therefore, has no captive market of diesel-electric submarines exported from the US that it could take for granted. In this environment, Kollmorgen's success in winning almost half of the available market is a strong indicator of the technical capability and cost-effectiveness of the Model 76. It is interesting to note that the company has a very high incidence of repeat orders, with nearly all customers coming back to the company for new production. This strongly suggests that operational user experience with the Model 76 is highly satisfactory.

In March 1999, Kollmorgen received a contract from German submarine manufacturer Howaldtswerke-Deutsche Werft AG (HDW) to produce a total of four Model 76 Attack and Model 76 Search shipsets periscopes (total eight periscopes) for the Turkish Navy's Type 209 submarines. This order will consist of the most advanced versions of the Model 76 today and will include image intensifiers, laser ranging, CCD TV cameras, image stabilization, magnification changes and the state-of -the-art imaging system. Operating one of the larger submarine fleets among NATO members, the Turkish Navy currently has eight Model 76 periscope shipsets built by Kollmorgen. Deliveries are scheduled to begin in May 2002 and to be completed by January 2005.

Funding

The development of the Model 76 periscopes was funded by Kollmorgen as a corporate venture.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Kollmorgen	$22	Mar 1999 – Contract from German shipyard Howaldtswerke-Deutsche Werft AG (HDW) to produce four Model 76 Attack and Model 75 Search periscopes for the Turkish Navy's Type 209 submarines. Deliveries are scheduled to begin in 2002 and be completed by January 2005.

Timetable

Month	Year	Major Development
	1972	Specified for Swedish Näcken class; specified for Turkish Type 209-1200
Feb	1976	Ordered for second pair Italian Sauro class
Nov	1977	Ordered for Argentinian Type 1700
Jun	1978	Specified for Dutch Walrus class
Dec	1981	Ordered for Indian Type 1500
Aug	1982	Ordered for Brazilian Type 209-1400
Mar	1983	Ordered for Italian Pelosi class
Nov	1987	Ordered for Turkish Type 209-1400
Jul	1988	Ordered for Italian Longobardo class
Jan	1991	Ordered for Israeli Dolphin class
Mar	1999	Additional shipsets ordered for Turkish Navy's Type 209 submarines
	2002	Deliveries to start for Turkish Navy Type 209 order

Worldwide Distribution

(Numbers refer to a shipset which usually contains two periscopes, one attack periscope and one search periscope, and a range of below-decks equipment).

Argentina. 4 on Type 1700
Brazil. 1 ordered for SNAC-1 class, 4 on Tupi class
India. 4 on Type 1500 Shishumar class, 2 more Type 1500 ordered
Israel. 3 on Dolphin class
Italy. 2 on Salvatori Pelosi class, 2 on Primo Longobardo class, 1 each on second pair Nazario Sauro class
Netherlands. 4 on Walrus class
Sweden. 2 on Näcken class
Turkey. 4 on Type 209-1400, 6 on Type 209-1200

Forecast Rationale

Deciding to diversify its operations away from the US Navy market in the 1970s, Kollmorgen developed the Model 76 periscope family. The program took a major step forward in 1976 when it was specified for installation on the second pair of Italian Sauro class submarines, displacing the Pilkington periscopes of the first two boats. Launch orders were also obtained in that year from Argentina, Sweden and Turkey.

Since then, Kollmorgen has become one of the more prominent periscope manufacturers in the defense industry. They are a main supplier to many of the world's navies including the United States, Italy and Argentina. Due to the modular design incorporated into many of its series of periscopes, the company's ability to offer easy upgrades for existing systems is considerable.

Two possible future orders for the Model 76 have been on hold for over a year now. More than likely, due to the economic crisis in Asia in 1998, an order for two new Type 209-1400 submarines for Indonesia has been postponed indefinitely. Another potential order, the possible upgrade for the Indian Navy's eight Kilo class submarines is also still pending. Supposedly the subs were to be refitted with new Western sensors, possibly the ArgoSystems AR-700 system, and an entirely new command system.

To date, the last known recent contract for Model 76 was awarded in March 1999. Kollmorgen received a contract at that time from the German submarine manufacturer Howaldtswerke-Deutsche Werft AG (HDW) to produce a total of four Model 76 Attack and Model 76 Search shipsets periscopes (total eight periscopes) for the Turkish Navy's Type 209 submarines. The Turkish Navy currently has eight Model 76 periscope shipsets built by Kollmorgen. Deliveries are scheduled to begin in May 2002 and to be completed by January 2005.

As indicated in the 10-year market outlook below, sales will probably remain healthy for the periscope. Based on the commissioning dates of known platforms for the Model 76 periscopes, numbers include the outstanding balance on existing orders, barring delays. A significant allowance is included for future submarine construction, particularly from countries new to the submarine market.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level			Speculative			
Designation	**Application**	**Thru 99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**Total 00-09**
MODEL 76 PERISCOPES	SSK (VARIOUS)	40	3	2	3	2	2	1	1	2	2	1	19

NOTE: numbers represent shipsets - pairs of one attack scope and one search scope