REPORT ON WEAPONS, TECHNIQUES, AND OBSERVATIONS IN THE ALASKAN BOWHEAD WHALE SUBSISTENCE HUNT

Prepared by the Alaska Eskimo Whaling Commission

Submitted by the
United States of America
to the Workshop on Whale Killing Methods
58th Meeting of the International Whaling Commission
St. Kitts, June 2006

INTRODUCTION

The Alaska Eskimo Whaling Commission (AEWC)

The AEWC is a not-for-profit entity composed of the ten coastal subsistence whaling communities in the Alaskan Arctic – ranging from the Villages of Gambell and Savoonga on St. Lawrence Island in the Bering Sea and the Village of Little Diomede on Little Diomede Island, to the Village of Kaktovik on Barter Island in the Beaufort Sea near the Canadian border. The culture and the social structure of these Yupik and Inupiat Native communities are built around the annual subsistence harvest of the Bering-Chukchi-Beaufort Seas stock of bowhead whales. In this paper, any reference to "bowhead whales" is to this stock.

The Bowhead Whale Subsistence Hunt

The Alaskan Eskimo subsistence hunt of bowhead whales is conducted pursuant to the regulations of the IWC Schedule; U.S. law; and the AEWC Management Plan, approved by the U.S. Government. The hunt takes place from small boats using hand-held weapons. The use of small boats and hand-held weapons requires hunting crews to approach the whale at very close range, positioning themselves to be virtually on top of the whale when it is struck.

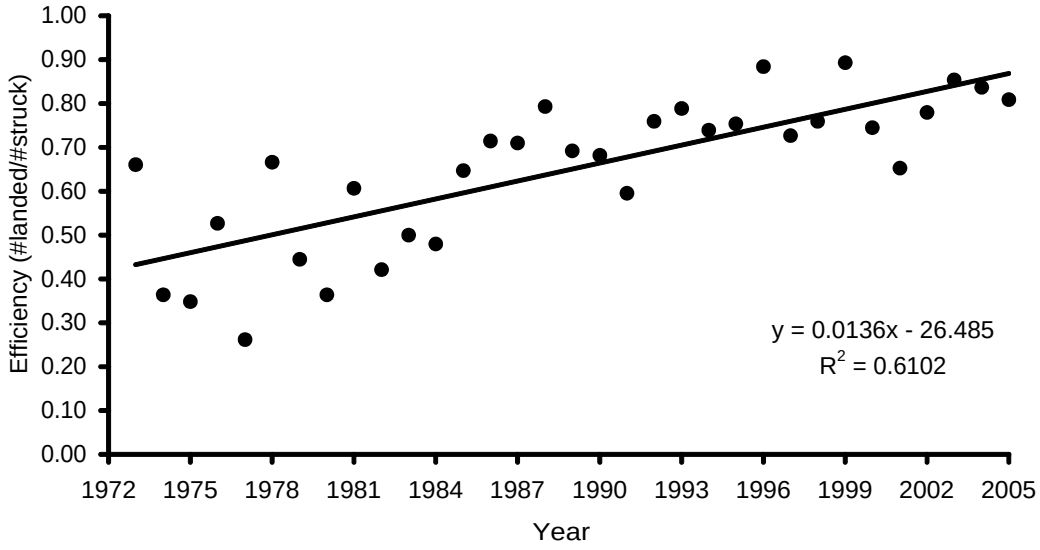
Eight of the ten subsistence whaling villages hunt in the spring as bowheads migrate north and east from the Bering Sea to the Canadian Beaufort Sea through the spring ice leads. This hunt is conducted from the edge of the shore-fast ice using wood-framed boats made by hand with walrus (St. Lawrence) or bearded seal skin and thread fashioned from caribou sinew. Because whales must be taken in an ice-covered ocean, some of the struck whales inevitably slip under the ice, where they may be lost.

Three of the villages hunt in the fall as the bowheads that summer in the Canadian Beaufort migrate west and south through the Alaskan Beaufort Sea and into the Chukchi Sea. This hunt is conducted from small skiffs with outboard motors in ice-choked waters and under conditions that often include high winds and rough seas.

Because of the treacherous conditions in which the bowhead whale subsistence hunt is undertaken, it is considered to be extremely dangerous and fatal accidents are a fact of the hunt. During a recent hunt in Barrow, one of the most experienced harpooners in the Arctic was killed when his boat capsized while towing a whale; he was trapped under it.

Efficiency in the Bowhead Subsistence Hunt

Historically, the efficiency in the bowhead whale subsistence hunt averaged approximately 50 percent. In 1978, the AEWC committed to the IWC that it would increase that efficiency to an average of 75 percent. In recent years, the average efficiency rate in the bowhead subsistence hunt has been at least 75 percent and in some years well above 80 percent.



WEAPONS USED IN THE ALASKAN BOWHEAD WHALE SUBSISTENCE HUNT

Primary Weapon

The primary weapon used in the Alaskan Eskimo bowhead whale subsistence hunt is a hand-held darting gun, armed with an explosive projectile and a harpoon that attaches a line and float to the whale to assist in recovery.[1]

Brief History of the Darting Gun

A black powder-loaded projectile has been used for approximately 150 years as the explosive projectile loaded into the traditional hand-held darting gun and shoulder gun: Inupiat and Siberian Yupik people of the northern and western coasts of Alaska have hunted bowhead whales for thousands of years. Early hunting equipment consisted of hand-held spears with points made of stone or bone. In 1847 and 1848, the North Pacific commercial exploitation of whales began in the Okhotsk and Bering Seas and ended for the Bering, Chukchi, Beaufort Seas (BCBS) stock of bowhead whales around 1914 (Montague, 1993). By the end of Yankee commercial whaling activities (1849 to 1914) 18,650 whales were estimated to have been killed (Bockstoce, 1986), dramatically decreasing the BCBS population. This industry severely depleted the BCBS stock, as well as other marine mammal stocks, especially walrus and gray whales. This caused serious starvation-related declines in the indigenous human population of coastal Alaska. The human populations also suffered further severe declines due to the introduction of disease through contact with the European whalers.

In addition, contact with Yankee whalers caused the Native people to change their hunting techniques as they incorporated new technologies in the form of the black powder exploding projectile (the black powder projectile), the darting gun, and the shoulder gun. These tools are still used in combination with traditional Eskimo whaling methods (shorefast ice-based operations) and equipment, (bearded seal, *Erignathus barbatus*, skin boat or umiaq), and some modern equipment (i.e. small outboard boats in the fall).

The traditional black powder projectile (approximately 28 cm length and 2.2 cm in dia.) is limited and dangerous to use in that it uses an old low-power explosive (black powder), has a fusing system that can be unreliable, and ignition of the fuse occurs in the barrel of the gun (Ingling, 1995). Until recently, no alternatives to the black powder projectile were available to Alaskan Eskimo subsistence hunters.

[1] For a detailed description of the darting gun, see Ingling, 1995.

However, since 1987, the AEWC through its Weapons Improvement Program Committee (WIP Committee) has worked closely with Dr. Egil Ole Øen and Henriksen Mek. Verksted of Norway on the design, testing, and manufacture of a penthrite-loaded projectile for use in the hand-held darting gun. In the course of developing the penthrite projectile, the AEWC and Dr. Øen also found it necessary to modify the design of the darting gun barrel to accommodate the dimensions of the new projectile. The work undertaken in the course of developing the penthrite projectile has been the subject of numerous reports to this Workshop and to the IWC Working Group on Whale Killing Methods. A detailed summary of the work on the darting gun barrel is provided in Alaska Eskimo Whaling Commission, 2005.

Secondary Weapon

The secondary weapon used in this hunt is a smooth bore, seven gauge shoulder gun used to shoot a finned projectile loaded with black powder. Under traditional practices and the rules of the AEWC Management Plan, the shoulder gun cannot be fired until after a line and float have been attached to the whale.

Overview of AEWC Weapons Improvement Program for the Hand-Held Darting Gun

Development of the Penthrite Projectile

Since 1987, the AEWC has pursued technical research and development designed to improve the safety and efficiency of the weapons used in the Alaskan Eskimo subsistence hunt of the bowhead whale. The most important guiding principle of the AEWC's Weapons Improvement Program is the need to ensure human safety. With the introduction of penthrite, caution is imperative due to its extraordinary explosive power and thus the potential for extreme danger in this hunt, where the crews are only feet from the whale when the darting gun is fired. Thus the penthrite projectile is equipped with a fuze head that serves as a "safe and arming mechanism" (SAM). The SAM is designed to ensure that the projectile detonates only after entering the whale to a safe depth. Redundant safety measures are included to prevent detonation if the projectile is dropped. For added safety, the projectile body and fuse head are delivered separately and are not joined until the crew is prepared to begin hunting.

Work on the development of the penthrite-loaded projectile for the hand-held darting gun began in late 1987 and was largely concluded by 1998.[2] During this period, bench trials of the penthrite projectile were conducted at Henriksen Mek. Verkstad, with accompanying field trials in Barrow, Alaska. The penthrite projectile was not used in the bowhead subsistence hunt during 1993, 1994 or 1996, due to the need for modifications based on experience in field trials in each of the previous years.

The Barrow field trials included post-mortem examinations by North Slope Borough Department of Wildlife Management biologists and veterinarians of whales landed using penthrite. After 1998, field trials revealed the need for further modifications to the projectile, in particular reinforcement of the connector between the fuse head and the tubular body, as well as reinforcement of the tip of the fuse head. This work was carried out in 2000 and 2001.

Modification of the Darting Gun Barrel

The Barrow field trials also revealed the need for modifications to the traditional darting gun barrel to accommodate the size and shape of the new projectile. Since 2001, the WIP Committee and Dr. Øen have concentrated their work on modifications to the darting gun, itself, to adapt the weapon to the penthrite projectile, and on the education and training of hunters in the use of the penthrite projectile. Field trials of the penthrite projectile continued in Barrow through 2004 in support of this work.[3]

Political Context of Weapons Improvement Work for Aboriginal Subsistence Hunters

Throughout the AEWC's work to develop the penthrite projectile and to modify the darting gun, the international aspect of this project was never a problem until recently. Both the U.S. and Norwegian Governments have been completely supportive of the work, and despite differences over certain issues related to whaling, the governments and their delegations to the IWC have maintained a cooperative and mutually supportive approach to this project.

[2] For a more detailed review of early modifications to the penthrite projectile, see Appendix A to Alaska Eskimo Whaling Commission, 1995.

[3] For a detailed overview of the AEWC Weapons Improvement Program for development of the penthrite projectile used in the hand-held darting gun, and modifications to the darting gun, see Alaska Eskimo Whaling Commission, 2005.

Unfortunately, however, in recent years the program has met with difficulty. A component of the time delay fuse, supplied by a Swedish manufacturer, unexpectedly became unavailable when the manufacturer closed its production in 2003. Henriksen Mek. Verkstad identified a similar French-made component that readily could be used to replace the Swedish component without the need for lengthy and expensive bench testing. However, the French manufacturer was unable to obtain the necessary export authorization. The situation is not yet resolved.

A delay fuse with dimensions to fit the SAM is not available elsewhere; therefore, if this delay fuse cannot be purchased from the French company, it will become necessary to manufacture the component separately in Norway and only for this single purpose. To ensure safety and reliability, both the production and the new product will need to undergo a detailed and very costly control and testing program before the component eventually could be qualified and used in the SAM. This will drive up the cost of an already expensive program and product, with the added cost ultimately being borne by the AEWC.

The AEWC currently is in the process of ordering a new shipment of penthrite projectiles from Henriksen Mek. Verkstad, and is waiting to learn whether the component will be available. It is hoped that this critical component will be made available for the current and for all future orders of the penthrite projectile used in the Alaskan bowhead subsistence hunt. The communities of northern Alaska who depend on the bowhead whale for nutritional and cultural survival greatly appreciate the support, not only of the U.S., but also of other IWC-member nations for the AEWC's ongoing work to improve the safety and humaneness of the Alaskan bowhead whale aboriginal subsistence hunt.

Use of the Penthrite Projectile in the Alaskan Bowhead Whale Subsistence Hunt (2003-2005)[4]

2003 Spring and Fall Bowhead Whale Subsistence Hunts in Barrow, Alaska

As discussed above, field trials of the penthrite projectile and modified darting gun barrel continued in Barrow through 2004. During the 2003 Alaskan bowhead hunt, five whales were taken with penthrite used as either a primary or secondary (second darting gun shot from crew other than the first strike crew) projectile, three in the spring and two in the fall. In all cases, the penthrite projectiles and modified darting gun barrels performed properly. Two of the whales taken with penthrite stopped moving almost immediately after being hit with the penthrite explosive (03B3, 03B4).

Due to delays in production and shipment of modified darting gun barrels, only a small number of Barrow crews were given penthrite projectiles for use during the 2004 spring and fall hunts. None of these crews had an opportunity to use the penthrite.

2005 Spring and Fall Bowhead Whale Subsistence Hunts in Barrow, Nuiqsut, and Kaktovik, Alaska

This was the first year of the Alaskan bowhead subsistence hunt after the AEWC WIP Committee and Dr. Øen determined that field trials could be concluded and the penthrite projectile and modified darting gun barrel could be distributed to villages outside of Barrow. As discussed below, training and certification workshops were held in Nuiqsut and Kaktovik prior to the fall hunt in those villages and captains certified in the use of the penthrite projectile were given a projectile and new darting gun barrel.

During the 2005 spring hunt, two whales were taken in Barrow with the penthrite projectile and modified darting gun. One whale, shot near the base of the skull on the left side, appeared to die instantaneously.

During the fall hunt, six whales were taken using penthrite, two in Barrow, one in Nuiqsut, and three in Kaktovik. A minor malfunction occurred when one of the penthrite projectiles was shot without removing the safety pin. Still, the projectile exploded safely, and the whale appeared to die quickly. One of the Kaktovik whales (05KK2), taken with a single penthrite projectile and struck approximately 1.5m behind the blowhole, appeared to die very quickly. According to the crew, upon being struck, the whale "shook, slapped its flipper, and died."

[4] For a discussion of prior years' results of the use of the penthrite projectile in the Alaskan bowhead whale subsistence hunt, see Alaska Eskimo Whaling Commission 1995, 2003, 2005.

HUNTER TRAINING AND CERTIFICATION

Hunter training is an ongoing priority of the AEWC and its captains. In Barrow, the Barrow Whaling Captains Association holds a hunter training workshop as part of its meeting prior to each spring and fall bowhead subsistence hunt. Similar efforts occur in the other villages. In addition, the AEWC holds a weapons workshop/hunter training session as part of its annual meeting. This workshop is always well-attended as it offers an opportunity for young hunters to receive instruction to upgrade their skills, as well as an opportunity for more experienced hunters from the different villages to share successful techniques.

The penthrite projectile is composed of a tubular body that holds the main charge and a fuse head designed as a complex and redundant "safe and arming mechanism" (SAM). With the SAM, the penthrite projectile is significantly safer to use than the black powder projectile, despite the fact that the penthrite charge is substantially more powerful than the black powder charge.

Given the complexity of the SAM and to ensure the most effective and efficient use of the penthrite projectile, a key component of the AEWC's Weapons Improvement Program for the new projectile has been the preparation of a handbook on its function and proper use, along with a training video. The WIP Committee prepared theses items, working in cooperation with Dr. Øen. The handbook was published in February of 2004, and the AEWC now requires that, before they are entitled to receive penthrite projectiles or a new darting gun barrel, all captains must be certified in the use of the penthrite projectile and modified darting gun barrel through a training course based on the handbook and administered by the WIP Committee.

The Chairman of the AEWC and the Chairman of the WIP Committee have worked together providing training courses in Barrow. In August 2005, they traveled to Nuiqsut and Kaktovik to train the captains in those villages prior to the fall 2005 bowhead hunt. In March 2006, the WIP Chairman traveled to Wainwright to train the captains there prior to the spring 2006 bowhead hunt. The training course also serves as a certification process, through which captains are required to demonstrate their understanding of proper use of the new equipment. Upon receiving certification through this process, the captain is given a new modified darting gun barrel and becomes eligible to receive penthrite projectiles from the AEWC for use in the bowhead hunt.

2005-2006 Training/Certification Sessions

Harry Brower, Chairman of the AEWC, and Eugene Brower, Chairman of the AEWC's WIP Committee conducted training and certification sessions for captains and harpooners in the villages of Nuiqsut and Kaktovik in August 2003. The Chairman of the WIP Committee, with the assistance of an AEWC staffer, conducted a training and certification session in the village of Wainwright in March 2006.

Because of the great distances between villages, each session required an airline charter for transportation. Training and certification were focused on the function and proper use of the penthrite projectile and the modified darting gun barrel. During each village session, the Chairmen covered how to setup and prepare the penthrite projectile and how it works with the modified barrel. They cautioned captains that the new modified barrel should only be used with the penthrite projectile since it is longer than the traditional black powder barrel. Other topics covered included: the need to ensure that the trigger rod is long enough to function properly given the greater length of the new barrel, and techniques used by Barrow captains for adjusting the length of the trigger rod to ensure proper penetration of the projectile; adjustment of the rubber wad on the end of the projectile with an allen wrench to keep the projectile from sliding out of the barrel too easily; and the amount of propellant charge required by the penthrite projectile for proper penetration (2.5 drams or 75 to 80 grains of ffg black powder).

As with all WIP training sessions, great emphasis was placed on the importance of striking the whale between the base of the neck and the diaphragm, since explosion in the thoracic cavity will lead to rapid insensibility and death. The sessions all went very well. Six captains in Nuiqsut, nine captains in Kaktovik, and eight captains in Wainwright all received their certification along with a penthrite projectile and modified barrel.

HUNTING EFFICIENCY AND RECOVERY METHODS

As noted, efficiency in the Alaskan bowhead whale subsistence hunt, historically, averaged approximately 50 percent. The AEWC made a commitment to the IWC in 1978 to increase this efficiency rate to an average of 75 percent, and since that time has made improving the efficiency of this extraordinarily difficult and dangerous hunt one of its highest priorities. In recent years the average efficiency rate has been at least 75 percent and in some years has exceeded 80 percent. For the last 10 years (1996-2005) the average efficiency was 79.4% (STD= 0.08) However, efficiency in any given year is heavily affected by sea, ice, and weather conditions during the bowhead migration.

The spring hunt, when eight of the ten AEWC villages hunt and seven attempt to take their annual quota, is especially difficult and this is where the majority of struck and lost whales occur. The reason here is that the spring hunt is conducted from the edge of the shore-fast ice as the whales migrate north through cracks, called leads, formed between shore-fast ice and the circulating ice pack. Depending on current and the whale's momentum, a struck whale, even if killed quickly, can be pulled under the ice as has happened at least twice during the spring 2006 hunt. When this occurs every attempt is made to recover the whale. Even "stinkers" may be salvaged for muktuk.

The AEWC has used a multi-faceted approach to improving the efficiency of the Alaskan bowhead hunt. In addition to the weapons improvement work reported on here, it has added "pingers" to some of the floats used in the hunt to increase the chances of recovering lost whales. When a whale is lost, local search and rescue operations will join the hunters in the attempt to locate and recover the whale. Finally, a renewed focus has been placed on hunter training, including a return to more traditional methods of training young harpooners, such as target practice using ice/snow banks. As can be seen from the following table of efficiency rates in recent years, while there can be significant year-to-year variability, the multi-year average represents a substantial improvement over historic rates.

Table of Efficiency Rates for the Alaskan Bowhead Whale Subsistence Hunt in Recent Years

Year of Hunt	# Landed	# Struck	Efficiency (%)
1996	38	43	88.4
1997	48	66	72.7
1998	41	54	75.9
1999	42	47	89.4
2000	35	47	74.5
2001	49	75	65.3
2002*	39	50	78
2003	35	41	85.4
2004	36	43	83.7
2005**	55	68	80.9
10 Year Average of yearly % efficiencies			79.4

* Two whales abandoned due to weather, high seas.
** One whale abandoned due to weather, high seas and ice.

MEASURING TIME TO DEATH

Measuring Time to Death in Controlled Situations

During the 2003 Workshop on Whale Killing Methods and Associated Welfare Issues, it was reported that

> Official criteria of death only exists (sic) for human beings and whales. The human criteria are controversial, the kernel of the debate being the definition and diagnose (sic) of brain death. Neurophysiological techniques used to assist diagnoses of brain death in humans and to assess insensibility in food animals have limitations and require some degree of subjective interpretations. They demand skill and appreciation of the technique and relatively sophisticated apparatus.[5]

Thus, the AEWC notes that even under highly controlled conditions, including clinical settings, it can be impossible to determine – objectively – when death occurs.

Measuring Time to Death in Stranded Whales

Measuring time to death can be difficult, even with stranded whales. During the 1999 Workshop on Whale Killing Methods, a report was given on the use of the Sperm Whale Euthanasia Device (SWED), a new weapon designed to improve humane euthanasia of stranded sperm whales in New Zealand:

> In March 1997 the SWED was used to euthanase (sic) two large male sperm whales . . . The target area was located by following veterinary advice . . . The first animal was killed immediately by a single shot. The second animal was thought to have been rendered insensible by the first shot but continued breathing and was shot a second time using the same target area. After the second shot a veterinarian pronounced the animal dead on the basis of complete pupillary dilation, and the absence of any other ocular reflexes. After 30 minutes, however, the animal resumed breathing. No further attempts were made to euthanase it, and it died about two and a half hours later.[6]

According to the report of the meeting, the paper (IWC/51/WK5) also indicated that the whale's jaw was slack and open, one of the IWC's three criteria for assessing death in a whale.

The report illustrates the fact that even a proven technique for killing large whales, applied under relatively controlled circumstances, can produce different results. Here, the SWED appeared to be very effective in the rapid euthanasia of one whale but not in another. In addition the report highlights the difficulty of determining whether death has occurred in a large whale even under controlled circumstances.

Measuring Time to Death in the Alaskan Bowhead Whale Subsistence Hunt

The Need for Safety Dictates Overestimation

In the Alaskan bowhead whale subsistence hunt, crews must paddle their small boats virtually on top of the whale as it swims past them. In most cases the whale is substantially larger than the boat. Thus the crew is forced to pull the boat back away from the whale as quickly as possible when the darting gun and shoulder gun are fired, to avoid being capsized or injured by the whale's reaction. Captains have reported whales diving or turning suddenly. Some, who were unable to pull away fast enough also have reported having their boats slapped with a flipper, in some cases causing injury.

After pulling back, the crew then has an opportunity to observe the struck whale. However, unlike the above example of observing a stranded whale, in the bowhead hunt the whale being observed is mostly under water and the crew is standing in a small boat on the water, where they must constantly be aware of wind, current, moving ice, sea state, and in some cases polar bears. At the same time, the crew will be attempting to recover the darting gun, hopefully floating on the water, and to observe the conditions of the lines and floats attached to the whale by

[5] International Whaling Commission, 2003, § 6.3, pp. 14-15, emphasis added.

[6] International Whaling Commission, 1999, § 7, pp. 14-15.

harpoon. If, upon being struck, the whale does not dive or slip under a near-by ice edge, the crew will follow the whale's movements until they cease. At some point, other crews will join the first crew. Some may fire follow-up shots if the whale is still moving when they arrived. They too will attempt to recover floating darting guns and will check lines and floats. Calls will be made on the CB radio to notify other crews and people on shore to prepare for the towing and landing. Everyone will pray.

After the whale has been motionless for some period of time, the captain will declare it safe to approach and touch the whale for the purpose of attaching a tow line. "Time to death" will be recorded as the time from the first strike until the prayer has ended and the order to attach the tow line has been given. As experienced whaling captains know and as the example from New Zealand illustrates, this waiting period is critical since a large whale can remain alive even hours after it appears to have died based on observable criteria. In the bowhead subsistence hunt, where the small boats must be brought next to the whale and the tow line attached by hand, a captain who declares a whale dead too soon puts his crew at grave risk.

As an illustration of the degree of overestimation that can result from the need for caution and patience dictated by the conditions of this subsistence hunt, during the 2005 fall bowhead whale hunt in Barrow, one of the whales taken (05B19) was declared dead one hour and 30 minutes after having first been struck with a harpoon and darting gun loaded with a black powder projectile. During a post-mortem examination of this whale by North Slope Borough wildlife biologists, it was discovered that the projectile had cracked the skull, causing severe brain damage. This whale obviously died much more quickly than reported.

Traditional Techniques for Reducing Time to Death

The goal of the bowhead whale subsistence hunt, in all cases, is to kill and land the whale in the shortest possible amount of time. Achieving this goal means the most humane possible death for the animal, the safest possible hunt for the crew, and the greatest likelihood that the whale will be landed successfully. Therefore, techniques for reducing time to death have always been part of this hunt. For example, firing a second shot from the shoulder gun once the darting gun is thrown is standard procedure to help ensure a quick kill.

Additionally, crews tend to hunt in close proximity to one another so that they are available to assist each other. When a crew targets a whale, it announces this to the other crews, who will cease their own scouting and prepare to assist the targeting crew. When a whale is struck, nearby crews will gather as quickly as possible, often firing follow-up shots. Tradition dictates that crews who assist in the kill and tow be rewarded with a share of the whale, helping to ensure cooperation and a safe and humane hunt. Experienced captains identify and learn to target the areas most likely to result in a quick kill. Captains describe and discuss these target areas during each of the AEWC's annual weapons improvement workshops.

Apparent Reductions in Time to Death With the Penthrite Projectile

The most important recent development in this hunt, of course, is the introduction of the penthrite projectile. Captains using the penthrite projectiles report that they are highly reliable compared with the black powder projectiles. Furthermore, according to the captains, this combined with the intense percussive effect resulting from the penthrite explosion make the penthrite projectile an extremely effective weapon for producing an apparently rapid time to death in most cases, thereby increasing the safety, humaneness, and efficiency of this hunt. These captains report the greatest success with this weapon when they are able to deliver it to the base of the skull or into the thorax region. Thus, hunters increasingly are being encouraged to target these areas with the goal of achieving the briefest possible time to death and the safest and most efficient possible hunt allowed by the conditions under which the hunt occurs.

REFERENCES

Alaska Eskimo Whaling Commission, 1995, "*Hunting Efficiency and Recovery Methods Developed and Employed by Native Alaskans in the Subsistence Hunt of the Bowhead Whale*," submitted to the International Whaling Commission, IWC Workshop on Whale Killing Methods as paper IWC/47/WK15, May 1995.

Alaska Eskimo Whaling Commission, 2003, "*Report on Alaska Eskimo Whaling Commission Progress Concerning Improvement of Whale Killing Methods*", submitted to the International Whaling Commission, IWC Workshop on Whale Killing Methods and Associated Welfare Issues as paper IWC/55/WK1, June 2003.

Alaska Eskimo Whaling Commission, 2005, "*Report on the Use of the Penthrite Projectile in the 2000 through 2004 Bowhead Whale Subsistence Hunts in Barrow, Alaska*," submitted to the International Whaling Commission, IWC Working Group on Whale Killing Methods and Animal Welfare Issues as paper IWC/57/WKM&AWI 3, June 2005.

Bockstoce, John R., 1986, Whales, Ice, and Men: The History of Whaling in the Western Arctic, University of Washington Press, Seattle, Washington.

International Whaling Commission, Chairman's Report, 1993, Appendix 1 of Chairman's report of the forty-fourth Annual Meeting of the International Whaling Commission (1992). Report of the International Whaling Commission 43: 38-39.

International Whaling Commission, 2003, Report of the Workshop on Whale Killing Methods and Associated Welfare Issues, IWC/55/Rep 5, 7-9 June, Berlin, Germany.

International Whaling Commission, 1999, Report of the Workshop on Whale Killing Methods, IWC/51/12, 17-19 May, Grenada.

Ingling, A., 1995. *Determination of the muzzle velocity of the black powder and the penthrite projectiles fired from a bench-mounted darting gun of the type used by Alaskan Eskimo in the subsistence hunt of the bowhead whale, as influenced by the propellant charge and other factors*, submitted to the International Whaling Commission, Workshop on Whale Killing Methods as paper IWC/47/WK16, May 1995. (Also submitted in an expanded version of 45 pages as a report in 1997 to the Department of Wildlife Management, North Slope Borough, Box 69, Barrow, AK 99723, from the Virginia-Maryland Regional College of Veterinary Medicine, University of Maryland, College Park, MD 20742.)

Montague, J.J. Introduction. In: J.J. Burns, J.J. Montague, C.J. Cowles Eds. *The Bowhead Whale. Special Publication Number 2* The Society for Marine Mammalogy. Lawrence, KS Allen Press, Inc. 1993: 1-17

Øen, E., 1995, *A New Penthrite Projectile Compared to the Traditional Black Powder Projectile: Effectiveness in the Alaskan Eskimos' Hunt for Bowhead Whales.* In: Øen, Egil Ole, *Killing Methods for Minke and Bowhead Whales*. (1995), Arctic. 48(2), 177-185. Submitted as paper IWC/47/WK8 to the IWC Workshop on Whale Killing Methods, Dublin, Ireland, 1995.

O'Hara, T., T. Albert, E. Øen, L. M. Philo, J.C. George, A. Ingling, *The Role of Eskimo Hunters, Veterinarians, and Other Biologists in Improving the Humane Aspects of the Subsistence Harvest of Bowhead Whales*, Journal of the American Veterinary Medical Association. In Press.

Sharpnack, D.D., Johnson, A.J., and Phillips, Y. *The pathology of primary blast injury*. In: R. Zatchuk, D. Jenkins, R. Bellamy, and C. Quick Eds. Textbook of Military Medicine: Warfare, Weaponry, and the Casualty. Published by Office of Surgeon general at TMM Publications. Center for Excellence in Military Medical Research and Education. Walter Reed Army Medical Center, Washington DC. US Government Printing Officer. 1990; 271-294.

ATTACHMENT I

OVERVIEW OF PENTHRITE PROJECTILE DESIGNED FOR THE ALASKAN BOWHEAD WHALE SUBSISTENCE HUNT

This overview was adapted from an explanation of the penthrite projectile and its development for use in the Alaskan bowhead whale subsistence hunt, prepared by Dr. Egil Øen.

The explosive

Penthrite (Pentaerytritol Tetranitrate or PETN) belongs to the so-called secondary explosives customary used for demolition purposes etc. It is regarded to be non-toxic and does not affect the usefulness or taste of whale meat because it does not dissolve in water and upon detonation it breaks down into natural gases and water. Also, penthrite is thermally the most stable and least reactive of its category of explosives. Curiously enough in recent years, it has also been used for medical treatment in the therapy of angina in humans and animal data suggest that it also might have antiatherosclerotic effects.

A Norwegian study of harvests and post mortem of more than 5000 minke whales shows that penthrite is very efficient in causing the (minke) whale to become unconscious almost instantly and causes quick death by producing "pulses" of shock and pressure waves that travel at supersonic speed in all directions, causing severe damage to vital organs. Injuries and bleeding are often found in the brain, heart, lungs and other vital organs. Therefore, if used correctly, and properly aimed, penthrite projectiles or grenades are both safer and more effective and kill the animals faster than grenades with conventional explosives. It is more powerful and a hunter may take aim at a broader area of the whale's body to achieve a rapid death in comparison to the traditional black powder grenade. Even so, hunters can expect the most rapid death only when the grenade explodes in or near the chest, spine, neck, and skull which are the most vulnerable regions. In the Norwegian hunt of minke whales an 80% rate of instantaneous kills is achieved compared to 17% in the beginning of the 1980s.

The projectile

The penthrite projectile for the darting gun is composed of two major parts:

A head (Fig. 1) comprising the firing mechanism with pyrotechnical devices, arming devices, and a number of safety devices. The sequence of operation contributes to a high degree of safety as the operation of the various devices in the projectile head must occur in the pre-determined sequence to fire the main charge in the bomb at penetration into the whale.

The bomb is a shaft or tubular body (Fig. 2) which is attached to the rear end of the head before the darting gun is loaded.

At transport these parts are held separately.

Manner of operation

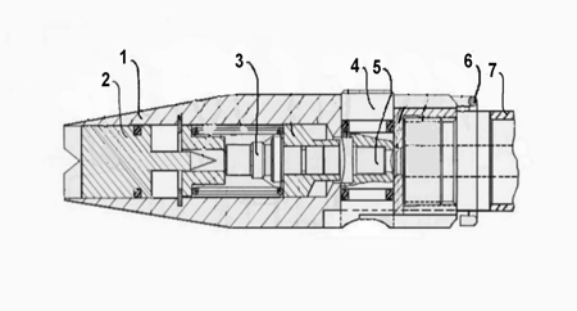
When the darting gun has been fired, the projectile will plunge into and penetrate the tissues (muktuk and musculature) of the whale. When the front end of the head hits the target, the striking force at penetration will break a shear pin through the plunger allowing the plunger with the striker pin to be forced backwards against a stopper device and the time delay fuse. The striker will ignite (activate) the time delay fuse after penetrating to the predetermined depth.
Having been activated by the striker pin, the time delay fuse starts burning and continues burning for approximately 4.5 seconds.

Upon further penetration of the head, the "stirrup" will be hit by the surface of the whale, disrupting another shear-pin and moved to a position flush with the shaft. At this movement of the stirrup, a detonator is moved in a position where it can be ignited by the delay fuse. At the rotation movement the detonator is aligned and in close contact with the burning time delay fuse at one end and the penthrite charge in the shaft at the other end. In this aligned position, the detonator is ready to set off the penthrite charge once it has been triggered by the time delay fuse after 4.5 seconds.

If the detonator housing is rotated accidentally before the time delay fuse has been ignited, the time delay fuse will move immediately into the detonator housing and be safely away and out of reach from the striker pin. Accordingly, the striker pin cannot ignite the time delay fuse and no detonation can occur accidentally.

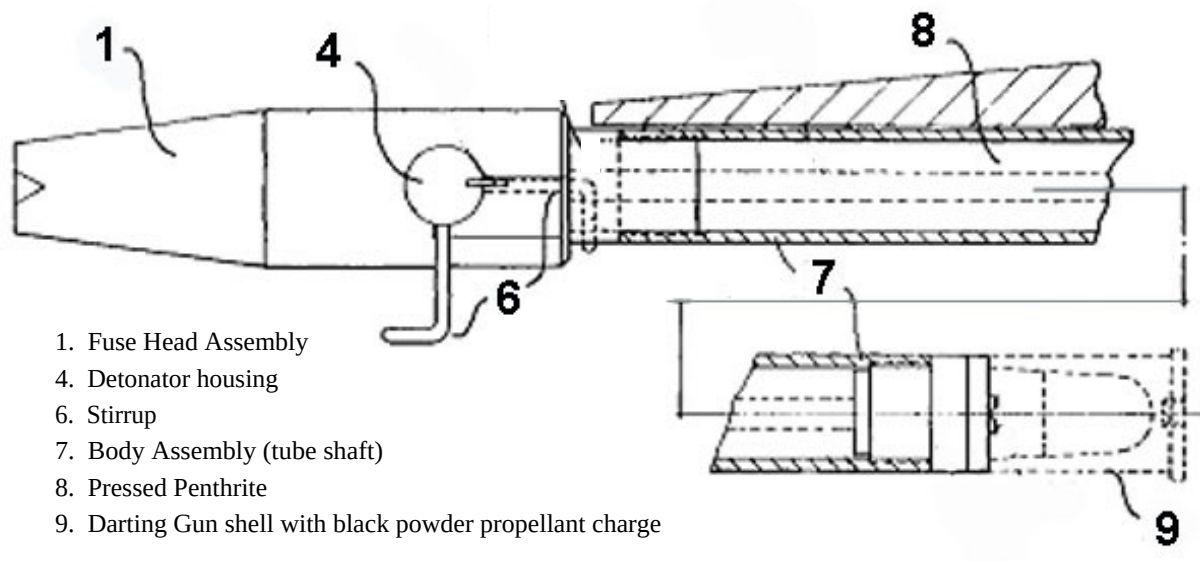
Diagram of penthrite projectile for Bowhead whale

Fig. 1. Fuse head assembly



1. Housing of Fuse Head Assembly
2. Ignition plunger with striker pin
3. Time Delay Fuse
4. Detonator housing
5. Detonator
6. Stirrup in activated (armed) position
7. Body Assembly

Fig. 2. Penthrite projectile: Fuse Assembly and Body Assembly



1. Fuse Head Assembly
4. Detonator housing
6. Stirrup
7. Body Assembly (tube shaft)
8. Pressed Penthrite
9. Darting Gun shell with black powder propellant charge