

into the breech, the operator attaches a lanyard to the pull ring. The operator moves to a safe position 25 meters

away and detonates the cartridge by pulling the lanyard.



Figure 8—The primer cartridge seated in the breech block.



Figure 10—The lanyard is attached to the firing mechanism.



Figure 9—The firing mechanism is threaded into the breech block.

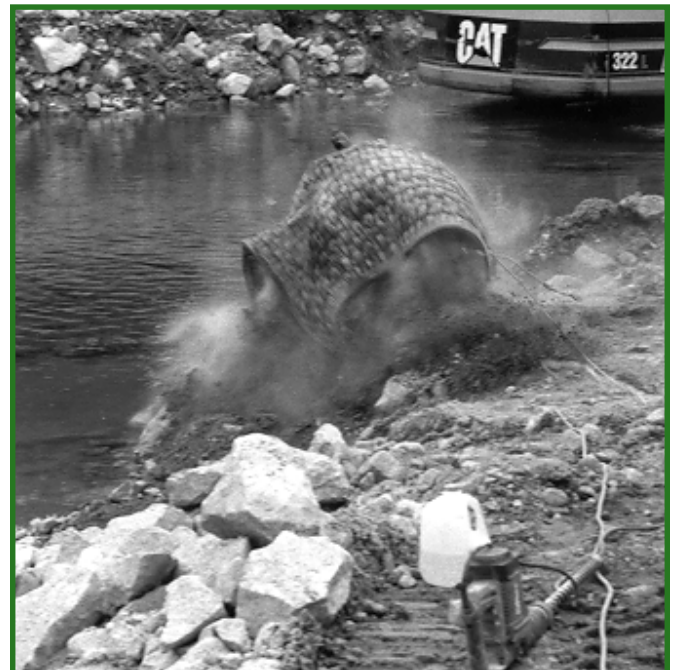


Figure 11—The lanyard is pulled to fire the primer cartridge.

Introduction

During Fiscal Year 1997, MTDC worked with the Umpqua and Idaho Panhandle National Forests in field testing the Boulder Buster. In 1998, Jim Tour, the Explosives Project Leader at MTDC, used it to help Northern Region engineers with the emergency removal of a

dam spillway on the Bitterroot National Forest in Montana. The tests of this device have been impressive. They show the Boulder Buster to be a safe, cost-effective substitute for explosives when rocks need to be broken.

This tool can be used safely relatively close to equipment and personnel. It can be used during periods of high fire danger without the risk of starting secondary fires.



Figure 12—Results of using the Boulder Buster.

Equipment Description

The Boulder Buster has four main components: a firing mechanism, a breech body, a mat support plate, and an impulse barrel (Figure 13). The impulse barrel can be 26 mm or 34 mm in diameter. The unit is always used with a heavy, flexible mat.

The cartridge is about the shape and size of a 12-gauge shotgun shell. It is inserted in the device by unscrewing the firing mechanism from the breech body. Even when the firing mechanism is screwed back into position on top of the cartridge, the unit is still safe. Until the lanyard is pulled, the spring-loaded firing pin is never in a *cocked and ready to fire* condition. Cocking and firing the unit requires a hard pull on the lanyard.

The complete Boulder Buster in its storage box weighs 18 kg (40 pounds). The mat weighs 30 kg (65 pounds). The Boulder Buster cartridge has a much thicker rim than a shotgun shell (Figure 14). It will not chamber in a 12-gauge shotgun. It is not classified as a firearm cartridge by the Bureau of Alcohol, Tobacco, and Firearms (BATF).

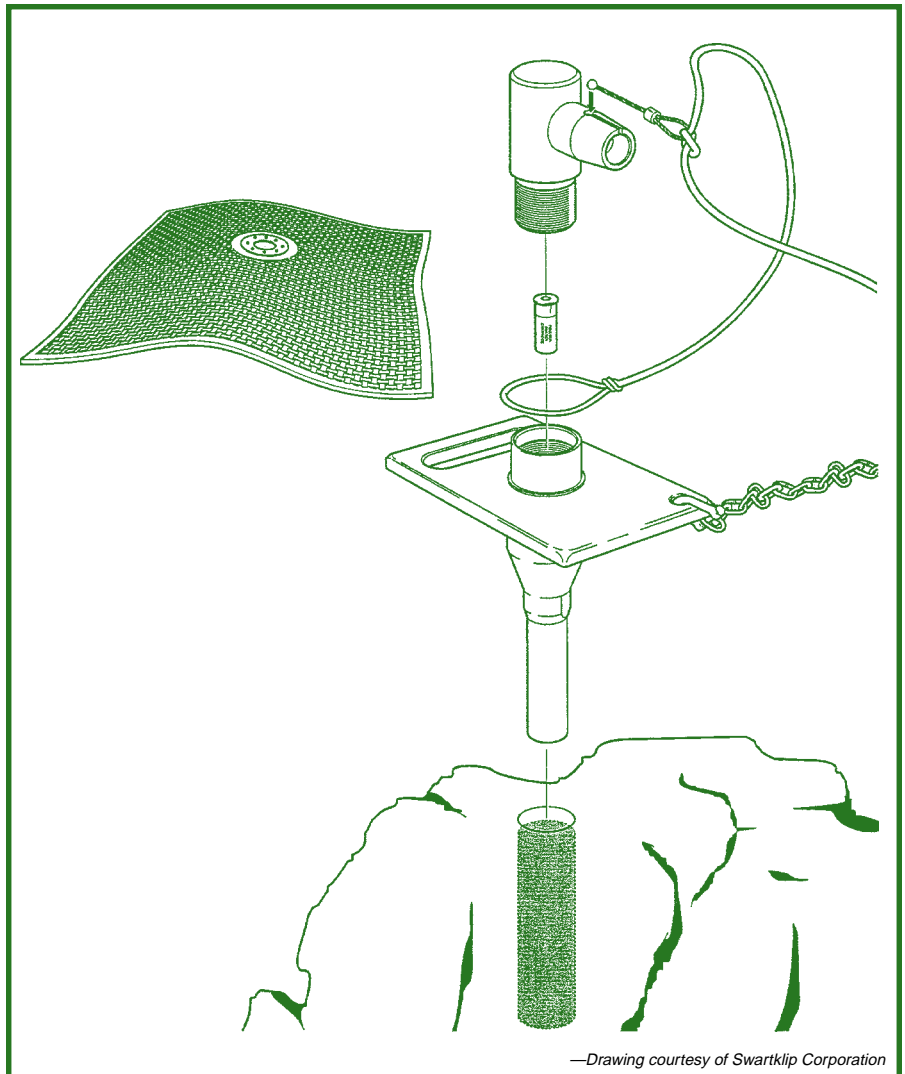


Figure 13—Assembling the Boulder Buster.



Figure 14—The Boulder Buster cartridge resembles a 12-gauge shotgun shell, but cannot be chambered in a shotgun.

Operational and Geological Considerations

To split an unconfined boulder, drill a hole past the rock's center of mass (beyond the middle). If the size of the boulder cannot be determined, the hole needs to be positioned and drilled deep enough to break the intended material away from the rock. When the Boulder Buster was used to loosen heavily reinforced concrete, excellent results were achieved by drilling a pattern of holes to 80% of the depth of the concrete.

The 26-mm impulse barrel is recommended for most projects where a Ponjar or equivalent drill is used. For holes with a larger diameter, use the 34-mm barrel. For deep holes, booster cartridges are available (Figure 15). These allow the operator to match the charge to the material to be broken, and to the hole depth. There are two different booster cartridges: one with a 10-gram propellant charge, the other with a 15-gram charge. Up to three booster cartridges can be dropped into the liquid-filled hole before inserting the

impulse barrel and breech body. These charges can be spaced at intervals along the hole for better results.

If the rock is layered or seamy (slate), or filled with voids (volcanic rock), then a sleeve must be used to keep the

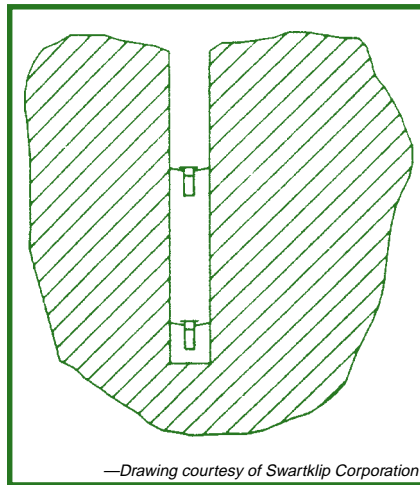


Figure 15—Booster cartridges can be placed in deep holes for optimum performance.

water or gel in the hole. Gel can also be used to position booster charges in a hole. Harder, solid rock will more readily transfer the shock wave generated by the Boulder Buster. Softer material, such as sandstone, absorbs much of the energy. In sandstones, booster charges are usually necessary.

Holes must be drilled beside seams and layers, not in them. Shock waves beside seams and layers will radiate from the drilled hole to the seams and layers, fracturing the surrounding structure. If shock waves are allowed to run along layers, they will be dissipated. Several holes can be drilled along an intended fracture line even though only one is filled with liquid. The cracking will propagate along the line of holes.

The Boulder Buster cannot be used in freezing conditions where ice might form in the drilled hole. The shock wave developed by the Boulder Buster will not propagate through ice.

Important Safety Advantages

Because the Boulder Buster develops low-order shock, flyrock is minimal. The operator can be completely safe at 25 meters from the boulder. Other personnel should be farther away. This avoids costly road closures and job shutdowns. Equipment

does not have to be moved from the area. Damage to adjacent structures from vibration is not a concern. The Boulder Buster can be used when the fire danger rating is high, because it does not start secondary fires. The cartridges and boosters do not require

special storage or handling. They can be shipped by a common carrier, such as the United Parcel Service. They can also be transported by air. Because the Boulder Buster is fired mechanically by pulling a lanyard, radio transmissions and electrical storms are not a concern.

Field Observations

Field tests of the Boulder Buster were conducted in the Pacific Northwest Region on the Umpqua National Forest, in the Intermountain Region on the Wasatch-Cache National Forest, and in the Northern Region on the Idaho Panhandle National Forests. Examples from these field tests illustrate situations where the use of an explosive would have been completely precluded, or where the Boulder Buster provided other advantages.

Boulder on a Road

A boulder 2 meters in diameter fell onto the side of a roadway on the Idaho Panhandle National Forest. It needed to be broken into pieces before it could be moved. Removing the rock with the Boulder Buster or explosives required drilling. Setup costs would have been equal. But if the crew had used explosives, they would have had to travel to the powder magazine for the blasting equipment, and would have had to return any unused explosives. Using the Boulder Buster required no travel.

Breaking the boulder with explosives would have required a certified blaster-in-charge with two guards for the road closure. The Boulder Buster required two personnel (dictated by unit policy). Neither individual had to be a certified blaster.

If explosives had been used, a road closure of 150 meters or more would have been necessary. With the Boulder Buster, only 50 meters of road had to be closed. Flyrock did not have to be removed from the roadway before the road was reopened.

Explosives would have cost \$2 for a pound, and \$2 for a nonelectric cap. The Boulder Buster cost \$4, the cost of one cartridge.

Dam Spillway Reduction

During 1997, work was begun on a project to lower the spillway adjacent to the Marjorie Lake Dam on the Wasatch-Cache National Forest's Kamas Ranger District in Utah. Two Ponjar drills,

wedges, and feathers, and a nonexplosive compound called *Bristar* were used on the project. With this equipment, four people removed 5.7 cubic meters of material in 8 weeks. The following year, the Boulder Buster was used. After 8 weeks, two people had removed 19.8 cubic meters of material.

Boulder Under a Bridge

A boulder measuring 4 meters by 2½ meters by 3 meters needed to be removed from beneath a wooden bridge on the Umpqua National Forest in Oregon. From the top of the rock to the bridge structure was just 1½ meters. Blasting was not an option because the bridge could have been damaged. Using the Boulder Buster, the rock was fractured without threatening the bridge. The fractured rock was used as riprap to protect the base of the bridge.

Emergency Work on a Leaking Dam

In the spring of 1998, a leak was discovered in an earth-filled dam on the Bitterroot National Forest in Montana. Engineers decided that the reservoir's water level had to be lowered immediately to relieve pressure on the dam. To do so, the spillway needed to be lowered. Excavating equipment was

flown in by helicopter. However, large rocks in the spillway needed to be broken up before the tracked backhoe could effectively remove them. Explosives could have further damaged the leaking earthen structure. Their use would also have slowed work on the

spillway because workers would have had to leave the site each time a charge was detonated. The Boulder Buster was used on this project, allowing larger rocks to be reduced to a manageable size while the backhoe and personnel continued to work safely nearby.

About the Authors

Bill Kilroy has a Bachelor of Science degree from Montana State University at Bozeman, MT, and has done graduate work at Golden Gate University, San Francisco, and at the University of Montana in Missoula, MT. He began his Forest Service career as an engineering draftsman at MTDC in 1980, and has worked on many of the Center's projects since then. Now he is the Forest Service's COMSEC custodian, coordinating the use of GPS receivers that have been encoded with military codes for increased accuracy.

Jim Tour is a Project Engineer at MTDC, specializing in explosives and incendiaries. Jim began working for the Forest Service in 1970, spending 8 years as a technician at the Technology and Development Center in San Dimas, CA. He received his degree in mechanical engineering at California Polytechnic University, Pomona, and came to MTDC shortly afterward. He has helped develop incendiary devices such as the Premo MK III aerial ignition device and has helped redesign the helitorch.

To purchase the Boulder Buster and cartridges:

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Additional single copies of this document may be ordered from:

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Library Card

Kilroy, Bill; Tour, Jim. 1998. Boulder buster: breaking rocks without explosives. Tech. Rep. 9867-2840-MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 10 electronic p.

Describes using the Boulder Buster rather than explosives to break rocks larger than 2 meters in diameter or rock walls in 2-meter lifts. The Boulder Buster uses a cartridge resembling a shotgun shell and a column of liquid to generate a high-pressure wave. The wave fractures the surrounding structure. The Boulder Buster does not produce flyrock, so operators can be 25 meters away when they pull a lanyard to fire the device. Because the Boulder Buster is not an explosive device, operators do not require explosives certification. No special transportation or storage regulations apply. The Boulder Buster is a commercial product made in South Africa. During Forest Service field tests, the Boulder Buster was used to break a large rock that had fallen alongside a roadway, break rocks to lower spillways on two dams, and break a rock beneath a bridge where explosives could not have been used without damaging the bridge.

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