THE GAZEX® AVALANCHE RELEASE SYSTEM

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1. SYSTEM OVERVIEW

The history of GAZEX® starts when Jacob Schippers of T.A.S. (Technologie d'Alpine de Securite) began research on gas explosives out of a need for an all-weather, remote activated, 24 hour avalanche control method that did not rely on traditional solid explosives. The GAZEX® system consists of an exploder, located in an avalanche start zone, connected by gas lines to a shelter, located on the ridgeline. The shelter houses oxygen and propane gases that are released to the exploder through electronically controlled valves. The gases collect in the exploder and are ignited by a pressure actuated firing mechanism creating an explosion. The resulting pressure wave fractures the snow mantle initiating an avalanche. The entire process is controlled remotely via a radio control system through a computer using sophisticated monitoring software. The evolution of the GAZEX® system over the past fifteen years has produced a very reliable system of active avalanche control having significant advantages over traditional methods.

2. HISTORY

Traditional methods of active avalanche control center around the detonation of a solid explosive in an avalanche start zone causing a rapid destabilization and movement of the snow pack. Methods of delivery of the solid explosives are hand charges, military artillery, compressed gas propelled projectiles, cable transported, helicopter, and now, fixed tower. All of these methods have different limitations that may include inaccessibility of the start zone, inoperation due to poor visibility and/or inclement weather, availability of explosive materials, lengthy control closure periods, and potential liability concerns.
In the early 1980's, Jacob Schippers of T.A.S. realized current control systems had enough limitations to warrant the research of an entirely new approach to active avalanche control. Design criteria included remote activation, fixed location having minimal environmental impact, 24 hour firing capability in any weather, data gathering for use in avalanche forecasting, and independence from solid explosives. After years of research and experimentation, the first GAZEX® prototype was installed in 1987. Based on the subsequent positive results, the first major installation of GAZEX® was completed in 1988 and T.A.S. went into full scale production thereafter. After nearly fifteen years of production improvements, there are now more than 1100 GAZEX® exploders installed worldwide servicing ski resorts, roadways, mines and municipalities.

3. RESEARCH

In 1987, after considering several options, a project to study the release of avalanches by gas explosive was undertaken. Shock waves produced from the detonation of 1 kg (0.8 cu m) of gas explosives were shown to be much more powerful than those from 1 kg of solid explosives and larger volumes of gas produced a greater effect. The results of initial delivery experiments suggested a large diameter steel tube permanently mounted in an avalanche start zone would best contain gases prior to detonation. The opening of the tube should point towards the snow pack at a 30° angle for maximum effect. Subsequent tests on various gases and gas mixtures showed that a 5 to 1 ratio of oxygen to propane was the best gas mixture. Upon detonation, these gases produced a pressure wave having a three-fold effect on the snow; direct push produced by the initial over-pressure of the expanding gases, a sympathetic effect of uplift on the surrounding snow due to the subsequent under-pressure as the gases disturb the surrounding air, and a seismic effect at the base of the exploder shaking the earth and breaking snow anchors near ground level.

4. THE EXPLODERS

The base of the exploder is anchored to the ground by long metal rods through a poured in place concrete thrust pad. The body of the exploder is a galvanized steel tube approximately 12 ft (4m) in length, terminating in an opening approximately 2 ft (62 mm) in diameter pointed down at the start zone. Exploder bodies vary in shape depending upon the desired volume of gas and subsequent blast effect. The neck of the exploder is anchored by long leg rods or counterweighted by a concrete filled steel tube to counteract the tremendous up thrust force caused by the rapid ejection of gases through the opening upon detonation.

5. THE PRESSURE ACTUATED FIRING MECHANISM

Attached near the base of the exploder on opposing sides is a pair of spark plugs. Each plug is part of a redundant firing circuit, housed in a waterproof electrical box, also attached near the base of the exploder. The circuit consists of a pressure actuated switch, a battery, a capacitor and an igniter. The pressure of the gases filling the exploder body closes the circuit at the switch causing the battery to charge the capacitor. When the flow of gas stops, the switch opens the circuit and the capacitor discharges to the igniter causing electricity to flow to the spark plug, resulting in an electrical arc capable of initiating detonation of the collected gases.

6. THE GAS LINES

The gas lines begin at expansion tanks in the shelter and terminate at backflow prevention valves mounted at the exploder body. Each exploder is serviced by twin lines that carry the oxygen and propane gases separately and vary in diameter from 1-1/4 to 2 inches (24/32mm to 31/40mm). The gas lines are either galvanized steel and surface mounted with rock anchors above and below every joint and bend, or polyethylene and buried where feasible to avoid problems with snow creep and glide. Runs can ascent up to 900 ft (300m) and descend even further.

7. THE SHELTER

The shelter is an oval structure of polyester or steel, set upon a wooden platform located on a ridgeline or other secure spot adjacent to avalanche start zones. An exterior enclosure houses as many as 16 cylinders of oxygen. An exterior access panel leads to the receiver unit of the radio control system, 12 volt battery, and wiring interface. A man door opens to the interior where oxygen and propane expansion tanks for up to five exploders are found, along with electronically controlled valves, and pressure regulators. Accessories include a solar panel, anemometer, thermometer, seismometer, gas and voltage metering devices, and lightning arrestor.

8. THE RADIO CONTROL SYSTEM

The radio control system consists of a transmitter unit connected to a computer in a remote location such as an office or vehicle, and a receiver unit located at the shelter. A modem and radio allows the units to transfer data via short range, high frequency radio waves. The transmitter sends security codes supplied by the operator to the receiver unit initiating the firing sequence for a selected exploder. The receiver unit returns data on gas and voltage levels, seismic activity, wind speed and direction, and temperature. The data is interpreted and recorded using sophisticated software.

9. THE SOFTWARE

The GAZEX avalanche release system uses windows based software designed by LEAS. The software can be set up to operate in one of several common languages and has three modes; firing procedures, weather data, and history. In the firing procedure mode, and with the correct security codes, the operator can initiate the firing sequence of a selected exploder, change valve opening times to fine tune the blast effect, and retrieve system information on gas and voltage levels. In the weather data mode, the operator can record information on wind speed and direction, temperature, and seismic activity. The history mode records an audit trail of system usage and data and a web based component of the software can retrieve weather information from NIVOLOG, available from Gester SA.

10. THE EVOLUTION

GAZEX® exploders are available in four models named for the volume of gas they can contain; 0.8, 1.5, 3.0. and 4.5 cubic meter. Single impact exploders have spark plugs mounted near the base plate for the largest pressure wave effect, while double action exploders have spark plugs mounted half way up the exploder body creating a much greater seismic effect in addition to the pressure wave. For secure installation in poor rock or soil conditions, the Inertia exploders use a concrete filled steel tube instead of anchor rods at the mouth of the exploder as an articulating counterweight and an articulating base plate. Two 0.8 or 1.5 cu m inertia exploders can now be controlled simultaneously for double the shock wave in half to the time. Initial direct wire connection between the shelter and exploder has been replaced by the redundant pressure actuated firing system resulting in a very low misfire rate. In 2002, GAZEX® satisfied the provisions of the PED (Pressure Equipment Directive) and was certified for CEM (Electromagnetic Compatibility) and AMDEC (Analysis of the Modes of Failure and Critical Effects).

11. THE ADVANTAGES

The GAZEX® avalanche release system is the only method of active avalanche control that can be done from a remote location, at any time, in any weather, safely, quickly, and reliably. Although initial installation costs may seem high, return on investment can be achieved in as little as four years and GAZEX® is the only method of active avalanche control that completely avoids the high liability costs associated with the use of solid explosives and the even higher costs of permanent avalanche barriers. While GAZEX® will never replace the effectiveness of well placed hand charges in controlling the clean up of pockets, small gullies and short faces, it is fast becoming the most economical choice of avalanche professionals around the world for the control of large, potentially devastating avalanche paths.