UNIVERSITY OF HAIFA
Faculty of Science and Science Education
אוניברסיטת חיפה
הפקולטה למדעים והוראתם

August 15, 2007

To whom it may concern

This is to confirm that the two products identified as:

1. Specimen #1: Helical Armor

Teldor P/N 95A8X9M04B[1] w/ single layer 36 x 0.3 mm steel wire armor O.D. 7.0 ± 0.2 mm

2. Specimen #2: Braided Armor

Teldor P/N 95A9X9M04B[2] w/ 96 x 0.3 mm braided steel wire armor O.D. 7.4 ± 0.2 mm

Produced by Terdor – Wires & Cables Ltd., were tested in our laboratory for resistance to rodent gnawing. The results of our tests appear in the attached report.

Sincerely yours,

Prof. Abraham Haim

הר הכרמל חיפה 31905 טל: 04-8288077/8, פקס: 04-8288108
Mount Carmel, Haifa, 31905, Israel, Phone: 04-8288077/8, Fax: 04-8288108, E-mail: sciences@research.haifa.ac.il

Testing Resistance of Steel Wire Armored FiberOptic Tactical Cables Against Gnawing By Rodents

Testing Performed for: *Teldor Wires and Cables Ltd.*

Performed by: Ehud Hilberger

SUPERVISED AND APPROVED BY: Professor Abraham Haim

University of Haifa, Faculty of Science and Science Education, Mount Carmel, Haifa 31905.

PRODUCT DESCRIPTION: Teldor FiberOptic Tactical Cables containing four 900μm tight buffered optical fibers, aramid strength yarns, inner Thermoplastic PolyUrethane jacket, steel wire armor, outer Thermoplastic PolyUrethane jacket.

PRODUCT IDENTIFICATION:
Specimen #1: Helical Armor
Teldor P/N 95A8X9M04B[1] w/ single layer 36 x 0.3mm steel wire armor O.D. 7.0 ± 0.2 mm

Specimen #2: Braided Armor
Teldor P/N 95A9X9M04B[2] w/ 96 x 0.3 mm braided steel wire armor O.D. 7.4 ± 0.2 mm

Test SAMPLES RECEIVED:
Specimen #1: Teldor P/N 95A8X9M04B – 20 meters
Specimen #2: Teldor P/N 95A9X9M04B – 20 meters

TESTING PEFORMED FOR: Teldor Wires & Cables Ltd.

CONTACT: Tuvia Liberman – CTO, Teldor Wires & Cables Ltd.

[1] Israeli Patent Pending
[2] Israeli Patent Pending

TEST DESCRIPTION

Teldor Wires & Cables Ltd., an Israeli designer and manufacturer of advanced fiberoptic cables for tactical and military applications approached the University of Haifa's Faculty of Science and Science Education to devise and execute a test methodology to determine the rodent resistance of flexible steel wire armored designs of fiberoptic tactical cables. Existing techniques, methodologies and industry practices were reviewed and adapted to test the worst-case scenario of rodent gnawing damage to terrestrially and aerially deployed cables in various geographic region of the State of Israel (and administered territories) in particular, and in the Northern Hemisphere in general. On this basis test apparatus were designed and constructed, and rodent species were determined, acquired and conditioned. The protocol and statistically representational populations were determined, taking into account national and international laws, regulations and treaties regarding the use of animals in clinical experiments.

At your request we have tested in our laboratory, University of Haifa, Faculty of Science and Science Education, Department of Science Education, Biology, the resistance of two kinds of cables (Helical and Briaded armor) to rodent gnawing. The following 4 species were tested: Tristrams' jird *Meriones tristrami*, black rat *Rattus rattus*, house mouse *Mus musculus* and social vole *Microtus socialis*.

Biological background of the studied species

Based on information from Harrison and Bates (1991) Shalmon et al., (1993).

Meriones tristrami

This species is distributed from North-western Iran and Asia Minor to the Arabian Peninsula, map1 (Harrison and Bates, 1991). In Israel it is abundant in agricultural lands in the Mediterranean parts of the country and in the semi-arid habitats in the northern Negev where due to the development of agricultural fields in the North-western parts of the Negev population sizes are expected to increase. This is a

nocturnal, crepuscular, burrow dweller species having a wide tolerance habitat. The burrows with a nesting chamber at the end are dug randomly at varying depths. This species occurs over a wide range of soils, including sand, alluvial deposits, loses and terra-rossa. Population numbers fluctuate markedly and at times it might become an agricultural pest. At high altitudes (above 1500m) it can exist in open meadows.
An interesting feature of this species is the fact that it does not store food in its burrow and therefore must always come to the surface to forage. It is a herbivore species and its diet consists of grain seeds, green leaves and plant stems. It breeds throughout the year with maximum fertility under longer days between April and September. The mean number of young in a litter is 3.6 after a gestation period of 25-29 days. Females can give birth up to 13 times during their life time. Its mean body mass is 80g. As this is a super-terrestrial species in its activity, its abundance and size makes it indicative of the worst case of gnawing cables that are terrestrially deployed in its areas of distribution.


Meriones tristrami מרירן מצוי

Rattus rattus

This species is distributed throughout most of the world due to its commensalism with humans. In Israel it is abundant in the Mediterranean ecosystem but it exists close to humans in the arid parts of the country. The commensally nature of this species means that it has been one of the most important vectors of pandemic disease. This species is an active climber and will frequently construct its nest in pine or palm trees. In

addition it is also an excellent swimmer and maintains extensive burrow systems. The nests are loosely constructed of twigs, dried grasses and leaves. The black rat breeds all the year round with a mean of four young in a litter and between four and five litters per year. It feeds on human foodstuffs, crops fruits, seeds, insects and mollusks. Apart from the Mediterranean forests it seems to be dependent on water. Its mean body mass is 150g. As this is an arboreal species that can use aerial cables for running, its abundance and its size makes it indicative of the worst case of gnawing cables that are aerially deployed in its areas of its distribution.

Rattus rattus (עליות) חולדה מצויה

Mus musculus

This species is found virtually worldwide due to its introduction by humans. In Israel it is distributed throughout the country where in semi-arid and arid environments it is close to human dwellings while in the Mediterranean ecosystem it can be independent of humans to a certain extent. Therefore, it is assumed that this species has two forms: commensally and feral with the latter being more abundant in the more fertile ecosystems. This species is very adaptive and it can be trapped in salt marshes. Its activity is mainly crepuscular and nocturnal. It is transferred from place to place in human stores and possessions. It is an omnivore species and it causes considerable damage in warehouses, agricultural stores and dwellings. It breeds throughout the year but most intensively in spring and autumn with up to 10 young after 22 days of pregnancy. The mean body mass of adults is 15g. As this is a very common species

with large populations, its abundance and its high numbers makes it indicative of the worst case of gnawing cables that are terrestrially deployed in its areas of distribution.

Mus musculus (הבית) עכבר מצוי

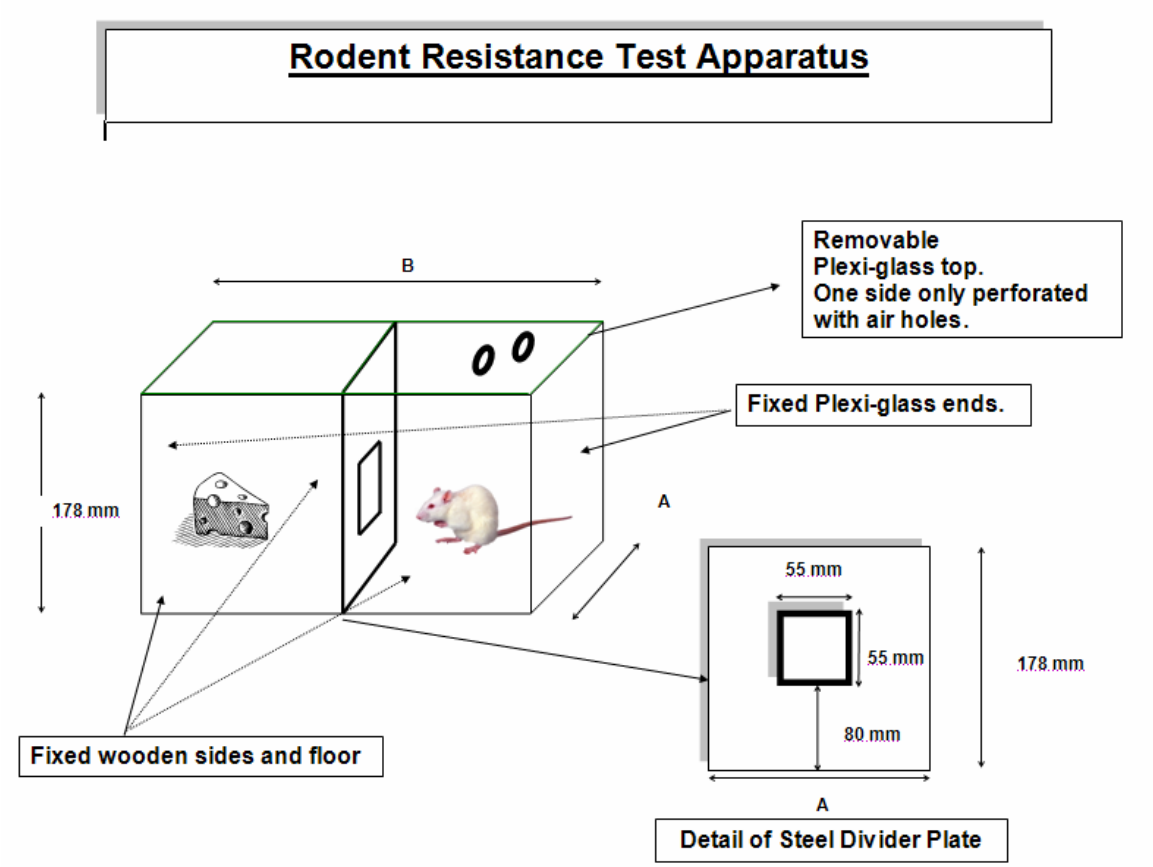
Microtus socialis

This species is distributed from Greece in the west to Afghanistan in the east and from the north in the Ukraine and Turkistan in the former USSR to Israel and Iraq in the south. In Israel it is abundant in the Mediterranean and steppe ecosystems in the northern parts of the country in agricultural and grassing lands and is considered the heaviest pest rodent to agricultural crops like alfalfa. It is a highly colonial species favoring grassy terrain but is also found in bushy scrub and uncultivated mountain valleys. The burrow systems are extensive and complicated. The tunnels are rather shallow, 50-80cm, beneath the soil surface. Activity is both diurnal and nocturnal and they seize blades of grass and herbs and eat them inside their burrows. Years of vole eruptions result in great damage to agriculture but also can change the type of vegetation in grasslands. In Israel the social vole can breed throughout the year with a maximum of birth rates under short days. The mean litter size is 6.1 voles and most females are able to breed at the age of two months with a potential of seven litters in one year. The mean body mass of adult voles is 45g.

Microtus socialis (=guentheri) נברן שדות

Testing Apparatus and Methodology

As stated above the test apparatus originally developed by The U.S. Fish and Wildlife Service for gopher resistance testing of cables, and referenced in Annex A of Bellcore GR-20 CORE, "Generic Requirements for Optical Fiber and Optical Fiber Cable", was chosen and adapted to test the species considered to reflect worst case scenario. The basic adaptation of the test apparatus design is presented in the schematic drawing below, where Dimension A is 220 mm for *Rattus rattus*, 178 mm for *Meriones tristrami Mus musculus* and *Microtus socialis* and Dimension B is 440 mm for *Rattus rattus* and, and 279 mm for *Meriones tristrami Mus musculus* and *Microtus socialis*. The variation in cage area is necessary so as not to create too cramped conditions relative to specimen body size, that bring on physiological stress,



The specimens were conditioned for 48-72 hours prior to testing. Conditioning consisted of placing nutrition in the adjacent cell of the test apparatus forcing the specimens to traverse the opening in the separating wall (without cables laid across it) in order to eat. This conditioning established the cognitive awareness that would create the impetus to go through any obstacles (the cables under test) in order to

survive. Additionally, in order to ensure that the specimens would not dehydrate and weaken during the testing, a petrie dish of Agar (practically zero nutritional value) was placed into the cell as well as bits of paper enabling the specimens to use it for bedding, as would be characteristic of their natural environment. After conditioning, the cables under test were horizontally (and vertically when needed to minimize the risk of the specimens squeezing their way though a relatively large horizontal aperture) affixed across (and effectively) the opening. The exact positioning of the tested cable enabled maximum circumferential attack by the individual without affording the needed space to squeeze through the space between the cables under test. The testing of the cables in the described setup generally lasted four days per trial. A predetermined number of trials were performed on each cable design under test, as appears in the section of results.

Damage Index Rating for Rodent Resistance

Definition	**Index**
No Damage	0
Outer Jacket Scratched	1
Outer Jacket Penetrated	2
Armor Penetrated	3
Fibers Damaged	4
Cable Severed	5

Results

Helical Armor (Teldor P/N 95A8X9M04B)

Species	Number of measurements (n)	Mean	Standard deviation (SD)
Meriones tristrami	14	3	0.0
Rattus rattus	11	3.1	0.9
Mus musculus	8	1.5	0.5
Microtus socialis	8	1.5	0.5

The results of our tests show that both species the rat (*Rattus rattus*) and the jird (*Meriones tristrami*) damage the outer jacket and penetrate the armor however, the fibers are not damaged. The greatest damage to this cable was caused by the rat and our results show a significant difference between the rat and the jird on the one hand and mouse and vole on the other. The results for the two other species the mouse (*Mus musculus*) and the vole (*Microtus socialis*) show that the outer jacket is scratched and only in some cases it is penetrated.

Braided Armor (Teldor P/N 95A9X9M04B)

Species	Number of measurements (n)	Mean	Standard deviation (SD)
Meriones tristrami	9	2	0.0
Rattus rattus	12	2.4	0.5
Mus musculus	8	0.75	0.7
Microtus socialis	8	1.5	0.6

The results of our tests show clearly that the Braided Armor is resistant to rodent gnawing (worst cases being the rat and the jird) as it scored less than 3.0 points of the damage index rating which means that only the outer jacket was penetrated by the rat (*R. .rattus*) and the jird (*Meriones tristrami*) but the armor was not damaged. Regarding the two other species, for *M. musculus* the outer jacket was only scratched and for *M. socialis* the outer jacket only in some cases was penetrated and in others only scratched.

Discussion and conclusions

The tested cables were designed for signal communication by conducting electromagnetic waves over optical fibers. The aim of our test was to examine the resistance of the jacket and the armor that protect these fibers and enable their

function under various external conditions including gnawing by rodents. The experiments carried out represent extreme conditions for the tested individuals as they were denied their food resource (but not deprived of water) for a minimal period of 48h. Therefore, our results show that the Braided Armor cable (Teldor P/N 95A9X9M04B) will be resistant to rodent gnawing under both rapid tactical deployment and multiple tactical deployment. As the threshold damage index rating point in our tests was 3.0 the Braided Armor cable should be resistant even to the rat and jird when these cables are aerial or terrestrial deployed respectively.
The Helical Armor cable (Teldor P/N 95A8X9M04B) can be used for rapid tactical and multiple tactical deployment for periods of time, bearing in mind that it is at the threshold point for the jird and still it is resistant to mice and voles. However, this cable is not suggested for aerial deployment over extended periods of time. Taking into account the attached distribution maps and descriptions of the different species it is recommended to choose the cable design for resistance to a particular species accordingly.

References

Harrison DL and Bates PJJ (1991) The Mammals of Arabia. Harrison Zoological Museum, Seven Oaks, Kent UK.

Shalmon B., Kofyan T and Hadad E. (1993) A Field Guide to the Mammals of Israel Their Tracks and Signs. Keter Publishing House Ltd. Jerusalem, Israel.