GLOBAL TRENDS IN SUBMARINE CABLE SYSTEM FAULTS

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Abstract: This paper is written on behalf of the Submarine Cable Improvement Group. Fault data from undersea systems continues to be collected by several organizations. The SCIG attempts to analyze and present the data in order to improve the totality of undersea system supply. This work is a continuation of previous studies, where global trends are reported with focus on data from the last three (3) years.

1. FAULT DATA SOURCES AND METHODOLOGY

Since the last time we reported on trends in undersea global faults, several geological events, turbidity currents, and anchors-while-underway have caused multiple simultaneous regional network failures. Although these events have occurred in the past, the density of network cables on the ocean bottom has made cable protection and network planning even more crucial to the un-interrupted service of undersea communication. Understanding these events and the resulting faults underlies the purpose of many fault studies.

Although somewhat difficult, but extremely valuable, the task of collecting fault data and maintaining fault databases continues to be carried out by several members of the SCIG and others within the submarine cable industry. This year's analysis is again based on Tyco Electronics SubCom database and that of Alcatel-Lucent Submarine Networks. In general the two databases compare well. This study focuses primarily on the last three years, but bridges the data back to previous studies published by the same authors. In some cases yearly data is presented, in others comparison to previous years is made to bring out potentially significant differences. Specifically, trends focused on the last three years from 2007 to 2009, and in some cases comparable data from 2004 to 2006 are presented.

Fault data has been separated into three general categories: External Aggression, Component, and Other. Within the External Aggression category, data was subdivided between Fishing, Anchors, Abrasion, Geological, Dredges, Crushing and Others.

Recently, due to great efforts by numerous maintenance organizations around the world, many faults that would have been allocated to Fishing or Others/Unknown, are now clearly assigned to Anchors due to vessels unknowingly loosing their anchors while under way, and dragging these anchors across undersea cable systems and damaging them. These findings by the maintenance organizations were due to their investments along with others in readily available technology (Automatic Identification System [AIS]) that allowed a better and more accurate tracking of vessels with respect to undersea system locations.

Great efforts have been expended to properly allocate the faults in the correct category. However, as it is with most field

data collection efforts, some interpretation is required. In instances where faults could not be binned, these were assigned the special category of other. Overall conclusions within the study are not affected by these interpretations.

The data is presented it in two sections. First, the total number of faults throughout the world, as reported in the two databases, is presented from an absolute point of view. Second, the data is normalized using the total number of systems and their associated lengths. Length-normalized fault rates are presented in units of 'faults per 1000 km', calculated as the sum of number of faults divided by the total length of cable known to the respective organizations. The data is further separated into two depth ranges – cable in less than 1000 meter water depth (shallow water) and cable in greater than 1000 meter water depth (deep water).

2. ABSOLUTE FAULT ANALYSIS

Faults are grouped in three major categories where External Aggression, System Component, and Other/Unknown are separated. These are also presented by data source (TE SubCom & A-L SN). The overall trend corresponds well with previous studies[12345] as shown in Figure 1, where External Aggression faults continue to represent the dominant category.

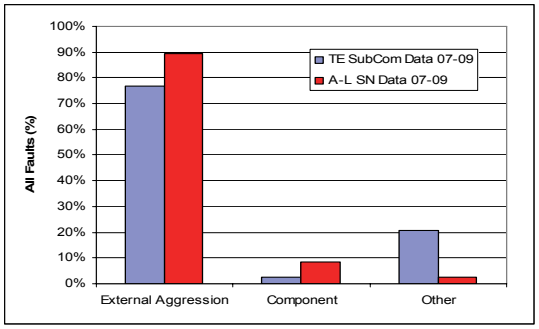

Figure 1. Overall Causes of Fiber Optic Cable Failure

They range between 77% and 89% whereas Component failures are in the range of 3% to 8%, and Other/Unknown range between 2% and 21%, depending on which database is considered.

External Aggression faults are further separated into sub-categories in Figure 2, which include either human activity or natural aggression. These are also presented by data source.

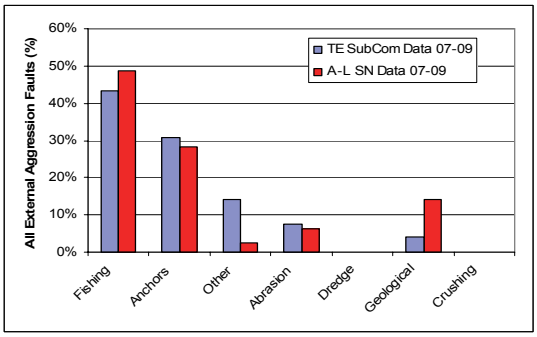

Figure 2. External Aggression Faults for all Water Depths

Faults attributed to human activity, such as fishing, anchors and dredging, are about 75% in both databases. Three out of four External Aggression faults continue to be attributable to human activity, either from fishing or from dropping and/or dragging anchors. As a result of the diligent effort of many maintenance organizations in selected regions, we are now able to better bin the failures and therefore assign numerous faults which would have been attributed to Fishing in the past into the Anchors category. Despite this, the overall fault rate due to human activity is still in the 75% range as shown in Figure 2b. Here we compare the two combined categories for two time periods, before and after the use of AIS. Nonetheless, Fishing remains the major cause of human activity faults, making up about 45% of all External Aggression.

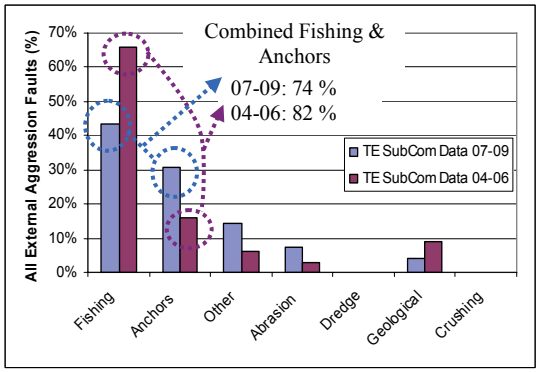

Figure 2b. Combined Comparison of Fishing & Anchor Faults for all Water Depths

Natural Aggression includes such faults as earth movement and chafe/abrasion. Abrasion failures though less than 10% have shown an increase in the two data sources. Geological failures are also higher and could possibly be attributed to greater turbidity currents reported throughout the globe, while no Crushing faults were reported.

For expediency, the rest of the data analysis is conducted using one data source, as we have established equivalency between the two databases.

All external aggression faults with respect to depth are presented in Figure 3a.

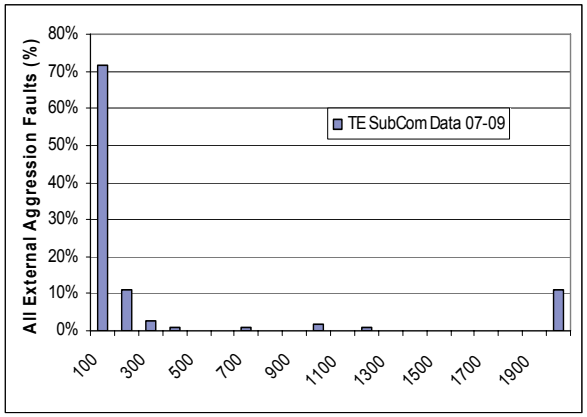

Figure 3a. Depth Distribution (m) of all External Aggression Faults

The majority of the faults still occur in water depths of 300 meters or less where over 80% of faults occur. The data is significantly different though from that of 2004 to 2006, since over 70% of the faults are in less than 100m water depth, where cable is diligently buried. Figure 3b compares the two time periods, i.e. 2004 to 2006 and 2007 to 2009, where the difference is clearly shown between the two time curves between 100 and 700m water depths. Deep water (greater than 1000m) External Aggression faults are still around 15%.

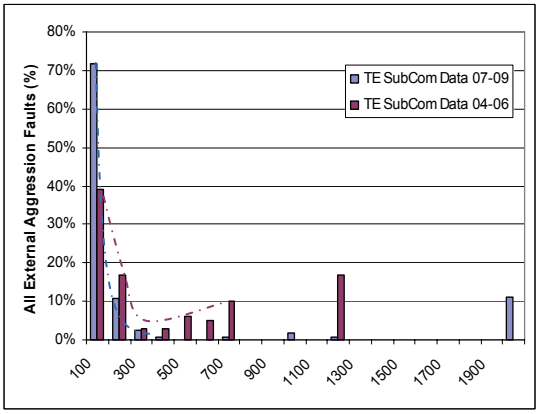

Figure 3b. Depth Distribution of All External Aggression Faults Comparing (2) time periods

Figure 4a focuses on fishing faults with respect to water depth. A similar conclusion could be drawn here, indicating perhaps that fishing closer to shore has increased markedly over the last few years.

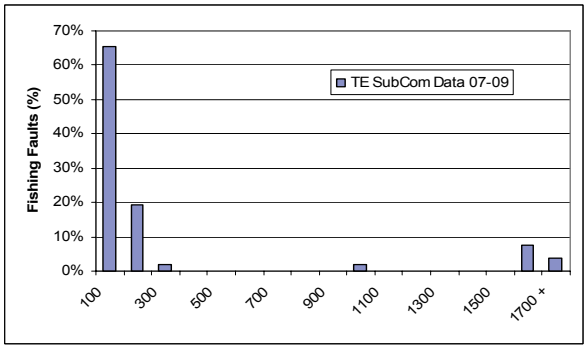

Figure 4a. Water Depth Distribution (m) of Fishing Faults

Figures 4b and 4c present respectively Anchor faults Human Activity faults, i.e. Fishing & Anchors. Figure 4b shows some anchor activity beyond what is considered to be normal anchor deployment.

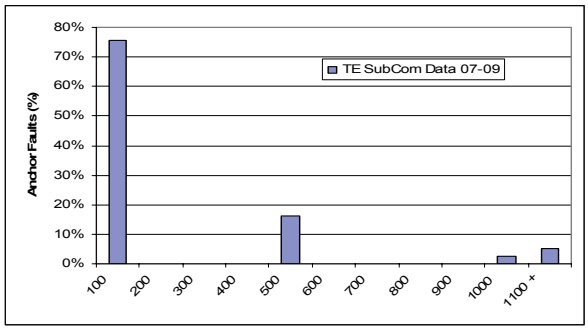

Figure 4b. Water Depth Distribution (m) of Anchor Faults

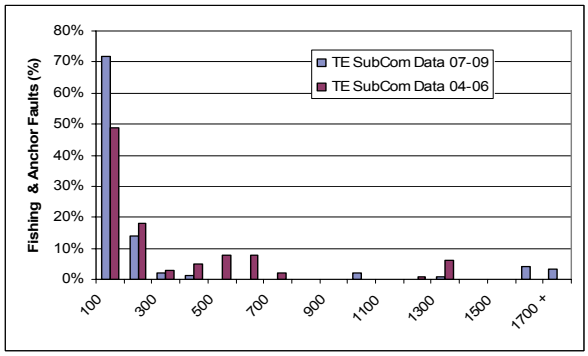

Figure 4c. Water Depth Distribution (m) of Fishing & Anchor Faults

3. LENGTH NORMALIZED DATA

The purpose of plotting and analyzing historical fault data is to attempt to reduce the overall number of faults, through studying individual faults, group of faults and trends. Such trends are then used to improve the planning of additional undersea systems, their routes and maintenance services. A useful standard unit could be obtained from further analysis of the data, if one is able to collect and update the length of undersea cables deployed around the world. Such standard/reference unit, normally called Faults per 1000km, is then obtained by dividing the number of faults by the total length of cables deployed.
This reference unit is only useful in a global sense, since it could be misleading if one uses it locally where fishing, and/or geological trends are significantly different.

Length-normalized fault rates per year, in shallow and deep waters, are presented in Figure 5 over the last decade. The rate has been decreasing overall, and holding steady over the last few years. The rates indicate about 0.22 faults per year per 1000 km for shallow water, and less than 0.1 faults per year per 1000 km for deep water, over the last three years.

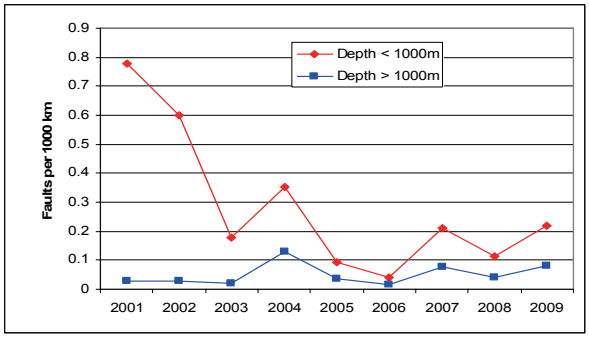

Figure 5. Length-Normalized Overall Fault Rates for Depths < 1000m and Depths > 1000m

The rest of the data analysis concentrates on faults in shallow water, i.e. less than 1000m. Annual fault rates for all external aggression causes are presented in Figure 6. The average rate over the last 10 years is about 0.1 faults per year per 1000km. Such rate seems to have leveled off at an average of 0.1 per year.

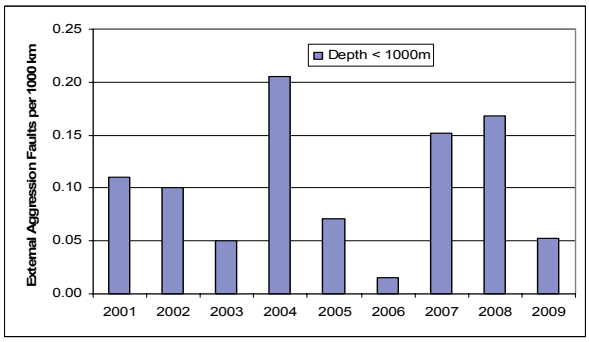

Figure 6. Length-Normalized External Aggression Faults in less than 1000m Water Depth

Figure 7 presents fishing faults only. Over the last decade the average is a little over 0.05 faults per year per 1000km. This continues to be an extremely low rate. It is even slightly lower than usual as some historically counted Fishing faults are now properly binned as anchor faults. The overall low rate is certainly due to

systematic cable burial and cable awareness throughout the world.

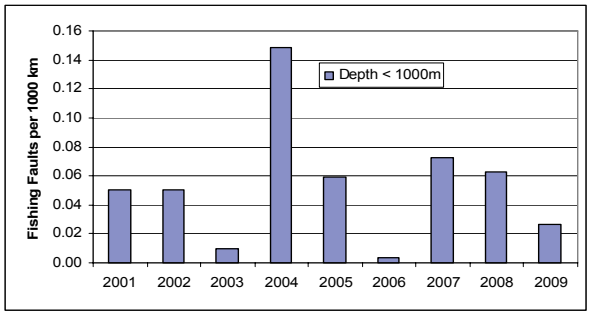

Figure 7. Length-Normalized Fishing Faults in less than 1000m Water Depth

Figure 8 shows the absolute number of deep water faults (deeper than 1000m) per year. This rate is slightly less than 2 faults per year (1.9) over the last decade.

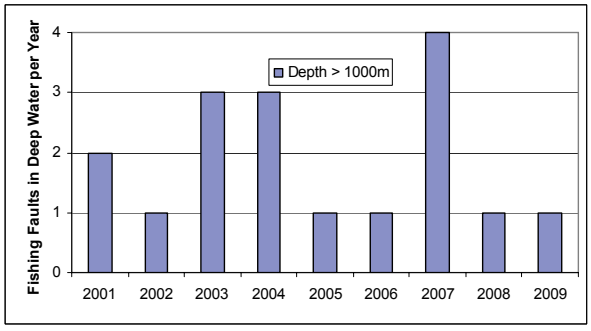

Figure 8. Absolute Fishing Faults in greater than 1000m Water Depth

The second largest category of external aggression faults, in less than 1000m water depth, is that of anchor faults. Figure 9 shows an average of less than 0.03 (0.025) faults per year over the last decade. These faults are mainly concentrated within busy harbors and ship traffic areas which are hard to patrol and protect.

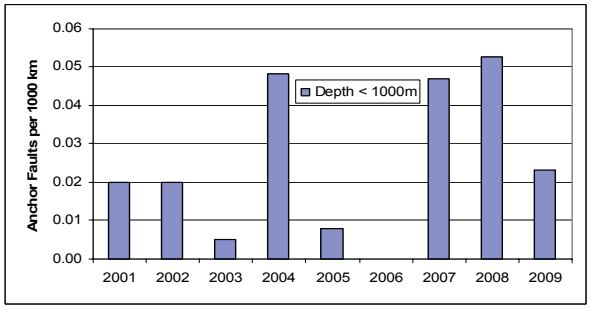

Figure 9. Length-Normalized Anchor Faults in less than 1000m Water Depth

5. CONCLUSIONS

This paper presents a global analysis of undersea system fault data over the decade. It concentrates on the last three years, but continues the same analysis done for previous years. External aggression remains the primary cause of faults, and fishing faults constitute the majority of those. Anchors while ship-under-way are now a greater percentage as they are being better identified. Most faults continue to occur in less than 200m water depth.

These conclusions provide global trends. Regional and local rates vary significantly. Normalized fault rates, for the length of cable deployed, show annual external aggression fault trends continue to be extremely low.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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