SURVEY AND ANALYSIS OF THE HAZARDS AND RISKS KNOWLEDGE FROM THE UNDERWATER ELECTRICAL CUTTING

September 2015

By Francis Hermans retired commercial diver

Prologue:

Underwater cutting has always fascinated most commercial divers. I myself had the opportunity to practice it very often during my 47 year career and early on, I became interested in safety issues related to this technique. During my years of work I saw that some of my colleagues (probably due to lack of knowledge) sometimes took significant risks.
That is why I made this little survey to see where the current level of knowledge is and whether it is sufficient or not.

Recall:

The underwater cutting operations may be performed in various ways:

- ✓ Explosives
- ✓ Water jet cutting
- ✓ Diamond wire cutting
- ✓ Gas burning
- ✓ Thermic lance
- ✓ Kerrie cable

In addition to the methods mentioned above, divers also have at their disposal a few electrical cutting tools. Among these we find in chronological order of invention:

- ✓ Shielded metal-arc cutting rods
- ✓ Steel tubular rods or oxy-arc
- ✓ Ultra-thermic or exothermic rods
- ✓ Plasma-arc

Regarding the solid electrodes, there is currently only one brand of full electrode for underwater use on the market; due to the low cutting performance it is seldom used.
Underwater plasma arc has existed for some years but it is not commonly used.
Therefore, only the steel tubular and ultra – thermic cutting methods have been selected for this study.

Duration of the survey:

The survey was conducted between August 18 and September 5, 2015

Survey Release:

To reach a maximum of commercial divers the questionnaire has been written in English, French and Spanish.
The dissemination of this survey was conducted via the various professional diving groups present on Face-book and through several dive sites present on the world-wide web.

Answers to questionnaires:

Despite the large population of divers identified in various Face-book groups (> 5000) only a very small percentage of them have bothered to answer this short survey since at total 372 responses were as follows recorded:

- ✓ English speaking community: 192
- ✓ French speaking community: 128
- ✓ Spanish speaking community: 52

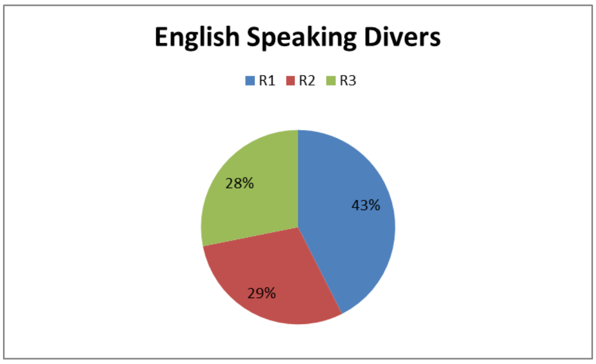
Despite the low response rates, the obtained results nevertheless allowed me to have an overview of the level of knowledge of risks associated with the practice of this type of cutting.

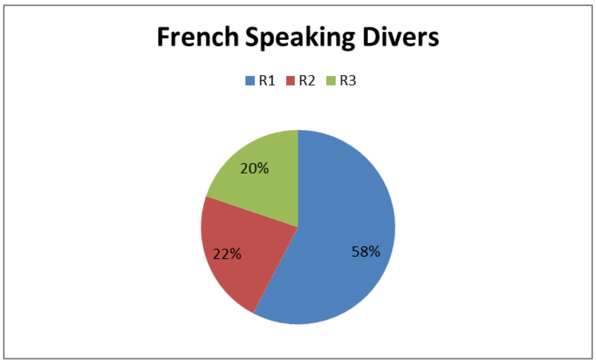
Acknowledgments:
A big thank you to Hal Lomax for his help in the translation of this document and to my colleagues who have taken the time to kindly participate in this survey.

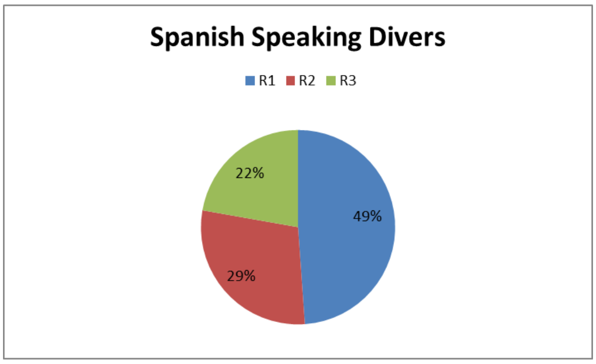
SURVEY RESULTS
ANALYZES
AND
COMMENTS

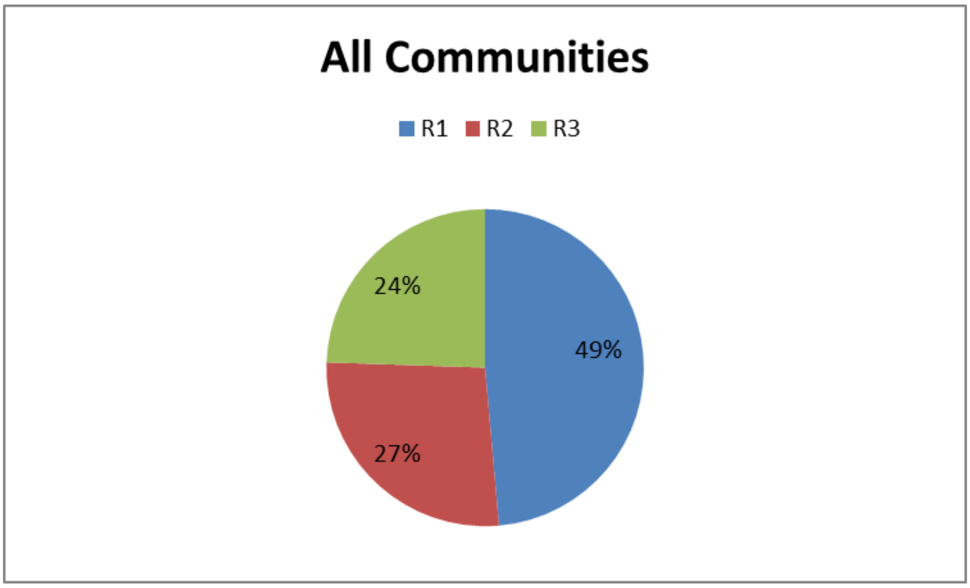
By Francis Hermans retired commercial diver

Question n° 1: How many times a year do you realize underwater cutting works?
R1: 1-5
R2: 5-20
R3: More









Analysis and comments of the response 1:

As we can see the result shows that:

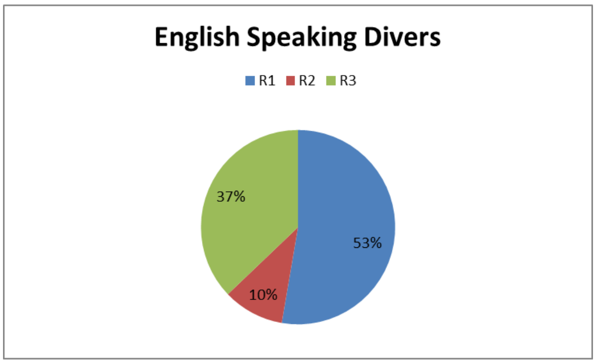
- ✓ 49 % of divers have only a relatively small work experience with this technique.
- ✓ 27 % probably already has a good working experience.
- ✓ 24 % can be considered specialized.

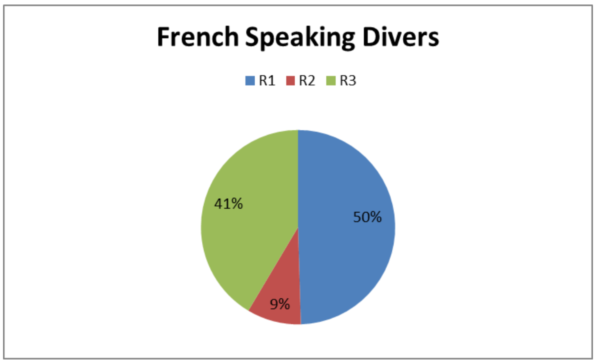
Question n° 2: Where did you learn this type of work?

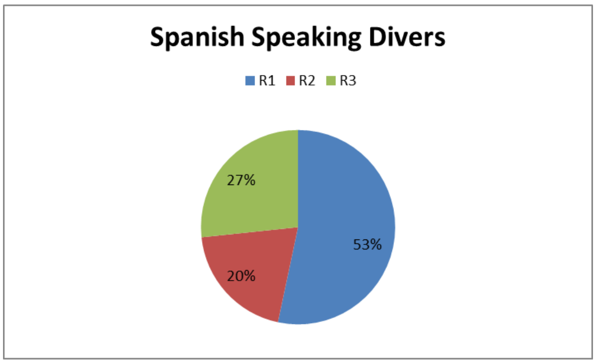
R1: During my training as a diver

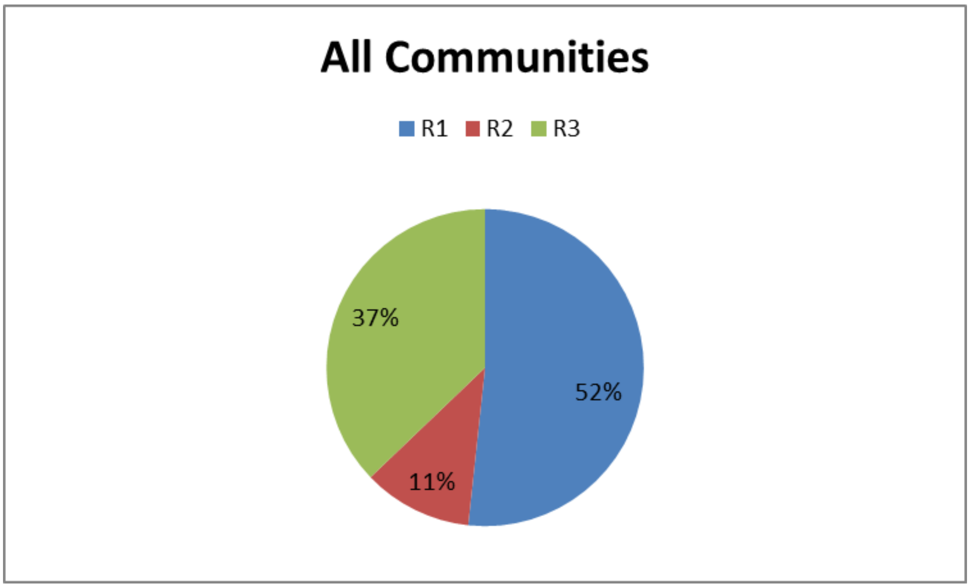
R2: During further training

R3: In the field





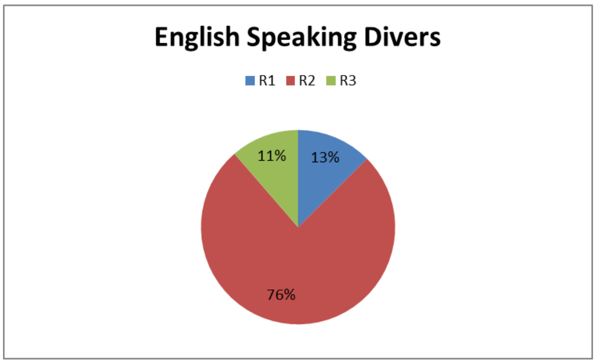


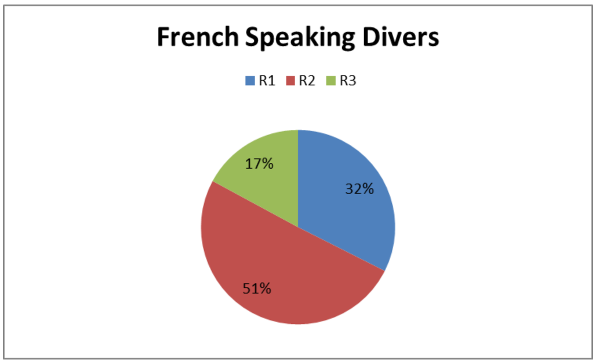


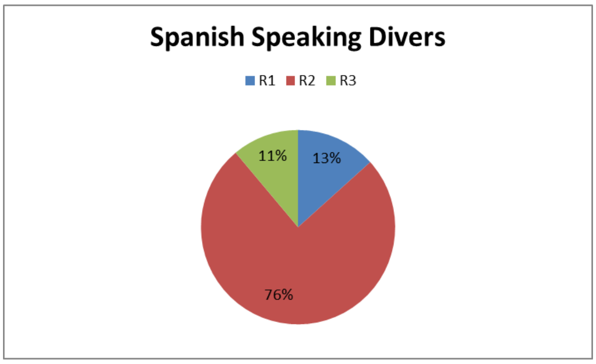
Analysis and comments of the response 2:

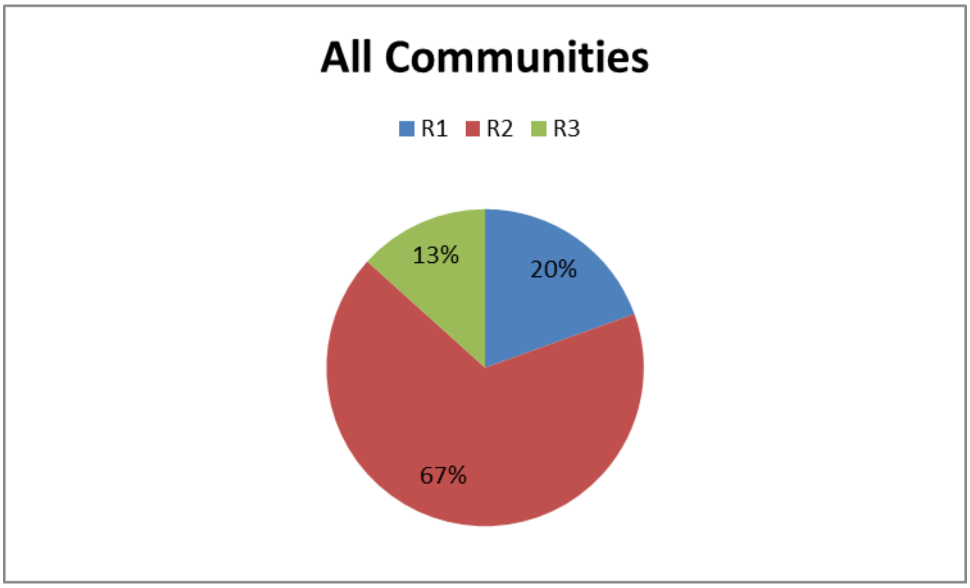
As seen, the professional diving school is the first teacher of this technique.

Question n° 3: Do you use a knife-switch during these works?
R1: Sometimes
R2: Always
R3: Never

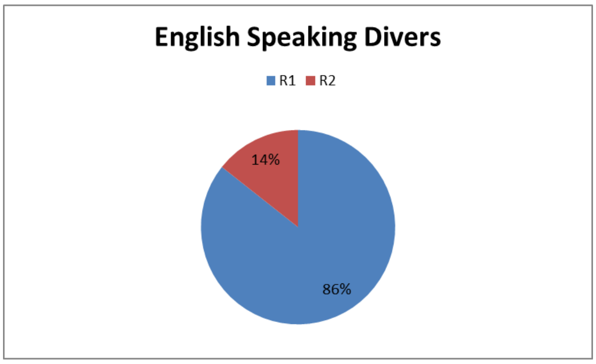


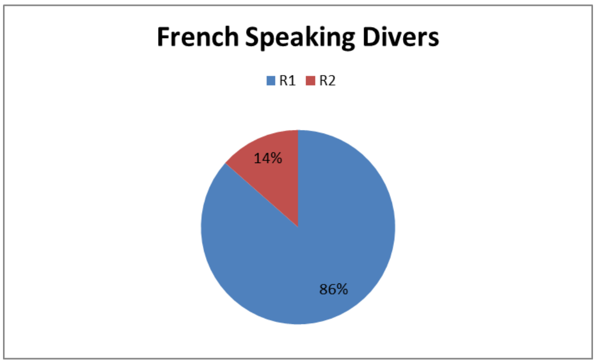


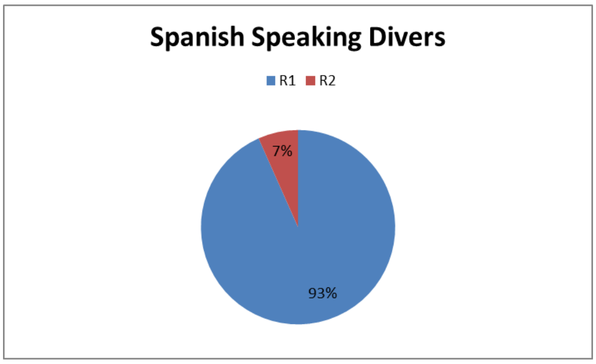


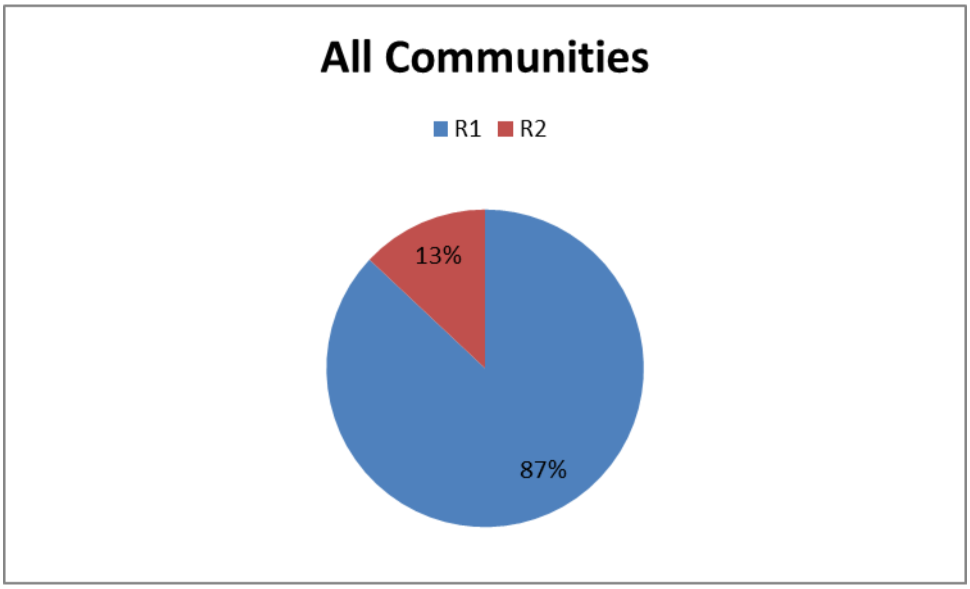


Question n° 4: Do you think that the knife-switch is needed?
R1: Yes
R2: No









Analysis and comments of the response 3 & 4:

As seen only 67% of respondents' divers regularly uses the knife switch and even a very small percentage of them believes it is not necessary.
If we go deeper into the results they show that among those who never use the switch 42 % have yet taken a cutting course during their dive training, 11% in refresher training and 47% on site.
What is a little strange when we look at the answers of Question 3 is that even among the divers who never or sometimes use the circuit breaker a large number of them agree it is necessary.
By analysing the comments we see that among the non-user population are quite a lot of oldies who said they had discovered that the knife-switch in the late 90s.
While it is true that this accessory will in no way disturb the quality of cutting it remains to be an indispensable part for diver safety as it eliminates the risk of experiencing electric shocks when changing electrodes.
During these same change of electrodes, the use of the knife switch also allows to stop the phenomenon of electrolysis and therefore greatly reduce the premature wear of all metal parts (cutting equipment and diving equipment) located in the electric field.
Finally, the non-use of such a switch will also cause the rapid wear and even the deterioration of the collet nuts.
On some occasions (5 times in Belgium in the seventies and eighties) we have also seen the explosion of a few cutting torches (with hand injuries) in which small hydrogen bubbles had formed in the torch head and had exploded at the introduction of a new electrode following the arc caused between the collet nut and the extremity of the rod.
This is also one among other reasons why it is now advisable to use a double isolation that performs a complete break in both poles of the circuit generator and the diver.
These will form a more effective and dependable isolation as described in the diagram below.

Oxy-arc underwater cutting recommended practice | 21

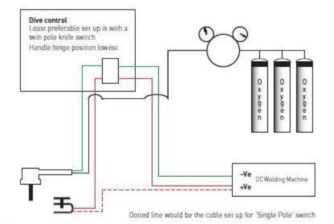


Figure 1: Basic oxy-arc cutting system

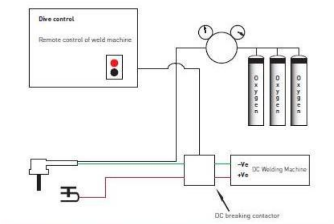
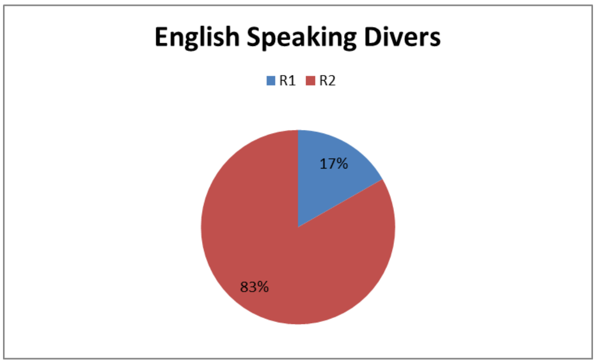
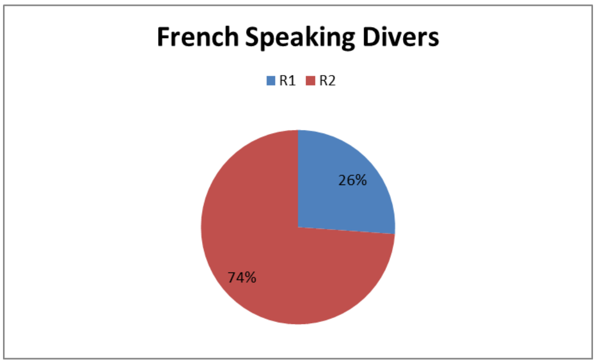
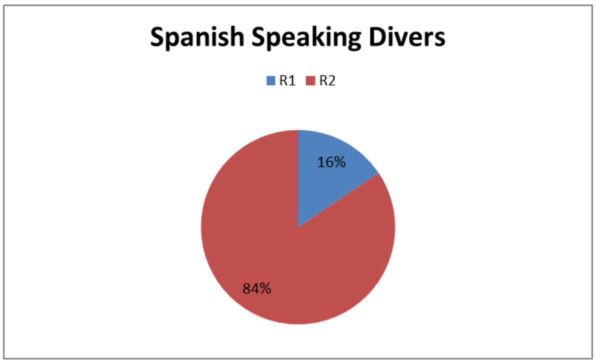


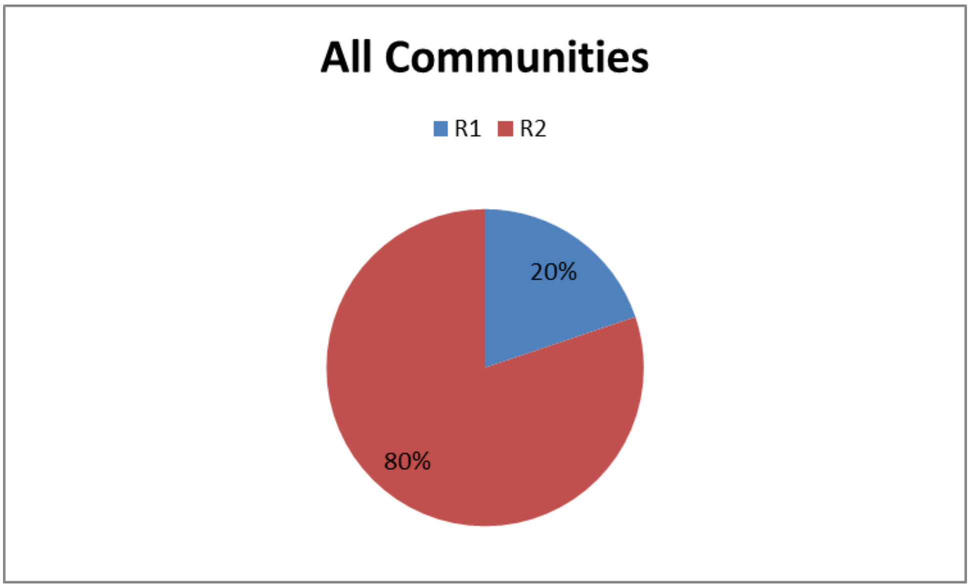
Figure 2: Preferred circuit breaker arrangement

Question n° 5: What kind of current do you use to carry out these works?
R1: Alternative current (AC)
R2: Direct current (DC)





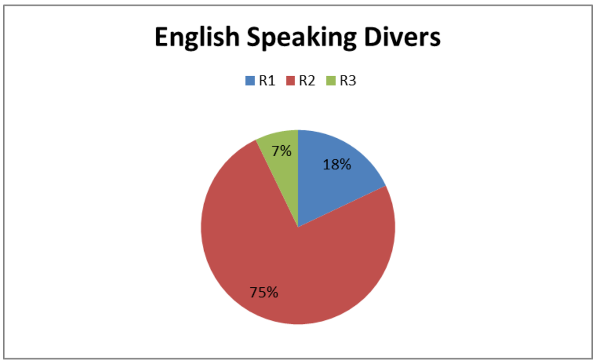


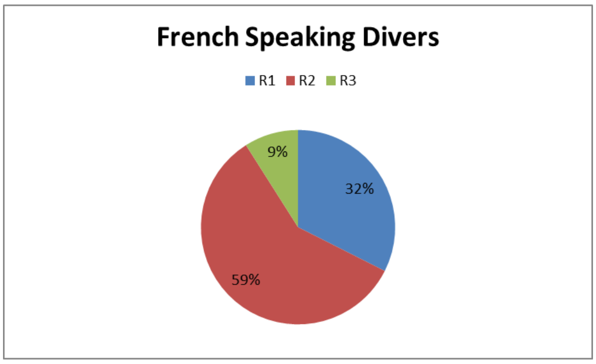


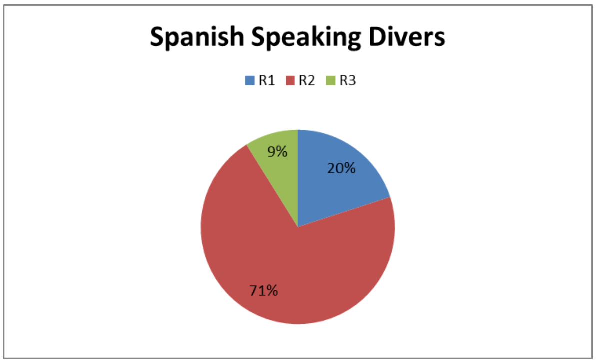
Analysis and comments of the response 5:

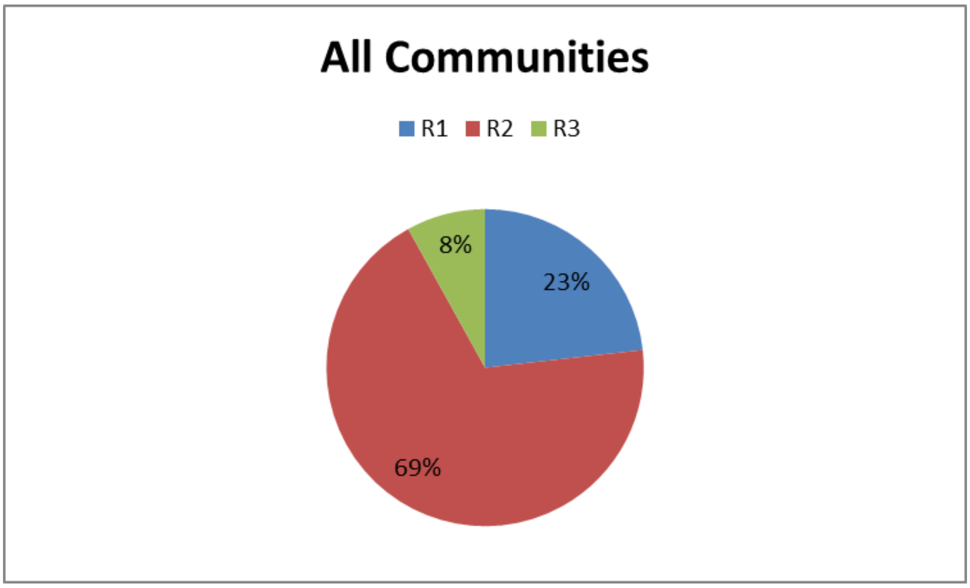
Reading that divers are still using alternating current is a bit perplexing.
Although cutting with AC has been described in some diving manuals its use was apparently abandoned in the 50s.
How is it therefore still possible that 20 % of respondent's divers say that they use alternate current for cutting while the electric shock with this type of current is much higher than with direct current?
Moreover, the effects are also felt more uncomfortable or even unbearable.
Are these answers not rather due to the ignorance of these divers due to a lack of training or information and are therefore not able to tell the difference between these two types of current.
One might think that the responses come mainly from divers who have very little experience but it is not specially the case so because when the figures are analysed in depth it is found that 18 % of those who say to use the AC are specialists cutters 45 % of seasoned cutters and the rest inexperienced cutters.
Another finding that challenges is due to the fact that 61 % of the divers who use AC said they had learned cutting during their diver's formation. 2% have even followed a specialized cutting course and the other concerned divers have apparently learned in the field.

Question n°6: What type of polarity do you use?
R1: Cutting torch to the +
R2: Cutting torch to the –
R3: Does not matter









Analysis and comments of the response 6:

The origin of this choice is not easy to find as since always **most** dive manuals advocate cutting with straight polarity that is to say with the cutting torch connected to the negative pole.
It seems that this choice is linked to the development of arc welding.
Cutting with straight polarity has the following advantages:

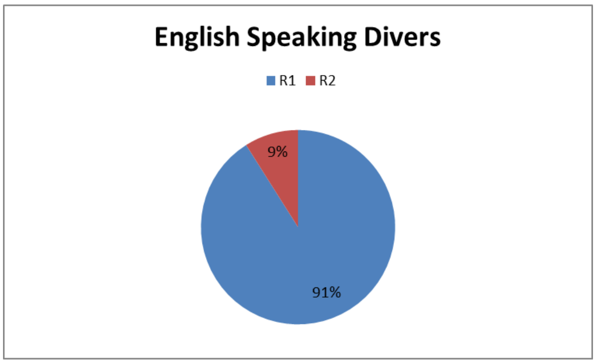
- ✓ Light ease of cutting due to the fact that about 2/3 of the heat produced is concentrated in the burning steel and one third at the tip of the electrode.
- ✓ Less corrosion of the equipment due to the cessation of the electrolysis.

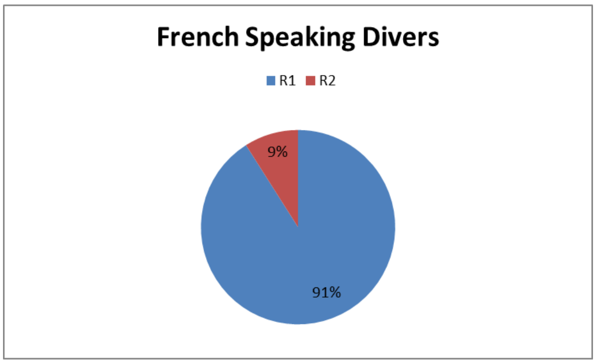
By cons no thorough study has yet been conducted on this subject, but it seems a priori that cutting (or welding) with straight polarity has no impact on a possible reduction in electrical hazards.

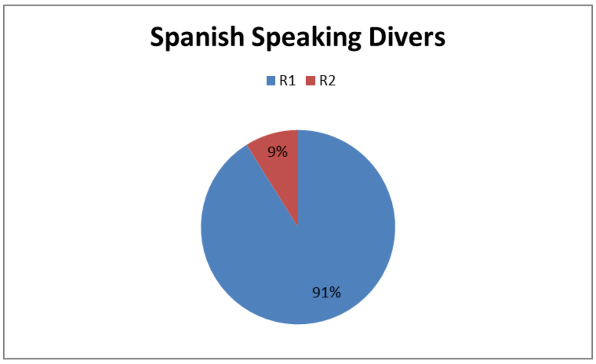
Question n° 7: During these works should you pay attention to your position relative to the ground lead?

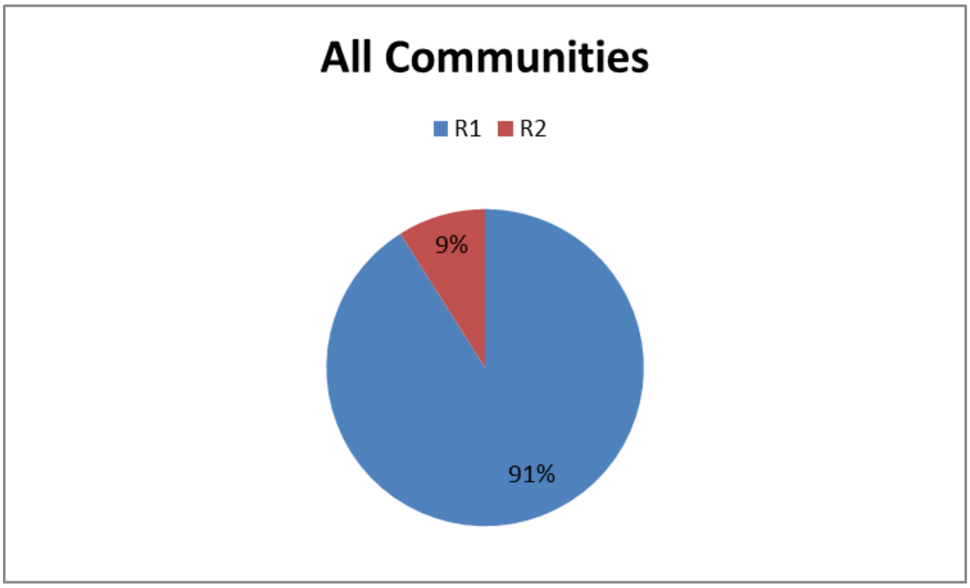
R1: Yes

R2: No



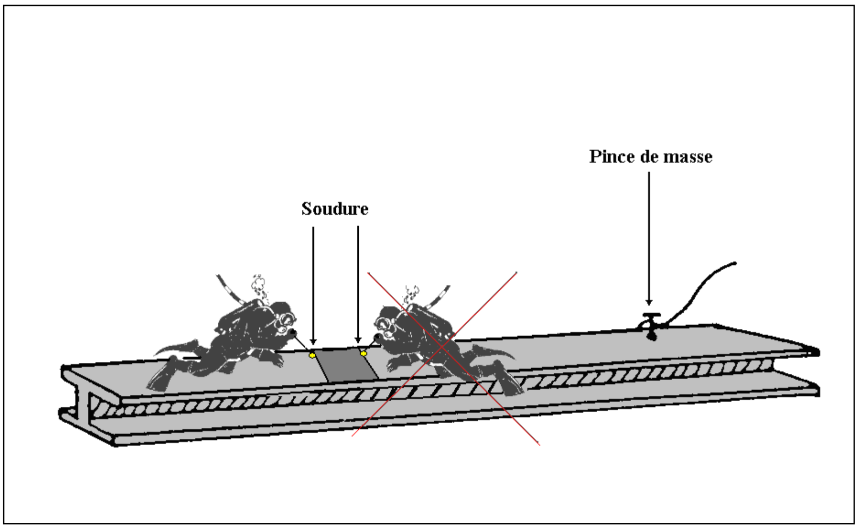






<u>Analysis and comments of the response 7</u>:

As can be seen the vast majority of divers are aware that they must avoid being between ground clamps and the part to be cut.

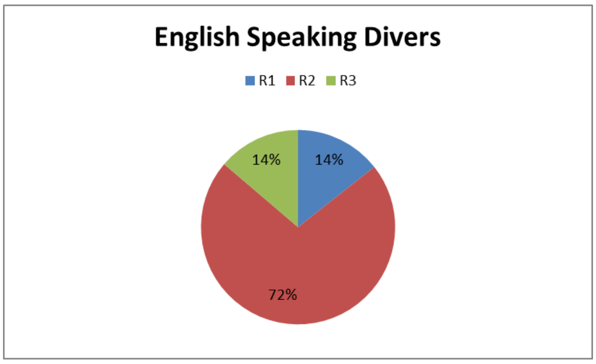


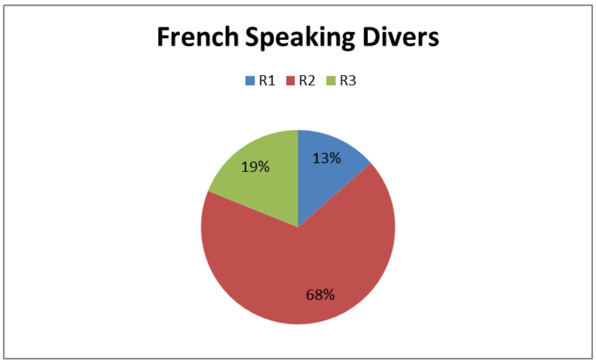
Question n° 8: Doing these works have you ever felt an electric shock?

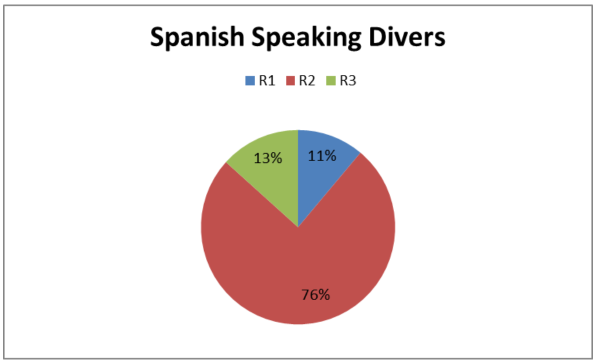
R1: Never

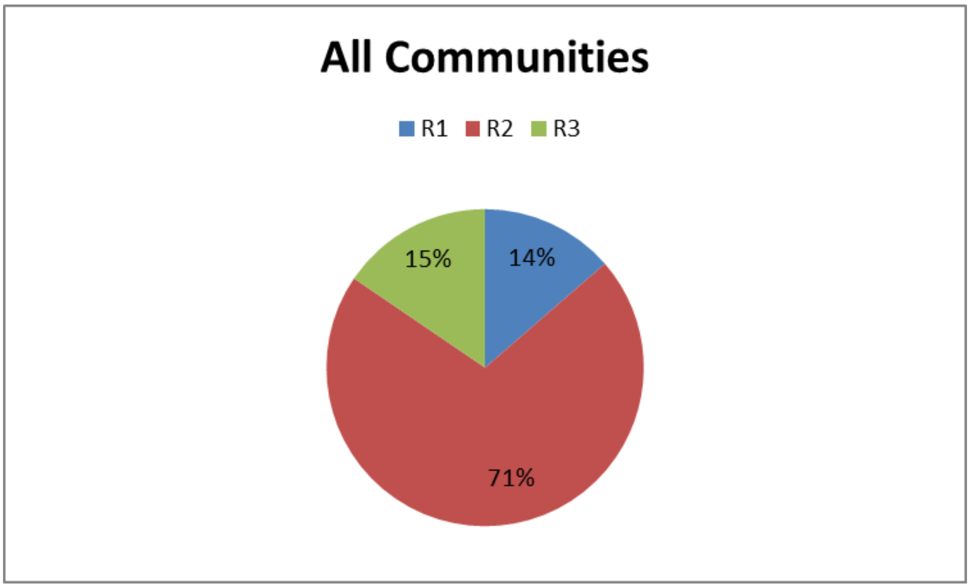
R2: Sometimes

R3: Often





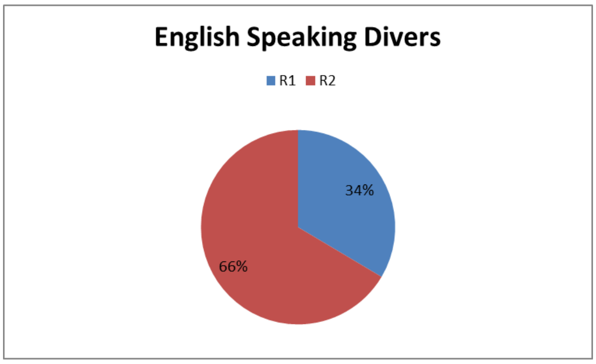


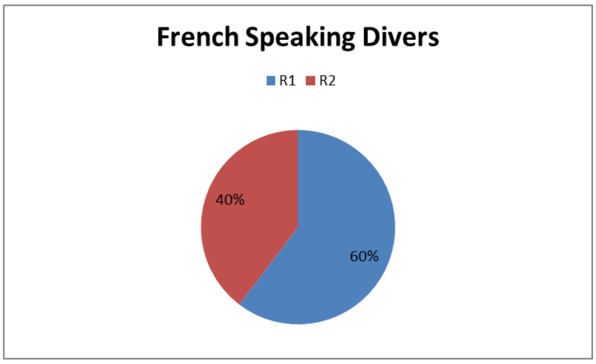


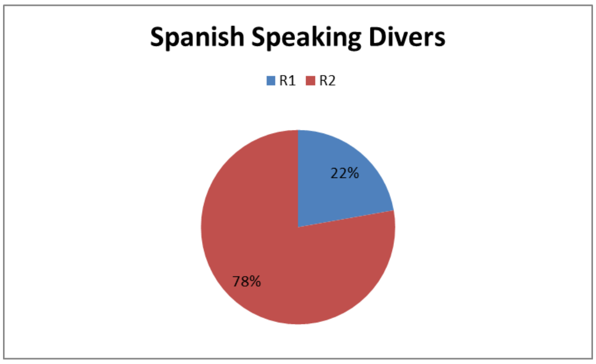
Question n° 9: When do you usually experience these electric shocks?

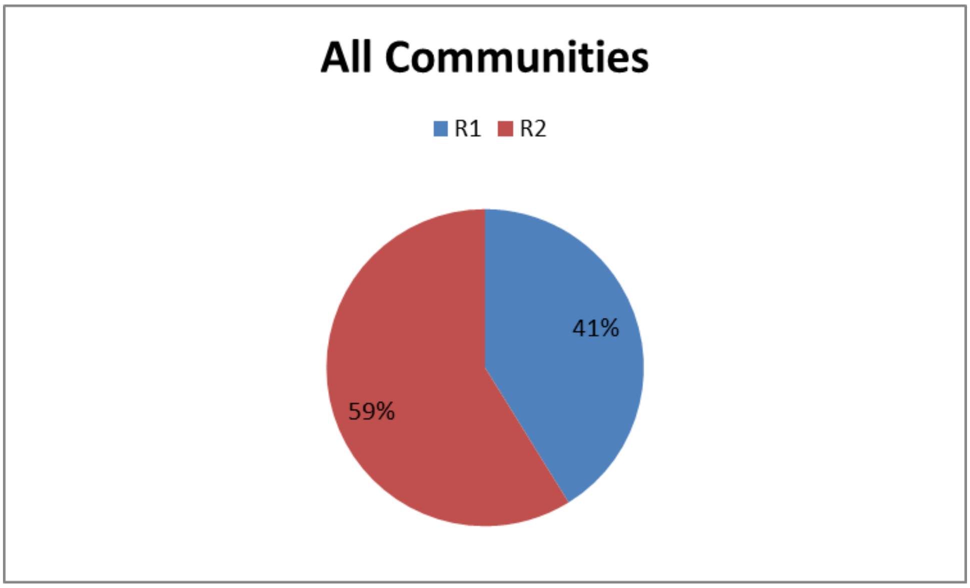
R1: When electrode change

R2: During cutting









Analysis and comments of the response 8 & 9:

As can be seen, French speaking divers are by far those who complain most to feel electric shocks when changing rods.

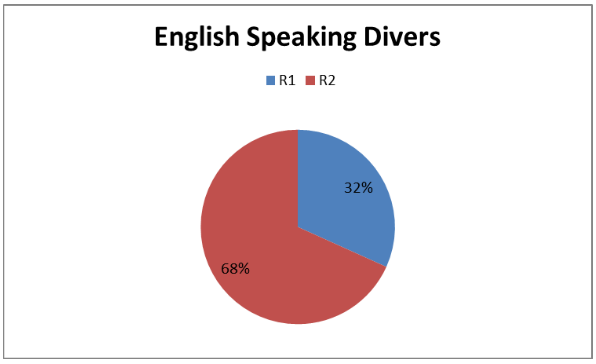
This situation seems to be normal since thanks to the answers provided to question 3 we see that they are also the ones who use the least knife switch.

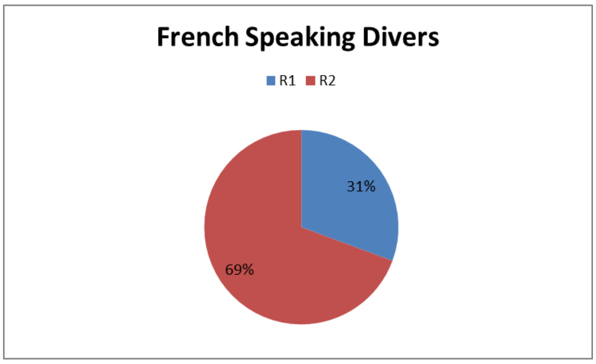
The R 2 answers appear to indicate a deficiency of diver isolation means and perhaps a poor state of cutting equipment.

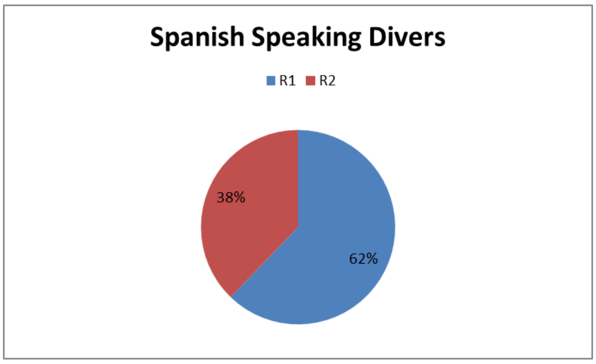
Question n° 10: When doing this type of work do you think that the electrocution hazard is high?

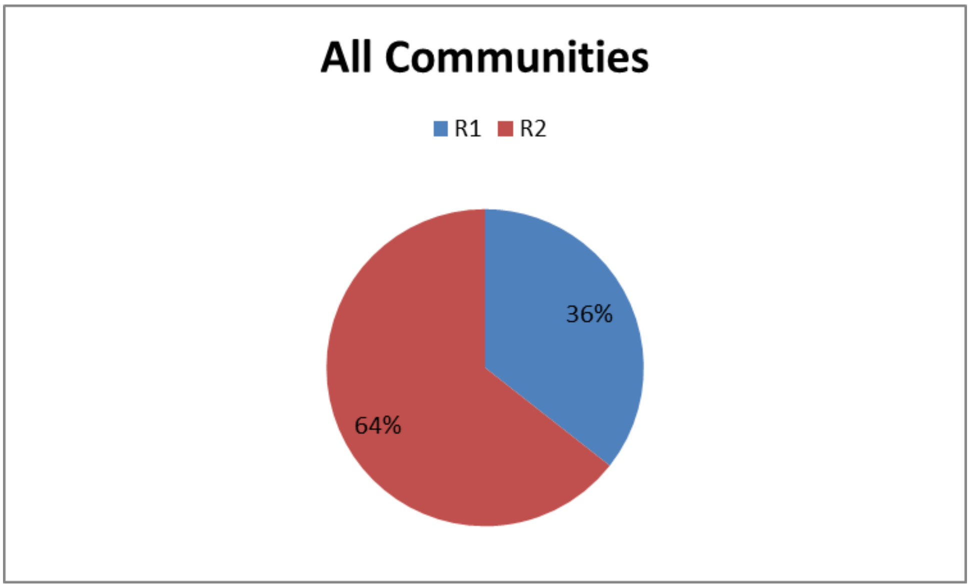
R1: Yes

R2: No









<u>Analysis and comments of the response 10</u>:

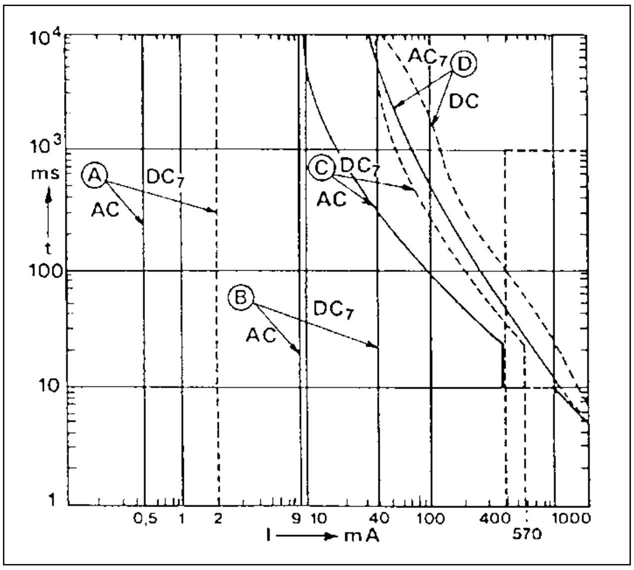
In view of the responses we see that an average of 36 % think that the risk of electrocution is high.
To date, very few studies have been conducted concerning the physiological effects of electric current in water and while it is true that this danger is real, it is very limited if the basic precautions associated with this technique are used.
When a diver comes into contact with a current source, the danger of electric shock depends on several factors such as:

- ✓ The duration of the contact.
- ✓ The type of current.
- ✓ The intensity of the current.
- ✓ The insulation type.

At the surface in a dry environment, the resistance of the human body varies from 3500 to 1000 ohms depending on the measurement locations.
In water, the resistance decreases greatly and generally does not exceed 750 to 100 Ohms. Four different thresholds have been established based on the intensity and duration.

A: sensation threshold of electric current
B: painful sensation threshold
C: safety curve beyond which there are significant risks
D: threshold beyond which there is a risk of fibrillation

Figure: the human body resistance level depending on the type of current



On reading this chart, we see that the body tolerates three times better the DC than alternating current.

This is due to the fact that on one hand it causes strong muscle contractions and on the other hand the voltage frequency (50 or 60 Hz) may result in the fibrillation of the heart. This is in particular one of the reasons for which the alternating current is no longer used under water.
It is clear that the risk of underwater electrical shock is strongly related to the type of insulating clothing worn by the diver.
The Battelle Memorial Institute has classified the resistance of the divers according to their type of equipment:

- ✓ 1000 Ohms for a diver in a dry suit and wearing a composite helmet and without gloves.
- ✓ 450 Ohms for a diver in a dry suit and wearing a band mask and without gloves.
- ✓ 300 Ohms for a diver in wet clothing and without gloves.

Currently it is recommended to use 750 Ohms as the reference value. If we refer to the security curve of the chart we see that to avoid the risk of a serious accident, the maximum intensity must remain below 40 mA and not exceed 10 seconds.
It should be noted that in the case of prolonged contact, the effects of DC are more severe than those of the alternating current because it produces electrolysis of the tissue while the alternating current acts on the muscles and the nervous system.
During cutting, the diver cutter faces two types of voltage:

1. The open circuit voltage which in function of welding group used will be between 65 and 80 volts.
2. The arc voltage which depending on the used electrode will range for ultra-thermic between 22 volts (short arc) and 30 volts (long arc) and the oxy-arc between 40 volts (short arc) and 47 volts (long arc).

Applying Ohm's law:

$$I = U / R$$

Or:

- I = Ampere
- U = Volt
- R = Ohm

It is noted that when the arc is created (and this regardless of the electrode used) the open circuit voltage is generally comprised between 65 to 80 volts and therefore the diver may be exposed during a very short time at an intensity of:

$$80/750 = 0.106 \text{ mA}$$

Applying the same formula to the arc voltage can be seen that depending on the type of electrode used the diver may be exposed throughout the combustion of the electrode at an intensity of:

30/750 = 0.04 mA (ultra-thermic)
47/750 = 0.062 mA (oxy-arc)

As can be seen above the intensity safety limit is exceeded on two occasions:
When starting the cut and when maintaining a long arc with a steel tubular electrode. However four elements must be present to cause an electric shock:

1. The electrical circuit must be greater than 40 mA for DC current and 10 mA for AC.
2. The contact time must be greater than 10 seconds.
3. There must be an insulation fault in the electric circuit.
4. The diver cutter must be exposed to insulation failure.

Therefore, to avoid the risk of electric shock it is important that the diver:

- ✓ Use preferably a dry suit.
- ✓ Wears rubber gloves.
- ✓ Avoids be between the work piece and ground.

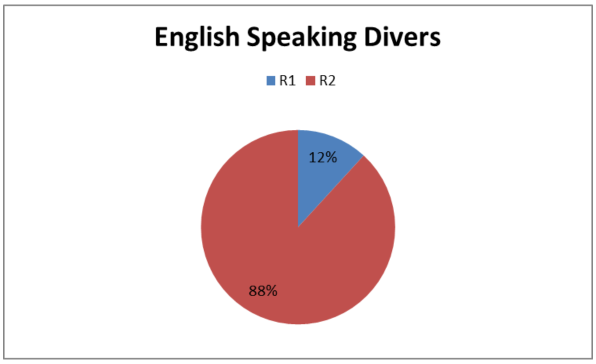
The danger is accentuated when a body part is not immersed.

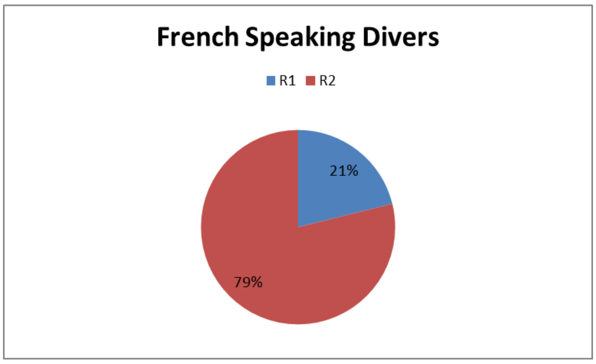
Despite the risks inherent to this type of work only one fatal accident is recorded since 1943. The accident happened at the Deep Sea Diving School, Washington Navy Yard to a student diver who was training to weld underwater in a tank 3 meters deep.
The diver was equipped with a Mark V helmet, a swimsuit and was barefoot.

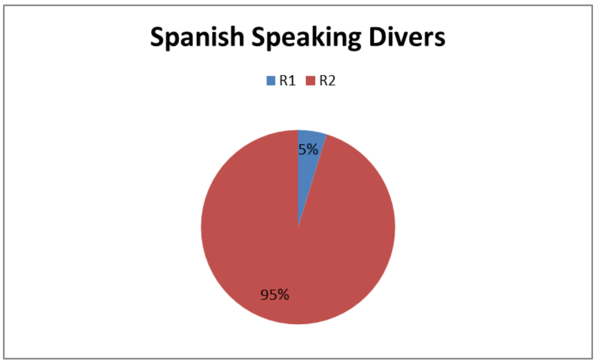
Question n° 11: Do you think electrical hazards associated with this type of work are higher in freshwater then seawater?

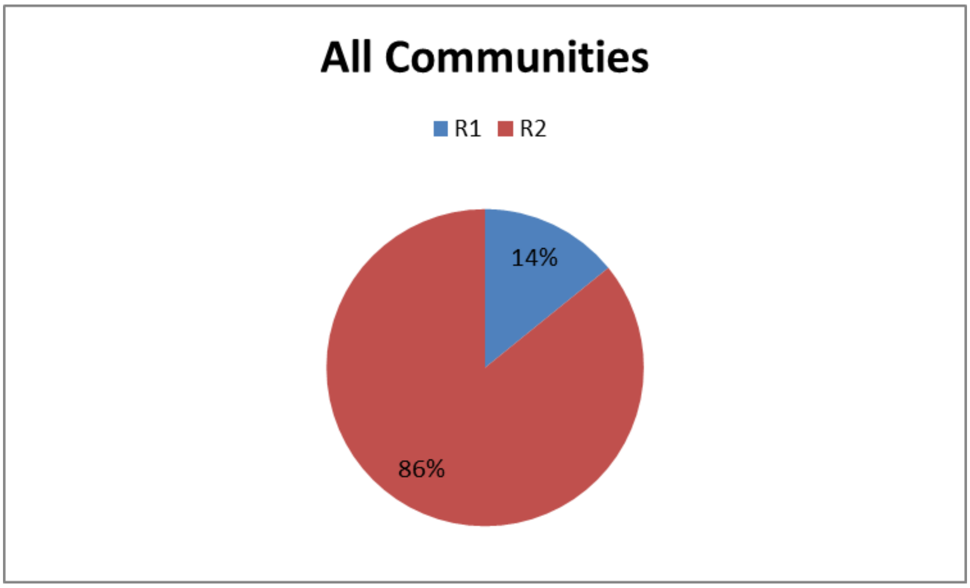
R1: Yes

R2: No









Analysis and comments of the response 11:

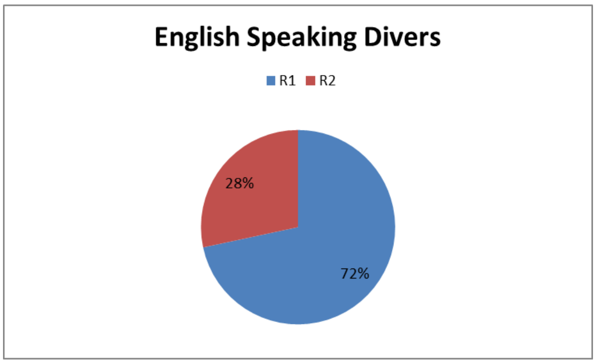
The vast majority of divers seem unaware that the electric cutting (and welding) present more risks in freshwater than seawater.
This is because the electrical current always seeks to follow the path of least resistance.
Tests carried out on immersed divers were able to determine that their electrical resistivity was around 750 Ohm / cm.
If the water in which works a diver has an electrical resistivity less than the diver's body thereof, such as seawater (25-30 ohms / cm), the current will then flow around the diver.
If, at contrary the diver is immersed in fresh water (resistivity of 1500 ohm / cm) the risk of receiving an electric shock is much more important since in this case the easiest path for the current will be to pass through the body rather than around it.

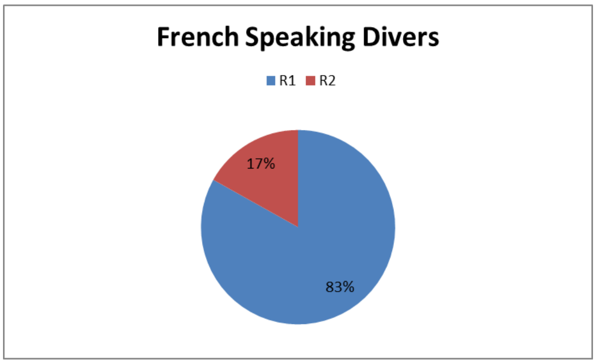
As a reminder, to date only one fatal accident was listed by electrocution.

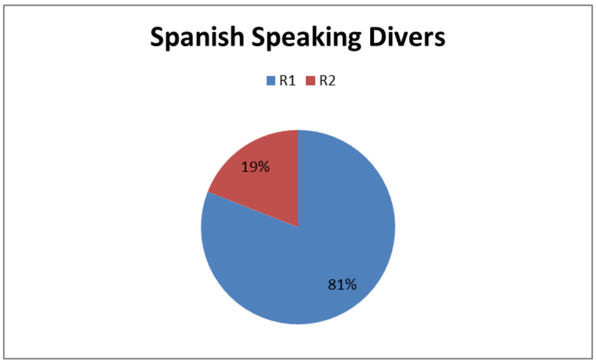
Question n° 12: Do you know a colleague or are you aware of any electric accident in water linked to this type of work?

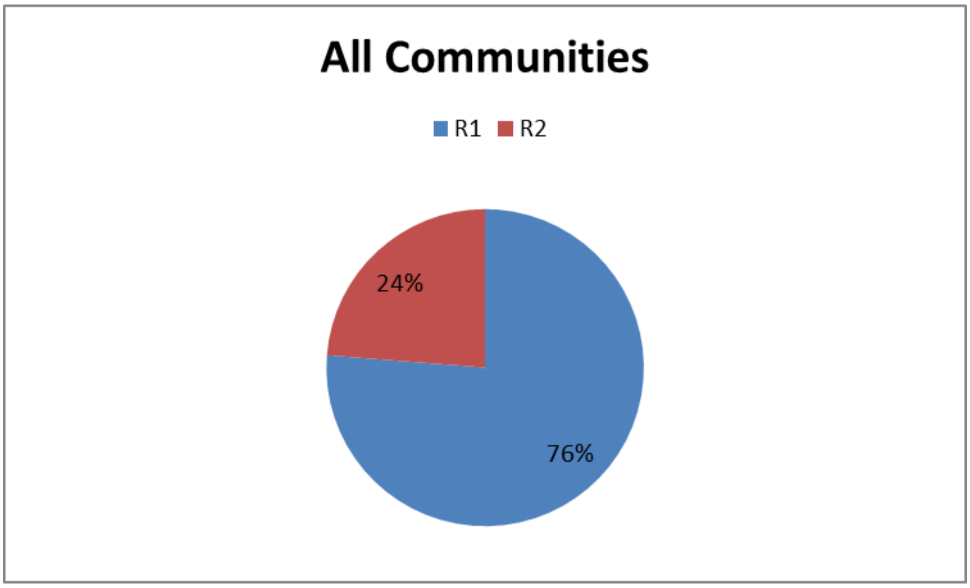
R1: No

R2: Yes









Analysis and comments of the response 12:

24% of responses mentioned knowing someone who has already suffered an electrical accident but when analysing the answers we find that in most cases these are the usual small not serious electric shocks.
6 replies, however, mention a more serious accident:

> 1: takes place during a salvage job in Spain during the 80s where the diver was left paralyzed on the bottom. No sequelae.
> 2. Takes place in France during a welding training course. Poorly insulated welding torch sticks for a very short period in diver's hand. No sequelae.
> 3. When welding on a pipeline with AC current, the welder's colleague is in sea water and does wear no gloves. Was electrocuted with loss of consciousness when the welder strokes the arc.
> 4. One English diver mentions being aware of three serious electric incidents but without giving more details.
> 5. One English diver reported another serious electrical incident during a salvage work in which a diver was electrocuted after accidentally using an AC / DC welding group.
> 6. Another French diver says he accidentally electrocuted an uninsulated colleague while welding on a partially submerged pipe with the AC power.

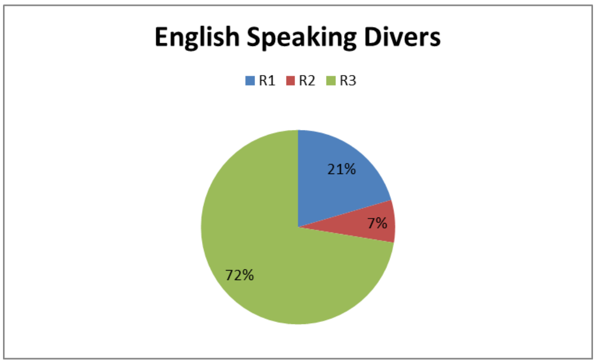
As a reminder, to date only one fatal accident was listed by electrocution.

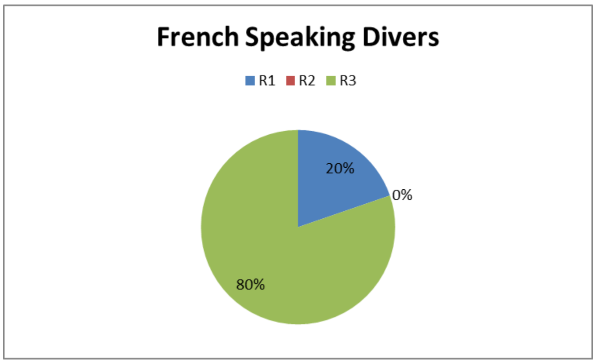
Question n° 13: It is known that these types of work generate an explosive gas mixture that if they are confined may explode violently. In your opinion what is the gas primarily responsible for these explosions?

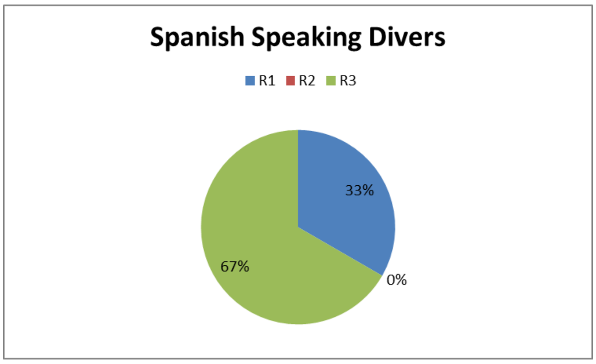
R1: Oxygen

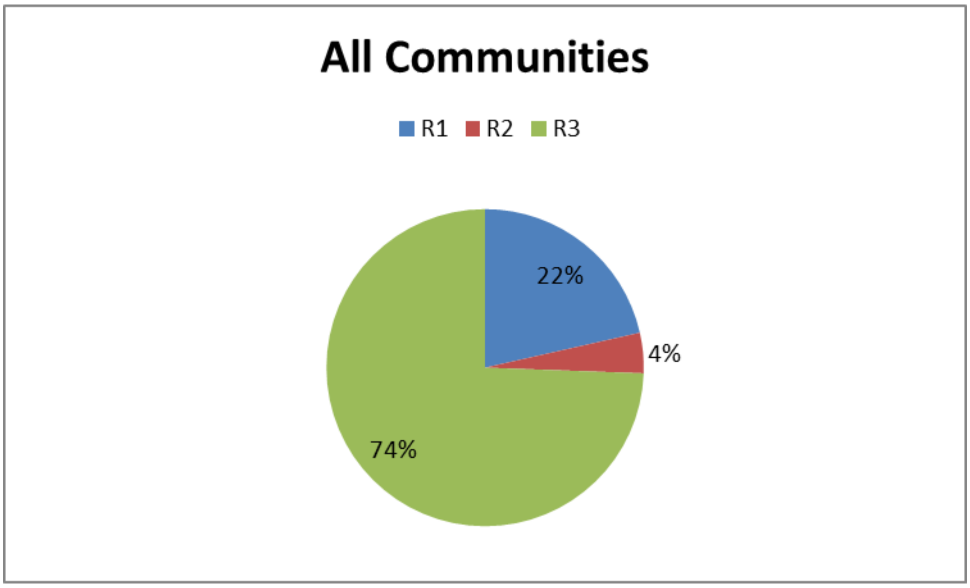
R2: Methane

R3: Hydrogen









Analysis and comments of the response 13:

More gaseous compounds are produced during the combustion of the electrodes but it is of course of the hydrogen formed by the vaporization and the electrolysis of water which is the main source of explosions.

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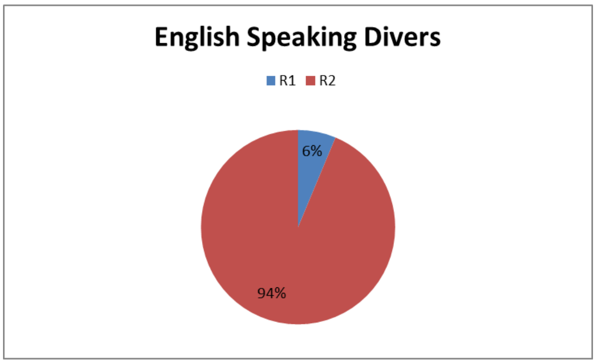
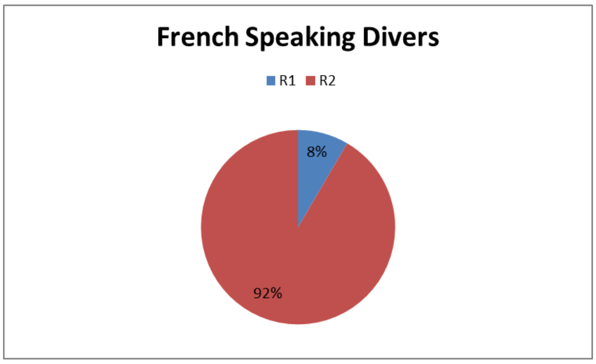
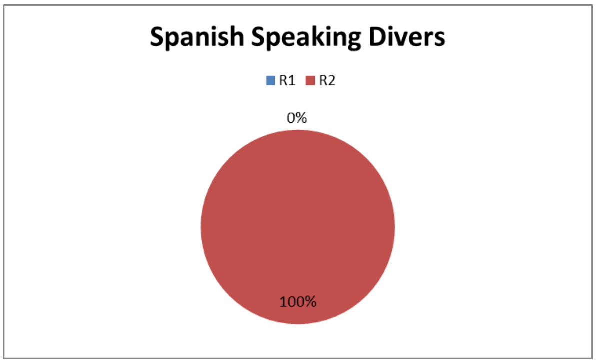
Question n° 14: When doing this type of work do you think it is possible to reduce or eliminate the risk of explosion?

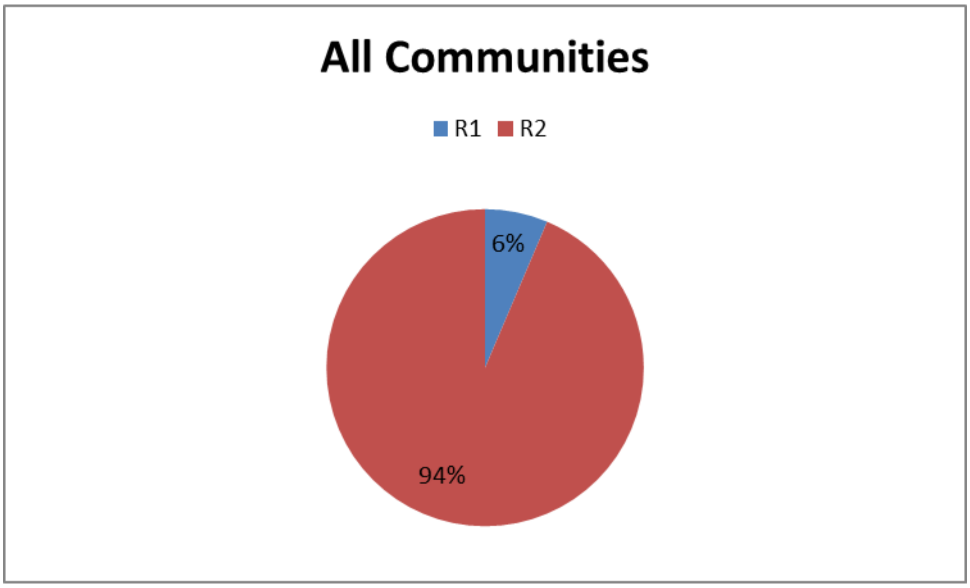
R1: No

R2: Yes









Analysis and comments of the response 14:

Before beginning a cut it is important and vital to do a correct risk analysis of the situation to determine if the gas can freely rise to the surface or whether there is a risk that they remain confined or be deflected in a specific area.

One of the few situations in which the electrical cutting (or gas cutting) exhibits substantially no risk of explosion occurs when cutting a structure in open water and when no material is present on the back of the cut thus allowing gas to freely rise to the surface.

In all other cases the risk is more or less present and must be taken into consideration.

One of the most effective ways to avoid the concentration of gas at a given location when cutting in an enclosed space is the realization of preventive evacuation window.

In many cases, the cutting of these windows can be carried out using cutting electrodes but in certain circumstances (presence of decomposition gas or other hydrocarbons) this method may prove to be highly dangerous and even fatal.

In this case the vent holes will be performed by using a tool that does not cause sparks (drill with reduced RPM).

The second method to evacuate the explosive gases when cutting is the venting with compressed air.

This method is primarily used when some material (concrete, sand, clay, etc.) is present on the back of the metal structure.

For this method to be effective, it is essential that the over-pressure surplus of the explosive gas and air can escape freely to the surface.

Ventilation with compressed air must nevertheless be carried out prudently and in all cases one must prevent that the pressure used for the ventilation is too high and thus increase the volume of any existing cavity.

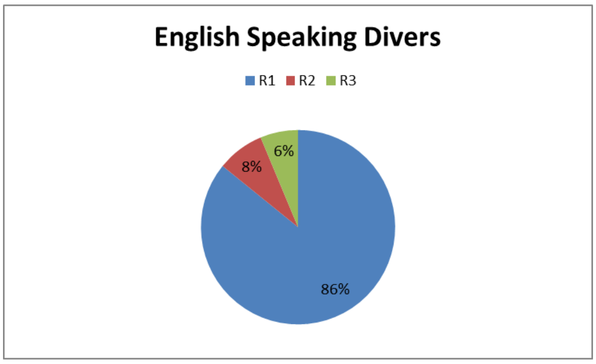
If during the risk analysis it is find that despite the completion of the drain holes and / or the ventilation a risk is still present that more than a few cubic centimetres of explosive gas can remain trapped then it is better to opt for a another cutting method.

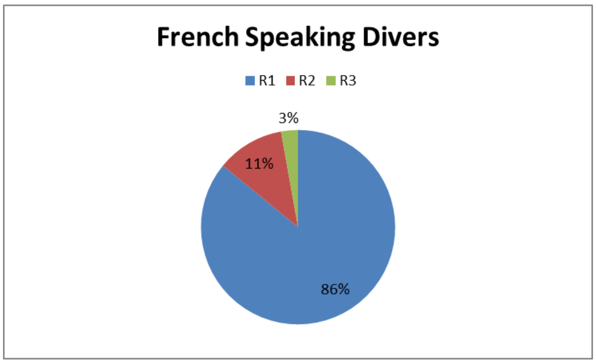
Question n° 15: According to you, when the gas mixture is confined what volume can cause serious injury if it explodes?

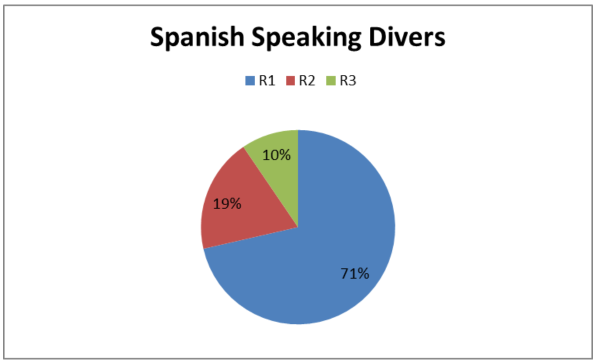
R1: 1-5 liters

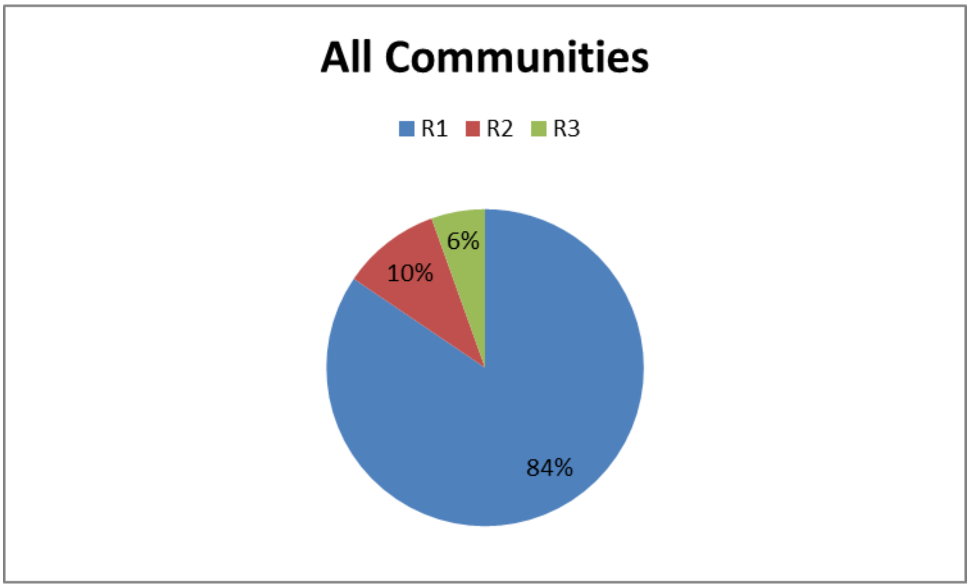
R2: 50-75 liters

R3: 100-200 liters









Analysis and comments of the response 15:

The intensity of the explosion depends on the volume of gas trapped in the cavity.
For instance the explosion of:

- ✓ A few (3-5) cm^3 (0,183- 0,305 $inch^3$) mixture is already strongly felt (finger slappers, punch effect, black eyes).
- ✓ A few (1-5) liters (0,035-0,177) ft^3 mixture usually causes a serious accident (rupture of the eardrums, sinus detachment, lung problems).
- ✓ One hundred liters of mixture is generally fatal (same as above, fractures, internal bleeding).

To provoke an explosion we need to bring 3 elements together: Oxygen - Fuel - Heat.
If one of the elements is missing, there can be no explosion.
It means that the accidents that regularly happen to divers during their cutting operation are not due to the explosion of the sole oxygen which is impossible but well because the oxygen mixes with a fuel gas.
When we use our electrical cutting torch, the electrolyse that is produced between the electrode tip and the piece to be cut dissociates the water molecules in two gasses, O_2 and H_2.
If a cavity is present at the back side of the cut, the hydrogen will mix with the oxygen and it can then rapidly reach the LEL (lower explosive limit) which for a mixture $H_2 + O_2$ is as low as 4%.
As we now already have 2 of the elements of the triangle, we just need a spark created by the fusion of the rod, to provoke the explosion.
It is not always the hydrogen that constitutes the fuel; it can also be another combustible gas (hydrocarbon - methane) which can be trapped in a closed cavity.
If the explosive gas is trapped in a small volume, the explosion takes the form of a deflagration where the decomposition speed will be around 500 to 600 m/sec (1666 to 2000 feet/sec) and in this case the overpressure of the blast is estimated around 7 - 10 bars.
But if the closed cavity can be filled by a greater volume of explosive gas (generally a hundred litres suffice) then the deflagration regime can progress into a detonation modus with a VOD (velocity of detonation) of about 2800 m/sec (9333 feet/sec) and in this case the overpressure can reach a few hundred bars, and the effects of the explosion will be much more serious and can then be compared with the explosion of a certain amount of TNT which we can imagine will have more lethal effects.
The other parameter that can increase (or decrease) the strength of the explosion is the percentage of fuel gas that mixes with the oxygen. Every mixture has a LEL (lower explosive limit) and an UEL (upper explosive limit) which are the limits at which the gas mixture can explode, and it is somewhere there between the lower and the upper limit that we find the optimum mixture which is the percentage of fuel gas that will produce the most effects.
The optimum $H_2 + O_2$ mixture is around 29/71.
If the diver's body had no gas containing cavities, they could resist the effects of an underwater explosion without problem because the shock wave would simply pass through their body without affecting it. But the problem is that we have lungs, sinus, bowels etc. and

hence, the effects are quite different because when the shock pulse encounters the body cavity, there is what is called a "spalling effect" along the gas/tissue interface.
Without entering in the details, it can be said that it is due to a difference of impedance between our tissues and the gas cavities which then provoke a negative reflection of the shock wave as with consequences the perforation of the stomach and intestine, the rupture of the air cells of the lungs and a lot of haemorrhage.
A lot of test have been made with animals and human volunteers (the animals were not volunteers) to determine the fatal and the non-dangerous overpressure.
The conclusions are:

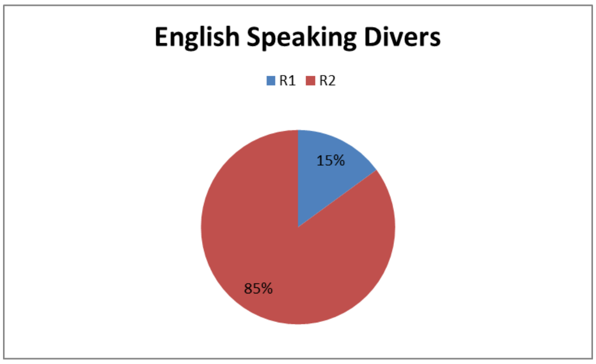
- ✓ Fatal overpressure = +/- 21 bars
- ✓ Non dangerous overpressure = +/- 3, 5 bars

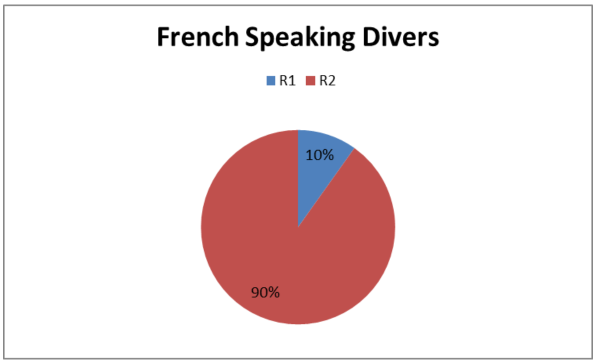
Unfortunately for divers, there are no means (except an armoured suit) to protect them from the effects of an underwater explosion.
A few decades ago, tests were also made on animals encased in foamed neoprene, but in most of the cases that didn't help because the problem of injuries doesn't only comes from the shock pulse, but also from some other phenomenon generated by the blast like the impulse, the time constant, the energy flux and the water movement, but that would be too long to explain here.

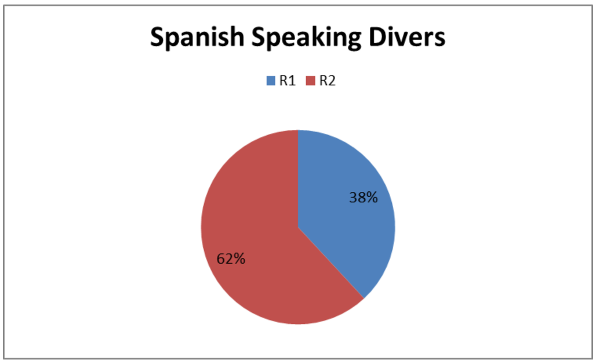
Question n° 16: When using ultra-thermic electrodes, do you think that cutting with a cold electrode (power off) removes the risk of explosion?

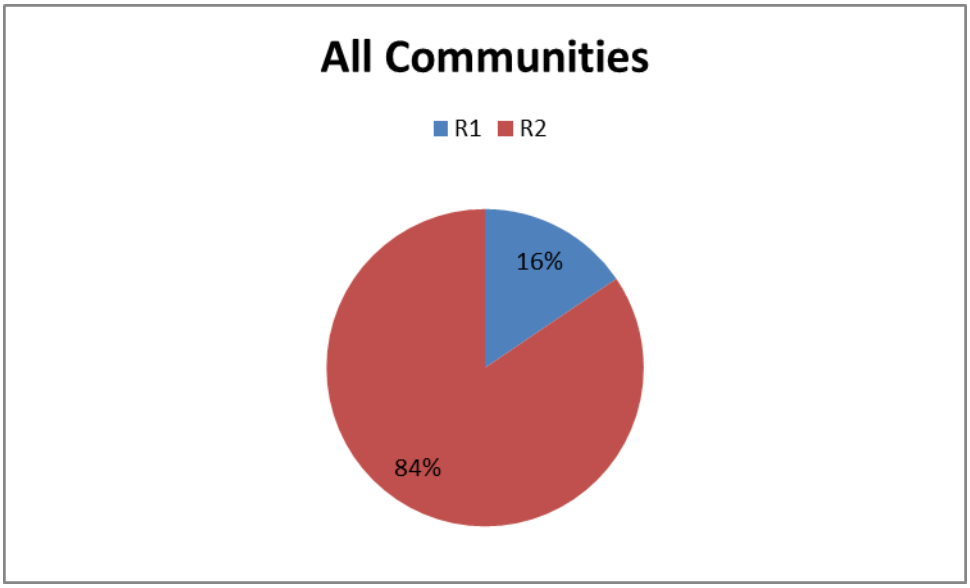
R1: Yes

R2: No





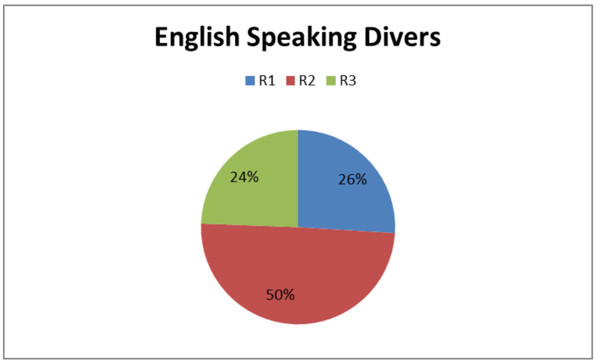


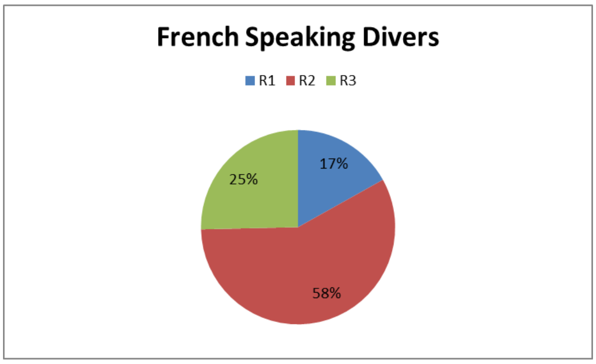


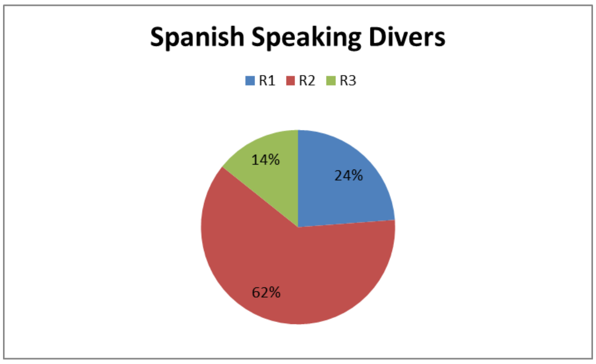
Analysis and comments of the response 16:

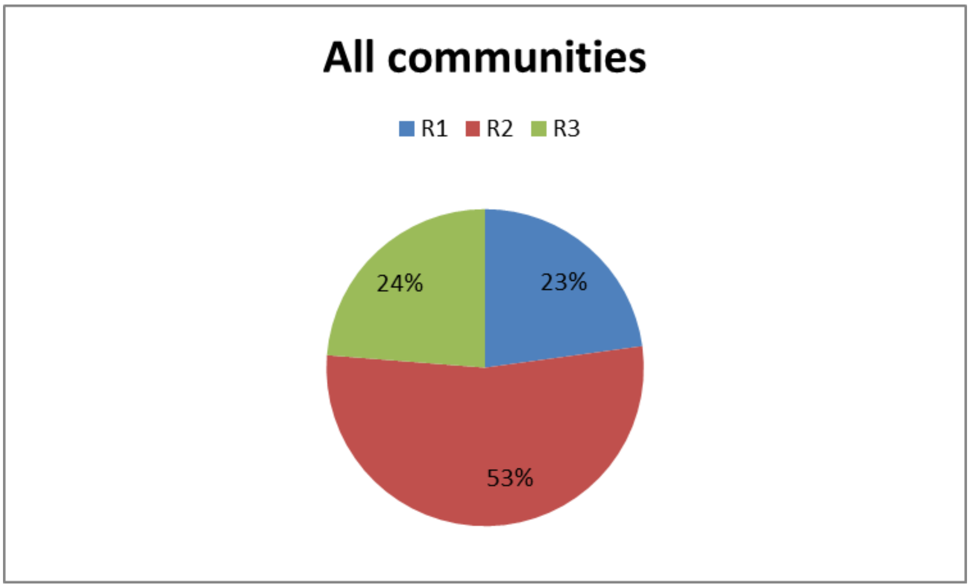
We have seen that during a cutting (or welding) operation the hydrogen and oxygen was created by using an electric current so we could logically assume that if the power source is removed the hydrogen production would cease and thus diminish the risk of explosion.
This is unfortunately not the case for a large portion of the hydrogen and oxygen is also produced by the vaporization of the water present around the burning tip of the electrode and in the kerf.
Indeed, the temperature at which the hydrogen molecules are dissociated from the water is at approximately 1095 ° C (3000 ° F) which is below the steel's ignition 1300 ° C. (2375 ° F) but well below the temperature of 4150 ° C (7500 ° F) prevailing at the end of an electrode which is consumed without the provision of an electric arc.
So we can say that the cutting with a cold electrode will reduce the formation of hydrogen but not enough to avoid the risk of explosion.

Question n° 17: Do you think that under water electric cutting can cause an arc-eye?
R1: No
R2: Yes
R3: Depends on water limpidity









By Francis Hermans retired commercial diver

Analysis and comments of the response 17:

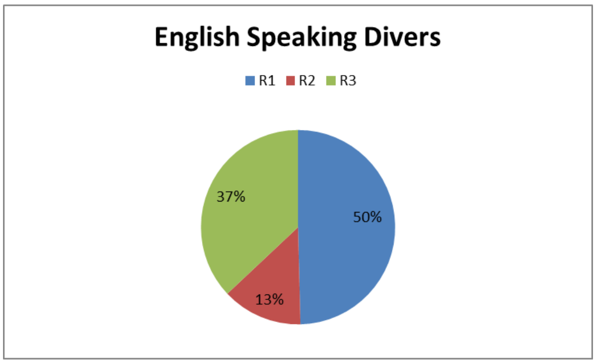
Such as on the surface, the underwater electric cutting emits ultraviolet and infrared rays that can cause serious ocular problems if the eyes are not protected by a screen. The radiation intensity depends on several factors such as:

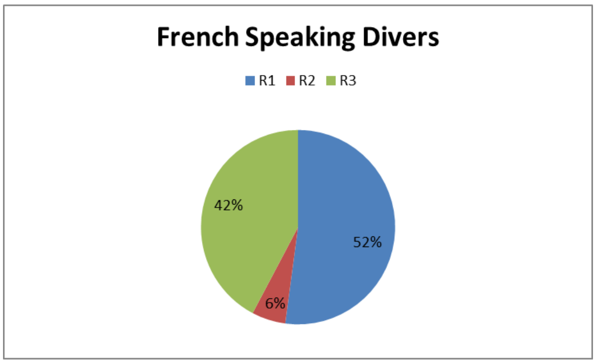
The type of electrode used:
Thanks to their low operating current ultra-thermic electrodes generate less UV than tubular electrodes but they emit more infrared rays.

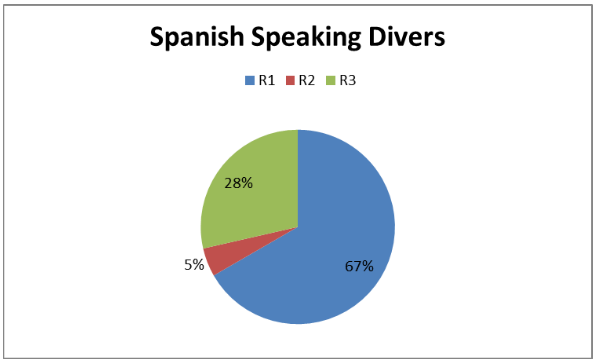
The length of the arc:
Whatever type of electrode is used it is possible with a little experience to greatly reduce the UV radiation by cutting with a very short arc.

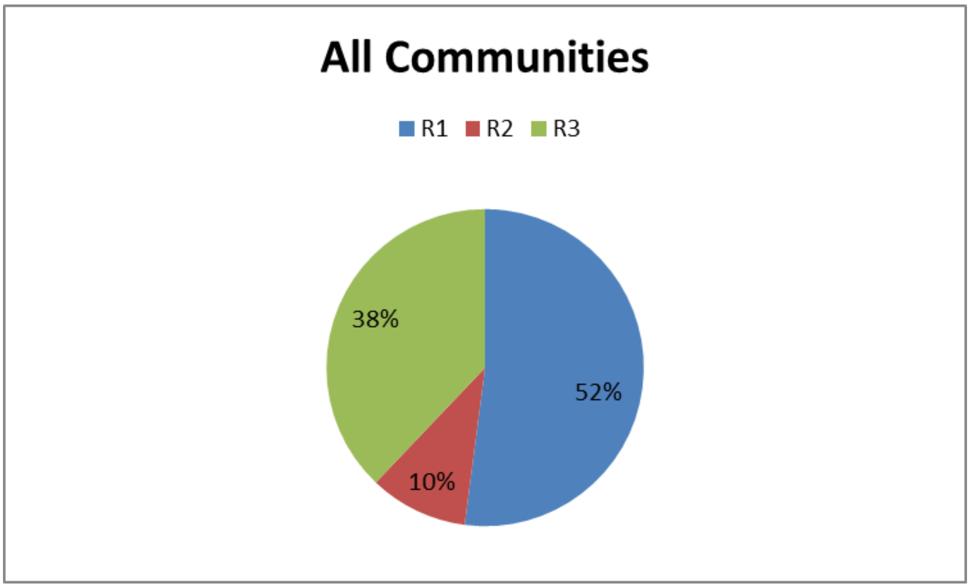
The water clarity:
In many cases (especially in civil engineering) cutting takes place in the dark and in this case the shield screen is absolutely useless. When the water clarity increases and the glare cause by the arc striking becomes annoying it is necessary to protect oneself with adequate filter glass.
It is interesting to remember that in clear water UV radiation is absorbed only slightly (1/10 per meter of thickness of water) and can therefore cause arc eyes and ocular irritation to people looking a cutting (or welder) diver through a window.

Question n° 18: Do you think that under water electric cutting is dangerous?
R1: Yes
R2: No
R3: Sometimes





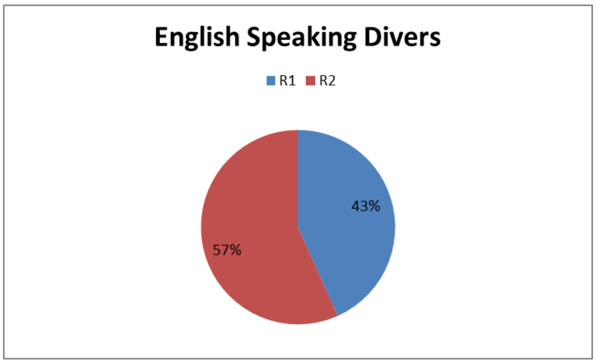


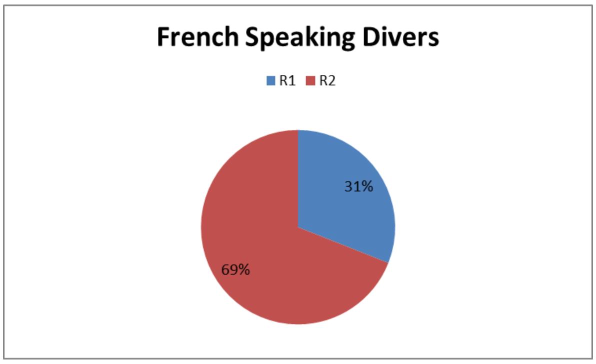


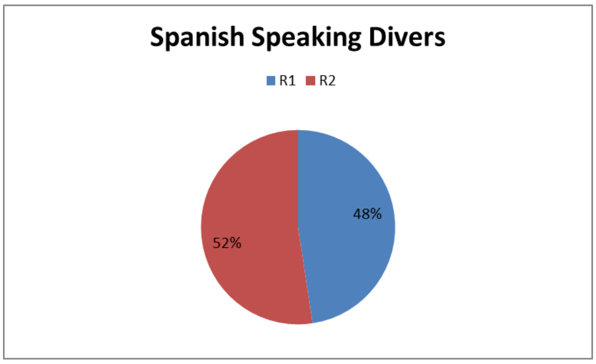
Analysis and comments of the response 18:

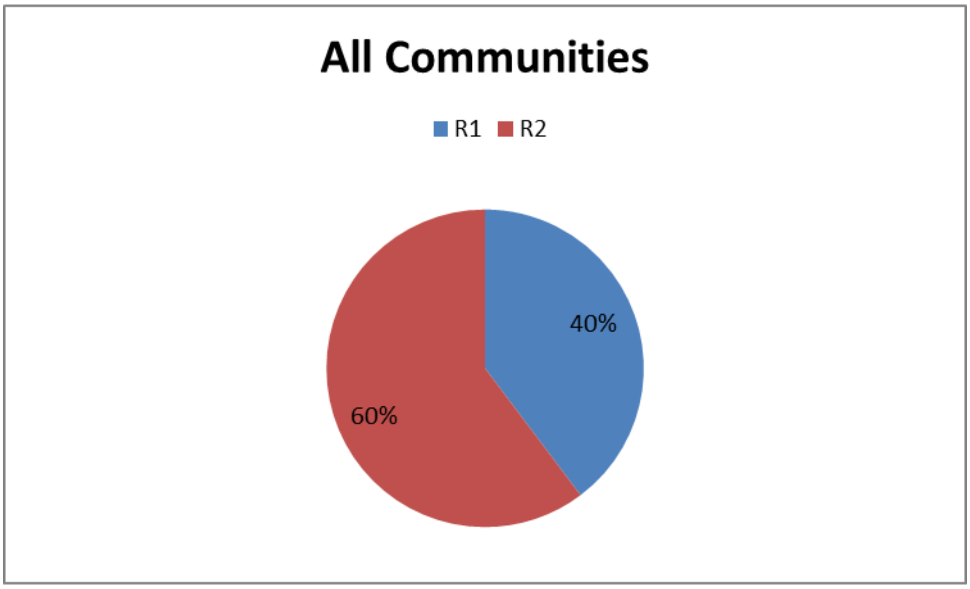
The whole community is well aware of the risks generated by this technique.
Although the risk of electrocution exists, it is however very limited and almost non-existent if basic precautions are taken.
The highest risk with electrical cutting and unfortunately shown by the statistics are the explosions.

Question n° 19: Have you apprehensive when cutting under water?
R1: Yes
R2: No





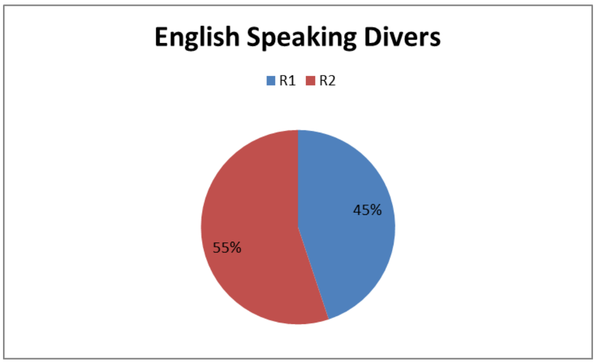


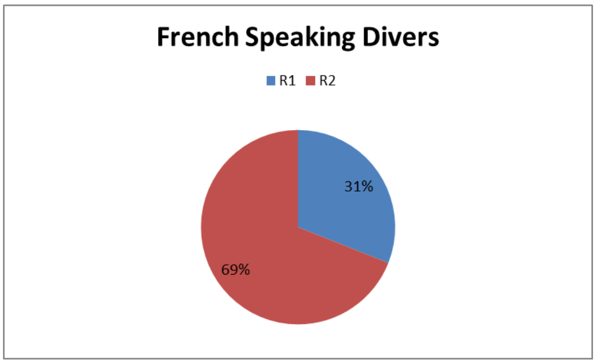


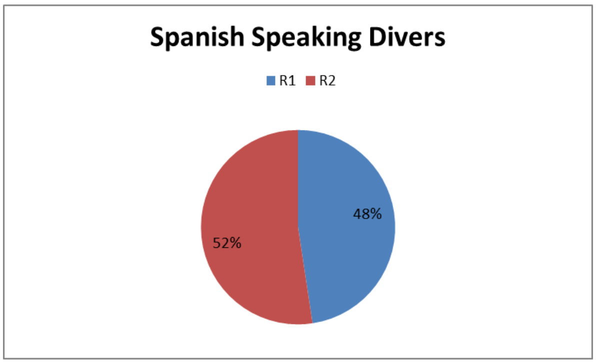
Analysis and comments of the response 19:

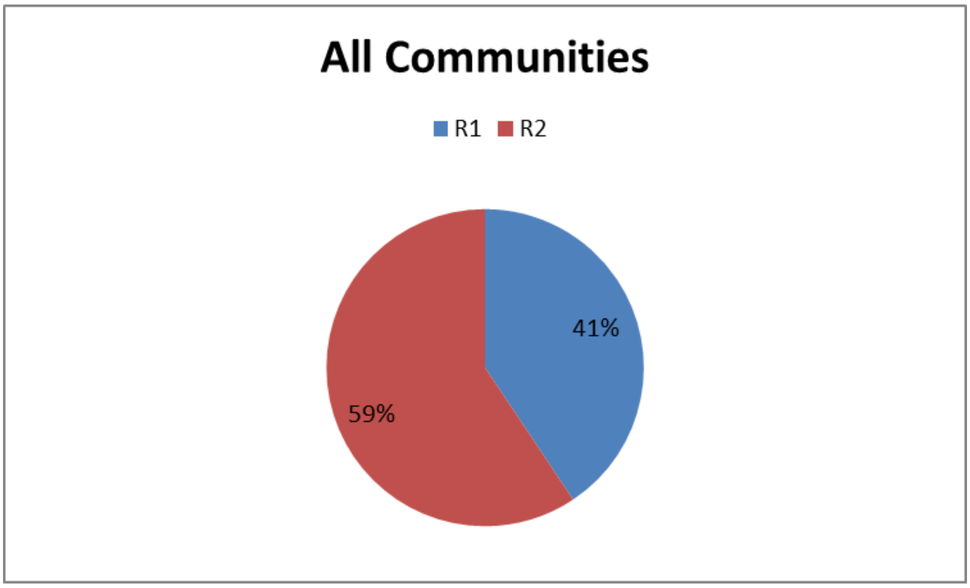
Cutting with a slight apprehension is not bad because it helps to stay alert. But too much apprehension could lead to the opposite effect and create dangerous situations.
It is then best to stop the cutting and taking the time to analyse the situation again.
If in doubt do not hesitate to replace electric cutting by another method with less risk for the diver.

Question n° 20: Do you think that what you have learned during your diver training is sufficient to allow you to use this technique safely?
R1: Yes
R2: No









Analysis and comments of the response 20:

If we analyse some comments attached to this question, it is found in the vast majority of student divers' answers that they are frustrated to only have burned a few rods under water during training.

Other comments sometimes mention some incompetence on the part of some of the teachers who have not fully mastered this technique.

Conclusions:

Although it was more interesting to have a greater response panel, this number nevertheless allows seeing some unexpected facts.

The first concerns the use and implementation of the current switch.
As can be seen, and although the whole community feels that this device is required, it is far to be systematically used.
The champion in this field is the French speaking divers' community where only 51% of them say to use it routinely.
The responses in the various comments related to this issue have unfortunately not allowed to find the reason for the non-use if not several old divers say they have seen the equipment in the late 90s and as they were used working without it they did not changed their habit.

Another troubling point revealed by the survey is that 20% of divers say they use alternating current for cutting under water.
One might think that few wacky divers have answered so to somewhat guided the survey, but by analysing the responses of those who responded: "AC" we find that the rest of their responses is sensible and therefore any supposition of "joke" is excluded.
The question whether the use of this type of current is real or is it due to a lack of knowledge that does not allow then to differentiate direct current from alternating current.

The third interesting element of this survey concerns the Commercial Diving School where it can be seen that a great part of the divers judge that the teaching of this technique is insufficient.
Based on feedback from former students we read that depending on the school they have only at their disposal between 5 and 20 electrodes to burn. Only the Belgian Commercial Diving School seems to provide between 45 and 60 electrodes per student.
While it is true that this technique cannot be mastered in a few days, it would nevertheless be beneficial that a few hours of additional practice would be devoted to it.
In view also of some responses it seems clear that for some schools the teaching of the theoretical part should be improved and some instructors should be more aware of this cutting technique.

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