

The peculiarities prevention emergency analysis abroad associated with the underwater location of explosives

Аналіз особливостей попередження надзвичайних ситуацій, пов'язаних з підводним розташуванням вибухонебезпечних предметів, за кордоном

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Purpose: analysis of the prevention emergencies features of associated with the underwater location of explosive objects in the leading countries of the world.

Method: the qualitative review of the science sources of the leading countries of the world, which discusses the features of humanitarian underwater demining at the regional level.

Findings: bibliographic information has been collected and analyzed from 105 sources; based on the results obtained, it was found that until recently, the national armed forces had exclusive experience in destroying underwater explosive objects, and today these dangers are eliminated along with them by various organizations (commercial companies, non-governmental organizations, teams of central and local authorities, etc.).

Theoretical implications: the method of systematic analysis of information sources by simultaneously considering both military and humanitarian information on issues of underwater demining has been further developed.

Practical value of the research: the main result of research on the subject of the article is the determination of the need to adjust the activities of the personnel of non-military organizations in addition to the skills that are given during the primary training by specialized units of the navy.

Value of the research: the process of preventing emergencies related to the underwater location of explosive objects must be considered taking into account the significant differences in

Мета роботи: аналіз особливостей попередження надзвичайних ситуацій, пов'язаних з підводним розташуванням вибухонебезпечних предметів, в провідних країнах світу.

Метод дослідження: якісний огляд літературних джерел провідних країн світу, в яких розглядаються особливості гуманітарного підводного розмінування на регіональному рівні.

Результати дослідження: зібрано бібліографічну інформацію та проведено аналіз 105 джерел; на основі отриманих результатів визначено, що якщо до недавнього часу ексклюзивним досвідом у знищенні підводних вибухонебезпечних предметів володіли національні збройні сили, то сьогодні ці небезпеки разом з ними усувають різні типи (комерційні компанії, неурядові організації, команди центральних та місцевих органів влади тощо) організацій.

Теоретична цінність дослідження: набув подальшого розвитку метод системного аналізу джерел інформації шляхом одночасного розгляду як військової, так і гуманітарної інформації щодо питань підводного розмінування.

Практична цінність дослідження: основним результатом досліджень за тематикою статті є визначення необхідності коригування діяльності особового складу невійськових організацій в додаток до тих навичок, які їм надають під час первинного навчання спеціалізовані підрозділи ВМС.

Цінність дослідження: показано, що процес попередження надзвичайних ситуацій, пов'язаних з підводним

the activities of sappers of the State Emergency Service of Ukraine from the activities of sappers of the Navy of the Armed Forces of Ukraine, that have been shown.

Research Limitations/Future Research: The conclusions drawn may differ from the analysis of the international activities charitable and non-profit organizations engaged in the clearance of mines and unexploded ordnance, which may pose a danger to civilians. Future studies should be related to experimental studies of the activities characteristics of sappers of the State Emergency Service of Ukraine.

Paper type: Conceptual.

розташуванням вибухонебезпечних предметів, необхідно розглядати з урахуванням суттєвих відмінностей діяльності водолазів-саперів ДСНС України від діяльності водолазів-саперів ВМС Збройних сил України.

Обмеження дослідження/Майбутні дослідження: Отримані висновки можуть відрізнятись за результатами аналізу діяльності міжнародних благодійних та некомерційних організацій, що займаються знешкодженням мін і боеприпасів, що не розірвались та можуть становити небезпеку для цивільних осіб. Майбутні дослідження мають бути пов'язаними з експериментальними дослідженнями особливостей діяльності водолазів-саперів ДСНС України.

Тип статті: Концептуальний.

Ключові слова: underwater demining, sapper diver, leading countries, literature review.

Key words: підводне розмінування, водолаз-сапер, провідні країни, огляд літератури.

1. Introduction

The global ocean economy is projected to grow by more than 100 percent between 2010 and 2030. During this period, more than 40 million people will be employed in the maritime industry. The European Union (EU) has developed a Blue Growth strategy to reap the expected economic benefits in recognition of this potential. At the same time, as technological advances make greater use of maritime resources, new access to untapped capabilities is forcing coastal states to face the explosive consequences of war and toxic warfare agents at sea [1]. The evidence is that, beginning with World War I and continuing through World War II and beyond, several world nations have dumped both chemical [2] and conventional weapons into the oceans around the world.

In our country, the problem of increasing the effectiveness of preventing emergencies associated with the underwater location of explosive objects is exacerbated by the significant amount of remnants of the Second World War in the waters of the Black and Azov Seas [3], as well as the consequences of aggression and hostilities. The water area of the Dnieper between the Antonov bridges is a typical example [4].

Considering this and the pan-European values and aspirations of our state in the direction of underwater humanitarian demining, further work should take place taking into account the world experience of the leading countries of the world.

2. Theoretical foundations of the study

An analysis of international documents regulating the process of eliminating emergencies related to the underwater location of explosive objects showed that this issue became relevant as early as the beginning of the twentieth century. Thus, the negative impact on commercial shipping led to the Hague Convention VIII in 1907. This convention concerns specific international legal restrictions on the use of sea mines [5]. In 1994, these restrictions were specified in the San Remo Guide [6]. In accordance with these guidelines, belligerents should only use mines that are effectively neutralized after they are released or lost control of them. It is clear that this is not always successful, as a result of which there will always be an underwater danger.

That is at the regional level the countries that have adopted the Convention for the Protection of the Marine Environment (the so-called "OSPAR Convention" [7], or the Mediterranean Sea of the North-East Atlantic, are aware. That convention involves the consideration of issues of underwater demining within the framework of the Regional Pollution Emergency Response Center Mediterranean Sea (REMPEC) It helps coastal states to implement international maritime conventions related to the prevention of pollution of the sea and the response to it in case of occurrence [8].

Non-governmental organizations involved in the problem of underwater demining are divided into two related groups. One group (in the majority) is engaged in a discussion of how

underwater munitions affect human health and the environment and the destruction of the sea and oceans. That group includes the United States Naval Institute (USNI). It is a private, non-profit military association that offers independent, non-partisan forums for discussing national security issues in journals and books it publishes and during academic conferences [9]. The Center for International Maritime Security (CIMSEC), an impartial think tank registered as a non-profit organization in Maryland, established in 2012, currently has 20 international chapters and over 3,000 members and subscribers in 60 countries. CIMSEC publishes articles on a variety of issues related to international maritime security on its Next War blog [10]. However, despite the wide coverage of underwater demining issues, the peculiarities of individual countries and regions, these organizations were not considered. The second group actively participates in international scientific programs. This group includes the Geneva Call [11] and the International Dialogue on Underwater Munitions (IDUM) [12] working on research within the framework of the Search and Assessment of Chemical Weapons Baltic Sea. sea); MODUM NATO Science for Peace and Security (SPS); DAIMON (Decision Assistance for Naval Munitions). In doing so, IDUM serves as the global focal point for policy, science, technology, and response to underwater munitions. Regional features are also not considered by these organizations.

A special place is occupied by the Geneva International Center for Humanitarian Demining (GICHD) is an international organization involved in mine action and explosive ordnance risk reduction. The work of GICHD is focused, among other things, on technical support and training, as well as the development and implementation of international norms and standards [13]. Thus, in 2013, the United Nations Mine Action Service (UNMAS) [14] responded to the GICHD initiative by agreeing to establish an international mine action standard for the handling of underwater explosive ordnance [15]. On December 1, 2014, UNMAS adopted the International Mine Action Standard IMAS 09.60 Underwater Survey and Explosive Ordnance Disposal (EO) which established the basic principles and requirements for underwater survey operations. [16] Based on this standard, the GICHD prepared the Guidelines for the Review and Cleanup of Subsea Explosive Ordnance in 2016 [17]. The information in this manual expands on the general information of IMAS 09.60 [16] to cover explosive underwater munitions in a country's territorial waters (typically nautical miles offshore) and inland waters below the mean low water mark (MLLW) to a depth of 50 m or less. This standard combined military tactics and mine action methodology using commercial technologies for the safe, efficient and cost-effective clearance of underwater explosive ordnance, but the consideration of the characteristics of individual States was left to their discretion.

3. Problem setting

In view of the foregoing, the lack of analysis of international experience regarding regional and departmental features of humanitarian underwater demining is a problem of increasing the effectiveness of preventing emergencies related to the underwater location of explosive objects.

That requires the definition of the emergencies prevention features of the associated with the underwater location of explosive objects abroad.

4. Research methodology

Review of literary sources of the leading world countries, which discusses the features of humanitarian underwater demining at the regional and departmental level:

- analysis of the elimination peculiarities of underwater explosive objects in European countries;
- determining the features of the emergency liquidation related to the underwater location of explosive objects in the United States;

- analysis features of the disposal explosive objects located under water in the Indo-Pacific region.

5. Results

5.1. Analysis of the elimination features underwater explosive objects in European countries

Approximately 175,000 mines in the Baltic Sea during the world wars have been laid [18]. There are currently about 1985 minefields in the Baltic Sea and another 4400 in the North Sea [19].

There remains a danger for civilian facilities in the Baltic countries. So, on November 25, 2019, in Swinoujse (Poland), employees of the company, which was deepening the fairway along the Szczecin-Swinoujście route discovered a British 900-kilogram (425 kg of explosive) Mk VI aircraft sea mine Second World War. The movement of ships in the area of the Svinouisk port due to the involvement of the army in the work to neutralize the mine for several hours has been suspended. The mine was lifted from the bottom and laid aboard the destroyer "Flaming" and neutralized at the sea range [20].

Also, in Poland 2020 on October 13 the aviation seismic bomb Tallboy was defused (weight 5400 kg, of which 2400 kg is the explosive) - the largest explosive object that has ever fallen on the territory of the country [21, 22]. Specialists of the Polish Naval Forces discovered it at the bottom of the shipping channel of the Baltic Sea near the town of Swinoujście. It located on the border with Germany [23, 24]. The decontamination operation itself lasted five days. For that 751 people from the nearby area were evacuated.

Dangerous for Poland are underwater burials of hazardous toxic materials from the Second World War [25]. In this regard, it noted that Poland should accede to the Nairobi Convention on the Removal of Wrecks [26] and cooperate more closely at the regional level to solve the problem of Baltic chemical waste.

In the countries of the Baltic region specialized units of the Navies are responsible for operations to withdrawal or detonate underwater munitions:

- Minentaucherkompanie [27] in Germany, where they are also responsible for maintaining underwater drones;

- the Minedykkerkommandoen group of the Norwegian Naval Command, engaged in underwater demining [28];

- a division of sapper divers engaged in underwater demining Tuukrigrupp in Estonia (since 1995, demining operations have been regularly carried out in Estonian waters, as a result of which more than 1200 explosive devices have been defused) [29];

- divers of the Swedish Navy, who are assigned to carry out underwater explosive ordnance disposal operations. Evidence of their high qualifications is their participation in the Atalanta operation in Somalia, where they provided mine protection for coastal areas and inland waters [31];

- in Finland [32], annually 20 conscripts are trained for 12 months for underwater demining at a shallow depth sufficient for underwater humanitarian demining, while deep-sea diving is carried out only by career personnel;

- various divisions of sapper divers of the Royal Netherlands Army, engaged in underwater demining on the rivers Korps Commandotroepen [33], deep diving and inspection of the beaches of Defensie Duikgroep [34], ensuring safety during the construction of various Constructieduikerspeloton crossings [33];

- similar tasks, if necessary, can be assigned to the Belgian Navy special forces group Frømandskorpset [36].

That has a specialized diving company and an elite corps of special forces combat scuba

divers of the Royal Danish Navy [37].

Coordination of efforts and provision of common approaches is carried out by the Baltic Munitions Safety Board (BOSB) [38]. However, he does not consider the features of the use of existing technical means of demining, which are different in each country. In Europe, the United Kingdom is the country with the most powerful underwater demining units [39]. So, already more than 170 years ago, the Corps of Royal Engineers (sappers) [40] began to train army divers. Divers of the Corps, unlike naval divers who perform combat operational operations, engaged in humanitarian search and disposal of explosive ordnance, work only in compressed air apparatus.

The sapper diver was originally a specialized sea diver. He was engaged in underwater demining and used explosives underwater to remove obstacles and/or make harbors and shipping channels safe to navigate. Later, the term "sapper diver" was used to refer to other offshore underwater activities. The United Kingdom Navy Sapper Diving Units were first formed during and after World War II to clear ports and harbors in the Mediterranean and Northern Europe of unexploded ordnance, shipwrecks and booby traps set by the Germans [41].

Thus, in the United Kingdom at one time there were 1,997 minefields, which contained from 338,500 to 350,000 mines. These mines were placed in places suitable for amphibious landings in the 1940s. In [42], it was noted that the most expensive underwater clearing was the coastal zone. At the same time, the United Kingdom Navy's sapper divers were replaced by "Port Clearance Parties" (P Parties). The first operations of the P Parties included the removal of unexploded ordnance left over from the invasion of Normandy [43].

Currently, preparations for underwater demining (in that case, humanitarian) are being carried out by the training regiment for the disposal of explosive ordnance and the search for the Royal Military Engineering School. It is, among other things, responsible for training all search operators in underwater demining [44, 45].

By this time, the problem of underwater demining remains relevant for France. That confirms the successful collaboration between Geomines, G-TEC and JIFMAR to locate, identify and destroy unexploded ordnance at the Calvados offshore wind farm [46]. Separately, one can single out the ECA Group, which in 2008 won a major contract for underwater demining [47].

In addition, the French army also has sapper divers engaged in underwater demining in the freshwater environment "Plongeurs de combat du génie". Along with the ability to blow up and neutralize explosives, sappers also examine the banks of rivers and places of possible crossings [48].

In Italy, as in France, humanitarian underwater demining is carried out by commercial organizations [49]. These have the appropriate powers and permits from their Ministries of Defense. Confirmation of the relevance of this activity is the situation that took place in Venice, Italy on February 2, 2020, when the operation to neutralize a 220-kilogram bomb during the Second World War began. By the time the operation was carried out, about 3,500 residents of Venice had been evacuated, and traffic had also been stopped in the area where the bomb was found. The operation to extract, neutralize and destroy the bomb was successful [50].

As for Italy, it should be noted that it was in this country that sappers divers were the first to switch to the use of light diving equipment (mainly scuba gear) instead of stationary diving suits and Davis apparatus [51].

In the South European region, the main underwater demining company is the "Montenegrin company Big blue montenegro doo" [52]. This campaign performs work in the coastal areas of the Black Sea and on rivers, primarily the Danube River [53]. In addition, in the regional center for underwater demining, it conducts [54] and trains sappers for humanitarian underwater demining in the countries of the former Yugoslavia.

At the same time, the largest underwater ordnance disposal operation in the Mediterranean took place in June 1999. Then, a joint detachment of the Standing NATO Mine Action Group (SNMCMG), consisting of 11 minesweepers and a support ship, discovered and neutralized 93 pieces

of ammunition. These were dropped during Operation Allied Force from 03/24/1999 to 07/10/1999, in nine areas covering 1041 square miles [55].

Thus, in Europe, along with the disposal of underwater munitions, mostly by the diving units of the navies of the respective countries, there is a tendency to overcome emergencies associated with the underwater location of explosive objects by specialized commercial and charitable non-profit organizations. And the implementation of operational work by sappers in the process of humanitarian underwater demining in light diving equipment.

5. 2. Determining of the emergency liquidation peculiarities situations related to the underwater location of explosive objects in the United States of America

The need to counter naval mines has been a constant US goal since the early days of the Republic. As early as January 1778, patriot David Bushnell used floating gunpowder casks equipped with contact firing mechanisms to attack the British fleet anchored in the Delaware River off Philadelphia. Four British sailors died while trying to get barrels. This is an early example of the challenges of explosive ordnance disposal against an unknown threat, but the ships remained unscathed. Since then, mines and anti-mine weapons have played an important role in the Civil War, the Spanish-American War, both World Wars, Korea, Vietnam, numerous Cold War crises, and Operations Desert Storm and Iraqi Freedom [56]. Although in the United States itself, World War II underwater munitions were only on the coasts of Alaska [57] and Hawaii, where they plan to leave unexploded ordnance from World War II in place off the coast of Maui until a non-explosive disposal option is developed. In this case, the decision is made to use "3Rs of Explosives Safety" [59], which consists of recognizing, retreating and reporting underwater explosives to emergency officials interacting with US Navy underwater demining specialists. These specialists are considered the most professional in the world in the disposal of all types of munitions, including improvised ones, and carry out ground and underwater localization, identification, disposal and detonation if necessary. In their activities, they integrate with various combat units of the Navy, Marine Corps, Air Force and Army and various public organizations, as well as secret services [60]. The high professionalism of Navy sappers was facilitated by the fact that it was the US Department of Defense that carried out back in 1964-1970. operation CHASE to dispose of unwanted munitions at sea (the sinking occurred at least 250 miles from the coast between Florida and the Bahamas; in four cases it was associated with chemical weapons) [61]. Public concern led to the passage of the US Marine Protection, Research and Preserve Act (MPRSA) [62].

The basis of the high efficiency of the military engineers of the US Navy, despite the widespread use of the program developed at Johns Hopkins University, the Advanced Robotic Explosive Ordnance Disposal System (AEODRS) [63], is a well-developed training system. In it, special attention is paid to the disposal of torpedoes and other underwater explosives [64,65], including improvised ones [66]. The activities of the specialized units have the full support of the Office of Elimination and Reduction of Forces of the Bureau of Political Military Affairs (PM / WRA) of the State Department. In [67], it is emphasized that the PM/WRA Mission is aimed at reducing the detrimental global impact of dangerous, illegally distributed and unused weapons, including those under water. As a result, in the United States, a humanitarian demining program [68, 69] whose purpose is to assist the civilian population of partner countries suffering from explosive remnants of war through land and underwater demining has been developed. It specifies that global program management and training for all US forces is carried out by the Defense and Security Cooperation Agency (DSCA) as part of the US Department of Defense, while each of the combat teams (CCMD) develops and executes regional programs. In Europe, this activity is coordinated by the Humanitarian Demining Training Center (HDTC) [70] and is aimed at strengthening cooperation and enhancing the interaction and combat readiness of demining divers from all stakeholders [71, 72].

And in the Indo-Pacific region [73], US Navy sappers are directly involved in the implementation of underwater humanitarian demining [74]. This activity also takes place in conjunction with the Canadian company Ocean Group, whose EOD Division is forming an extensive program of underwater demining. The program combines extensive experience in various areas of mine action and the development of advanced underwater mine clearance technologies [75].

Thus, despite the fact that the US Navy underwater demining specialists are considered the most professional in the world, in their activities they not only integrate with various combat units of the Navy, Marine Corps, Air Force and Army, secret services, but also with various public organizations and also, integration with the commercial company Ocean Group. It develops advanced methods of underwater demining along with independent demining activities.

5.3. Analysis of the disposal features explosive objects located under water in the Indo-Pacific region

This region has its own characteristics. First, the US government fully funds [76,77] and directly conducts underwater demining in Palau and other Forum Island countries (Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Papua New Guinea, Solomon Islands, (Tuvalu and Vanuatu) [78, 79], which are still contaminated with explosive remnants from battles during World War II [63, 64]. conduct independent underwater demining with simultaneous training with the help of specialists from the US Navy [84] and using American equipment.⁸⁵ In addition, given that the Cambodian rivers and tributaries contain a huge amount of ammunition from shipwrecks at shallow depths, the Golden West Humanitarian Foundation has developed a special diver training course to train Cambodian citizens in advanced diving skills and basic recovery procedures [86]. The remnants of World War II on the territory of the Japanese Islands (about 191,000 tons of Japanese military equipment) remain underwater [87]. These humanitarian demining in this direction is carried out by the Japan Mine Clearing Service (JMAS), established in September 2001 and 2002 and received a certificate of a non-profit organization from the Tokyo Metropolitan Office [88]. In addition to Japan, JMAS carries out demining operations in Laos, Cambodia, Angola, Palau [89]. JAPAN MARINE SCIENCE INC [90] is also licensed for commercial underwater demining. Underwater mine defense operations are entrusted to personnel from the Japan Maritime Self-Defense Force (JMSDF), whose teams are located throughout Japan, including the bases of Kure, Maizura, Ominato and Yokosuka [91]. The sappers of this group (except for operations in their own country) regularly cooperate with US Navy specialists during underwater mine clearance in other countries, mainly in Vietnam [92,93]. Among the countries of the region, Indonesia stands out, where underwater demining is carried out by the national company of Indonesia, RT. SEGARA CAHAYA MANDIRI, which for many years has been the leading company in the provision of underwater services in the Southeast Asian region [94]. In Australia, the approach to underwater mine clearance is close to the British. For example, a specialized diving unit of the Royal Australian Navy (RAN) [95] has been operating since the 1920s, but it was only after the Second World War that mine clearance operations came to the fore. RAN divers worked alongside Royal Navy divers to remove naval mines from British waters and from captured ports on the European mainland. The skills learned in the European theater were brought back to Australia and used in the war against Japan. After the war, RAN divers were used to clear the waters of Australia and Papua New Guinea from underwater mines [96]. The usefulness of this work prompted the Australian Commonwealth Naval Board to establish a Diving Demining Division at the RAN in 1951 [97]. In late 1966, a Diving Demining Team was established to assist overburdened US Navy Explosive Ordnance Disposal units and to provide RAN personnel with the ability to conduct demining diving operations in the operational environment [98]. In addition, the personnel carried out mine clearance operations for coalition forces during the Gulf War in 1991, during Operation Falconer (the invasion phase of the Iraq War) in 2003, and, together with American

and British partners, carried out operations for clearing shipping lanes from explosive objects in 2003-2009. During Operation Catalyst (after the coalition's invasion of Iraq), it fought against improvised explosive devices. The practical experience of RUN made it possible to adjust the standard mine action measures (clearing sea mines in shallow water, search and clearance of ammunition below the highwater level, etc.) in maritime combating terrorism, primarily the features of explosive ordnance disposal in the interests of ensuring the mobility of the tactical assault group [99]. China occupies a separate place in underwater demining. The Chinese People's Liberation Army (PLA) Navy's efforts are primarily aimed at using the growing upgradeable capability of sea mines to severely damage US operations in any Taiwan scenario [100]. Military exercises show China's commitment to mine warfare as a pillar of its naval strategy [101]. Thus, in the event of a conflict with Taiwan, China will not only block but also replace Taiwanese ports [102]. Despite the modernity of various means of underwater mining in the PLA Navy, analysts believe that their widespread use will lead to a deterioration in the situation with explosive objects located under water in the region [103].

With this in mind, underwater mine clearance in China is considered from the point of view of improving naval capabilities in the event of US intervention in the Taiwan Strait, the South China Sea, or the East China Sea [104]. However, among other military personnel there are specially trained specialists capable of extracting explosive substances from under water and carrying out underwater blasting [105].

Thus, in the Indo-Pacific region, the US government fully finances and directly conducts humanitarian underwater demining in the countries of Forum Island, most countries (with the exception of China, whose main efforts of sappers are directed to underwater blasting) with the help of US Navy specialists. It conducts independent demining, in which, along with the military, both commercial organizations and even individual advanced divers who have completed a special course can be involved.

6. Conclusions

An important and unresolved part of the problem of improving the effectiveness of preventing emergencies associated with the underwater location of explosive ordnance today is the lack of analysis of the regional characteristics of humanitarian underwater demining.

In Europe, along with the clearance of underwater munitions, mainly by the diving units of the navies of the respective countries, there is a tendency to overcome emergencies associated with the underwater location of explosive ordnance by specialized commercial and charitable non-profit organizations, as well as the implementation of operational work by sappers in the process of clearing mines in light diving equipment.

Despite the fact that the US Navy underwater demining specialists are considered the most professional in the world, in their activities they not only integrate with various combat units of the Navy, Marine Corps, Air Force and Army, secret services, but also with various public organizations, as well as with the commercial company Ocean Group, which, together with independent mine action, develops advanced methods of underwater demining.

In the Indo-Pacific region, along with the fact that the US government fully finances and directly conducts humanitarian underwater demining in the countries of Forum Island, most countries (with the exception of China, whose main efforts of sappers are aimed at carrying out underwater blasting) US Navy. It conducts independent demining, in which, along with the military, both commercial organizations and even individual advanced divers who have completed a special course can be involved.

All this testifies to the fact that if until recently the national armed forces had exclusive experience in the destruction of underwater explosive objects, today these dangers are eliminated

along with them by various types (commercial companies, non-governmental organizations, teams of central and local authorities, etc.) organizations that require adjustments in their activities in addition to the skills that they are provided during the initial training by specialized units of the navy.

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8. Competing interests

The authors declare that they have no competing interests.

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