NATO Undersea Research Centre
Centre de Recherche Sous-Marine de l'OTAN

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NATO Undersea Research Centre Human Diver and Marine Mammal Risk Mitigation Rules and Procedures

Marine Mammal Risk Mitigation Project

September 2006

NATO Undersea Research Centre (NURC)

NURC conducts world class maritime research in support of NATO's operational and transformational requirements. Reporting to the Supreme Allied Commander Transformation, the Centre maintains extensive partnering to expand its research output, promote maritime innovation and foster more rapid implementation of research products.

The Scientific Programme of Work (SPOW) is the core of the Centre's activities and is organized into four Research Thrust Areas:

- Expeditionary Mine Countermeasures (MCM) and Port Protection (EMP)
- Reconnaissance, Surveillance and Undersea Networks (RSN)
- Expeditionary Operations Support (EOS)
- Command and Operational Support (COS)

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NURC's plans and operations are extensively and regularly reviewed by outside bodies including peer review of the research, independent national expert oversight, review of proposed deliverables by military user authorities, and independent business process certification. The Scientific Committee of National Representatives, membership of which is open to all NATO nations, provides scientific guidance to the Centre and the Supreme Allied Commander Transformation.

NATO Undersea Research Centre
Human Diver and Marine Mammal Risk Mitigation Rules and Procedures

Marine Mammal Risk Mitigation Project

This document, which describes work performed under Project 04F (Marine Mammal Risk Mitigation) of the NATO Undersea Research Centre Scientific Programme of Work, has been approved by the Director.

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Executive summary

The NATO Marine Mammal Risk Mitigation project has as its goals the development of risk mitigation protocols, computer tools, and in-water devices to provide risk mitigation before sonar or other noisy experiments and naval exercises so as to avoid negative impact on human divers and marine mammals.

At the beginning of this project there were no comprehensive and systematic databases of marine mammal sightings and strandings for Mediterranean Sea cetaceans. One of the first actions of the NATO Undersea Research Centre (NURC) Marine Mammal Risk Mitigation project was the development, in cooperation with various European nations and organizations, of a standardized geo-referenced collection of strandings and sightings of cetaceans in the Mediterranean.

These data, supplemented with new information collected during NURC sea trials and data "mined" from historical documents, provides the baseline information for the major scientific goals of the Marine Mammal Risk Mitigation project at NURC, the development of a cetacean density prediction capability, and the creation and evaluation of on-site acoustic risk mitigation procedures and tools for use by NURC researchers and military commanders who make loud noises as part of their operations (sonars, explosives, etc.). This document outlines risk mitigation protocols and procedures that are in use by NURC at this time. This is an updated, public release version of the NURC Staff Instruction 77 (SI-77). As new information becomes available from continued research by the Marine Mammal Risk Mitigation Project as well as other documented sources these procedures are reevaluated and modified as appropriate.

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Abstract

The NATO Marine Mammal Risk Mitigation project has as its goals the development of risk mitigation protocols, computer tools, and in-water devices to provide risk mitigation before sonar or other noisy experiments and naval exercises so as to avoid negative impact on human divers and marine mammals. This document outlines the procedures and marine mammal risk mitigation protocols that are in use by NURC at this time. This is an updated, public release version of the NURC Staff Instruction 77 (SI-77). As new information becomes available from continued research by the Marine Mammal Risk Mitigation Project as well as other documented sources these procedures are reevaluated and modified as appropriate.

Contents

1 Introduction

Despite the lack of knowledge of the precise nature of the biological effects and behavioural response of human divers and marine mammals and the range, depth and specific circumstances when these effects may occur, evidence exists that some high level sound, whether it be explosive, electro-mechanical or general ship noise in origin, may in some circumstances have a detrimental effect on divers and on marine mammals.

Knowledge of the effect of energy on human behaviour and body functions in water is not scientifically precise. Known reaction in the air medium is not transferable with confidence. Until such time that reliable information establishes threshold levels with accuracy, deliberately conservative limits on the use of sound and explosives will be used in the vicinity of divers. Evidence regarding behavioural responses of marine mammals is often conflicting: some species show clear avoidance tendencies, while others exhibit no response at all or may even congregate in the vicinity of a sound source, dependent on its characteristics and prevailing oceanographic conditions. The ear anatomy, hearing range and sensitivity of marine mammals vary widely among marine mammal species.

Many marine mammals are physiologically adapted to sustain moderately rapid and extreme pressure changes from natural sources and appear capable of accommodating acoustic power relationships several magnitudes greater than in air. It is possible that these adaptations may provide protective mechanisms that lessen the risk of injury from high-level sound. Nevertheless, recent observations indicate that there may be a complex relationship between sound energy levels, signal type, and behavioural reactions. Few anatomical and behavioural studies are available and precise identification of marine mammals is not always possible. Since it is necessary to present precautionary risk mitigation procedures that apply generally to all marine mammals, these guidelines are deliberately conservative and may be modified to reflect the results of future studies. It also must be emphasized that while no risk mitigation measure can absolutely eliminate the risks associated with sonar use, thoughtful and prudent planning and actions can significantly reduce these risks. Therefore, the rules discussed in this document represent the minimum precautions that must be observed. This does not relieve the NURC Scientist-in-Charge, all scientists involved in the experiment and the vessel master of the responsibility to use good judgment and caution.

2 Background

2.1 Introduction

There is significant concern about the influence of high-level underwater sound on life in the sea, particularly with the possible effects on divers and marine mammals. Those who utilize sonar and explosives in the course of their work at sea must be concerned with the impact such acoustic energy and explosive shock waves may have within the marine environment.

In the absence of other overarching regulations, NURC will conduct its at-sea research operations in a responsible manner. This will include an Environmental Scoping Study (ESS), mitigation procedures and monitoring together with an associated audit trail. To this end, all operations conducted on vessels or from shore, are to be conducted in accordance with applicable environmental laws, local regulations and accepted maritime practice.

Precautions to minimize potential harm to human divers and to marine mammals from high level sound sources, whether of explosive or electro-mechanical origin, are to be followed. Diving sites, marine mammal sanctuaries and habitats should be avoided whenever possible. A database of these zones for the Mediterranean is maintained by the Marine Mammal Risk Mitigation project. The project will keep an updated list of laws, regulations and protected areas available to be used for planning purposes and, if possible, GIS shape files representing protected areas.

NURC has undertaken to improve the understanding of anthropogenic noise characteristics, such as frequency structure, loudness, or context that make a sound aversive and potentially harmful to marine mammals. The NURC policy and risk mitigation rules will be maintained to conform to best available techniques and environmental practices.

2.2 NURC Policy

As NATO nations work to prevent pollution in the marine environment and since energy is classified as a potential pollutant, it must be used responsibly, i.e., potentially harmful effects must be mitigated, consistent with operational objectives. As sound energy is transient and does not accumulate, the test for environmental protection in marine research is the magnitude of the direct harmful effects likely to result to human health or deleterious to living resources and the marine ecosystem. Even though sound energy does not accumulate like chemical pollutants, long-term chronic problems may arise from indiscriminate use.

The effect of sound and explosives on divers is incomplete and on marine mammals is generally undetermined. There are reasonable grounds for concern that high intensity sound at certain frequencies (at the point of reception) can have unintended harmful effects. As a matter of policy, the Centre will take preventive measures to circumvent harm to divers and marine mammals from sound energy and explosives by institution of procedures in Section 6. In addition, information will be made available and regularly updated on the Sound, Ocean and Living Marine Resources (SOLMAR) website at http://solmar.nurc.nato.int.

2.3 Technique

The *precautionary principle* has emerged as the standard of conduct for compliance with duties of environmental protection in situations where reasonable grounds for concern that hazard, harm or damage may result. A description of the precautionary principle is contained in the

Conventions on the Protection of the Marine Environment of the Baltic (1992) and Northeast Atlantic (1992).

The Contracting Parties shall apply the precautionary principle, i.e., to take preventive measures when there is reason to assume that substances or energy introduced, directly or indirectly, into the marine environment may create hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea even when there is no conclusive evidence of a causal relationship between inputs and their alleged effects. (Baltic, 1992, Article 3). The description of the principle in the Northeast Atlantic Agreement is identical except that preventive measures are to be occasioned by reasonable grounds for concern (Article 2, paragraph 2(a)).

The description of the precautionary principle (which incorporates the definition of pollution) and corollary principles of *best available techniques* and *best environmental practice* have a current primary focus on substances. Application of these principles to energy, including the features relating to the balance of objectives and practicality is an expedient.

The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area, (1996), includes a requirement to apply the precautionary principle (which is not defined in the Agreement) to the protection of mammals and habitats.

Consideration of potential harm is accomplished by assessing the potential for deleterious effects *likely to result* in a sea trial, and taking action designed to avoid the effects during legitimate use of the seas. Actions can include ensuring that a sea trial never takes place in or near to known diving sites, marine mammal breeding areas or migration routes. In a selected area, pre-trial surveys should include using precautionary sound limit levels or a benign process (ex. ramp-up) to encourage marine mammals to leave the area of potential harm or to minimize the startle effect.

2.4 Conclusion

Although environmental protection includes avoidance of *hazards to human health*, the effects of sound and explosives on divers are not well studied. Naval and other users of sonar have however restricted use in the presence of divers to avoid injury. The application of the precautionary principle to avoid hazards to humans preceded the institution of environmental rules and will continue.

General principles of environmental protection are focused on the conservation of marine mammals due to their dependence on sound and the uncertainty related to the impact of it on their physiology and behaviour. While many of our institutional objectives require the discharge of energy into the marine environment, it must be done prudently and consistent with our conservation objectives.

Knowledge of the behaviour of marine mammals and reaction to sound is rudimentary. The Centre has a lengthy history of using sound for research in the Mediterranean. Since the establishment of this policy no deleterious effects of the research are known to have resulted. Notwithstanding the fact that we have not been able to establish a causal relationship between the single instance of a NURC sea trial location coinciding with a stranding event, harmful effects of high-energy sound on marine mammals can not be excluded from consideration. Even though a scientific prediction of likely harm cannot be accurately made, prudence requires efforts to avoid potentially harmful effects.

3 Risk to Humans in the Marine Environment from High Level Sound

3.1 Assessment of Risk

Since the early days of warship sonar operation, many of the world's navies have, when transmitting on such systems and when underwater explosives are to be detonated, taken measures to ensure that no diving activity is taking place in the vicinity. Naval and commercial navigational warning messages have provided these alerts to relevant local authorities. The Code of Practice for Scientific Diving, Second Edition 1996, Chapter 10.7, makes the following statements:

"Most acoustic devices, such as echo-sounders, range-finders and directional beacons, radiate such little power as to be harmless. However, there are acoustic systems, used in geophysical research, and military sonars that radiate power at levels high enough to be harmful to divers. When divers are likely to be active near such systems the Chief Diver should establish contact with the operators of such systems to ensure that power is not radiated during diving.

Three main physiological symptoms can be associated with LF high level sound sources. The first involves the Pacinian corpuscle, a sensor of the nervous system that is distributed throughout the epidermis and provides for vibrotactile sensitivity. The frequency response of the Pacinian corpuscles peaks at about 250Hz, the most annoying frequency in divers' complaints of tingling and numbness. The second effect involves acoustically forced vibrations of gas pockets in the gastrointestinal tract, which may be responsible for complaints of abdominal discomfort.

The third major effect is one involving (temporary) hearing threshold shifts, of which there is quite a lot known at search sonar frequencies, but very little at low frequencies. Other effects, including tissue or arterial resonance, lung haemorrhage and so on, may also be important.

At present, medical and acoustics scientists are addressing these effects to determine the appropriate exposure thresholds at a variety of source levels. At the same time, environmental acousticians are studying shallow water scenarios which favour the propagation of LF high level sound in areas where divers are likely to be found. Although it is premature to discuss what these acceptable exposure thresholds might be, acoustic bio-affects scientists are now concerned with low frequency energy even when delivered at relatively low energy levels over considerable ranges".

It is therefore vital that the use of acoustic sources from NURC's vessels is carried out in accordance with the rules described in this document. Additionally, the Centre's own diving activity will comply with the rules in the *Diving Operations Staff Instruction*.

3.2 Mitigation Rules

3.2.1 Impulsive Sources (SUS MK 61/82)[12]

Minimum safety range 3000 m

3.2.2 Coherent Sources

The sound level for alerted NATO or other military divers should not exceed the following levels[1 2 3] (re 1μPa):

Frequencies 125 Hz – 4 kHz 160 dB

Frequencies >4 kHz – 25 kHz 167 dB

Frequencies >25 kHz – 31.5 kHz 172 dB

Frequencies >31.5 kHz – 250 kHz 177 dB

For frequencies > 250 kHz safe operating distance is 10 meters or greater. Diving operations may be conducted around this type of sonar provided that the diver does not stay within the sonar's focus beam.[4]

The ceiling values may be verified by using an integrating sound level meter with slow detection and 1/3 octave bands.

3.2.3 Recreational Divers

Minimum Safety range 3000 m

US Navy tests using recreational divers indicated that the maximum acceptable sound pressure level for 600 -- 2500 Hz (without causing changes in heart rate or breathing frequency) is 154 dB[5]. No tests were performed on recreational divers at higher frequencies.

[1] Effects of Intense Water-Borne Sound on Divers. Prepared by Naval Submarine Medical Research Laboratory, Groton, CT, Department of the Navy, 1996

[2] U.S. Department of Labor, OSHA Technical Manual, Section III, Chapter 5

[3] Naval Submarine Medical Research Laboratory Report No. 1203, 30 September 1996

[4] U.S. Navy Diving Manual, Appendix 1A

[5] Naval Submarine Medical Research Laboratory Report No. 1223, 13 June 2002

4 Risk to Marine Mammals from High Level Sound

4.1 Assessment of Risk

The influence of sound energy on marine mammals is a function of the sound level at the point of reception by the mammal. When submerged they are much more at risk from the potential effect of high level sound due to potential abnormal behavioural reactions than when on the surface. The mitigation rules are based on available scientific evidence and the application of a conservative bias to protect the mammals at risk.

From sound level strength at the point of reception, maximum source-level strength will be determined by propagation loss over distance. While source-level may be adjusted when in the presence of marine mammals to comply with the mitigation rules, prudence is the responsibility of the NURC Scientist-in-Charge.

As an exception, small, generally fast moving marine mammals are known to be attracted to certain noise sources and are not harmed by approaching the source. In the event that such animals approach the electro-mechanical sound source after the commencement of normal operations, the operation should not be suspended, provided that transmission will be terminated if the mammal is identified as a beaked whale or being on the endangered species list.

4.2 Mitigation Rules

In view of the fact that the sensitivity of marine mammals to high-level sound is neither well known nor consistent across species, a conservative, yet practical approach is prudent and necessary.

4.2.1 Impulsive Sources (SUS MK 61/82)[6]

Safety range:

Mysticetes 2000 m

Odontocetes/Pinnipeds 2000 m

[6] Final Environmental Impact Statement Shock Testing the Seawolf Submarine, Department of the Navy, May 1998

4.2.2 Coherent Sources

The sound level at the reception point should not exceed the following levels (re 1μPa):

Small Odontocetes[7]:

Frequencies - 3 kHz 186 dB

Frequencies 3 - 20 kHz 181 dB

Frequencies 20 - 75 kHz 178 dB

Mysticetes and Large Odontocetes[8]:

Frequencies _ 100 kHz 160 dB

The ceiling values may be verified by using an integrating sound level meter with slow detection and 1/3 octave bands.

Maximum continuous duration of sonar transmissions to be less than 100 s, duty cycle less than 20% and total cumulative exposure maximum 3 hrs in 24 hrs. As far as practicable the safety zone, which is subject to higher noise levels, should be monitored during the experiment.

Recent research[9] into the strandings of Beaked whales (*Ziphius cavirostris*) in the Canary Islands in 2002 associated with military sonars, indicates that one of the causes of the strandings may be an effect similar to the "bends" in human divers. The study, supported by data collected during necropsies after the US Navy incident in the Bahamas[10], suggests that the animals may have a panic or startle reaction to the sonar and come to the surface faster than nitrogen can be removed from the fat cells and blood. This emphasizes the need to carefully plan operations to avoid Beaked whale habitats and to follow a strict and, possibly, extended "ramp up" procedure prior to a sonar experiment when the habitat cannot be completely avoided.

The Marine Mammal Risk Mitigation project office maintains the latest estimate of the extent of Beaked whale habitat in the NURC operating area. In the event that sonar experiments are being performed outside of the normal operating area, the host nation should be requested to supply the habitat information.

In the case where there has been: (1) A suspected incident concerning a NURC experiment and recreational or professional divers or marine mammals, or (2) a mass stranding in the NURC operating area (even if no NATO units involved) or in the vicinity of a NURC experiment outside the normal operating area, the Incident Action Team (IAT) will be activated in accordance with Section 6.

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[7] Ridgeway, .SH., Carder, D.A., Smith, R.R., Kamolnick, T., Schlundt, C.E. and Elsberry, W.R., Naval Command, Control, and Ocean Surveillance Center, RDT&E Division, San Diego, CA, Technical Report 1751, *Behavioral Responses and Temporary Shift in Masked Hearing Threshold of Bottlenose Dolphins, Tursiops truncatus, to 1-second tones of 141 to 203 dB rel 1μPa* of July 1997

[8] Ketten, D., Marine Mammal Auditory Systems, a Summary of Audiometric and Anatomical Data and its Implications for Underwater Acoustics, NOAA Tech Memo, NOAA-TM-NMFS-SWFSC-256, September 1998

[9] *Nature*, **425**, 2003; pp. 575-576.

[10] Joint Interim Report: Bahamas Marine Mammal Stranding Event of 14-16 March 2000 (www.nmfs.noaa.gov/prot_res/overview/Interim_Bahamas_Report.pdf)

5 Environmental Scoping Study (ESS) of Work Area

5.1 Requirements

Prior to any NURC experimental activity using high-level sound sources other than normal navigation and standard shipboard equipment (ADCP, fathometer, etc.), the Scientist-in-Charge is required to prepare an Environmental Scoping Study (ESS). The ESS is to identify potential environmental hazards associated with the use of sonars or other equipment (bottom grabs, cores, etc.). Special attention is needed when sea trials are carried out in waters where the Centre normally does not work and the environmental knowledge is limited. The Marine Mammal Risk Mitigation project, with the assistance of the NURC Diving Officer, will maintain documents and graphics indicating known areas where diving activities are expected to exist, where certain restrictions may apply, and habitats of marine mammal species of concern.

The following is a checklist of the issues and activities that should be accomplished prior to any trial employing high-level acoustic devices:

- Research any previous studies of the area.
- Determine if there are swimming beaches, recognized diving sites or expected diving activities within 20 km of work area.
- Determine known wreck sites and fishing areas.
- Determine known marine mammal habitats.
- Itemize details of high-level sound sources (explosives, sonars, seismic systems, etc.) to be used, as well as transmission source levels, pulse types, frequencies, duration and location.
- Avoid explosive sources in NURC sea trials whenever possible.
- Perform modelling estimates to determine the safety range for divers and mammals.
- Consult with the Marine Mammal Risk Mitigation project, Diving Officer and other internal and external authorities/experts as appropriate.
- Prepare the request for permission to carry out the activity when required.
- Assess the impact of the high level sound on each of the environmental elements – divers and marine mammals in the area concerned.
- Determine/confirm visual and acoustic monitoring requirements of experiment.
- Complete the ESS Matrix (Annex A).
- Maintain audit trail of all environmental precautionary activities on file.

5.2 Responsibilities

The Scientist-in-Charge, supported as required by the Marine Mammal Risk Mitigation project leader, the NURC Diving Officer and appropriate external authorities, is responsible for ensuring that the above issues are checked off and that any related risk mitigation procedures are briefed to the Master of the research vessel prior to the experiment. Copies of the Visual Watch Recording Form (Annex B) and Sighting Report Forms (Annex C) must be submitted to the Marine Mammal Risk Mitigation project and included as an annex to the Cruise Report.

When the Centre's vessels are operating together with other research vessels, all units will adhere to the same environmental policy. The policy used must be agreed upon before the sea-going activity commences, and it will be the NURC set of rules or stricter.

The Programme Officers are to verify that the sea trials are planned in accordance with the procedures described in this document.

6 Implementation

All NURC personnel involved will adhere to the following procedures in order to insure that neither humans nor marine mammals are exposed to harmful noise levels. It is recognized that the implementation of the above policy and procedures will present some difficulties at sea which could cause delays to experiments and may require additional resources as well as specific training. Furthermore, the difficulty of undertaking an effective acoustic listening and identification watch with the systems available is understood. Scientists-in-Charge and the research vessel Masters are, however, to make the best effort possible to minimize the risk to human divers and marine mammals.

6.1 Planning Environmental Protection and Monitoring

The following guidelines are designed to minimize the risk to human divers and marine mammals during sonar experiments and other NURC operations, and are used by Scientists-in-Charge when planning marine operations during which high level sound sources will be used.

- Select the trial area based on the ESS, on the in-house marine mammal and dive site databases, including consideration to avoid wrecks, mammal breeding areas, special sanctuaries, etc. The Marine Mammal Risk Mitigation project office and NURC Diving Officer should be consulted.
- Consider invitation to observers on board with due regard to security considerations.
- Evaluate source levels required to meet scientific objectives.
- Prepare horizontal and vertical plots showing noise levels in relation to distance based on sound propagation/prediction modelling.
- Heighten awareness by organizing visual and acoustic lookout training, sound recording, video, etc., prior to operations.
- Include section in Pre-Cruise Brief on the precautions to be taken.
- Minimize sonar operations at night.
- Plan tracks and operations to provide mammal escape routes and avoidance of embayment.
- Avoid enclosed areas and coastal areas with complex, steep sea bed topography.
- Reflect results of ESS and summary of planning activities in the Test Plan.

The *Visual Watch Recording Forms* (Annex B) and the *Sighting Report Forms* (Annex C) are to be made available and used during experiments. These forms will be made a part of the post-cruise report and copies sent to the Marine Mammal Risk Mitigation project for inclusion in the Sightings Data Base.

6.2 Execution at Sea

6.2.1 Before Commencing Operations

Diving operations at sea are conducted from the shore or surface platforms. Any moored or stationary platforms should be investigated to determine whether divers are or will be in the water. Particular attention should be paid to marked buoys.

Marine mammals are difficult to detect. Whales can remain submerged for up to 1 hour. The instant surface is reached the animal immediately exhales or “blows” and creates a characteristic

spout. In large whales, the spout may rise more than 6 m. With practice, species can be identified from the characteristics of the spout. Dolphins and porpoises generally surface 2 to 3 times per minute to breathe. Dive times and surfacing behaviour are more erratic when they are feeding, but most dives are unlikely to exceed 5 minutes. Marine mammals are capable of brief swimming speeds of about 30 knots and of sustained movement at 8 knots. If disturbed they may alter their heading rapidly.

Feeding seabirds can sometimes indicate the presence of marine mammals. Some species may be attracted to boats from some distance away, probably by engine noise. They may accompany a vessel for a considerable period and even bowride if it is fast moving. Towed arrays may also attract dolphins.

Marine mammals communicate using whistles, creaks, chirps and moans. Trains of clicks are used for echolocation and foraging. Such noises for many species may be heard with a hydrophone at distances of several nautical miles.

Prior to energizing the sound source, the following ***Risk Reduction Measures*** must be accomplished:

- Trained lookouts on station, briefed and equipped with binoculars.
- Aircraft/helicopters, when available, should be used to aid visual search.
- All surface contacts to be identified to ascertain that no human diving activity exists. Establish radio contact if necessary.
- Set acoustic watch on passive devices such as towed array and deploy wide band sonobuoys.
- Alert other units involved to establish visual and acoustic watches as above. Reporting procedure to be agreed.

6.2.2 Clearing the Area

- Transit work area with trained visual lookouts and passive listening systems (i.e. array, sonobuoy) deployed.
- Keep track of all vessels approaching the area, with special attention to be paid to vessels slowing down or dead in water.
- Listen, look and record from at least 30 minutes before to 30 minutes after operations.
- Details of the visual and acoustic lookout to be recorded in *the Visual Watch Recording Form* (annex B) and scientific logbooks respectively.

6.2.3 Ramping up Procedures

If no indication of human diver activity or marine mammals exists within the appropriate safety zones for at least 30 minutes:

- Ramp-up source gradually from 150 dB re 1µPa @ 1m or lowest possible setting if higher than 150 dB re 1µPa @ 1m. For example: If the desired maximum source is 180 dB, the initial transmission should be 150 dB or the lowest possible setting if above 150 dB. Since the difference between 150 dB and 180 dB is 30 dB then the source should be increased at the rate of 5 dB per 5-minute period. If the difference is 60 dB then the ramp-up should be at the rate of 10 dB per 5-minute period.
- If no evidence exists of marine mammals within safety range, commence operations after ramp-up. Otherwise delay and repeat.
- Continuous operations are then permissible.

- Keep source level as low as possible consistent with achieving the work.
- If transmissions stop for more than 30 minutes, the start up procedure is to be repeated.
- Similar procedures will be used when explosives are being utilized as the sound source, progressing from smaller to larger charges, or using alternative broadband sources such as lightbulbs, longer intervals between explosions and/or coherent mechanical or electrical sources for ramp-up.

6.2.4 During Operations

- Maintain lookout for vessels moving into the area from which diving might occur and establish communications, if possible. Terminate if vessel moors, until evaluation is complete.
- Operations are to be suspended upon detecting diving activity or marine mammals within safety range, except for mammals approaching within 45 degrees of the stern (use acoustics to alert lookout) when using an electro-mechanical source, if they are the small, fast moving species, known to be attracted to certain noises.
- Transmissions and use of explosives ***must*** be terminated if any marine mammal within range of double the calculated safety range is recognized as belonging to the endangered species list or is identified as *Ziphius cavirostris* see Annex D.
- Sightings/acoustic identification to be reported in the *Sighting Report Form* (Annex C).
- Photograph or video film any sightings whenever possible.
- NURC management to be informed immediately if divers are observed within the safety range or if there is a suspicion that marine mammals could have been affected by the research activity.

6.2.5 Post Cruise

In order to further marine biological knowledge on migration patterns and to assist the Centre in the planning of future experiments in the least populated areas, the following reporting arrangements are to be adopted. The Scientist-in-Charge is to include copies of completed annex B and annex C in post-cruise report and supply originals to the Marine Mammal Risk Mitigation project office.

7 Human Diver and Marine Mammal Incident Action Team Makeup and Responsibility

7.1 Introduction

Human diver and acute marine mammal incidents are rare in the NURC operating areas. Nevertheless, it is important for the Centre to be prepared to respond to either of these quickly and without confusion to determine if actions by Centre personnel may have contributed to the incident, assist national authorities analyze its cause, and assess the oceanographic conditions related to the incident. The Human Diver and Marine Mammal Incident Action Team (IAT) has been established to quickly respond to information related to these types of incidents.

7.2 Human Diver and Marine Mammal Incident Action Team

The team is made up of the following, supported as necessary by other Centre personnel:

a. Marine Mammal Risk Mitigation Program Manager (04FPM)

b. NURC Diving Officer (for cases involving human divers)

c. Science Technology Officer (STO).

d. Reconnaissance, Surveillance and Networks (RSN) Department Head

e. Other Department Heads if their department is involved in the incident or vessel under their department control in vicinity of incident.

7.3 Decision Tree

a) Upon notification of a human diver or major (2 or more animals) marine mammal incident in Mediterranean or other areas of interest to NATO (usually by phone call by a Marine Mammal Risk Mitigation project partner, from a newspaper, or observation from NRV Alliance or CRV Leonardo), 04FPM is notified.

b) 04FPM obtains information on location and operation of NURC ships and the specifics of the incident and notifies other member(s) of IAT. (This meeting may be handled by phone at the discretion of 04FPM.

c) Decision Points

DP1a. No NURC involvement and no NURC ship in area.

- 04FPM generates memorandum for record (copy to the Director (D), Deputy Director (DD), RSN). 04FPM may collect pertinent oceanographic information from Centre assets and other supporting organizations. This information may be offered to national authorities to assist in the analysis into the causes of the incident.
- 04FPM gives feedback to notifier where appropriate.
- No further action required.

DP1b. Possible NURC involvement or NURC Ship in area of marine mammal incident.

- IAT assesses issues and with the concurrence of the appropriate department head makes recommended course of action to DD/D.

- Department Head notifies Scientist-in-Charge of decision If it is determined that NURC was probably involved in incident:
  - 04FPM generates memorandum for record (copy to D, DD, ASW and appropriate department head). Scientist-in-Charge retains all records and recordings made during sea test.
  - IAT convenes board of inquiry in consultation with D, DD, and appropriate Department Head.
  - Board may consist of outside experts.
  - IAT produces report of findings of board of inquiry

A. Environmental Scoping Study Matrix

Activity	Valued Ecosystem Components			
	Biological		Social	
	Marine Animals	Marine Habitat	Recreation	People/Health
Use of Acoustic Sources				
Use of Explosive Charges				
Collection of samples of seabed sediments including cores				
Use of Ocean Bottom Seismometer				
Tagging of mammals				

LEGEND

N Effect Negligible/Non-existent

I Insignificant Effect

S Significant Effect or Public Concern

U Unknown Effect

M Mitigable Effect

P Positive Effect (optional)

B. Visual Watch Recording Form (English and Italian)

LOG for VISUAL WATCH

Ship

Ship operation (Source, E/R, bistatic, etc.)

Please register the following information for every watch, regardless of whether cetaceans are seen or not.

Date	Observer	Approximate location at beginning of watch		Cetacean watch		Length of time Sonars were operating	Wind speed and direction (Beaufort)	Sea state	Visibility P – poor M – moderate G - good
		Latitude	Longitude	Start	End				

Return to Scientist in Charge on completion of trial

Log dei Turni di Avvistamento

Nave

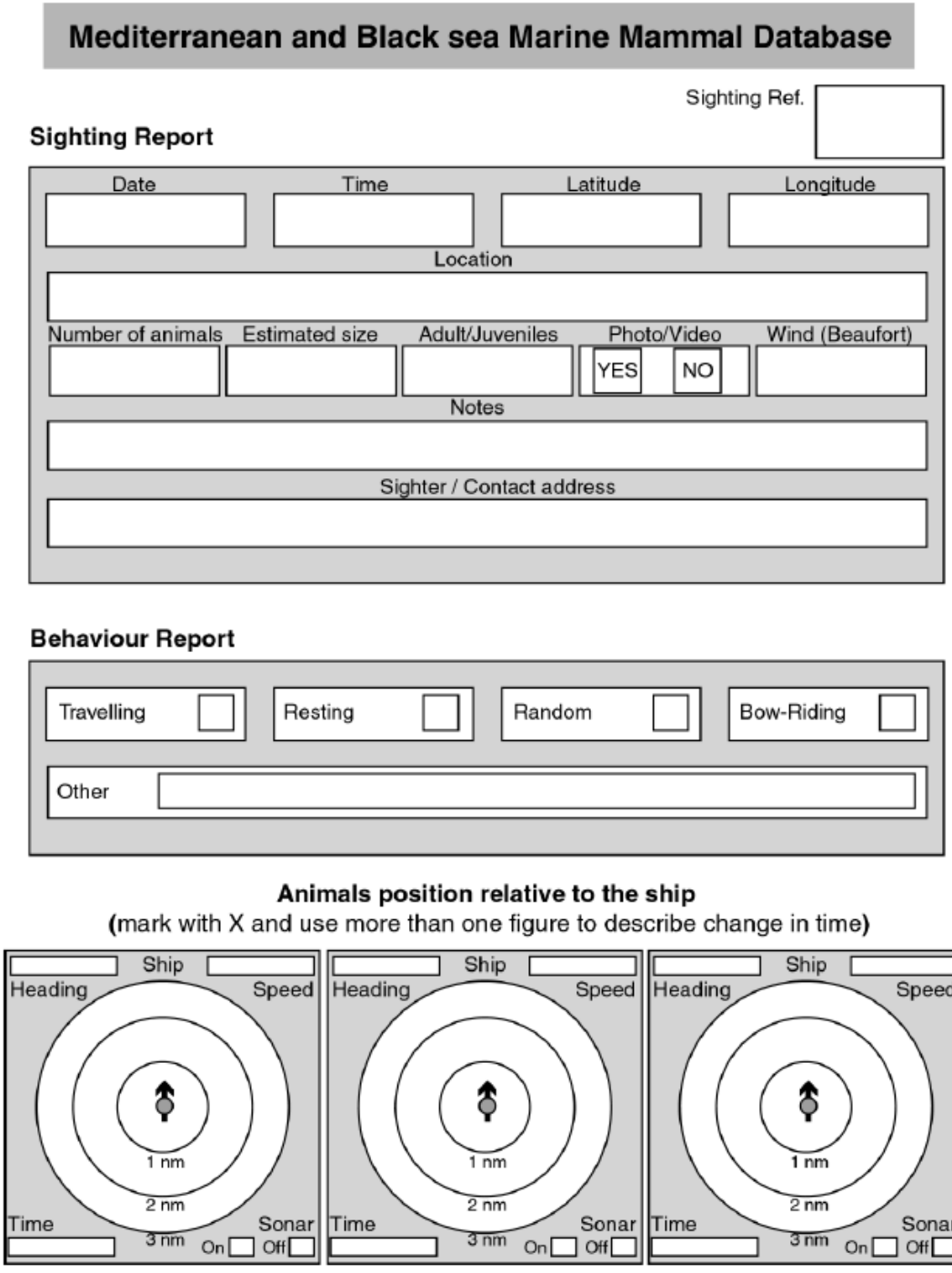
Tipo di operazione in corso (Trasmissione, E/R, bistatico, etc)

Registrare le seguenti informazioni durante ogni turno

Data	Osservatore	Coordinate all'inizio del turno		Turno di guardia		Durata della trasmissione	INtensità e direzione del vento (Beaufort)	Stato del mare	Visibilità S- scarsa M – moderata B - buona
		Latitudine	Longitudin	Inizio	Fine				

Da consegnare al Capo crociera (Scientist in Charge)

C. Sighting Report Form (English and Italian)



Mediterranean and Black sea Marine Mammal Database

Sighting Ref.

Sighting Report

Date | Time | Latitude | Longitude

Location

Number of animals | Estimated size | Adult/Juveniles | Photo/Video (YES / NO) | Wind (Beaufort)

Notes

Sighter / Contact address

Behaviour Report

Travelling | Resting | Random | Bow-Riding

Other

Animals position relative to the ship

(mark with X and use more than one figure to describe change in time)

Ship Heading Speed

1 nm 2 nm 3 nm

Time Sonar On Off

Mediterranean and Black sea Marine Mammal Database

Rif. avvistamento

Scheda di avvistamento

Data	Ora	Latitudine	Longitudine

Luogo dell'avvistamento (es. Mar Ligure, Tirreno Centrale)

Num. degli animali	Adulti/Giovani	Grandezza stimata	Foto/Video	Vento (Beaufort)
			SI NO	

Note

Osservatore / Indirizzo

Comportamento

In movimento	In riposo	Spostamento casuale	Vicino alla prora

Altro

Posizione degli animali rispetto alla nave

(marcare con una X e usare piu' di una figura per descrivere cambiamenti nel tempo)

D. Endangered Species List

Category	English name	Italian name	Latin name
CR	Monk seal (1)	Foca monaca	*Monachus monachus*
EN	Fin whale (2)	Balenottera comune	*Balaenoptera physalus*
	Loggerhead (2)	Tartaruga comune	*Caretta caretta*
	Leathery turtle (2)	Tartaruga liuto	*Dermochelys coriacea*
VU	Sperm whale (3)	Capodoglio	*Physeter macrocephalus*
LR cd	Striped dolphin (3)	Stenella	*Stenella coeruleoalba*
DD/EN	Cuvier's beaked whale (3)	Zifio	*Ziphius cavirostris*
	Bottlenose dolphin (3)	Tursiope	*Tursiops truncatus*
	Risso's dolphin (3)	Grampo	*Grampus griseus*
	Common dolphin (3)	Delfino comune	*Delphinus delphis*
	Pilot whale (3)	Globicefalo	*Globicephala melas*

Legend

1) Mammamalia, Phocidae
2) Reptilia, Sea Turtle
3) Mammalia, Cetacea

Categories

Critically Endangered (CR)

A species in an extremely high risk of extinction in the wild in the immediate future.

Data Deficient (DD)

A species were there is inadequate information to make a direct, or indirect, assessment of the risk of extinction based on its distribution and/or population status. In the case of Cuvier's Beaked Whales there is strong evidence that this species is particularly sensitive to sonar operations and should be treated as *Endangered*.

Endangered (EN)

A species not Critically Endangered but in a high risk of extinction in the wild in the medium-term future.

Vulnerable (VU)

A species not Critically Endangered or Endangered but in a high risk of extinction in the wild in the medium-term future.

Lower Risk (LR)

A species that has been evaluated but does not satisfy the criteria of any of the categories Critically Endangered, Endangered or Vulnerable. Species included in the lower risk category can be separated into three subcategories:

- Conservation Dependant (cd)
- Near Threatened (nt)
- Least Concern (lc)

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Marine Mammal Risk Mitigation Project

Title

NATO Undersea Research Centre Human Diver and Marine Mammal Risk Mitigation Rules and Procedures.

Abstract

The NATO Marine Mammal Risk Mitigation project has as its goals the development of risk mitigation protocols, computer tools, and in-water devices to provide risk mitigation before sonar or other noisy experiments and naval exercises so as to avoid negative impact on human divers and marine mammals. This document outlines the procedures and marine mammal risk mitigation protocols that are in use by NURC at this time. This is an updated, public release version of the NURC Staff Instruction 77 (SI-77). As new information becomes available from continued research by the Marine Mammal Risk Mitigation Project as well as other documented sources these procedures are reevaluated and modified as appropriate.

Keywords

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