



FORUM V
Chemical Safety
for Sustainable Development
IFCS
Budapest, Hungary
25-29 September 2006

Plenary Information/Discussion Session on Tools and Approaches for Applying Precaution in the Context of Chemicals Safety

Information Request for Background Paper

Dear Colleague,

A Forum V Plenary Open Information/Discussion Session has been organized to advance open dialogue and understanding about how precaution is applied in practice with regards to chemical safety to protect health and environment and implementation of goals identified in IFCS declarations and recommendations and the SAICM Overarching Policy Strategy (OPS). A Forum V Thought Starter paper presents the rationale, objectives and organization of the session.¹

Through a series of practical case examples, the session will explore tools and approaches for applying precaution in chemical safety decision-making as well as commonalities and differences in these approaches. Following these presentations, guided discussion with delegates will occur, with the goal of identifying some key commonalities and differences in approaches and providing practical next steps for the future.

To ensure adequate thinking occurs in individual countries before the start of Forum V and thoughtful discussion at the Forum, an Information Background Document will be provided to delegates in advance of Forum V. This Backgrounder Document will summarize information collected on how governments and other organizations domestically apply precaution in chemicals management including:

- A collection of structured information requested from governments and organizations to provide examples of tools and frameworks for how they have applied precaution in the context of domestic chemicals safety efforts.
- Interviews with selected active members in IFCS to understand differences in how precaution is applied and some of the controversies in its application; how they are applying precaution in chemicals management including tools and approaches and the types of tools and processes that would support precautionary decision-making in the context of chemicals management.

¹ Thought Starter: Forum V Plenary Open Information/Discussion Session On Tools And Approaches For Applying Precaution In The Context Of Chemicals Safety, Prepared By: Forum Standing Committee (IFCS/FORUM-V/01-TS
http://www.who.int/ifcs/documents/forums/forum5/meet_docs/en/index.html)

Information Request

The purpose of this structured information collection process is to collect examples of tools, approaches and frameworks for applying precaution (or making decisions in the face of uncertainty) with regards to national chemical safety efforts. The goal is to understand similarities and differences in how precautionary decisions (or decisions in circumstances of uncertainty) are made across countries; what tools and approaches countries use to apply precaution in chemicals management; how policy, regulatory and scientific processes support precautionary decision-making in the context of chemicals management; the challenges and needs for applying precaution in the context of chemicals management; and varying perceptions with its application.

This information will be collected via the template questionnaire (Annex) which consists of specific and more open-ended questions. We ask that you fill in the template as thoroughly as possible. *Please provide any links or additional supporting materials that provide information on particular policies, tools, or activities.*

Process of soliciting information

The request for information submissions is being sent to the entire IFCS mailing list. Submissions are welcomed from everyone and government staff are encouraged to coordinate submissions through the IFCS National Focal Point (see IFCS website for list of designated NFP: <http://www.who.int/ifcs/focalpoints/en/>).

We ask that submissions be returned by **20 July 2006**. Please return completed form to:

IFCS Secretariat
Email: ifcs@who.int
Fax: +41 22 791 4875

If you have any questions, please do not hesitate to contact us.

Thank you for your willingness to participate in this important effort.

Sincerely,

Joel A. Tickner, ScD
Special Advisor, IFCS
Email: joel_tickner@uml.edu

Judy A. Stober, PhD
Executive Secretary, IFCS
Email: ifcs@who.int

Annex

IFCS Forum V
Plenary Information/Discussion Session on Tools and Approaches for
Applying Precaution in the Context of Chemicals Safety
Information Request for Background Paper
Structured Questionnaire

Background Information

Country: Israel

Ministry/Agency/Institute/Organization: Ministry of Health

Contact Person: Prof. Yona Amitai

Contact Details:

Mailing address:

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20 King David St. Jerusalem 91010 Usrael

Email: yonamitai@moh.health.gov.il

For telephone and fax numbers, please indicate country and city codes:

Tel : 972-2-6228836

Fax : 972-2-6228907

Please submit completed questionnaire by 20 July 2006 to:

IFCS Secretariat
Email: ifcs@who.int
Fax: +41 22 791 4875

Please note: Unless you indicate otherwise in your response, these submissions will be posted on the IFCS website.

Please provide any links or additional supporting materials that provide additional information on particular policies, tools, or activities.

National chemicals policy or management:

1. How is the concept of precaution explicitly or implicitly (in terms of decision-making under conditions of uncertainty) incorporated in national chemicals policy or management in your country/organization?

Please check all that apply.

- | | |
|--|---------------------------------|
| In the country constitution ? | no
<input type="checkbox"/> |
| In legislation? | yes
<input type="checkbox"/> |
| In agency/ ministry /organization policy? | yes
<input type="checkbox"/> |
| In specific guidance documents for risk assessment or risk management? | yes
<input type="checkbox"/> |
| Applied in specific cases but no particular policy? | <input type="checkbox"/> |
| Not applied at all? | <input type="checkbox"/> |

Please provide greater detail (1 para).

1. Drinking Water Regulation (from 2000), revised 2006
2. Clean Air Act – 2006
3. Policy position paper on principles of regulation in Environmental Protection - 1997

Tools and approaches for applying precaution:

2. What are some of the key tools and approaches used by your country/organization in applying precaution (or making decisions in circumstances of uncertainty) in the context of chemicals safety?

- Legislation, Standards (Israeli standard Institution), Environmental and Occupational monitoring

a. Is there a defined approach to applying precaution or decision-making under uncertainty?

Yes No

If yes, can you outline the elements of that approach or provide references to it?

b. Is precaution integrated in other decision-making processes, tools and approaches such as;

Please check all that apply.

- Data collection?
- Prioritization of substances for risk management actions
- Uncertainty characterization?
- Socio-economic analysis (e.g., social impact, proportionality/cost-benefit assessment, trade concern)?
- Risk assessment and risk management options?
- Screening, comparison of alternatives, informed substitution?
- Stakeholder and Public involvement?
- Other

For those boxes checked, please briefly provide greater detail or links to additional information.

Screening, comparison of alternatives, and informed substitution: sewage treatment and its use for irrigation

Drinking water treatment

Stakeholder and public involvement: Participation of representatives from NGO's, academia and the industry in expert committees.

Public Hearing before issuing regulations and standards (Israeli standard Institution, Drinking water standards)

c. How are gaps in knowledge addressed?

Please check all that apply.

- Though conservative risk assessment assumptions
- Through safety factors
- Through modeling techniques
- Through an assumption that lack of information is indication of potential harm
- Through requesting additional research
- Gaps are not addressed

For those boxes checked, please briefly provide greater detail or links to additional information.

Radiation damage: use of conservative thresholds

Bisphenol A: adoption of strict regulations (EC, rather than USA, for drinking bottles for infants)

Requesting additional research: Hiring an international company to do risk assessment in the national site for hazardous chemicals (Ramat Hovav)

3. Please provide details of a particular case (or example) where precaution was applied (or decisions made in the face of uncertainty) in the context of chemicals management?

a. What stimulated/initiated the precaution process/action?

Please check all that apply.

- Government concern over hazards and/or exposures
- Stakeholder concerns over the particular threat
- International policy requirements/pressures
- Negative impacts/experience(s) from not acting on a previous chemical risk
- Other

For those boxes checked, please briefly provide greater detail or links to additional information.

Government concern etc.

1. In Ramat Hasharon, high levels of perchlorate were found in drinking water. In response the ministry of health closed the wells, and did research on the possible effects of gestational exposure to this water on neonatal thyroid function.

2. Restricting the domestic use of diazinone and chlorpyrifos

3. Prohibiting the import of wood treated with CCA (copper, chrome and arsenic).

b. What process was used to make the decision? (please briefly describe the process or tools used to make the decision)

Consultations with experts, research (e.g. – study of neonatal thyroid function in babies born to mothers who ingested water with high perchlorate content, compared with a control group).

c. Were there positive or negative impacts of this process/action?

Please check all that apply.

<u>Positive</u>		<u>Negative</u>	
Ecological or Health benefits	<input type="checkbox"/>	Ecological or health impacts	<input type="checkbox"/>
Economic benefit	<input type="checkbox"/>	Economic impacts	<input type="checkbox"/>
Improved government/industry image	<input type="checkbox"/>	Substitutes/alternatives did not work	<input type="checkbox"/>
Improved government/public morale	<input type="checkbox"/>	Negative public reaction	<input type="checkbox"/>
Improvements to scientific tools/decision processes	<input type="checkbox"/>	Other?	<input type="checkbox"/>
Other?	<input type="checkbox"/>		

For those boxes checked, please briefly provide greater detail or links to additional information.

Impacts are not known yet

d. Were there any unintended consequences from this process/action?

Positive – please describe

Negative - please describe

-
4. Are there any particular cases in your country/organization where precaution was not applied (decisions not made in the face of uncertain chemical risks) resulting in adverse impacts?

Yes No

If yes, briefly describe if and how decision-making processes have been modified as a result.

Fuel stations were located in proximity to wells of drinking water. This was amended in 1996, when protecting radius has been requested by law.

5. Does your government have processes in place to re-examine decisions made based on precaution or made in the face of uncertainty as additional data are available?

Yes No

If yes, briefly describe the process and how this process may be used to modify decisions, decision-making process, or tools.

Lessons Learned from applying precaution in chemicals management

6. What are some of the biggest challenges to your country's (organization's) application of precaution in the context of chemicals management or in chemicals management decision-making in the face of uncertainty?

Please check all that apply.

- Scientific capacity
- Lack of scientific information x
- Legal challenges
- Technical challenges
- Financial challenges x
- Trade Challenges
- Other?

For those checked boxes, please briefly indicate what were the implications of these barriers and how have they been addressed or if not yet addressed, how could they be addressed?

In drinking water standards, the upper limit of nitrates is 70 ppm, whereas the optimal level should be 50 ppm or lower. This decision is influenced by the alternative cost of reducing the threshold.

Are these challenges also applicable to decision-making and actions regarding established risks?

Yes

No X

Next steps

7. What are the most important needs of your country or organization for more effectively applying precaution (or making decisions in the face of uncertainty) and overcoming barriers in chemicals management decision-making?

Please check all that apply.

- | | |
|---|--------------------------------|
| <input type="radio"/> Data on chemical toxicity/risks | <input type="checkbox"/> |
| <input type="radio"/> Tools for prioritization | x
<input type="checkbox"/> |
| <input type="radio"/> Tools for risk assessment | <input type="checkbox"/> |
| <input type="radio"/> Decision-making tools/frameworks | <input type="checkbox"/> |
| <input type="radio"/> Technical assistance in risk assessment processes | x
<input type="checkbox"/> |
| <input type="radio"/> Technical assistance in risk management processes | <input type="checkbox"/> |
| <input type="radio"/> Financial support for implementation | x
<input type="checkbox"/> |
| <input type="radio"/> International dialogue | xx
<input type="checkbox"/> |
| <input type="radio"/> Information sharing to facilitate understanding of the issues | <input type="checkbox"/> |
| <input type="radio"/> Other | <input type="checkbox"/> |

For those boxes checked, please briefly provide greater detail or links to additional information.

For risk assessment of the planned new national for disposal and treatment of hazardous chemicals (in Ramat Hovav), a private company from the Netherlands was hired, since there was no local expert in risk assessment

8. Briefly describe your perceptions as to some of the concerns regarding application of precaution in the context of chemicals safety?

Please briefly provide details or links to additional information

1. In a small country like Israel, the disposal of hazardous chemicals may be problematic.
2. The above mentioned example of compromising on nitrate level of 70 ppm in drinking water standards (shortage of water)

-
9. Do you have any additional information on tools and approaches for applying precaution that would be helpful to inform discussion?

Please provide any additional materials or web links.

1. The case study of perchlorate in drinking water (see paragraph 3 in page 4). The research on neonatal thyroid function in newborns whose mothers had gestational exposure to perchlorate has been presented at the Scientific Meeting of the American Academy of Clinical Toxicology in 2005, and further research is done.
2. We have developed novel guidelines for diving in polluted/contaminated water, which is scheduled for presentation in an expert meeting in Washington DC in July 25, 2006. These guidelines had been developed by a group of experts in Israel in response to a Governmental Investigation Committee on the question of Health effects of Diving in Polluted Water. The new guidelines are applicable to the general population in swimming and diving activities in polluted water.

Please note: Unless you indicate otherwise in your response, your submission and those of others will be posted on the IFCS website.

ADDITIONAL INFORMATION

Proposed Guidelines for Diving in Polluted / Contaminated Water

Report of the Israeli Expert Committee

Executive Summary

Committee Members:

Yona Amitai, M.D., M.P.H. – Chairman

Shlomo Almog, Ph.D. – Co-chairman

Asher Pardo, Ph.D.

Mario Sculsky, M.D.

Matitiahu Lifshitz, M.D.

Presented to:

General Giora Martinowitz, ex-Surgeon General, Israeli Defense Force and Major

General David Ben Ba'ashat

Scheduled for presentation at a Conference on Diving in Polluted / Contaminated

Water in Washington DC, July 25-26, 2006 by: Almog S, Amitai Y

July 13, 2006

Abbreviations:

ABS_{dermal} – Dermal absorption factor from sediment

ABS_{oral} – GI bioavailability

ACGIH – American Conference of Governmental Industrial Hygienists

ADDD – Allowable Dermal Daily Dose

AF – sediment Adherence Factor

ASSDU - Allowable Sediment/Skin Daily Uptake

BEIs – biological exposure indices

DWS – Drinking water standards

DPWG – diving in polluted water guidelines

EPA – Environmental Protection Agency

IARC – International Agency for Research on Cancer

IDF – Israeli Defense Forces

PCBs – polychlorinated biphenyls

PAHs – polycyclic aromatic hydrocarbons

RfD – Reference dose

SF_{dermal} – slope factor based on dermal exposure experiments

SWSQGV – Sea Water and Sediment Quality Guidelines Values

TBT – tributyl tin

Background:

The Committee was appointed in August 2001, following the recommendations of the "Shamgar Committee", a National Committee that investigated the consequences of military activity of the Israeli Defense Forces (IDF) navy divers who trained in the Kishon River and the surrounding waters, on their health. The Shamgar Committee specified that further diving should be done only after setting environmental standards for chemical pollutants in sea water for naval activities.

A search in over 20 navies worldwide did not reveal any previous diving standards regarding sea water and sediment. Thus, our Committee had to create novel Diving in Polluted Water Guidelines (DPWG). Of note, sea water guidelines for recreational activities were received from the navies of Singapur and Venezuela. These include a limited number of physical / chemical parameters with quantitative guidelines, but with no definitions for duration of exposure and routes of absorption (ingestion, dermal absorption).

In February 2003, the US-Naval Sea System Command issued a Diving in Polluted / Contaminated Waters Manual. This included general recommendations on hazards, protective equipment, pollution categories, pre-diving planning and decontamination. However, only qualitative water categories were defined, without risk assessment of exposure to specific chemicals, or guidelines for the duration of exposure of divers. Similar guidelines have been issued by the Canadian Navy in 2003.

An ecological standard for sea water quality exists, aimed at protecting marine life, but does not address human divers.

Chemical contaminants of concern:

The Committee is aware that the variety of contaminants from natural and anthropogenic sources is almost infinite. These include industrial waste, fertilizers, pesticides, biological materials etc., in addition to toxic substances unique to the marine environment, such as the antifouling substance tributyl tin (TBT).

Setting guidelines for all potential chemical contaminants in sea water and sediment is impractical. Therefore, we have opted to base the DPWG on the best available risk assessment data, relevant to human health. For this purpose, the chemicals included in the US-EPA Drinking Water Standards (DWS), were chosen as contaminants of concern for DPWG. With some adaptations for sea water and sediment, 156 substances, including heavy metals, pesticides, polycyclic aromatic hydrocarbons, halogenated hydrocarbons and

others, were selected. Long exposure to these substances might increase the risk for malignancy and chronic toxicity in various body systems.

The scope of the Committee was to define DPWG including Sea Water and Sediment Quality Guidelines Values (SWSQGV) for chemical contaminants. Biological and radiological standards were not addressed.

Risk Assessment Model for Calculating SWSQGV

The marine environment is a dynamic system in terms of a complex interrelationship between the diver, the sea water and the sea sediment. The model assumes dermal exposure through 2 different pathways, dermal-water and dermal-sediment, and oral exposure through possible swallowing of sea water.

The reference diving scenario adopted was characterized by the following parameters:

- (1) Healthy young men, 70 Kg body weight, aged 18-30 years.
- (2) Diving with a wet suit.
- (3) One diving event per day, 125 events per year for 5-12 years.
- (4) Two hours diving per event of which one hour in contact with sea sediment.
- (5) The whole body surface area ($SA = 19,600 \text{ cm}^2$) is exposed to the sea water.
- (6) Two feet (1310 cm^2) and one arm (455 cm^2) are in contact with the sea sediment.
- (7) Up to 50 ml of sea water are swallowed during each diving event.

We adopted the 2002 US-EPA Drinking Water Standards for chemical contaminants as the Sea Water Quality Guideline Values for diving ($C_{w,crit}$). The dermal absorption of chemicals from water was estimated from Fick's Law as follows:

$$\text{Water/skin uptake } (\mu\text{g/day}) = C_{w,crit} (\mu\text{g/cm}^3) * K_p (\text{cm/hr}) * 19,600(\text{cm}^2) * 2(\text{hr/event}) * 1(\text{event/day}) * 125(\text{days})/365(\text{days})$$

The oral absorption of chemicals following sea water swallowing was calculated by substituting bioavailability values (ABS_{oral}) into the following equation:

$$\text{GI uptake } (\mu\text{g/day}) = C_{w,crit} (\mu\text{g/cm}^3) * ABS_{oral} * 50\text{cm}^3 / \text{event} * 1(\text{event/day}) * 125(\text{days})/365(\text{days})$$

We allowed an addition of $\frac{1}{4}$ RfD (Reference Dose, derived from dermal sub-chronic studies) to the daily uptake of chemical contaminants inducing non-carcinogenic effects. For those contaminants, classified by IARC as group A, 1B and 2B, we allowed an addition of $\frac{1}{4}$ ADDD (Allowable Dermal Daily Dose) calculated from dermal slope-factor (SF_{dermal}) and an excess estimated lifetime cancer risk of 1 in 75,000.

Thus, the Allowable Sediment/Skin Daily Uptake (ASSDU; $\mu\text{g/day}$) for non-carcinogenic effects was estimated as:

$$ASSDU = \frac{1}{4}RfD - (\text{Skin/Water uptake} + \text{GI uptake})$$

And for carcinogenic effects:

$$ASSDU = \frac{1}{4}ADDD - (\text{Skin/Water uptake} + \text{GI uptake})$$

The Sediment Quality Guideline Values ($C_{\text{sediment,crit.}}$) for diving were calculated from the equation:

$$C_{\text{sediment,crit.}} (\mu\text{g/gr sediment}) = \frac{ASSDU}{[SA(\text{cm}^2) * AF(\text{mg sediment/cm}^2) / 1000(\text{conversion of mg to gr for sediment}) * ABS_{\text{skin}} (\text{day}^{-1}) * 1\text{hr}/24\text{hrs} * 125(\text{days}) / 365(\text{days})]}$$

where SA is the surface area of 2 feet and one arm (1755 cm²), AF is the adherence factor (18.5 mg/cm² SA) and ABS_{skin} is the dermal absorption fraction from sediment.

All values used (sub-chronic dermal RfD, dermal SF, ABS_{oral}, Kp) reflect the updated values extracted from the Risk Assessment Information System (US-RAIS).

This model is flexible allowing both estimation of exposure at different diving scenarios and a trade-off between water/skin and sediment/skin uptakes.

Limitations of the Model:

This model, although based on worldwide accepted risk assessment approaches has several limitations:

- (1) The model does not take into account effects of multiple exposures. For this purpose, we recommend to adopt the NIOSH approach adopted by the ACGIH for occupational standards. This approach suggests that in the lack of evidence for synergism between the substances in the mixture, one can assume an additive effect. This effect is calculated by adding up the fractions of the threshold values of SWQGV of those chemicals which have the same target organ toxicity, using the formula: $C_1/T_1 + C_2/T_2 + \dots + C_n/T_n \leq 1$ where C_n and T_n are the concentration of substance n and its correspondent threshold value, respectively.
- (2) The model has not been validated in real life conditions.
- (3) The model does not take into account the contribution of the wet suit to dermal uptake. Whether the wet suit plays a protective role, minimizing the skin/sediment exposure or serves as a "sink" for some contaminants where they can accumulate over long periods of time has to be elucidated.
- (4) The model does not take into consideration the effect (if any) of hydrostatic pressure on dermal absorption.
- (5) The model assumes homogenous dissolution of chemicals in sea water and in sediment. However, many of the environmental chemical contaminants are

hydrophobic, resulting in uneven distribution between the water column, the upper layer and the sediment. Thus, the analytical data obtained from sea water and sediment samples are limited in estimating exposure.

- (6) The model applies permeability coefficient values (K_p) for compounds in water to estimate the dermal uptake from sea water.

Safety Factors Minimizing Model Uncertainties:

In an attempt to minimize uncertainties, we implemented some safety factors in the model:

- (1) The Committee elected to use the strict principles of environmental standards rather than the principles of occupational standards, which are more liberal. These were implemented in the model in terms of the Allowable Daily Dermal Dose (ADDD) and slope-factor (SF_{dermal}) values originally calculated for life-time exposure (70 years) of the general population including susceptible groups (children, elderly, pregnant women and debilitating diseases). By using environmental standards, the proposed DPWG could be applied to the general population.
- (2) The model uses a very conservative approach by implementing DWS as Sea Water Quality Guidelines for diving. The Committee was aware of the fact that oral absorption is much more effective than dermal absorption. Moreover, the exposure duration of a diver to chemical contaminants via sea water and sediment is about 250 hrs/year for 5-12 years compared to life-time exposure to chemicals in drinking water. However, the DWS are peer-reviewed and have been established on evidence-based data. The Committee found the common activities of swimming and bathing in drinking water the most comparable exposure scenario to diving.
- (3) We adopted a conservative value for adherence factor ($AF = 18.5 \text{ mg sediment/cm}^2$ skin) which is used for estimating dermal absorption in children playing in the mud, despite the fact that the diving suit reduces by-far the skin contact with sediment.
- (4) We chose conservative values of dermal absorption factors of 3-10%/24hrs and 1%/24hrs for organic materials and heavy metals, respectively.
- (5) The proposed Sea Water and Sediment Quality Guidelines for diving are one of many other DPWGs aimed to insure the health and the safety of the diver in polluted sea water.

Hazardous Areas and Activities where the DPWG Applies

Hazardous Areas

Based on environmental monitoring results obtained during 2001-2004 at 24 sites along the Mediterranean and 3 sites at the Red Sea, two categories were defined:

1. Hazardous areas: harbors, sea ports, marinas and estuaries with spillage of waste, at a radius of 500 meter from the source, with the exception of the "Shafdan" (the main effluent of the partially treated sewage of the greater Tel Aviv area), for which a 2,000 meter radius was defined.
2. Open sea: all other beaches excluding those classified under "hazardous areas".

Activities

From the dermal exposure point of view, we consider diving and swimming in high risk areas as a continuum. Therefore, the DPWG address divers' activities at the hazardous areas both for diving and swimming.

Recommendations

A. General

1. The model for calculating the Sea Water and Sediment Quality Guidelines Values (SWSQGV) for chemical contaminants as well as the DPWG may apply not only to diving and swimming activities in the military scenario but to the **general population** in polluted / contaminated waters as well. In our opinion, such generalization is possible, since we elected to use the strict principles of environmental standards (such as EPA-DWS; ADDD; SF_{dermal}) with adaptations to account also for exposure to the sea bottom sediment. In order to do so, fitting the parameters defined in the model to the relevant activity scenario, is necessary.
2. The Committee recommended keeping a personal logbook, for recording the exposure time in sea water and contact with the sediment, in all hazardous areas. All divers and other navy personnel, who swim in hazardous areas, should keep such logbooks.
3. Routine surveillance of divers' health and safety consists of periodical medical examinations accompanied by biological and environmental monitoring.
4. The proposed DPWG are limited to chemical / toxicological aspects. Monitoring of the physical, biological and radiological marine environment in the diving / swimming sites should be done using general or specific standards, if available.

5. The threshold concentrations of chemicals in sea water and sediment in the proposed SWSQGV are temporary, and intended to provide a practical tool for monitoring and supervision of the marine environment for diving activity. Gaining more experience and knowledge on divers' safety, based on environmental and biological monitoring, will allow establishing improved guidelines for diving in polluted water in the future.
6. Diving and swimming in "open sea" areas (as defined above) are not restricted by the DPWG.
7. Periodical environmental monitoring should be done at "hazardous areas". Routine diving / swimming in these areas is not restricted as long as the concentrations of chemicals listed in the SWSQGV during monitoring, are within the guidelines for sea water and sediments.
8. Regardless of the results of the structured environmental monitoring program, in the event of a spillage, ecological accident, visible pollution, or an obvious excess mortality in marine life, diving / swimming at such a site will be prohibited, until the suspected area has been examined and cleared.
9. For the practical implication of the DPWG and its day by day handling, it is suggested that a forum of experts will be appointed for ongoing consultation.
10. Further steps recommended to improve the proposed DPWG include:
 - a. Developing an in vitro model to assess the end-effect of multiple chemicals (mixtures) in sea waters by bioassay methods.
 - b. Developing a standard method for sampling of the upper layer of the sea surface. Such sampling is significant mainly for low specific gravity hydrophobic chemicals, some of which are carcinogenic.
 - c. Improving the biological monitoring of chemicals by quantitation of persistent organic pollutants (PCBs, organochlorines, dioxins, PAHs and others) in human fat biopsy.
 - d. Re-evaluation of the proposed DPWG is recommended at 3-5 year intervals, based on new data and other scientific progress.
 - e. Studying the kinetics of accumulation of chemical contaminants in the wet suit material and its thermodynamic effects on the skin, as well as sea water and sediment system decontamination processes to reduce exposure.

B. Health Recommendations and Personal Precautions

1. Health education and health promotion to all divers regarding healthy lifestyle (e.g. reducing exposure to sun radiation, smoking cessation, healthy nutrition).

2. Diving / swimming at high risk areas are prohibited for divers with an active skin disease or extensive skin abrasions.
3. Wet diving suits should be removed immediately following the mission, as the diver arrives at the dive-station. After the diver has been initially rinsed, he should be scrubbed with a stiff-bristle synthetic brush and a cleaning solution. Diving suits should be thoroughly cleaned.
4. Contact with the sediment is not limited, as long as the concentrations of chemicals in the sediment do not exceed the guideline values.
5. When the concentration of one or more of the chemicals in sea water exceeds the SWSQGV, diving at that site should be continued with dry suits. When the concentration of chemicals in the sediment exceeds the SWSQGV, diving at that site could continue either with wet suits without contact with the sediment, or with dry suits, when contact with the sediment is required.

C. Environmental Monitoring

1. Periodical environmental monitoring of chemicals in sea waters and sediments should be limited to "hazardous areas".
2. In addition to the environmental monitoring of specific chemicals, a "toxic screen" of sea waters and sediment is suggested using mass spectrometry technology and identification of unknown chromatography peaks by available mass spectral reference libraries (NIST, Wiley). Such a screening is recommended also in the event of an ecological accident from an unknown source.
3. The frequency of sea water and sediment sampling depends on its concentration in previous monitoring at a specific site, as follows:
 - a. When the concentration of a chemical substance is 10- 100% of its SWSQGV, it should be measured annually.
 - b. When the concentration of a chemical substance is 1- 10% of its SWSQGV, it should be measured again once in a 3 years.
 - c. When the concentration of a chemical substance is < 1% of its SWSQGV, it should be measured again at that site after 5 years.
4. Chemicals whose limit of detection in sea water or sediment is higher than the threshold in the proposed SWSQGV, should be measured annually.

5. When a trend of increasing concentrations of a certain chemical at the same site is detected, even when below the SWSQGV threshold, it should be reported to the State EPA for environmental survey and detection of the source of pollution.
6. When one or more of the contaminants is found in the environmental monitoring to be in excess of the threshold value as defined in the SWSQGV, the forum of experts should be consulted for risk assessment of the specific chemical/s. The model allows adjustments, e.g. – limitation of the duration of swimming / diving allowed in that site, limiting contact with the sediment, etc.

D. Biological Monitoring

1. Baseline tests should be taken from all personnel who swim at the hazardous areas, at the beginning of their diving career. These should include routine chemistry and urinalysis, CBC, metabolites of toluene, xylene, benzene, styrene, tri-chloro organic solvents, PAHs, PCBs, heavy metals, cholinesterase inhibitors and TBT.
2. This biological monitoring profile will also include a "toxic screen" using mass spectrometry technology and identification of unknown chromatography peaks by available mass spectral reference libraries (NIST, Wiley).
3. All active divers who dive ≥ 25 hours/ year at hazardous areas will undergo annual occupational health supervision, including the above biological monitoring profile.
4. Interpretation of results will be based on the current Biological Exposure Indices (BEIs) as published by the ACGIH.
5. Blood and urine samples will be taken during a period of active diving, within 4 hours of the last dive, to account for those chemicals and metabolites with short elimination half life times.

Closing Remark

These proposed DPWG can not be an ultimate solution for the complex problem of estimating exposure to chemical contaminants during diving in polluted sea water. However, they are based on current scientific knowledge in this field. We believe that these guidelines pave the way for continuous improvement in diver safety. Implementation of these recommendations should be accompanied by a forum of experts for solving ongoing questions that may arise, and refining the proposed DPWG accordingly.