

# OIL POLLUTION RESEARCH AND TECHNOLOGY PLAN

Fiscal Years 2015-2021



## INTERAGENCY COORDINATING COMMITTEE ON OIL POLLUTION RESEARCH (ICOPR)

September 2015



**DISCLAIMER**

This Oil Pollution Research and Technology Plan (OPRTP) presents the collective opinion of the 15 departments and agencies that constitute the members of Interagency Coordinating Committee on Oil Pollution Research (ICCOPR), regarding the status and current focus of the federal oil pollution research, development, and demonstration program (established pursuant to section 7001(c) of the Oil Pollution Act of 1990 (33 U.S.C. 2761(c))). The statements, positions, and research priorities contained in this OPRTP may not necessarily reflect the views or policies of an individual department or agency, including any component of a department or agency that is a member of ICCOPR. This OPRTP does not establish any regulatory requirement or interpretation, nor implies the need to establish a new regulatory requirement or modify an existing regulatory requirement.

## **TABLE OF CONTENTS**

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TABLE OF CONTENTS .....	III
LIST OF FIGURES .....	XI
LIST OF TABLES.....	XII
LIST OF ACRONYMS .....	XIII
DEFINITIONS .....	XXI
EXECUTIVE SUMMARY .....	1
INTRODUCTION.....	3
Background .....	3
Purpose of the Plan .....	4
Scope and Use of the Plan .....	4
<b>PART ONE – OIL POLLUTION RESEARCH.....</b>	<b>7</b>
1.    The Need for Oil Pollution Research .....	7
1.1    U.S. Oil Production .....	8
1.2    History of Oil Spills in the U.S.....	12
1.3    Analysis of the Oil Spill System .....	15
1.4    Exploration and Production Facilities.....	16
1.5    Onshore and Offshore Pipelines.....	17
1.6    Railroads .....	19
1.7    Refining and Storage Operations.....	21
1.8    Maritime and Riverine Transport - Tank Vessels (Ships & Barges) and Non-Tank Vessels.....	22
1.9    Oil Tankers .....	24
1.10    Regional and Geographic Areas of Interest.....	25
2.    Federal Oil Pollution Research .....	27
2.1    ICCOPR .....	27
2.1.1.    Origin.....	27
2.1.2.    ICCOPR Membership.....	27
2.1.2.1    U.S. Coast Guard (USCG).....	29
2.1.2.2    National Oceanic and Atmospheric Administration (NOAA).....	29
2.1.2.3    National Institute of Standards and Technology (NIST) .....	30
2.1.2.4    U.S. Department of Energy (DOE).....	31

2.1.2.5	Bureau of Safety and Environmental Enforcement (BSEE)	31
2.1.2.6	Bureau of Ocean Energy Management (BOEM)	32
2.1.2.7	U.S. Fish and Wildlife Service (USFWS)	32
2.1.2.8	Maritime Administration (MARAD)	33
2.1.2.9	Pipeline & Hazardous Materials Safety Administration (PHMSA)	33
2.1.2.10	US Army Corps of Engineers (USACE)	34
2.1.2.11	U.S. Navy (USN)	34
2.1.2.12	U.S. Fire Administration (USFA)	35
2.1.2.13	U.S. Environmental Protection Agency (EPA)	35
2.1.2.14	National Aeronautics and Space Administration (NASA)	36
2.1.2.15	U.S. Arctic Research Commission (USARC)	36
2.2.	Other Federal Stakeholders and Entities	37
2.2.1	Arctic Executive Steering Committee (AESC)	37
2.2.2	Federal Oil Spill Team for Emergency Response Remote Sensing (FOSTERRS)	37
2.2.3	Federal Rail Administration (FRA)	37
2.2.4	U.S. Geologic Survey (USGS)	38
2.2.5	Gulf Coast Ecosystem Restoration Council	38
2.2.6	Gulf of Mexico Fishery Management Council (GMFMC)	38
2.2.7	U.S. Marine Mammal Commission (MMC)	39
2.2.8	National Institute of Environmental Health Sciences (NIEHS)	39
2.2.9	U.S. National Response Team (NRT) - Science and Technology (S&T) Committee	40
2.2.10	National Science Foundation (NSF)	40
2.2.11	NOAA RESTORE Act Science Program	40
2.2.12	North American Wetlands Conservation Act (NAWCA) Gulf of Mexico Funds	41
2.3	Federal Research Laboratories and Testing Facilities	41
2.3.1	Ohmsett	41
2.3.2	USCG Research & Development Center (RDC)	42
2.3.3	USCG RDC Joint Maritime Test Facility	42
2.3.4	USCG Marine Safety Laboratory	42
2.3.5	U.S. EPA National Risk Management Research Laboratory (NRMRL)	42
2.3.6	Cold Regions Research and Engineering Laboratory (CRREL)	43
2.3.7	U.S. Army Engineer Research and Development Center (ERDC)	43
2.3.8	Hollings Marine Laboratory (HML)	43

2.2.9	U.S. Naval Research Laboratory (NRL) Stennis Space Center.....	44
2.3.10	Pacific Northwest National Laboratory (PNNL).....	44
2.3.11	Coastal and Ocean Research Vessels.....	45
2.3.10.1	USCG Cutter Healy.....	45
2.3.11.2	EPA Vessels.....	45
2.3.11.3	MARAD Vessels.....	45
2.3.11.4	NOAA Vessels.....	45
2.3.12	Oil Spill Field Research.....	46
3.	Non-Federal Oil Pollution Research Entities.....	47
3.1	State Organizations.....	47
3.1.1	Alaska Department of Environmental Conservation (ADEC).....	47
3.1.2	California Office of Oil Spill Prevention and Response (CAOSPR).....	47
3.1.3	Florida.....	48
3.1.4	Louisiana Applied and Educational Oil Spill Research and Development Program (OSRADP).....	48
3.1.5	Gulf States Marine Fisheries Commission (GSMFC).....	48
3.1.6	Minnesota National Crude Oil Spill Fate and Natural Attenuation Site.....	49
3.1.7	Pacific States/British Columbia Oil Spill Task Force (PSBCOSTF).....	49
3.1.8	Texas General Land Office (TXGLO).....	49
3.1.9	Washington Department of Ecology (WADOE).....	50
3.2	Industry.....	50
3.2.1	American Petroleum Institute Joint Industry Task Force (API JITF).....	50
3.2.2	American Salvage Association (ASA).....	51
3.2.3	Association of Petroleum Industry Co-op Managers (APICOM).....	51
3.2.4	Industry Technical Advisory Committee (ITAC).....	52
3.2.5	International Maritime Organization (IMO).....	52
3.2.6	International Petroleum Industry Environmental Conservation Association (IPIECA).....	52
3.2.7	International Spill Control Organization (ISCO).....	53
3.2.8	International Tanker Owners Pollution Federation (ITOPF).....	53
3.2.9	Oil Spill Response (OSR) Joint Industry Program (JIP).....	53
3.2.10	Petroleum Environmental Research Forum (PERF).....	53
3.2.11	Pipeline Research Council International (PRCI).....	54
3.2.12	Spill Control Association of America (SCAA).....	54

3.3	Independent Research Interests .....	54
3.3.1	Cook Inlet Regional Citizen's Advisory Committee (CIRCAC).....	55
3.3.2	Gulf of Mexico Alliance (GOMA).....	55
3.3.3	Gulf of Mexico Research Initiative (GoMRI) .....	55
3.3.4	Gulf Restoration Science Programs Ad Hoc Coordination Forum .....	56
3.3.5	National Academy of Sciences Gulf Research Program (GRP) .....	56
3.3.6	National Fish and Wildlife Federation (NFWF) .....	56
3.3.7	Ocean Energy Safety Institute (OESI).....	56
3.3.8	Oil Spill Recovery Institute (OSRI) .....	57
3.3.9	Pew Charitable Trusts (PCT) Arctic Science Program .....	58
3.3.10	Prince William Sound Regional Citizen's Advisory Committee (PWSRCAC) .....	58
3.3.11	Ship Structure Committee .....	58
3.4	Academia .....	58
3.4.1	Gulf of Mexico Research Consortia.....	59
3.4.2	Gulf of Mexico University Research Collaborative (GOMURC) .....	60
3.4.3	Harte Research Institute for Gulf of Mexico Studies.....	61
3.4.4	NOAA's Sea Grant Program.....	61
3.4.5	National University Rail (NURail) Center .....	61
3.4.6	Oil Spill Academic Task Force (OSATF) .....	62
3.4.7	Scripps Institution of Oceanography (SIO) .....	62
3.4.8	UAA/SIT Center of Excellence for Maritime Research (CMR).....	62
3.4.9	UAF Arctic Center for Oil-Spill Research & Education (A-CORE) .....	62
3.4.10	U.S. Coast Guard Academy .....	63
3.4.11	University of New Hampshire (UNH) Oil Spill Centers.....	63
3.4.12	Woods Hole Oceanographic Institution (WHOI) .....	63
3.5	International Efforts .....	64
3.5.1	Arctic Council .....	64
3.5.2	Australia .....	65
3.5.3	Canada.....	65
3.5.4	Centre of Documentation, Research and Experimentation on Accidental Water Pollution (CEDRE).....	66
3.5.5	China.....	66
3.5.6	European Union (EU) .....	66

3.5.7	France .....	67
3.5.8	Kill-Spill .....	68
3.5.9	Mexico .....	68
3.5.10	Norway .....	68
3.5.11	Russia .....	69
3.5.12	SINTEF .....	69
3.5.13	United Kingdom (UK) .....	69
3.6	Non-Federal Oil Pollution Testing Facilities.....	70
3.6.1	Bedford Institute of Oceanography Center for Offshore Oil, Gas and Energy Research (BIO COOGER).....	70
3.6.2	CEDRE Technical Facilities.....	70
3.6.3	Churchill Marine Observatory.....	71
3.6.4	Ocean Coastal Research Engineering (OCRE).....	71
3.6.5	PRCI Technology Development Center.....	71
3.6.6	SINTEF Sealab .....	72
3.6.7	Southwest Research Institute (SwRI).....	72
3.6.8	Texas A&M Corpus Christi Center for Coastal Studies (CCS) .....	72
4.	Structuring Oil Pollution Research.....	75
4.1	Introduction to the Oil Spill Research Framework .....	75
4.2	Classes .....	76
4.3	Standing Research Areas (SRAs).....	77
4.3.1	Prevention SRAs.....	78
4.3.1.1	Human Error Factors [1000 series].....	78
4.3.1.2	Offshore Facilities and Systems [1100 series] .....	79
4.3.1.3	Onshore Facilities and Systems [1200 series] .....	80
4.3.1.4	Waterways Management [1300 series].....	80
4.3.1.5	Vessel Design [1400 series] .....	80
4.3.1.6	Drilling [1500 series] .....	81
4.3.1.7	Rail & Truck Transportation [1600 series].....	82
4.3.1.8	Pipeline Systems [1700 series].....	82
4.3.2	Preparedness SRAs.....	83
4.3.2.1	Pre-spill Baseline Studies [2000 series].....	83
4.3.2.2	Response Management Systems [2100 series].....	83

4.3.3	Response SRAs .....	84
4.3.3.1	Structural Damage Assessment and Salvage [3000 series] .....	84
4.3.3.2	At Source Control and Containment [3100 series] .....	84
4.3.3.3	Chemical and Physical Behavior Modeling [3200 series] .....	85
4.3.3.4	Oil Spill Detection and Surveillance [3300 series] .....	86
4.3.3.5	In- and On-water Containment and Recovery [3400 series] .....	86
4.3.3.6	Shoreline Containment and Recovery [3500 series] .....	87
4.3.3.7	Dispersants [3600 series] .....	87
4.3.3.8	In-situ Burning [3700 series] .....	88
4.3.3.9	Alternative Countermeasures [3800 series] .....	89
4.3.3.10	Oily and Oil Waste Disposal [3900 series] .....	89
4.3.3.11	Bioremediation [4000 series] .....	90
4.3.4	Injury Assessment and Restoration SRAs .....	90
4.3.4.1	Environmental Impacts and Ecosystem Recovery [4100 series] .....	90
4.3.4.2	Environmental Restoration Methods and Technologies [4200 series] .....	91
4.3.4.3	Human Safety and Health [4300 series] .....	91
4.3.4.4	Sociological and Economic Impacts [4400 series] .....	92
4.4	Research Needs .....	92
4.5	Projects .....	93
5.	Knowledge Transfer and Advancement .....	95
5.1	Factors Affecting Research and Technology Program Success .....	95
5.1.1	Funding .....	95
5.1.2	Continuity of Research .....	97
5.1.3	Field Testing .....	97
5.1.4	Building the Next Generation of Researchers .....	98
5.1.5	Public Perceptions .....	99
5.2	Communicating Research and Technology Efforts .....	99
5.2.1	ICCOPR OP RTP .....	99
5.2.2	ICCOPR Biennial Reports to Congress .....	100
5.2.3	ICCOPR Meetings .....	100
5.2.4	Meetings with Non-Federal Entities .....	100
5.2.5	Demonstration Projects .....	100
5.2.6	Conferences .....	101



5.2.7	Workshops and Seminars .....	102
5.2.8	Publications .....	102
5.2.9	Newsletters.....	103
5.2.10	Internet and Social Media.....	103
5.3	Monitoring the Status of Oil Pollution Technologies .....	103
<b>PART TWO – ESTABLISHING RESEARCH PRIORITIES .....</b>		<b>105</b>
6.	Oil Pollution Research Needs Identification and Prioritization Process .....	105
6.1	Research Needs Identification Process.....	106
6.1.2	Extraction and Consolidation of R&D Needs .....	111
6.1.3	Assignment of Research Needs to an SRA.....	111
6.2	Research Need Prioritization Process.....	111
6.2.1	Development of Research Needs Survey.....	112
6.2.2	Administration of Survey to SMEs .....	114
6.2.3	Processing of Survey Results.....	114
6.2.4	Identification of Top Priority Research Needs for Each SRA.....	114
7.	Noteworthy Oil Spill Incidents .....	117
7.1	Vessels Spills .....	117
7.2	Offshore Drilling Operations .....	121
7.3	On-Shore Pipeline Spills.....	124
7.4	Facility Spills.....	127
7.5	Railroad Spills .....	128
8.	Current State of Oil Pollution Knowledge.....	131
8.1	National Research Council - Oil Spill Dispersants: Efficacy and Effects.....	131
8.2	The Coastal Response Research Center Workshops .....	132
8.3	Department of Energy (DOE) Programs.....	138
8.4	Ultra-Deepwater Advisory Committee Annual Plan Reviews.....	139
8.5	Deepwater Horizon Oil Spill Principal Investigator Conferences .....	140
8.6	Deepwater Horizon Incident Specific Preparedness Review.....	140
8.7	National Commission on BP Deepwater Horizon - Final Report.....	142
8.8	Public Meetings, Letters, and Reports Submitted to ICCOPR.....	143
8.9	National Research Council: Responding to Oil Spills in the U.S. Arctic Marine Environment .....	144
8.10	National Petroleum Council: Arctic Potential – Realizing the Promise of U.S. Arctic Oil	

and Gas Resources.....	144
8.11 Industry Reports.....	145
8.12 Prince William Sound Oil Spill Recovery Institute (OSRI) Research Plan 2011-2015 (February 2010).....	146
9. Oil Spill Research and Technology Priorities.....	147
9.1 Prevention Priority Research Needs.....	150
9.1.1 Human Error Factors Priorities (Section 4.3.1.1).....	150
9.1.2 Offshore Facilities and Systems Priorities (Section 4.3.1.2).....	151
9.1.3 Onshore Facilities and Systems Priorities (Section 4.3.1.3).....	151
9.1.4 Waterways Management Priorities (Section 4.3.1.4).....	152
9.1.5 Vessel Design Priorities (Section 4.3.1.5).....	152
9.1.6 Drilling Priorities (Section 4.3.1.6).....	153
9.2 Preparedness Priority Research Needs.....	157
9.2.2 Response Management Systems Priorities (Section 4.3.2.2).....	158
9.3 Response Priority Research Needs.....	160
9.3.1 Structural Damage Assessment and Salvage Priorities (Section 4.3.3.1).....	160
9.3.2 At-Source Control and Containment Priorities (Section 4.3.3.2).....	160
9.3.3 Chemical and Physical Modeling and Behavior Priorities (4.3.3.3).....	161
9.3.4 Oil Spill Detection and Surveillance Priorities (Section 4.3.3.4).....	163
9.3.5 In- and On-water Containment and Recovery Priorities (Section 4.3.3.5).....	164
9.3.6 Shore Containment and Recovery Priorities (Section 4.3.3.6).....	165
9.3.7 Dispersants Priorities (Section 4.3.3.7).....	166
9.3.8 <i>In Situ</i> Burning (ISB) Priorities (Section 4.3.3.8).....	168
9.3.9 Alternative Chemical Countermeasures Priorities (Section 4.3.3.9).....	169
9.3.10 Oily and Oil Waste Disposal Priorities (Section 4.3.3.10).....	170
9.3.11 Bioremediation and Biodegradation Priorities (Section 4.3.3.11).....	171
9.4 Injury Assessment and Restoration Priority Research Needs.....	172
9.4.1 Environmental Impacts and Ecosystem Recovery Priorities (Section 4.3.4.1).....	172
9.4.2 Environmental Restoration Methods and Technologies Priorities (Section 4.3.4.2).....	174
9.4.3 Human Safety and Health Priorities (Section 4.3.4.3).....	174
9.4.4 Sociological and Economic Impacts Priorities (Section 4.3.4.4).....	175
References.....	177
<b>APPENDICES.....</b>	<b>189</b>

## LIST OF FIGURES

---

Figure 1-1: The start of the commercial oil industry in the U.S. – Oil Creek, PA, 1859 (Source: Drake Wells Museum).....	7
Figure 1-2: The Lakeview Gusher, CA; the US's single largest well blowout, 1910. (Source: San Joaquin Valley Geology) .....	7
Figure 1-3. Petroleum and other Liquid Estimated Consumption, Production and Net Imports (in million bpd) for 1949 – 2014 in the U.S. Source: EIA, 2015. ....	9
Figure 1-4 Domestic Shale gas plays. Source: EIA 2015.....	10
Figure 1-5: Location of U.S. Refineries and Refining Capacity. EIA 2015.....	11
Figure 1-6 Movement of crude oil (MBBL) by pipeline, tanker barge and rail to refinery areas. Source: EIA 2015.....	11
Figure 1-7 A comparison of crude oil movements by rail from 2010 and 2014. Source EIA 2015...12	
Figure 1-8: Average Annual Oil Spillage from Petroleum Industry Sources by Decade. Etkin, 2009. ....	13
Figure 1-10 Barrels of Oil Spilled by Pipelines (1995-2014).....	18
Table 1-6: U.S. Oil spills from vessels 2001-2010. (USCG, 2012) .....	23
Figure 1-11: Seaborne oil trade and oil spill trends.....	24

## **LIST OF TABLES**

---

Average Annual Oil Spillage from Petroleum Industry Sources, bbls. Modified From Etkin, 2009	.14
U.S. Gross Inputs to Refineries (Thousands of Barrels per Day) .....	21
Spill Events that Occurred in the Path of Hurricane Katrina (2005).....	22
U.S. Oil Spills from Vessels – 2001 - 2010. From: USCG, 2012 .....	23

## LIST OF ACRONYMS

A-CORE	Arctic Center for Oil-Spill Research & Education
AAR	After Action Review
AC	Area Committee
ACP	Area Committee Plan
ADEC	Alaska Department of Environmental Conservation
ADEQ	Arkansas Division of Environmental Quality
AESC	Arctic Executive Steering Committee
AIP	Australian Institute of Petroleum
AMOSOC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
APICOM	Association of Petroleum Industry Co-op Managers
ARTES	Alternative Response Technologies Evaluation System
BAST	Best Available and Safest Technology
bbl (s)	Barrel (equals 42 U.S. Gallons)
BIO COOGER	DFO Canada's Bedford Institute of Oceanography Center for Offshore Oil, Gas and Energy Research
BOEM	Bureau of Ocean Energy Management
BOEMRE	[former] Bureau of Ocean Energy Management, Regulation and Enforcement
BP	British Petroleum
Bpd	Barrels per day
BSEE	Bureau of Safety & Environmental Enforcement
CAOSPR	California Office of Oil Spill Prevention and Response
CASP	Center for Arctic Study & Policy
CEC	CEDRE Experimentation Column
CEDRE	Centre of Documentation, Research and Experimentation on Accidental Water Pollution
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Resource, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGHQ	Coast Guard Headquarters
CIRCAC	Cook Inlet Regional Citizen's Advisory Committee
CMR	Center of Excellence for Maritime Research
COP	Common Operating Picture
CPF	Coastal Protection Fund
CRADA	Cooperative Research and Development Agreement
CRRC	Coastal Response Research Center
CRREL	Cold Regions Research and Engineering Laboratory

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CSE	Center for Spills in the Environment
CSIRO	Commonwealth Scientific and Industrial Research Organization
CWA	Clean Water Act
DDO	Dispersants and dispersed oil
DECC	Department of Energy and Climate Change
DFO	Department of Fisheries and Oceans Canada
DHHS	Department of Health and Human Services
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOR	Dispersant to Oil Ratio
DOT	Department of Transportation
DWH	<i>Deepwater Horizon</i>
E&P	Exploration & Production
EC	Environment Canada; European Union
EDDM	Environmental Disasters Data Management
EDRC	Effective Daily Recovery Capacity
EDRP	Emergency Disaster Recovery Program
EEZ	Exclusive Economic Zone
EIA	U.S. Energy Information Administration
EMERCOM	Russian Ministry of Civil Defense, Emergencies and Disaster Response
EMSA	European Maritime Safety Agency
EOI	Expression of Interest
EOP	Executive Office of the President
EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 2005
EPPR	Emergency Prevention, Preparedness and Response Working Group
ERA	Environmental Risk Assessments
ERDC	U.S. Army Engineer Research and Development Center
ERRC	European Response Coordination Center
ERT	Environmental Response Team
ERW	Electric resistance welded pipe
ESA	Endangered Species Act
ESB	Environmental Specimen Bank
ESI	Environmental Sensitivity Index
ESP	Environmental Studies Program
EU	European Union
FACA	Federal Advisory Committee Act
FMSAS	Florida Marine Spill Analysis System

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FEMA	Federal Emergency Management Agency
FIO	Florida Institute of Oceanography
FOSC	Federal-On Scene Coordinator
FOSTERRS	Federal Oil Spill Team for Emergency Response Remote Sensing
FWPCA	Federal Water Pollution Control Administration
GIRG	Global Industry Response Group
GIS	Geographic Information Systems
GMFMC	Gulf of Mexico Fishery Management Council
GOMA	Gulf of Mexico Alliance
GoMRI	Gulf of Mexico Research Initiative
GOMURC	Gulf of Mexico University Research Collaborative
GRP	[National Academy of Science] Gulf Research Program
GSMFC	Gulf States Marine Fisheries Commission
HAZMAT	Hazardous Material
HML	Hollings Marine Laboratory
HMTA	Hazardous Materials Transportation Act
ICCOPR	Interagency Coordinating Committee on Oil Pollution Research
ICS	Incident Command System
ILI	In-Line Inspection
IMO	International Maritime Organization
IOM	Institute of Medicine
IOOS	Integrated Ocean Observing System
IOSC	International Oil Spill Conference
IPIECA	International Petroleum Industry Environmental Conservation Association
ISB	In-situ Burn
ISCO	International Spill Control Organization
ISPR	Incident Specific Preparedness Reviews
ITAC	Industry Technical Advisory Committee
ITOPF	International Tanker Owners Pollution Federation Limited
JITF	Joint Industry Oil Spill Preparedness and Response Task Force
JIP	Joint Industry Programme; Joint Industry Program
LEGEPA	General Law of Ecological Equilibrium and Environmental Protection
LiDAR	Light Detection and Ranging
LNG	Liquefied Natural Gas
MARAD	Maritime Administration
MARPOL	Marine Pollution (International convention for the Prevention of Pollution from Ships)
MCA	Maritime and Coastguard Agency
MER	Marine Environmental Response
META	Maritime Environmental and Technical Assistance
MMC	U.S. Marine Mammal Commission

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MMPA	Marine Mammal Protection Act
MMS	[former] Minerals Management Service
MOC-A	Marine Operations Center, Atlantic
MOC-P	Marine Operations Center, Pacific
MOC-PI	Marine Operations Center, Pacific Islands
MODU	Mobile Offshore Drilling Units
MPCSA	State Marine Pollution Control, Salvage and Rescue Administration
MPD	Managed pressure drilling
MRCC	Marine Rescue Coordination Centres
MSA	China Maritime Safety Administration
MSL	USCG Marine Safety Laboratory
MTBE	Methyl Tertiary Butyl Ether
NAS	National Academy of Sciences
NASA	National Aeronautics & Space Administration
NAVSEA	Naval Sea Systems Command
NAWCA	North American Wetlands Conservation Act
NDRF	National Defense Reserve Fleet
NEBA	Net Environmental Benefit Analysis
NEPA	National Environmental Policy Act
NCP	National Contingency Plan
NETL	DOE's National Energy Technology Laboratory
NFWF	National Fish and Wildlife Federation
NGO	Non-governmental Organization
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institutes of Health
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NPC	National Petroleum Council
NPFC	U.S. Coast Guard's National Pollution Funds Center
NRC	National Response Center; National Research Council
NRDA	Natural Resource Damage Assessment
NRDAR	Natural Resource Damage Assessment and Restoration
NRF	National Response Framework
NRL	U.S. Naval Research Laboratory
NRMR	U.S. EPA National Risk Management Research Laboratory
NRP	National Response Plan
NRT	National Response Team
S&T	National Response Team Science & Technology Committee
NSAR	National Strategy for the Arctic Region
NSCS	National Spill Control School



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NSF	National Science Foundation
NSTC	National Science and Technology Council
NTIS	National Technical Information Service
NTNU	Norwegian University of Science and Technology
NTSB	National Transportation Safety Board
NURail	National University Rail (NURail) Center
OCRE	Ocean Coastal Research Engineering
OCS	Outer Continental Shelf
ODRP	Oil Disaster Recovery Program
OESI	Ocean Energy Safety Institute
OGP	Oil and Gas Producers
OMAO	NOAA's Office of Marine and Aviation Operations
OPA 90	Oil Pollution Act of 1990
OPRTP	Oil Pollution Research & Technology Plan
OR&R	NOAA Office of Response & Restoration
OSC	On Scene Coordinator
OSHA	Occupational Safety & Health Administration
OSPR	Oil Spill Preparedness and Response
OSRADP	Oil Spill Research and Development Program
OSRI	Oil Spill Recovery Institute
OSRO	Oil Spill Removal Organization
OSP	Oil Sands Products
OSLTF	Oil Spill Liability Trust Fund
OST	[Executive Office of the President] Office of Science & Technology
OSV	Ocean Survey Vessel
OSWG	Oil Spill Working Group
PAJ	Petroleum Association of Japan
PCT	Pew Charitable Trusts
PEMEX	Petróleos Mexicanos
PERF	Petroleum Environmental Research Forum
PHMSA	Pipeline & Hazardous Materials Safety Administration
PI	Principal investigators
P.L.	Public Law
PNNL	Pacific Northwest National Laboratory
PRCI	Pipeline Research Council International
PRI	Paleontological Research Institution
PROMAM	Navy's Marine Environment Protection Division
PSBCOSTF	Pacific States/British Columbia Oil Spill Task Force
PTSA	Port and Tanker Safety Act of 1978
PWS	Prince William Sound

## Final Oil Pollution Research & Technology Plan – Approved September 29, 2015

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PWSA	Ports and Waterways Safety Act of 1972
PWSRCAC	Prince William Sound Regional Citizen's Advisory Committee
RAPID	Rapid Response Research
RAR	Resources at Risk
RDC	Coast Guard Research & Development Center
RDT&E	Research, Development, Test, and Evaluation
R&D	Research & Development
R&T	Research & Technology
RESTORE	Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act
RFP	Request for Proposal
ROV	Remotely Operated Vehicle
ROW	Right of Way
RP	Responsible Party
RRT	Regional Response Team
RSPA	[former] Research and Special Projects Administration
S&T	Science and Technology
SCAA	Spill Control Association of America
SCAT	Shoreline Cleanup Assessment Technique
SETAC	Society of Environmental Toxicology and Chemistry
SIO	Scripps Institution of Oceanography
SIT	Stevens Institute of Technology
SMART	Special Monitoring of Applied Response Technologies
SME	Subject Matter Expert
SONS	Spill of National Significance
SPCC	Spill Prevention, Control & Countermeasures
SRA	Standing Research Areas
SRM	Standard Reference Materials
SSC	NOAA Scientific Support Coordinator
SUPSALV	NAVSEA Supervisor of Salvage and Diving
SwRI	Southwest Research Institute
TCEQ	Texas Commission on Environmental Quality
TDC	Technology Development Center
TPWD	Texas Parks and Wildlife Department
TRB	Transportation Research Board
TXGLO	Texas General Land Office
UAA	University of Alaska Anchorage
UAF	University of Alaska Fairbanks
UDAC	Ultra-Deepwater Advisory Committee
UDW	Ultra-Deepwater

**Final Oil Pollution Research & Technology Plan – Approved September 29, 2015**

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UIUC	University of Illinois Urbana
UNEP	United Nations Environment Programme
UNH	University of New Hampshire
USACE	United States Army Corps of Engineers
USARC	United States Arctic Research Commission
USCG	United States Coast Guard
USGS	United States Geological Survey
USFA	United States Fire Administration
USFWS	United States Fish and Wildlife Service
USN	United States Navy
UTC	University Transportation Center
VOC	Volatile Organic Compound
VTSS	Vessel Traffic Service / Separation
WADOE	Washington Department of Ecology
WHOI	Woods Hole Oceanographic Institution

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## DEFINITIONS

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ICCOPR uses the following definitions solely for purposes of this Oil Pollution Research and Technology Plan (OPRTP). These definitions do not reflect all existing/relevant statutory and/or regulatory definitions and do not supersede any statutory or regulatory requirements.

**Allision** is the running of one vessel against another vessel or structure that is stationary. An allision is different from a collision in that a collision is the running of two moving vessels against each other.

**Applied Research** is any systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met, in this case related to advancing knowledge about oil spill prevention, preparedness, response, mitigation, and restoration/recovery.

**Basic Research** is any systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.

**Baseline Study** refers to studies conducted to gather a set of critical observations or data that provide a basis for comparing conditions before and after an action or event. Baseline studies document the ecological and socioeconomic conditions of an area before an oil system activity or potential spill occurs. These studies provide a basis for assessing changes or damages that occur as a result of the activities or a spill.

**Collision** means the running of two vessels against each other (both under power). A collision is different from an allision where only a single vessel is underway and strikes a stationary vessel or structure.

**Damages** means injury to natural resources, to real or personal property, loss of subsistence use of natural resources, loss of governmental revenues, loss of profits or earning capacity, and increased cost of additional public services. Damages also include the cost of assessing these injuries. Removal costs and damages covered by OPA 90 are defined in 33 U.S.C § 2702(b)(2).

**Demonstration** refers to activities that are part of research or development (i.e., that are intended to prove or to test whether a technology or method does, in fact, work). Demonstrations intended primarily to make information available about new technologies or methods should not be included in this definition (NSF, 2009).

**Development** is any systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods,

including design, development, and improvement of prototypes and new processes to meet specific requirements.

**Discharge** means any emission (other than natural seepage), intentional or unintentional, and includes, but is not limited to spilling, leaking, pumping, pouring, emitting, or dumping of oil that is not permitted.

**Dispersants** means those chemical agents that emulsify, disperse, or solubilize oil into the water column or promote the surface spreading of oil slicks to facilitate dispersal of the oil into the water column

**Facility** means any structure, group of structures, equipment, or device (other than a vessel) that is used for one or more of the following purposes: exploring for, drilling for, producing, storing, handling, transferring, processing, or transporting oil. This term includes any motor vehicle, rolling stock, or pipeline used for one or more of these purposes. The OPA 90 definition of a facility is codified at 33 U.S.C § 2702(b)(2).

**National Contingency Plan** (NCP) refers to the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 300), the federal government's blueprint for responding to both oil spills and hazardous substance releases. The NCP is the result of efforts to develop a national response capability and promote coordination among the hierarchy of responders and contingency plans.

**Natural Resource Damage Assessment** (or assessment) means the process of collecting and analyzing information to evaluate the nature and extent of injuries resulting from an incident, and determine the restoration actions needed to bring injured natural resources and services back to baseline and make the environment and public whole for interim losses.

**Natural Resources**, for purposes of injury assessment and restoration, refers to land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the exclusive economic zone), any State or local government or Indian tribe, or any foreign government. Natural resources, for other purposes, may include minerals such as oil and gas.

**Oil** refers to oil of any kind or in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil. It may also refer to: fats, oils, or greases of animal, fish, or marine mammal origin; vegetable oils, including oils from seeds, nuts, fruits, or kernels; and, other oils and greases, including synthetic and mineral oils. The CWA definition of oil is codified at 33 U.S.C. § 1251 *et seq.*; the OPA definition of oil is codified at 33 U.S.C. § 2701 *et seq.*

The ***Oil Pollution Act of 1990*** (OPA 90), codified at 33 U.S.C § 2701 *et seq.*, is a law that amended the Clean Water Act (CWA) and addressed the wide range of problems associated with preventing, responding to, and paying for oil pollution incidents in navigable waters of the United States. Title VII of OPA 90 established ICCOPR.

An ***Oil Spill*** is a non-permitted occurrence or series of occurrences having the same origin, involving one or more vessels, facilities, or any combination thereof, resulting in the discharge or substantial threat of discharge of oil into or upon navigable waters of the United States, adjoining shorelines, or the exclusive economic zone (e.g., oil spill in coastal waters from a tanker). This term also includes discharges of oil on land with the potential to reach any waters of the United States.

***Oil Spill Response Organizations*** (OSROs) are companies that specialize in cleaning up oil spills. They often serve as contractors or subcontractors for spill response efforts.

An ***On-Scene Coordinator*** (OSC) is the federal official pre-designated by EPA or the USCG to coordinate and direct responses under Subpart D of the NCP. It also refers to a designated representative of a lead Federal agency to coordinate and direct removal actions under Subpart E of the NCP. General responsibilities of OSCs are found in 40 CFR 300.120. OSCs are sometimes referred to as Federal On-Scene Coordinators (FOSCs).

The ***Ports and Waterways Safety Act*** (PWSA) 1972, as amended by the Port and Tanker Safety Act of 1978 (PTSA), and the Oil Pollution Act of 1990 (OPA), is designed to promote navigation, vessel safety, and protection of the marine environment. The PWSA authorizes the U.S. Coast Guard (USCG) to establish vessel traffic service/separation (VTSS) schemes for ports, harbors, and other waters subject to congested vessel traffic.

The ***Ports and Tanker Safety Act*** (PTSA) of 1978 amended the PWSA. Under the PTSA, Congress found that navigation and vessel safety and protection of the marine environment are matters of major national importance and that increased vessel traffic in the nation's ports and waterways creates substantial hazard to life, property or the marine environment. In addition, increased supervision of vessel and port operations was deemed necessary.

***Preparedness*** is an activity, program, or system developed prior to an oil spill to support and enhance the ability of personnel and organizations to prevent, respond to, and recover from an oil spill or other adverse event.

***Prevention*** is an on-going activity to minimize the likelihood of discharges of oil into the environment. Prevention may be a long-term approach to looking at the

fundamentals of minimizing the potential of oil spills with the goal to identify, minimize, and mitigate risks.

**Release** means any spilling, leaking, pumping, pouring, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of oil into the environment.

**Research** is the systematic study directed toward fuller scientific knowledge or understanding of the subject studied. (NSF, 2009)

**Response** includes all activities involved in containing and cleaning up oil in order to: 1: maintain safety of human life; 2: stabilize a situation to preclude it from worsening, and; 3: minimize adverse environmental and socioeconomic impacts by coordinating all containment and removal activities to carry out a timely, effective response.

The **Responsible Party** (RP) of an incident is the person, business, or entity that has been identified as owning or operating a vessel or facility that caused an oil spill. The OPA definition of responsible party is codified at 33 U.S.C. § 2701 *et seq.*

**Restoration** is the process of restoring an affected area or resource to its pre-incident state. Restoration can take several months to many years and may require technical and financial assistance from a variety of sources. Restoration efforts are primarily concerned with actions that involve rebuilding destroyed property, re-employment of effected stakeholders, rehabilitating, replacing, or acquiring the equivalent of injured natural resources and the services they provided prior to the damage being inflicted and the repair of other essential infrastructure.

**Submerged and subsurface** oil refers to oil that is not floating on the water surface.

**Surface Washing Agent** is any product that removes oil from solid surfaces, such as beaches and rocks, through a detergency mechanism and does not involve dispersing or solubilizing the oil into the water column.

**Technology** is the study, development, and application of devices, machines and techniques for manufacturing and productive processes. Technology also includes tools, equipment, and methods or methodologies that apply scientific knowledge or tools. For purposes of this plan, technology represents the application of knowledge or widgets to the development and/or usage of equipment, systems and organizational capabilities for oil spill prevention, preparedness, response, and restoration.

**Vessel** means every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water.



## **EXECUTIVE SUMMARY**

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Title VII of the Oil Pollution Act of 1990 (OPA 90) established the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) to coordinate a comprehensive program of oil pollution research, technology development, and demonstration. Pursuant to Section 7001(b) of OPA 90, ICCOPR developed the Oil Pollution Research and Technology Plan (OPRTP) to implement the Federal research and development program.

ICCOPR published its first version of the OPRTP in 1992 and published a revised version in 1997. These two versions provided an initial baseline assessment and analysis of: agency roles and responsibilities; status of knowledge of oil pollution prevention, response, and mitigation technologies; priority research and development needs; and an estimate of resources and time needed to implement the program.

The purpose of the FY 2015-2021 version of the OPRTP, and subsequent revisions, is to provide current assessments of the oil pollution research needs and priorities. ICCOPR intends to update this OPRTP every six years to reflect advancements in oil pollution technology and changing research needs. This ongoing planning process will capitalize on the unique roles and responsibilities of member agencies to address oil pollution research and development needs and maintain awareness of research needs.

This version of the OPRTP includes two parts. Part One, Oil Pollution Research, explains why oil pollution research is needed, the parties that are involved in the research, and presents ICCOPR's Oil Pollution Research Categorization Framework for tracking research activities and successes. Part Two, Establishing Research Priorities, presents ICCOPR's priority Research Needs. It also explains the process that ICCOPR used to identify the research gaps and priorities, noteworthy oil spill events, and the current state of oil pollution knowledge. In future versions, Part One will remain relatively static; however, Part Two is expected to change significantly as research advances the state of knowledge and priority Research Needs are successfully addressed.

The Introduction and Chapter 1, The Need for Oil Pollution Research, describes the historical basis for oil pollution research and reviews trends in oil spills from different sources. ICCOPR member agencies share responsibilities to monitor changes in the oil spill system and find opportunities to improve technologies to meet changing needs. ICCOPR recognizes that activities in the Arctic and Alaska, the Gulf of Mexico, inland areas, and the Atlantic Outer Continental Shelf are all of high importance at this time.

Chapter 2, Federal Oil Pollution Research, describes the Federal entities involved in oil pollution research including the ICCOPR member agencies, other Federal research organizations and facilities. Similarly, Chapter 3, Non-Federal Oil Pollution Research Entities, describes state, industry, independent organizations, academia, and international oil pollution research entities.

Chapter 4, Structuring Oil Pollution Research, presents ICCOPR's Oil Pollution Research Categorization Framework, which provides a common language and planning framework that would enable researchers and interested parties to identify and track research in each topic area. The Framework groups research into four broad Classes: Prevention, Preparedness, Response, and Injury Assessment and Restoration. ICCOPR further classified research within each Class into 25 Standing Research Areas (SRAs), which represent the most common research themes encountered for oil spills.

Chapter 5, Knowledge Transfer and Advancement, describes ICCOPR's efforts to promote continuous improvement in the nation's ability to address oil pollution by monitoring the state of knowledge and adjusting the program to meet changing needs. The R&T planning process emphasizes and strengthens the roles and responsibilities of the member agencies to assure that research advances the capabilities to reduce oil pollution.

Chapter 6, Oil Pollution Research Needs Identification and Prioritization Process, documents the process ICCOPR employed to establish the research priorities. ICCOPR established an R&T Working Group that identified more than 900 research gaps, consolidated them into 570 unique Research Needs, and evaluated them with the assistance of the results from a survey of 280 subject matter experts.

Chapter 7, Noteworthy Oil Spill Incidents, describes important oil spill events and lists the oil pollution research gaps that they illuminated. Spills associated with vessels, drilling operations, on-shore pipelines, facilities, and railroads are included.

Chapter 8, Current State of Oil Pollution Knowledge, describes the sources and mechanisms that ICCOPR uses to obtain and share information on research needs and accomplishments.

Chapter 9, Oil Spill Research and Technology Research Priorities, presents ICCOPR's priority Research Needs. ICCOPR identified three top priorities for each SRA. For SRAs with a large number of Research Needs (i.e., Dispersants), ICCOPR established subcategories of similar research. Three priority Research Needs were assigned to each subcategory.

There are eight SRAs and 33 priorities within the Prevention Class. Two SRAs and 12 priorities are in the Preparedness Class. The Response Class has the largest number of priorities with 72 in 11 SRAs. The four SRAs in the Injury Assessment and Restoration Class have 33 priorities.

## INTRODUCTION

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Title VII of the Oil Pollution Act of 1990 (OPA 90) established the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) to “... coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the Federal agencies, in cooperation and coordination with industry, universities, research institutions, State governments, and other nations, as appropriate, and shall foster cost-effective research mechanisms, including the joint funding of research.” Section 7001(c) of OPA 90 required ICCOPR to establish a Federal oil pollution research and development (R&D) program. Pursuant to Section 7001(b) of OPA 90, ICCOPR developed the Oil Pollution Research and Technology Plan (OPRTP) to implement the Federal research and development program.

### Background

Federal oil pollution research efforts began to take shape in the late 1960s following the *Torrey Canyon* oil spill off the coast of England. At that time, the U.S. had neither the technical or operational capacity to deal with a large oil spill in the marine environment (EOP-OST, 1969). The Federal government developed the first National Contingency Plan (FWPCA, 1968) to address oil spills and began extensive oil pollution research over the next 20 years. Coordination of the Federal research efforts was informal and on an ad hoc basis through conferences, workshops, and committees of researchers scheduling their projects at the Ohmsett facility. The challenges posed by the response to the *Exxon Valdez* oil spill in 1989 revealed the need for Federal agencies to better coordinate their research. Efforts to coordinate the research resulted in Title VII of OPA 90 and the first requirement for a comprehensive and coordinated research and technology plan.

ICCOPR submitted the original OPRTP to Congress in April 1992. As directed by OPA 90, ICCOPR provided the OPRTP to the National Research Council’s (NRC’s) Committee on Oil Spill Research and Development for review. Using input from the NRC’s Marine Board, ICCOPR started a revision of the plan in May 1993 to include topics related to spill prevention, human factors, and the field testing/demonstration of developed response technologies. ICCOPR released a revised version in April 1997, which identified 21 research areas divided into three levels of priority and served as a strategic planning document for ICCOPR to communicate and coordinate research needs.

This version of the OPRTP is the first in a new series of revisions covering six-year planning cycles, and presents ICCOPR’s coordinated research and technology plan for FY 2015-2021. This ongoing planning process will capitalize on the unique roles and responsibilities of member agencies to address oil pollution research and development needs and maintain awareness of research needs.

## Purpose of the Plan

The 1992 version of the OPRTP provided Congress with an implementation plan for the new research and development program established by OPA 90. That version, and the 1997 revisions, provided an initial baseline assessment and analysis of: agency roles and responsibilities; status of knowledge of oil pollution prevention, response, and mitigation technologies; priority research and development needs; and an estimate of resources and time needed to implement the program. The purpose of the FY 2015-2021 version, and subsequent revisions, is to provide current assessments of the oil pollution research needs and priorities. To that end, the principal objectives of the OPRTP are to:

1. define common research themes related to oil pollution research;
2. identify on a regular basis the knowledge gaps associated with common research themes and recommend what gaps should be considered as high research priorities within them;
3. act as an umbrella or connecting document with other strategic Federal research plans (or accomplishment reports) that also address research support for oil pollution topics;
4. document the interagency research coordination process, as well as the feedback processes developed by Federal research, management and regulatory agencies; and
5. promote research information transfer between the government, the public and other stakeholders.
6. encourage and track efforts to implement improvements and technological change within agency roles and responsibilities via updates in the biennial reports to Congress.

## Scope and Use of the Plan

This OPRTP provides a basis for coordinating research to address oil pollution issues in the U.S. It is primarily directed at Federal agencies with responsibilities for conducting or funding oil pollution research, but can serve as a research planning guide for industry, academia, State governments, research institutions, and other nations.

Research, in the context of the OPRTP, includes both basic and applied studies that are considered as peer-reviewed and published as well as studies reported in the “grey literature,” which is publically available scientific literature that has not been peer reviewed. The following National Science Foundation definitions apply with respect to the OPRTP:

- **Basic research** is any systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.
- **Applied research** is any systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. ICCOPR

interprets this to mean studies to advance knowledge about oil spill prevention, preparedness, response, mitigation, and restoration/recovery.

- **Development** is any systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.
- **Technology** is defined as making, usage, and knowledge of tools, machines, techniques, crafts, systems or methods of organization in order to solve a problem or perform a specific function. ICCOPR believes this definition represents the application of knowledge as well as the development and usage of the equipment, systems and organizational capabilities concerning oil spill prevention, preparedness, response, mitigation, and restoration/recovery.

At the federal level, this OPRTP provides information that can be used as a basis to conduct interagency coordination and track progress toward addressing the nation's research needs. It can also help Federal agencies:

1. identify high-priority research emphasis areas;
2. promote needed research based on priorities; and
3. synchronize and collaborate research activities to avoid overlapping research efforts.
4. track progress of key efforts to aid implementation of needed improvements.

ICCOPR recognizes that there are a large number of oil pollution research programs conducted by non-Federal organizations and the private sector. This OPRTP provides these entities with ICCOPR's recommendations on research areas that will best address the nation's oil pollution research needs.

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## PART ONE – OIL POLLUTION RESEARCH

### 1. The Need for Oil Pollution Research

Oil is a dominant source of energy in the United States, supplying the nation with approximately 40 percent of its energy needs (Ramseur, 2012). Oil provides fuel for the transportation, industrial, and residential sectors and serves as a primary feedstock for making plastics. Oil is expected to remain a major source of energy in the U.S. for at least the next several decades. With historical, current and projected use and constant movement, it is inevitable that spills will occur.

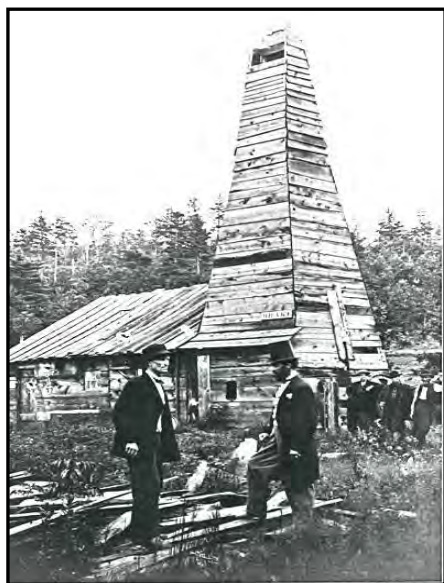


Figure 1-1: The start of the commercial oil industry in the U.S. – Oil Creek, PA, 1859 (Source: Drake Wells Museum)

Spills of oil in the U.S. accompanied the inception of early commercial efforts for petroleum drilling in the early 19<sup>th</sup> century in the United States and continue to this day. The first oil discovery was on land at Oil Creek, Pennsylvania in 1859 by George Bissel and Edwin Drake (Figure 1-1) (Pees, 2004). This success quickly led to additional commercial investments in oil drilling refining and marketing in the western Appalachian Mountains, where oil seeps were common. Commercial drilling projects rapidly spread to include areas in Southern California, Kansas, Oklahoma, Arkansas, North Louisiana and Texas by the late 1890's.

In 1910, the largest onshore blowout in the U.S. and the world occurred at the Lakeview No. 1 well in the San Joaquin Valley, CA (Figure 1-2). The initial flow estimates ranged from 125,000 barrels per day (bpd) at the start to 90,000 bpd after a month. The well remained uncontrolled for 544 days with an estimated 9.4 million bbl of crude being released into the environment (one barrel = 42 U.S. gallons).

Oil spills continued to occur but it wasn't until the late 1960s that the national attention focused on the need to address the problems associated with oil spills. In 1967, reaction in the U.S. to the *Torrey Canyon* oil spill off the coast of England resulted in the creation of the original National Multiagency Oil and Hazardous Materials Contingency Plan in 1968 (FWPCA, 1968). That Plan was superseded in 1970 when the Council on Environmental Quality (CEQ) published the National Oil and Hazardous Materials Pollution



Figure 1-2: The Lakeview Gusher, CA; the US's single largest well blowout, 1910. (Source: San Joaquin Valley Geology)



Contingency Plan in the Federal Register at 35 FR 8508 (CEQ, 1970). In 1969, a well blowout and undersea faults spilled an estimated 42 million gallons of oil into the Santa Barbara Channel, one of the largest environmental disasters in the U.S. (NOAA, 2014). This spill increased awareness of oil pollution problems and contributed to creation of the U.S. Environmental Protection Agency, the National Environmental Policy Act, and the National Marine Sanctuaries system. It also prompted several federal agencies to begin oil pollution research programs.

Oil pollution research must continually evolve to keep pace with new oil spill risks and environments where they occur. The process by which oil is produced, processed, and delivered to consumers is ever evolving. The oil industry opens new areas for exploration and production as technological advances make the ventures profitable. In turn, the location and methods of transporting that oil to markets shifts, affecting the potential locations and types of oil spills. For example, the opening of the Alaska North Slope and the Trans-Alaska Pipeline necessitated transportation of crude oil by tanker through Prince William Sound, site of the *Exxon Valdez* oil spill. Similarly, the technological advances that allow deep water oil exploration and production also pose new hazards and risks as evidenced by the British Petroleum (BP) *Deepwater Horizon* oil spill. Those spills posed new response challenges and revealed the need for additional oil pollution research.

There will continue to be a need for oil pollution research as long as there is a demand for oil-based products. Human errors, mechanical failures, natural events, and accidents all have the potential to cause spills. This chapter examines the oil production system and patterns of oil spills that affect the oil pollution research needs addressed in this OPRTP.

## 1.1 U.S. Oil Production

Figure 1-3 shows the U.S. Energy Information Administration (EIA) Annual Energy Review 2015 (EIA, 2015) and provides a review on the production, import and consumption for petroleum and other liquids for the last 60 years (from 1949 to 2014). The U.S. has experienced a steadily increasing consumption rate that quickly outstripped the U.S. petroleum production capabilities, resulting in a regular increase in net imports of petroleum products to address the shortfall beginning in 1970. Domestic production of oil continued to decrease until 2008 when new finds and improved drilling capabilities began to increase U.S. field production.



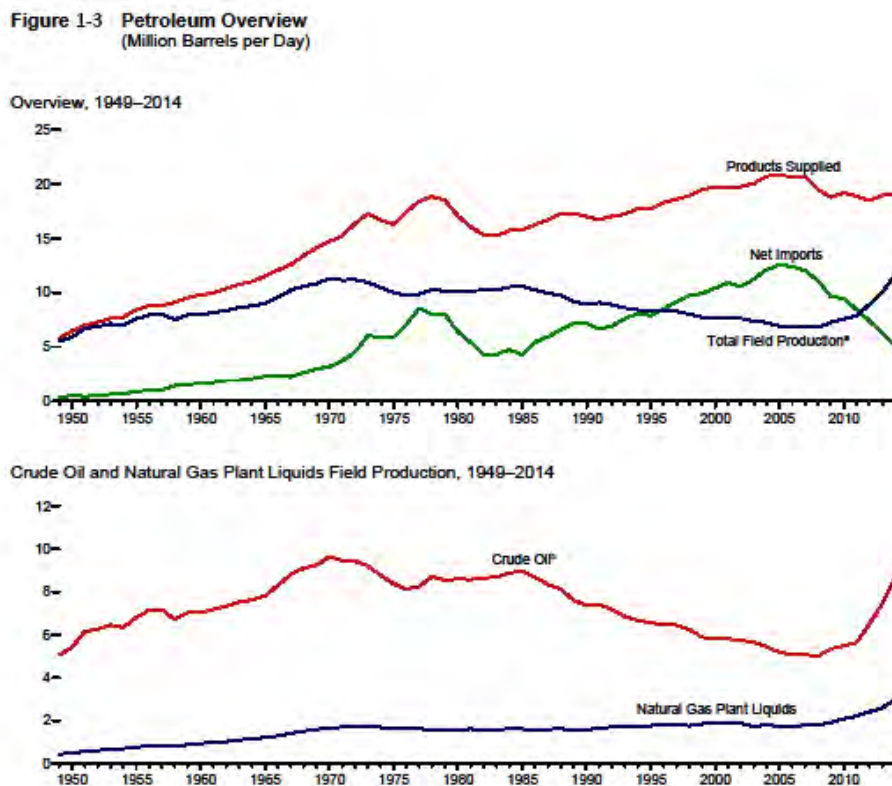


Figure 1-3. Petroleum and other Liquid Estimated Consumption, Production and Net Imports (in million bbl) for 1949 – 2014 in the U.S. Source: EIA. 2015.

Of particular note was the discovery of the Bakken field in North Dakota, Montana and in Canada (Figure 1-4). Significant increases in domestic production from these discoveries resulted in a decrease in net oil imports as shown in Figure 1-3. The increase in production of natural gas has also led to a decrease in net imports. The application of hydraulic fracturing and horizontal drilling technologies caused a significant increase in Bakken production since 2000. By the end of 2010, oil production rates had reached 458,000 bbls per day, outstripping the pipeline capacity to ship oil out of the Bakken. The result was an expansion of rail transportation to move the crude oil to refineries or ports for export.

Shale oil and natural gas resources are found in shale formations that contain significant accumulations of natural gas and/or oil (Figure 1-4). The Barnett Shale in Texas has been producing natural gas for more than a decade. Information gained from developing the Barnett Shale provided the initial technology template for developing other shale plays in the U. S. Another important shale gas play is the Marcellus Shale in the eastern U. S. While the Barnett and Marcellus formations are well-known shale gas plays in the United States, more than 30 U.S. states overlie shale formations. The Marcellus natural gas trend, which encompasses 104,000 square miles and stretches across Pennsylvania and West Virginia, and into southeast Ohio and upstate New York, is the largest source of natural gas in the United States, and production was still growing rapidly as of 2014.

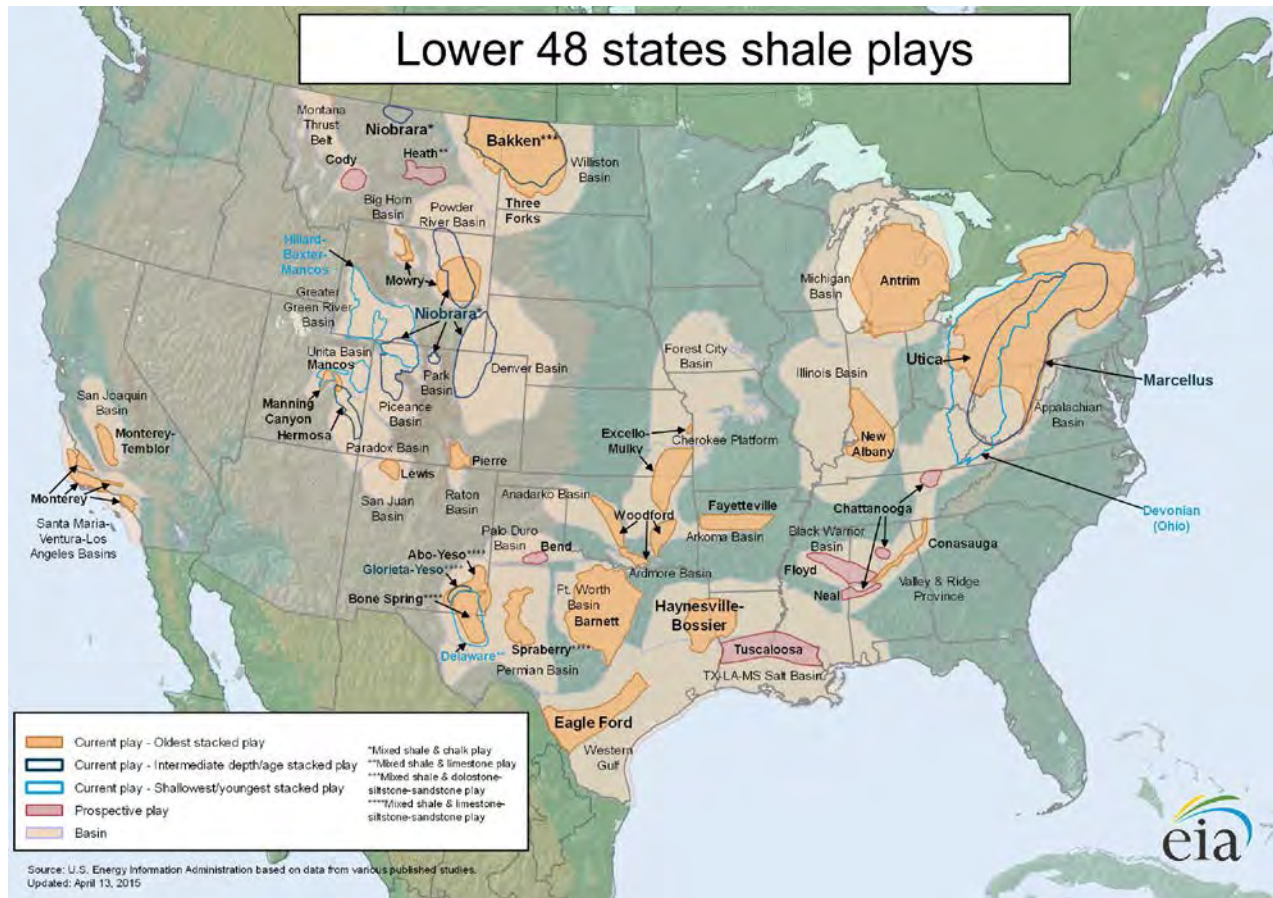


Figure 1-4 Domestic Shale gas plays. Source: EIA 2015

Figure 1-5 shows the location of refineries in the U.S. Figure 1-6 shows the substantial increase in transportation of petroleum from the Midwest to other parts of the country where the refinery capacity exists. The greatest overall volumes were transported to the Gulf coast. The 2010 to 2014 period reflects the increase in U.S. production in the shale-producing locations.

The significant increase in petroleum being transported within the U.S. has taxed the available pipeline capacity significantly. In order to meet some of the increased demand, there has been a significant increase in rail transportation of crude oil.

The large increase in U.S. and North American petroleum production has resulted in a significant change in the transportation patterns. The production from the Bakken field and the Canadian oil sands products (OSP) areas have resulted in a significant change in the number trains and tank cars carrying petroleum. The Association of American Railroads (2015) reports that the number of rail tankers carrying crude oil and petroleum products in the U.S. increased from just under 19,000 carloads in 2008 to more than 1,033,000 carloads in 2014. Figure 1-7 shows the change in the number of rail cars and the change in train movements between 2010 and 2014; this represents the time period when the development of Bakken oil began to be significant.

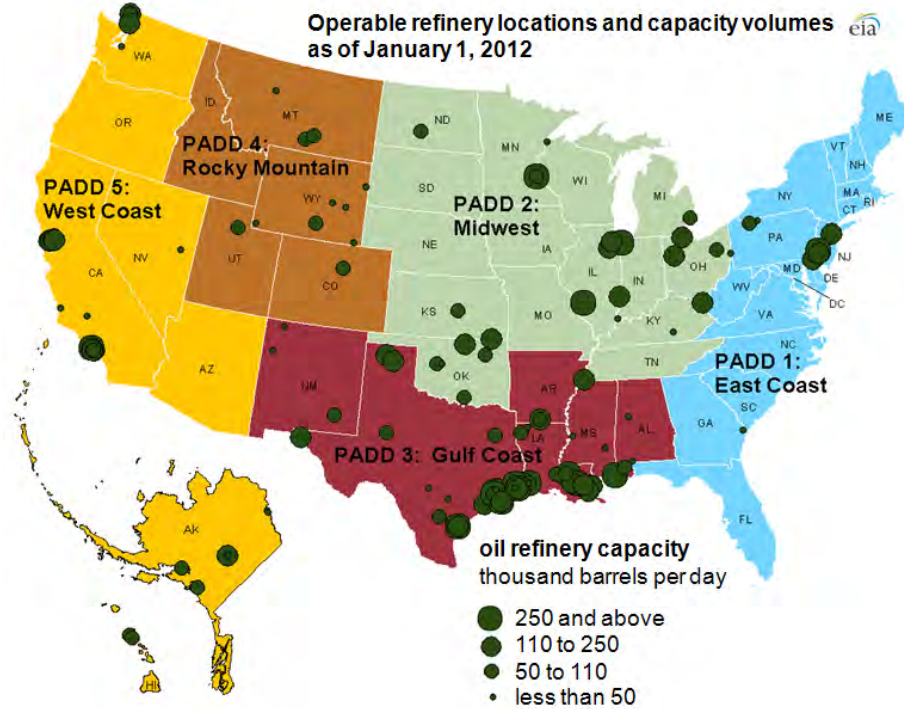


Figure 1-5: Location of U.S. Refineries and Refining Capacity. EIA 2015.

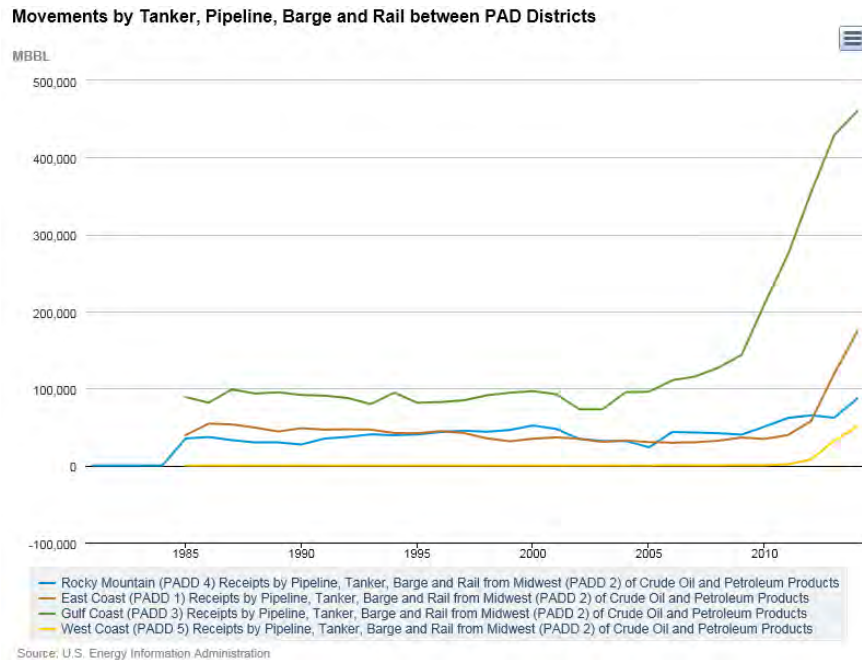


Figure 1-6 Movement of crude oil (MBBL) by pipeline, tanker barge and rail for refinery areas. Source: EIA 2015.



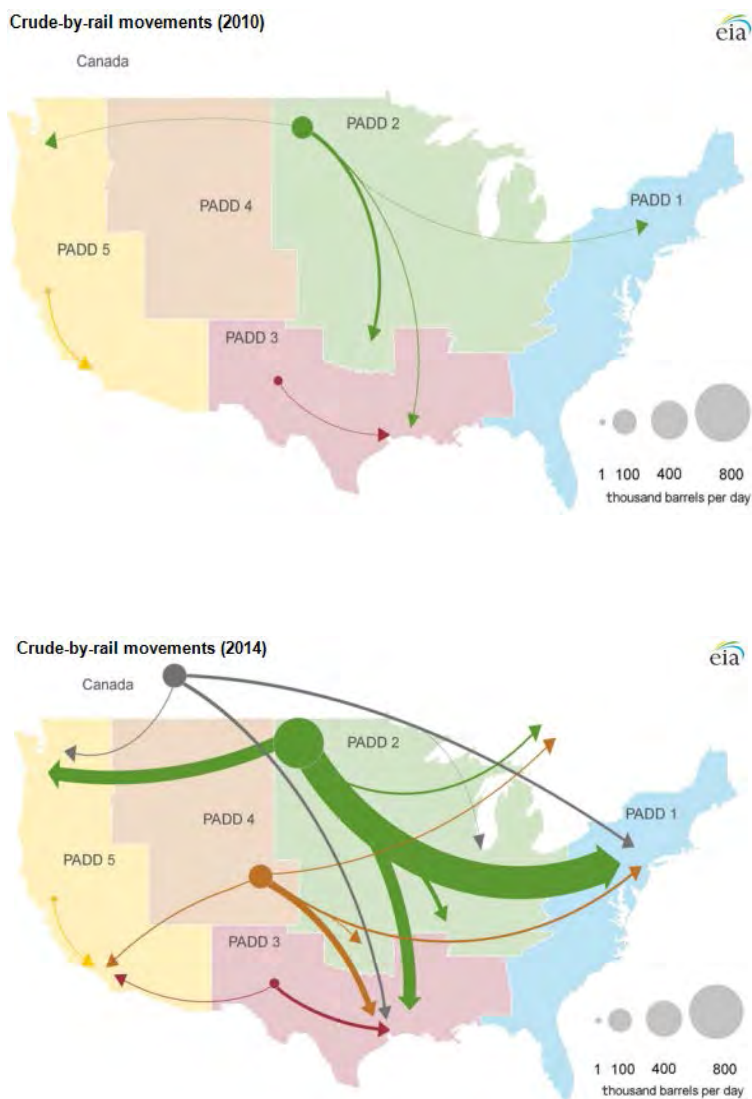
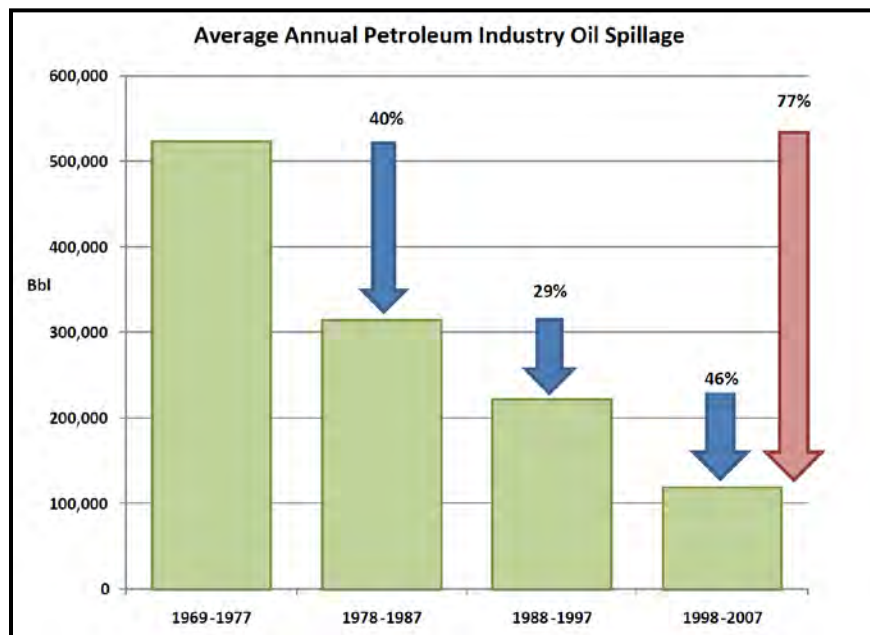


Figure 1-7 A comparison of crude oil movements by rail from 2010 and 2014. Source EIA 2015.

## 1.2 History of Oil Spills in the U.S.

From 1973 to 1990, an average of 2.8 million bbl of oil was spilled every year. Since 1990, that number has reduced to 35,700 bbl a year. Based on data between 1973 and 2009, the annual number and volume of oil spills declined, and in some cases dramatically (Etkin, 2009). Total petroleum industry spillage has decreased consistently over the last 40 years through 2007 (Figure 1-8). Table 1-1 summarizes the average annual oil spillage from petroleum industry

sources, including: spillage related to oil exploration and production platforms and offshore pipelines; spillage from coastal and inland pipelines, tank vessels, railroads, and tanker trucks; spillage from oil refineries; and spillage at gas stations. By multiplying the average annual spill volumes for each decade by 10, the total volume spilled (as recorded) from 1969 to 2007 would approximately equal 17.5 million bbls. (See Table 1-1.)



**\*NOTE:** The average annual oil spillage volumes represented here are gathered from petroleum industry spillage sources, including: spillage related to oil exploration and production, platforms and offshore pipelines; spillage from coastal and inland pipelines; spillage from oil transport by tank vessels, railroads, and tanker trucks; spillage from oil refineries; and spillage from gas stations.

Figure 1-8: Average Annual Oil Spillage from Petroleum Industry Sources by Decade. Etkin, 2009.

These figures do not address any other significant spillage events in the U.S. after 2007, which would include the 2010 Macondo/*Deepwater Horizon* (DWH) well blowout and oil spill and the 2010 Enbridge Pipeline release in the Kalamazoo River in Michigan or any other significant spillage events in the U.S. after 2007. The 4.9 million bbls spilled during the *Deepwater Horizon* oil spill (USCG, 2011b) would reverse this downward trend and increase the total volume spilled between 1969 and 2007 by nearly 1400 percent; this incident represents nearly 95% of the total volume spilled from all oil platforms in the last 42 years. In general, the very largest spills, which constitute only 0.4% of the total spills, comprise 90.6% of the total volume spilled in the U.S. for the period 1988 – 2007.

**Final Oil Pollution Research & Technology Plan – Approved September 29, 2015**

Average Annual Oil Spillage from Petroleum Industry Sources, bbls. Modified From Etkin, 2009				
Source	1969-1977	1978-1987	1988-1997	1998-2007
<b>PRODUCTION</b>	31,435	8,701	15,183	9,938
Offshore Platform Spills	25,858	1,344	1,814	1,273
Offshore Pipelines	4,48	3,462	8,127	2,614
Offshore Supply Vessels	95	245	48	10
Inland Production Wells	1,000	3,650	5,194	6,041
<b>REFINING</b>	3,000	3,512	15,015	12,136
Refinery Spills	3,000	3,512	15,015	12,136
<b>TRANSPORT</b>	488,662	301,645	190,753	96,393
Inland Pipelines	259,340	181,196	118,297	76,754
Tanker Trucks	3,000	4,888	5,213	9,181
Railroads	2,000	2,322	2,164	1,431
Tank Ships	192,492	60,250	42,197	3,598
Tank Barges	31,830	52,989	22,882	5,429
<b>STORAGE AND CONSUMPTION</b>	118,523	97,206	278,525	77,613
Non-Tank Vessels (Cargo Ships)*	5,000	6,786	2,817	1,602
Other Vessels*	14,858	6,574	6,301	4,167
Gas Stations and Truck Stops	1,195	1,195	1,564	814
Residential*	150	179	518	498
Aircraft*	3,700	3,714	3,862	4,044
Inland EPA-Regulated Facilities*	30,000	34,740	245,017	59,676
Coastal Facilities (Non-refining)*	62,220	42,781	15,059	4,230
Inland Unknown*	900	967	2,198	516
Motor Vehicles*	500	270	1,189	2,066
<b>AVERAGE ANNUAL TOTALS</b>	641,620	411,064	499,476	196,080
<b>ESTIMATED DECADE TOTAL</b>	6,416,200	4,110,640	4,994,760	1,960,800
<b>ESTIMATED GRAND TOTAL SPILLAGE for 1969 – 2007</b>	17,482,400 bbls (734,560,800 gallons)			
*Additional storage and consumption data for the 1969-1977 period was provided by Dagmar Schmidt Etkin, 2011, personal communications.				

**Table 1-1: Average Annual Oil Spillage from Petroleum Industry Sources, bbl. (Modified from Etkin, 2009).**

### 1.3 Analysis of the Oil Spill System

In their Congressionally-mandated review of the 1992 OPRTP, the National Research Council (NRC) Marine Board recommended “...an analysis of the marine oil spill system, which consists of a variety of subsystems beginning with drilling for oil and ending at delivery of the product to the consumer.” The oil spill system described by the NRC consists of all components and nodes of the oil supply chain (see Figure 1-9) including all aspects of the oil handling and transport processes, succeeding environments affected as a spill spreads, and intervention techniques for preventing or minimizing environmental damage (Marine Board, 1993; 1994). The NRC advocated that such an approach would identify critical nodes of potential failure within the system where ICCOPR could focus its research planning efforts.

ICCOPR agreed with the NRC on the value of a systems analysis approach in research planning but full implementation of the approach has been beyond the funding capabilities of the ICCOPR membership. In 2007, the USCG Research & Development Center (RDC) completed a system analysis of the response system and used the results to identify and evaluate research opportunities as part of strategic planning to improve spill response (VanHaverbeke, 2012). ICCOPR member agencies also have expertise on specific components of the oil spill system. This base of knowledge on the system components provides a general framework from which ICCOPR plans its research coordination, funding allocations, and measures of effectiveness. The oil spill research categorization scheme discussed in Chapter 4 reflects how ICCOPR used its understanding of the oil supply chain and oil spill response system to focus research planning as envisioned by the NRC.

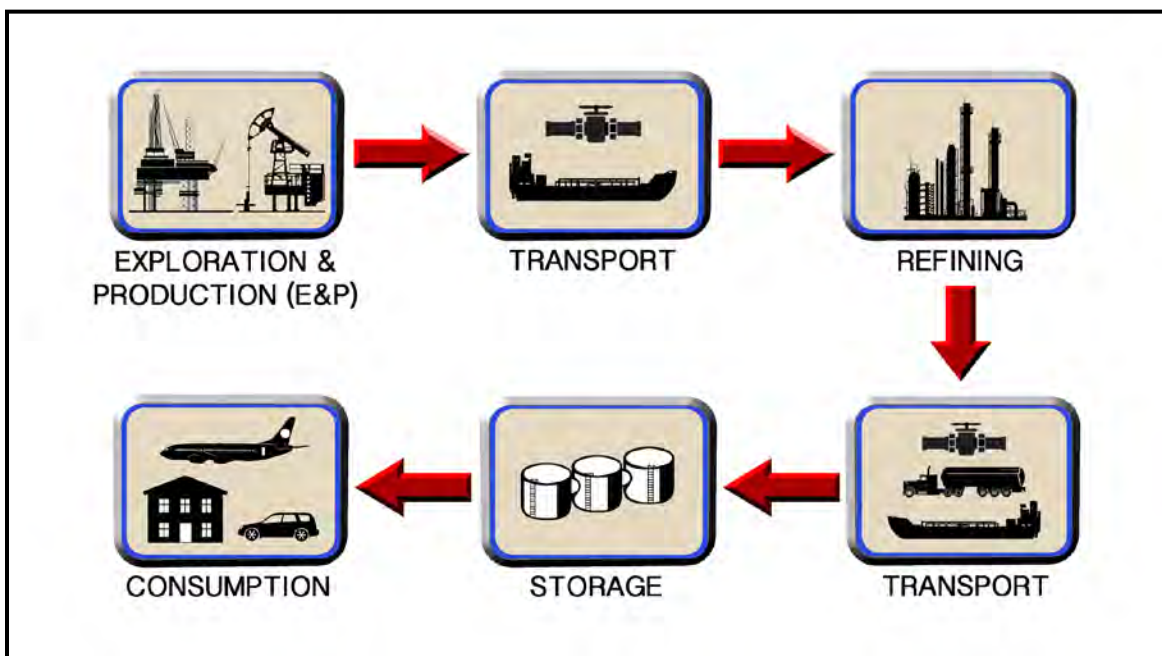


Figure 1-9: Oil Supply Chain.

For planning R&D activities, the oil supply chain for petroleum oils consists of five subsystems (Figure 1-9):

- **Subsystem 1-Exploration and Production Facilities** - This is the origination point of crude oil and includes onshore and offshore exploration and production facilities.
- **Subsystem 2-Transportation** - This is the transportation of foreign and domestic oil products (generally crude oil) to refineries in the U.S. either by tank vessel (ship and barge), pipeline (offshore and onshore), tank railcar (unit trains), or tanker trucks.
- **Subsystem 3- Refining** - Refining of crude oil into petroleum products including the storage of crude oil, actual refining operations, storage of refined products, and the loading of refined products on tank vessels (ship and barge), tank railcars, and tanker trucks. In addition, refining would also encompass those activities that produce biofuels or vegetable oils. The latter products present many common and novel challenges compared to their traditional petroleum counterparts.
- **Subsystem 4- Transport / Storage/Distribution** - This subsystem involves the transportation of refined products to a bulk distribution storage facility by various modes of transportation, (e.g., product pipeline, tank vessel (ship and barge), tanker truck, tank railcars). Imported refined products would enter the U.S. system, as well as exported refined products would leave the U.S. system at this point. Tanker trucks may also deliver direct from refinery storage to the end user, e.g., residence or retail gas station.
- **Subsystem 5-Consumption/Consumer/Retail/Industrial** - This subsystem includes the retail gas station and the residential home heating oil segments of the oil system as well as industrial users (e.g. electric generation facilities).

There are available historic data to support claims that the improved safety and operating procedures implemented have generally reduced the risk of a spill at any point along the system. However, because accidents cannot be completely eliminated, efforts to improve pollution prevention and response must be sustained. In the following section, five potential high risk spill sources (exploration & production, vessels, onshore and offshore pipelines, railroads and refineries / bulk terminals) are examined to highlight existing weaknesses and concerns, and the efforts being made to address them.

## 1.4 Exploration and Production Facilities

The spill record for domestic drilling and production over the past 30 years suggested that technology and procedures for preventing oil spills were being employed effectively. However, that trend was interrupted in 2010 when the DWH drilling rig experienced an uncontrollable well blowout and oil spill. Even with modern equipment and modern safety measures, spills are a part of the oil and gas industry. The DWH blowout occurred when human errors circumvented the modern technological safeguards designed to prevent such an accident.



“Current technology enables drilling in water twice as deep as Macondo. Drilling at such depths requires all parties to set their standards still higher for difficult issues such as remote containment systems in water depths with extreme pressures and very limited human access, as well as different geological pressures and formations and mixes of hydrocarbons. Desire to tap resources in deeper waters should be accompanied by equivalent investments in subsea equipment, operator training, research and development for containment and response technologies, demonstrated financial capacity, and continuous improvement in and communication of industry practices devoted to safety.” (*National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011*)

Due to the rising energy demands in developed economies and dramatically rising levels of consumption in emerging economies, the world’s appetite for oil and other fuels will continue growing for the foreseeable future. This demand will increase pressure for continued and new oil and gas exploration in challenging environments including in the Arctic and in deep and ultra-deep waters. It will also encourage exploration and production of unconventional resources (e.g., oil sands) and the increased use of advanced technologies (e.g., hydraulic fracturing and horizontal drilling).

## 1.5 Onshore and Offshore Pipelines

Approximately 2.6 million miles of pipelines provide an efficient and fundamentally safe means of transporting gases and liquids. They are an integral part of the U.S. energy supply and provide vital links to other critical infrastructure such as power plants, airports, and military bases. Currently, there are 199,157 miles of pipelines that carry volatile, flammable, or toxic materials with the potential to cause public injury and environmental damage.

Canadian oil exports to the U.S. have been increasing rapidly, primarily due to growing extraction from the oil sands in Western Canada. Oil sands are a mixture of clay, sand, water, and heavy black viscous oil known as bitumen. After extraction, the bitumen is converted into an oil sands product (OSP) suitable for pipeline transport. Canada’s OSPs are exported as either light, upgraded synthetic crude (“syncrude”) or a heavy crude oil that is a blend of bitumen diluted with lighter hydrocarbons (“dilbit”) to ease transport. The bulk of oil sands’ supply growth is expected to be in the form of dilbit.

The expansion of petroleum pipelines from Canada has generated considerable controversy in the U.S. One specific area of concern was the potential new risks of the OSPs to pipeline integrity. An NRC panel (TRB, 2013) concluded, however, that diluted bitumen does not have any unique properties that make it more likely to cause internal failure of pipelines than other types of crude oil. However, additional research is needed to understand the fate and transport of unconventional oils, relative to that of traditional crude oils and refined products.

In the 49 year period between 1964 and 2012, there were 79 oil spills from pipelines on the Outer Continental Shelf according to BSEE (2015) statistics, or about 1.6 per year. However, 25 of those spills were caused by damage from a series of hurricanes in the Gulf of Mexico in 2004, 2005, and 2008. Otherwise, spills from offshore pipelines occur at a rate of about one per year.

Both government and industry have taken numerous steps to improve pipeline safety over the last 10 years such as improved corrosion resistance, integrity testing, and requirements to identify pipelines before digging. According to PHMSA, pipelines are extremely safe when compared to other modes of energy transportation relative to the volumes of products transported (PHMSA, 2007). The trend is down, however, major pipeline incidents in 2010 and 2011 suggest that more work is needed. Figure 1-10 and Table 1-2 provide information from PHMSA on pipeline oil spills over the past 20 years.

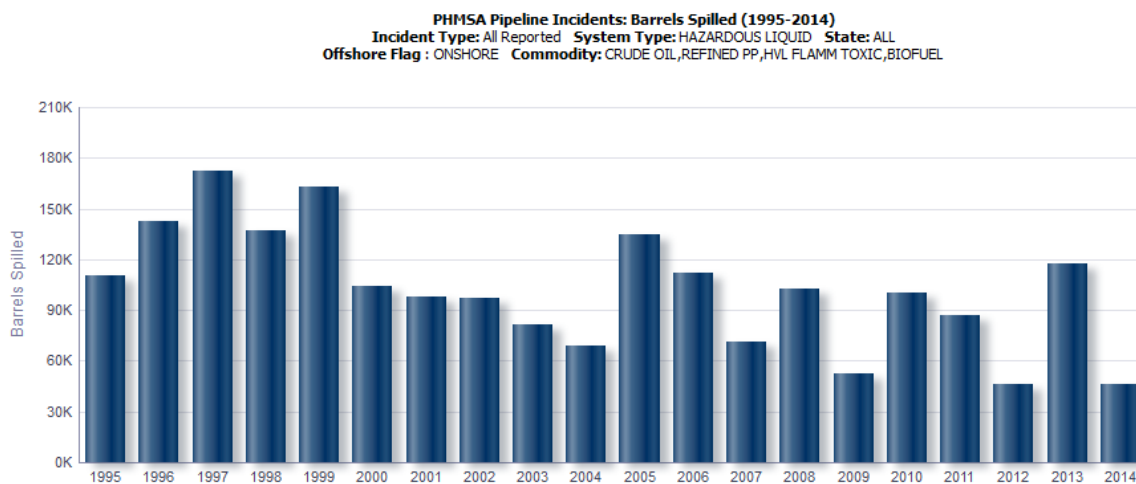


Figure 1-10 Barrels of Oil Spilled by Pipelines (1995-2014)

**PHMSA Pipeline Incidents: (1995-2014)**  
**Incident Type:** All Reported **System Type:** HAZARDOUS LIQUID **State:** ALL  
**Offshore Flag :** ONSHORE **Commodity:** CRUDE OIL, REFINED PP, HVL FLAMM TOXIC, BIOFUEL

Calendar Year	Number	Fatalities	Injuries	Property Damage As Reported	Barrels Spilled	Net Barrels Lost
1995	176	0	9	\$31,575,189	109,865	0
1996	180	3	7	\$74,543,311	141,994	0
1997	155	0	2	\$40,836,392	171,988	0
1998	133	1	5	\$52,048,979	136,760	0
1999	151	4	17	\$81,722,760	162,637	0
2000	131	1	4	\$130,605,839	103,806	0
2001	121	0	9	\$24,684,499	97,852	0
2002	442	1	0	\$49,258,448	96,809	0
2003	421	0	0	\$67,314,774	81,292	0
2004	355	5	16	\$83,996,433	68,840	0
2005	340	2	2	\$275,460,922	134,614	0
2006	326	0	2	\$52,848,585	112,029	0
2007	321	4	9	\$59,509,192	71,032	0
2008	360	2	2	\$136,858,894	101,940	0
2009	325	0	1	\$58,112,827	52,437	0
2010	340	1	4	\$1,066,323,312	100,223	49,116
2011	339	1	2	\$268,056,467	86,490	54,832
2012	359	3	4	\$143,694,837	45,861	29,315
2013	392	1	5	\$276,271,799	117,415	85,799
2014	438	0	0	\$101,402,847	45,975	20,612
<b>Grand Total</b>	<b>5,805</b>	<b>29</b>	<b>100</b>	<b>\$3,075,126,306</b>	<b>2,039,859</b>	<b>239,675</b>

Table 1-2, PHMSA Pipeline Spill Statistics (1995-2014)

## 1.6 Railroads

New technologies and high global oil prices have made it economical for energy companies to develop shale oil and oil sands petroleum reserves in the United States and Canada. The challenge is getting the oil from the oil fields to the appropriate refineries across North America so they can process the oil. That has created an opportunity for railroads to fulfill the transportation demand. In 2011, railroads and other facility and transportation businesses began building loading facilities and adding tank cars to compete with pipelines for a piece of this transportation demand.

The movement of Bakken oil and OSP occurs via unit trains, which can be composed of more than 100 tank cars, all carrying the same cargo. Tank cars are typically double-lined and made of hardened steel to survive a derailment. With the increased use of unit trains there has been an increase in the number of significant spills from derailments.

The American Petroleum Institute’s Analysis of U.S. Oil Spillage (Etkin, 2009), which tracks oil spill statistics up through 2007 data, stated that railroads spilled 1,400 bbl of oil annually as cargo in tank cars and as fuel. This was a 34% reduction from the previous decade (1990s). The Association of American Railroads (2015a,b) reports that the number of rail tankers carrying

crude oil and petroleum products in the U.S. increased from just under 19,000 carloads in 2008 to more than 1,033,000 carloads in 2014. The Federal Railroad Administration (FRA) statistics indicate number of train accidents has continued to decrease from 2005-2014 (Table 1-3). The number of hazmat releases has decreased also over this time period, although the level of damages over \$1 million dollars has remained constant. However, the increased transportation of crude oil resulted in a number of significant rail accidents that resulted in damages and deaths. (See section 7.1.5)

In 2014, the U.S. Department of Transportation (DOT) began a comprehensive rulemaking proposal to improve the safe transportation of large quantities of flammable materials by rail - particularly crude oil, denatured alcohol, and ethanol/gasoline mixtures - because of the concern for the quantity of Bakken crude transported by rail and the increase in number of accidents. DOT proposed enhanced tank car standards, a classification and testing program for mined gases and liquids, and new operational requirements for high-hazard flammable trains that include braking controls and speed restrictions. Within two years it proposes the phase out of the use of older DOT 111 tank cars for the shipment of packing group I flammable liquids, including most Bakken crude oil, unless the tank cars are retrofitted to comply with new tank car design standards.

<b>Category(1)</b>	<b>CY05</b>	<b>CY06</b>	<b>CY07</b>	<b>CY08</b>	<b>CY09</b>	<b>CY10</b>	<b>CY11</b>	<b>CY12</b>	<b>CY13</b>	<b>CY14</b>
<b>Freight Train Accidents(2)</b>	3266	2998	2693	2481	1912	1902	2022	1760	1822	1736
<b>Hazmat cars Damaged or Derailed (3)</b>	915	1041	1056	750	743	708	665	671	822	779
<b>Hazmat Releases(4)</b>	39	30	46	21	22	21	21	26	18	15
<b>Cars Releasing Damages &gt;100k</b>	52	71	76	37	44	40	66	50	78	26
<b>Damages &gt;1mil.</b>	526	571	540	481	385	423	407	347	406	381
<b>Deaths</b>	57	59	69	52	52	57	53	43	66	58
	33	6	9	27	4	8	6	9	11	2

(1) Calendar years

(2) Not including crossing collisions and other accidents with death

(3) Total hazard material cars damaged

(4) Accidents with hazard material releases

**Table 1-3: Number of Train Accidents and Hazmat Releases 2005-2014. (FRA 2015)**

## 1.7 Refining and Storage Operations

Potentially damaging discharges of crude oil or petroleum products in a refinery or at a bulk storage terminal can and do occur at every point in this system (offloading, storage, loading), and the factors that can influence the occurrence of these accidental discharges includes: the design, construction, maintenance, and operational activities; and human factors (e.g. training).

Despite a decrease in the number of domestic refineries between 1982 and 2010, the U.S. combined daily throughputs have slowly increased from about 12 million up to approximately 15 million bbl/day (Table 1-4). Increased throughput has occurred in spite of decreased numbers of refineries, because remaining refineries operate at increased capacities/efficiencies to compensate for the lack of production at decommissioned older refineries.

U.S. Gross Inputs to Refineries (Thousands of Barrels per Day)										
Decade	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
1980s						12,165	12,826	13,003	13,447	13,551
1990s	13,610	13,508	13,600	13,851	14,032	14,119	14,337	14,838	15,113	15,080
2000s	15,299	15,352	15,180	15,508	15,783	15,578	15,602	15,450	15,027	14,659
2010s	15,177	15,289								

Source: U.S. Energy Information Administration (EIA), 2012.

**Table 1-4: U.S. Gross Inputs to Refineries (Thousands of Barrels per Day)**

Thousands of above ground crude oil and refined product storage tanks are in service at refineries and other oil/product handling/storage facilities. Buried pipelines within refinery boundaries represent another source of leaks. Aging domestic refinery infrastructure increases the risk of spillage and better systems are needed to detect potential problems. Another possible source of leakage is the refinery process line.

On June 19, 2006, a violent rain storm compromised a waste oil tank at the CITGO Refinery on the Calcasieu River, near Sulfur, Louisiana. Oil booms initially contained the spilled oil but subsequently failed and oil spread down the Calcasieu River and into Calcasieu Lake. The spill released up to an estimated 71,000 bbls (approximately 3 million gallons) of waste oil into the environment. The exact amount of oil spilled and the amount reaching the water is still unknown. Hurricane Katrina also caused considerable damage and oil spills from the refineries and bulk storage terminals in the storm’s path (Table 1-5).

Spill Events that Occurred in the Path of Hurricane Katrina (2005)	
Spill Location	Quantity (bbls)
Bass Enterprises (Cox Bay)	90,000
Shell (Pilot Town)	25,000
Chevron (Empire)	23,600
Murphy Oil (Meraux and Chalmette)	19,500
Bass Enterprises (Pointe à la Hache)	10,980
Chevron (Port Fourchon)	1,260
Venice Energy Services (Venice)	595
Shell Pipeline Oil (Nairn)	320
Sundown Energy (West Potash)	310
Source: Pine, 2006	

**Table 1-5: Spill Events that Occurred in the Path of Hurricane Katrina (2005).**

## 1.8 Maritime and Riverine Transport - Tank Vessels (Ships & Barges) and Non-Tank Vessels

A combination of Federal, State, and international authorities are responsible for regulating oil spills from vessels in the U.S. They are collectively responsible for creating and implementing legislation to prevent oil spills and handling the decisions and procedures that follow in the aftermath.

There has been a reduction of operational and accidental oil spillage in the U.S. that can largely be attributed to the domestic and international regulations that have improved shipping safety and increased limits of liability for oil spills. These regulations required the phase-out of single hull tank vessels (ships and barges) and development of new tank vessels designs for double hulls to reduce accidental discharges in the event of grounding, collision, and allisions. Operational preventative measures including mandatory tug escorts for tank ships transiting through environmentally-sensitive areas in ports may also have contributed to the downward spillage trend by ensuring immediate assistance to a vessel experiencing a loss of propulsion or steerage.

Section 703 of the Coast Guard Authorization Act of 2010 directed the USCG to conduct a study of oil spills involving commercial vessel sources between 2001 through 2010 (Table 1-6). The Coast Guard released the study in May 2012 and reported that a small number of vessel casualties resulted in the greatest percentage of the overall spill volume. The data also show that most spills do not involve vessel casualties. These non-casualty spills are termed “operational”

spills. The report addressed casualty and non-casualty groupings separately in order to identify their respective causal factors. The report defined a non-casualty spill as one in which the only reported occurrence is an oil spill (i.e., the incident did not involve an allision or collision).

U.S. Oil Spills from Vessels – 2001 - 2010. From: USCG, 2012		
Vessel Type	Spills	Barrels
MODU*	259	9,842
Tank Barge	1,318	75,044
Tank Ship	426	30,070
Freight Ship	893	17,284
Fishing Vessel	3,619	8,746
Tow / Tugboat	2,965	6,956
Public Vessel	486	3,077
OSV / Oil Recovery	883	2,334
Recreational	5,058	1,696
Unclassified Vessel	2,479	1,511
Passenger	1,100	8,66
Industrial Vessel	604	675
Freight Barge	407	408
Research Vessel	162	107
Other	51	11
<b>TOTALS</b>	<b>20,710</b>	<b>158,633</b>

\*MODU- Mobile Offshore Drilling Units

Table 1-6: U.S. Oil spills from vessels 2001-2010. (USCG, 2012)

The study concluded that the most frequently reported human factors were inattention, procedural errors and situational awareness. However, while the study focused on human factors, it found that more than half of all discharges were the result of material failure. Vessel casualty statistics showed that the combination of material failure and loss of vessel control led to some of the largest oil spill volumes from 2001 through 2010. Material failure was a significant factor for propulsion and steering problems. The potential for damage due to allision, collision, or grounding is significant when such failures occur on large vessels, (e.g. tank ships, freight ships). According to industry feedback, material failures are also a significant factor in near-miss incidents.

## 1.9 Oil Tankers

Stricter regulations and improved operations of oil tankers has reduced the number of large (> 5,000 bbls, or 7 tonnes) and medium (50 – 5,000 bbls) oil spills from tankers globally, as well as in the U.S. despite an increase in marine transportation of oil. Following the grounding of the single-hull tank vessel *Exxon Valdez*, OPA 90 mandated that all newly built tank vessels have double hulls and that single-hull tank vessels be phased out and replaced by double-hulled vessels by January 1, 2015 for operations in the U.S. waters. Similarly, requirements stemming from the International Convention for the Prevention of Pollution from Ships (MARPOL) have increased the safety of tanker transport.

The International Tanker Owners Pollution Federation Limited (ITOPF), which tracks oil spills from tankers, reports that 19 of the 20 largest spills from tankers occurred before 1970 (ITOPF, 2015). Figure 1–11 shows the trend in oil tanker transport and the number of spills. Figure 1-12 shows the downward trend in oil spills from tankers since 1970 according to ITOPF.



Figure 1-11: Seaborne oil trade and oil spill trends



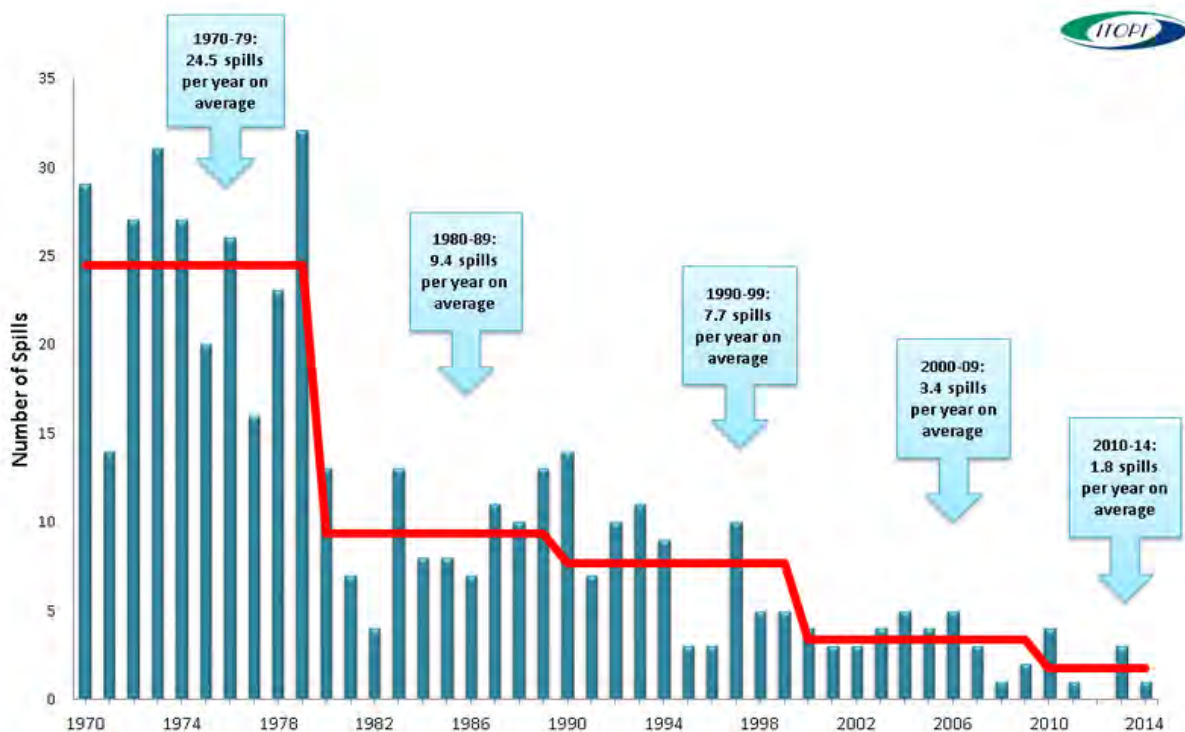


Figure 1-12: Number of Large Spills (>5,000 bbls) from 1970-2014 (ITOPF, 2014)

## 1.10 Regional and Geographic Areas of Interest

ICCOPR considers regional issues an important element in executing an effective oil pollution R&T program. The applicability of research results can vary significantly between geographic regions due to their unique environmental characteristics. Regional issues are prevalent in the Arctic with its potential for new oil exploitation and related activity, and in the Gulf of Mexico where ultra-deepwater drilling and injury assessment and restoration activity from the *Deepwater Horizon* spill continues. Inland regions, likewise, have evolving issues related to onshore shale oil, oil sand products development, and pipeline and rail transportation safety. Development of other OCS regions will raise their own geographically-specific issues. In its research planning efforts, ICCOPR maintains visibility of regional issues by coordinating with RRTs, states, and regional research groups.

ICCOPR considers the following regional and geographic areas to be of high importance at this time or during the next six-year planning cycle:

The Arctic and Alaska – The extent of sea ice in the Arctic and Alaskan waters has diminished in recent years, a trend that is expected to continue for the foreseeable future. The oil industry is expanding exploration and production operations into the Arctic region as conditions change to make operations feasible in the region. One oil company is drilling in the Arctic Ocean during the 2015 summer season. Understanding and overcoming the operational and logistical

challenges of responding to an oil spill in the Arctic region is a major focus of ICCOPR member research planning. This focus is reflected in the number of research priorities (see Chapter 9) that apply directly to Arctic conditions.

**Gulf of Mexico** – The Gulf of Mexico has abundant oil and gas resources, which results in extensive exploration and production activity. Advances in drilling technology have enabled industry to expand operations into progressively deeper areas of the Gulf. It is also the site of two of the largest oil spills from well blowouts, *Macondo/Deepwater Horizon* and *Ixtoc*, as well as numerous other spills. Federal and state agencies are continuing to conduct studies to determine the short- and long-term effects of the *Deepwater Horizon* oil spill. Both Federal and non-Federal Gulf of Mexico research programs established because of the *Deepwater Horizon* oil spill will continue through the next several years.

**Inland Areas** – As discussed in Section 1.1, the production of oil and gas from the shale plays in the U.S. and tar sand regions in Canada has dramatically increased over the past five years. The resulting increase in oil shipments by rail and pipeline has elevated the importance of research to prevent and prepare for oil spills from train accidents or pipeline breaks. In addition, the potential for these spills to affect freshwater rivers and lakes necessitates greater emphasis on research into non-marine response techniques.

**Atlantic Outer Continental Shelf (OCS)** – At present, there are no active oil and gas leases in any of the four Atlantic OCS planning areas. However, the Bureau of Ocean Energy Management (BOEM) Draft Proposed Plan for 2017-2022 proposes one lease sale in the Atlantic in 2021. Preparation for leasing in the Atlantic will involve pre-spill baseline studies to document environmental conditions prior to exploration and drilling.

## 2. Federal Oil Pollution Research

ICCOPR serves to coordinate research by its member federal agencies and other federal research entities to promote a coordinated approach to addressing oil pollution issues. This section describes ICCOPR and the other federal research entities.

### 2.1 ICCOPR

#### 2.1.1. Origin

Congress created ICCOPR in the Oil Pollution Act of 1990 (OPA 90). The Committee's membership, roles, and responsibilities are outlined in the original Public Law (P.L.) that mandated its creation, as amended and codified in the United States Code. Consequently, when referencing ICCOPR, it is generally cited with: *Oil Pollution Act of 1990, § 7001, 104 Stat. 484, 559-564 (1990) (33 U.S.C. 2761)*.

ICCOPR is charged with two general responsibilities: (1) to prepare a comprehensive, coordinated federal oil pollution research and development plan; and (2) to promote cooperation with industry, universities, research institutions, state governments, and other nations through information sharing, coordinated planning, and joint funding of projects. ICCOPR reports on its activities to Congress every two years.

#### 2.1.2. ICCOPR Membership

ICCOPR is comprised of fifteen federal independent agencies, departments, and department components. The U.S. Coast Guard (USCG) chairs ICCOPR. The National Oceanic and Atmospheric Administration (NOAA), the Bureau of Safety and Environmental Enforcement (BSEE), and the Environmental Protection Agency (EPA) rotate as the vice-chair every two years.

OPA 90 originally stipulated that ICCOPR include representatives from: the Department of Commerce, including NOAA and the National Institute of Standards and Technology (NIST); the Department of Energy (DOE); the Department of the Interior (DOI), including the Minerals Management Service (MMS) and the US Fish and Wildlife Service (USFWS); the Department of Transportation (DOT), including the USCG, the Maritime Administration (MARAD), and the Research and Special Projects Administration (RSPA); the Department of Defense, including the U.S. Army Corps of Engineers (USACE) and the Navy; the EPA; the National Aeronautics and Space Administration; and the US Fire Administration (USFA) in the Federal Emergency Management Agency (FEMA).

Today ICCOPR's original membership remains mostly intact but with some recent changes (Table 2.1). In 2012, the DOI reorganized MMS to form BSEE and the Bureau of Ocean Energy Management (BOEM) – both of which are now members of ICCOPR. Additionally, the USCG and FEMA reorganized under the DHS and DOT re-designated the RSPA as the Pipeline and

Hazardous Materials Safety Administration (PHMSA). In 2013, ICCOPR welcomed its newest member, the U.S. Arctic Research Commission (USARC), to help address emerging issues associated with the Arctic and cold weather environments.

**Table 2.1 - ICCOPR Membership**

Member	Current Department	Notes
USCG	Homeland Security	Transferred from Transportation
FEMA/USFA	Homeland Security	Originally Independent
MARAD	Transportation	
PHMSA	Transportation	Agency renamed from RSPA
USFWS	Interior	
BSEE	Interior	Formerly part of MMS
BOEM	Interior	Formerly part of MMS
NOAA	Commerce	
NIST	Commerce	
Navy	Defense	
USACE	Defense	
DOE	Energy	
EPA	Independent	
NASA	Independent	
USARC	Independent	Added in 2013

ICCOPR membership may continue to evolve to fully address new research challenges when agency missions change or there are changes in patterns of oil exploration, production, and transportation. OPA 90 provides that the President may designate other agencies as members of ICCOPR. The President delegated this power to the Secretary of the “Department in which the Coast Guard (USCG) operates” through Executive Order 12777 (October 18, 1991) Section 8 (h) and as amended by Executive Order 13286 (March 5, 2003). The Secretary of Homeland Security delegated this power to the USCG Commandant in DHS Delegation No. 0170.1, II.80. ICCOPR may also invite other federal agencies to participate in a non-voting observer role. Currently the U.S. Geological Survey (USGS) is participating in ICCOPR as a non-voting observer.

The diversity of ICCOPR’s membership reflects Congress’ intent to adequately address the full spectrum of oil spill preparedness, response, and restoration research. Each organization in ICCOPR bears unique regulatory responsibilities, research capabilities, and/or technical expertise that collectively give ICCOPR its knowledge and networks for tackling varying oil pollution research and technology issues. The following sections briefly discuss each of ICCOPR’s member organizations and their connections to oil pollution research. Some organizations directly oversee oil pollution research programs while others provide guidance and resource support or specialized expertise.

#### ***2.1.2.1 U.S. Coast Guard (USCG)***

The USCG serves as the Chair of ICCOPR in accordance with OPA 90. It also serves as the vice-chair of the National Response Team (NRT) and a co-chair of Regional Response Teams (RRTs). The USCG, together with the EPA, has the primary responsibility for federal oil spill response activities. In accordance with the National Contingency Plan (NCP), the USCG is the lead agency for response to spills in the U.S. coastal zone as defined in 40 CFR 300.5.

The USCG provides pre-designated Federal On-Scene Coordinators (FOSCs) for spills in the coastal zone (all United States waters). In addition to spill response, the Coast Guard also has statutory and operational responsibility for oversight of ship design and construction, periodic vessel inspections, investigation of marine casualties, waterway management and port safety and security (including the regulation of hazardous cargoes). These activities all help the USCG improve pollution prevention and response capabilities.

Since 1969, the USCG Research & Development Center (RDC) in New London, Connecticut, has been the Coast Guard’s sole facility performing applied oil pollution research, development, test, and evaluation (RDT&E) experimentation and demonstrations.

The USCG also hosts the National Response Center (NRC), which serves as the NRT communications center and the official federal point of contact for pollution incident reports. The National Contingency Plan (40 CFR Part 300) requires that the NRC be notified in the event of an oil spill into navigable water. The U.S. Coast Guard’s National Pollution Funds Center (NPFC) administers the Oil Spill Liability Trust Fund (OSLTF) and provides funding from the OSLTF Emergency Fund for responses, compensates claimants for cleanup costs and damages, and takes action to recover costs from responsible parties. The NPFC also provides funding from the OSLTF Principal Fund for operations and for research and development.

#### ***2.1.2.2 National Oceanic and Atmospheric Administration (NOAA)***

NOAA serves as a rotating Vice Chair of ICCOPR. NOAA provides science, service and stewardship for the oceans and atmosphere; with a goal of healthy ecosystems, communities and economies that are resilient in the face of change. Many components of NOAA may support response to a major oil spill (including the National Ocean Service, National Weather Service;

the National Marine Fisheries Service; the National Environmental Satellite, Data and Information Service; and the Office of Marine and Aviation Operations). A core component of the support is NOAA's Office of Response and Restoration (OR&R) and its network of Scientific Support Coordinators (SSCs) who respond to approximately 120 oil spills annually, primarily in the coastal zone. These SSCs serve as the primary scientific advisors to Federal On-Scene Coordinators (FOSCs), coordinating scientific expertise from federal and State agencies, academia, industry and the local community (40 CFR 300.145). NOAA support includes assessments of hazards, predictions of fate and behavior (trajectories), recommendations on cleanup and mitigation methods and endpoints, emergency consultations on protected resources, environmental information and data management, wildlife operations, meteorological, hydrological and oceanographic observations and forecasts and satellite imagery access and analysis.

NOAA supports the NRT and RRTs as delegated Department of Commerce representatives and serves on workgroups and area committees on activities associated with preparedness, assessment and restoration. NOAA applies and develops tools for emergency response support, transitioning research into operations. In coordination with states and other federal agencies, NOAA produces environmental sensitivity maps, which rank coastal areas by sensitivity to oil and identify priority locations to be protected in a spill. Federal, State and local agencies use these maps to plan and respond to oil spills.

As a Federal Natural Resource Trustee for living marine resources and their habitat, NOAA is required to assess the injuries that result from an oil spill, to determine and recover monetary compensation and, using those sums, to restore, rehabilitate or recover the equivalent of the damaged resources. NOAA is also responsible for the issuance and implementation of regulations governing oil spill damage assessment.

### **2.1.2.3 *National Institute of Standards and Technology (NIST)***

Founded in 1901, NIST is a non-regulatory federal agency within the U.S. Department of Commerce. NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST has a long history of scientific, technical and measurement support to other federal agencies and U.S. industry on a reimbursable basis.

NIST maintains unique measurement facilities and has an experienced technical staff able to assist with oil spill response and oil pollution research providing a wide variety of scientific and measurement services. NIST's most recent activities relating to oil spills include developing protocols for sampling of protected species, providing for archival for marine animal specimens associated with oil spills, conducting interlaboratory comparison exercises for laboratories involved in assessing oil contamination, providing measurements of contamination in archived marine mammals and seabirds, and assisting with measuring oil flow from well blow-outs. NIST develops Standard Reference Materials (SRMs) for crude oil and other fossil-fuel materials



and additionally has groups involved with research in Fire and Pipeline Safety. NIST maintains and manages the Marine Environmental Specimen Bank (ESB) that contains marine mammal samples dating back as far as the Exxon Valdez oil spill damage assessment and includes marine organism samples from the Pacific Islands, Alaska, and coastal regions of the lower 48 states. NIST has worked more than 30 years developing environmental specimen banking technology so that samples can be used to understand environmental exposure and effects from oil and other contaminants. Because samples have been collected continuously from many locations they provide a resource in the event of a spill to establish pre-spill baseline conditions.

#### **2.1.2.4 U.S. Department of Energy (DOE)**

The DOE works to ensure America's energy security and prosperity by addressing energy and environmental challenges with research and technology solutions. This includes ensuring the prudent development of America's oil and natural gas resources through R&D that improves the safety and environmental performance of oil and natural gas exploration and production.

In its offshore research program, DOE works toward mitigating the risks and challenges associated with drilling and production operations through a research portfolio dedicated to oil spill prevention. Completed and ongoing research focus on the following areas: geologic uncertainty; drilling and completions; surface systems and umbilicals; and subsea systems reliability/automated safety systems.

Onshore DOE focuses on prudent development of unconventional oil and gas resources with emphasis on resource characterization, protecting water quality, increasing water availability, protecting air quality, and reducing induced seismicity associated with waste water injection. The advent of shale gas development also brings a host of safety and environmental issues, including: 1) demand for water for use in hydraulic fracturing; 2) protection of drinking water aquifers; 3) evaluation of the safety of chemicals used in fracturing; 4) environmental impacts resulting from the treatment and/or disposal of produced or fracturing flowback water; 5) air quality impacts; and 6) community safety issues.

DOE's National Energy Technology Laboratory (NETL) conducts laboratory, field, and modeling-based research on offshore oil spill prevention, focusing on reducing the risk and mitigating the risk of a loss of well control that leads to spills. Onshore modeling includes life cycle analysis of natural gas, and modeling of methane emissions.

#### **2.1.2.5 Bureau of Safety and Environmental Enforcement (BSEE)**

The DOI's BSEE serves as a rotating Vice Chair of ICCOPR. The Bureau works to promote safety, protect the environment, and conserve energy resources offshore through vigorous regulatory oversight and enforcement. The BSEE develops standards and regulations to enhance operational safety and environmental protection in connection with the exploration and development of offshore oil, natural gas, and renewable energy sources on the U.S. Outer

Continental Shelf (OCS); and undertakes actions to ensure compliance with those standards and regulations. BSEE has two research programs that support its mission. The Technology Assessment Program supports research regarding operational safety and pollution prevention related to offshore oil and natural gas and renewable energy exploration and development. The Oil Spill Response Research Program is dedicated to improving oil spill response options. The major focus of the program is to support BSEE's mission of ensuring offshore operators are prepared to respond to any potential oil spill. Research is conducted to improve the methods and technologies used for oil spill detection, containment, treatment, recovery and cleanup.

As part of ensuring that offshore operators are prepared to respond to an oil spill BSEE conducts oil spill response plan reviews, government-initiated unannounced exercises, equipment inspections, and audits of oil spill removal organizations and spill management training. Risks identified through these activities are mitigated by directed changes to plans, training programs, equipment, response strategies, and BSEE-funded research projects.

The BSEE also manages the operation of the national Oil Spill Response Research & Renewable Energy Test Facility (Ohmsett), the only facility where full-scale oil spill response equipment testing, research, and training can be conducted in a marine environment with oil under controlled environmental conditions (waves and oil types). OPA 90 mandated continued operation of Ohmsett. (See Section 2.3.1.)

#### **2.1.2.6 Bureau of Ocean Energy Management (BOEM)**

The DOI's BOEM manages the exploration and development of the nation's offshore resources on the U.S. Outer Continental Shelf (OCS). It seeks to appropriately balance economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies. BOEM conducts studies to improve pre-spill baseline information and estimates of oil-spill transport, fate, and impacts to the environment. BOEM manages an Environmental Studies Program (ESP), which, since 1973, has included: development and use of oil transport and weathering models; measurement of oil effects in laboratory and field conditions on marine organisms including birds, fish, and mammals; identification of sensitive biological resources; and assessment of the social and economic impacts of oil development. While some of the ESP consists of in-house investigations, BOEM manages a substantially larger program that is conducted by contractors, industry, universities, and other federal agencies. Interagency coordination of this program is overseen by the National Ocean Pollution Policy Board and the Interagency Arctic Research Policy Committee, in addition to review provided by the OCS Scientific Committee.

#### **2.1.2.7 U.S. Fish and Wildlife Service (USFWS)**

The DOI's USFWS has trustee responsibility for migratory birds, threatened and endangered species, certain marine mammals, anadromous and catadromous fish, and national wildlife refuge lands. The USFWS is the primary DOI Bureau that responds to oil spills, provides



information and advice on safeguarding sensitive habitats and protected species (including advice on use of dispersants and other chemicals), and oversees the rescue and the rehabilitation of oiled birds and certain marine mammals. It works closely with state fish and wildlife agencies to ensure the protection of potentially affected fish and wildlife and takes an active role in protecting USFWS lands, such as national wildlife refuges. USFWS, in its role as trustee, is also the most active DOI bureau in natural resource damage assessment and restorations (NRDAR). In addition to civil actions, USFWS may also pursue criminal violations of the Migratory Bird Treaty Act, Marine Mammal Protection Act, and the Endangered Species Act.

The USFWS R&D efforts are focused on identifying chemical pollutants and their metabolites in biological tissues; defining and mapping wetlands, other critical habitats and natural resources; inventorying species of particular concern, including threatened and endangered species; developing biological indicators and economic tools for damage assessment; and determining biological requirements for sustaining viable populations and habitats and identifying factors contributing to their demise. The USFWS R&D efforts support the needs of the DOI in meeting the operational needs and the requirements of OPA 90.

#### *2.1.2.8 Maritime Administration (MARAD)*

The DOT's MARAD is tasked with promoting the use of waterborne transportation and its seamless integration with other segments of the transportation system, and the viability of the U.S. merchant marine. MARAD's role in maritime transportation spans many areas involving ships and shipping, shipbuilding, port operations, vessel operations, national security, environment, and safety. MARAD supports the Maritime Environmental and Technical Assistance (META) program, which focuses on environmental research and demonstration projects. The Maritime Administration collaborates extensively with stakeholders from all transportation sectors and modes in order to accomplish its mission to improve and strengthen the U.S. marine transportation system. Through long range planning and analysis, the Maritime Administration's Office of Policy and Plans looks ahead and develops plans for integrating the Maritime Administration's activities with those of other appropriate government agencies, as well as private sector marine transportation stakeholders.

#### *2.1.2.9 Pipeline & Hazardous Materials Safety Administration (PHMSA)*

The mission of DOT's PHMSA is to protect people and the environment from the risks of hazardous materials transportation by establishing national policy, setting and enforcing standards, providing education, and conducting research to prevent oil spills and hazardous materials incidents. PHMSA's Office of Pipeline Safety promulgates and enforces regulations addressing the design, construction, operation and maintenance of pipeline systems. PHMSA's Pipeline Safety Research Program supports the PHMSA mission by: 1) funding technology development research; and 2) generating and sharing new technical knowledge with decision makers in support of planning, evaluating, and implementing pipeline safety programs. This

research focus is providing near-term solutions that will increase the safety, reduce environmental impact and improve reliability of the Nation's pipeline system.

PHMSA, via its Office of Hazardous Materials Safety, also provides support to federal agencies in oil spill related areas such as logistics management, transportation infrastructure, telecommunications, command and control systems, expert computer systems, facilities maintenance management, mobilization preparedness and hazardous materials transportation by any mode.

#### ***2.1.2.10 US Army Corps of Engineers (USACE)***

The USACE has specialized equipment and personnel that can be used in oil spill response activities. The Corps has responsibilities for maintaining navigation channels, removing obstructions, performing structural repairs, and maintaining hydropower electric generating equipment. Their Engineer Research and Development Center (ERDC) conducts research and development (R&D) in support of the Soldier, military installations and civil works projects (water resources, environmental missions, etc.) as well as for other federal agencies, state and municipal authorities, and with U.S. industry through innovative work agreements. USACE ERDC has seven laboratories in four states: Construction and Engineering Research laboratory in Champaign, Illinois; Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire; Geospatial Research Laboratory in Alexandria, Virginia; and the Coastal and Hydraulics, Geotechnical and Structures, Environmental, and Information Technology Laboratories in Vicksburg, Mississippi. CRREL, maintains unique cold facilities to conduct research on oil spill detection and response in Arctic and other ice covered waters. Other USACE research with applicability to oil pollution issues include providing technical support on wind and wave effects, diffusion, remote sensing, satellite imaging, image enhancement systems, alternative methods for removing oil, shoreline cleanup and environmental evaluation, effects and mitigation.

The Corps also assists in design and construction and, on a reimbursable basis, provides technical manpower and support for any federal agency involved in any aspect of research and development described in this Plan. Special note should be made of USACE capabilities for assisting in the engineering aspects of conducting various research projects. As the nation's environmental engineer, the USACE manages one of the largest federal environmental missions: restoring degraded ecosystems; constructing sustainable facilities; regulating waterways; managing natural resources; and cleaning up contaminated sites from past military activities.

#### ***2.1.2.11 U.S. Navy (USN)***

NAVSEA's Directorate of Ocean Engineering, Supervisor of Salvage and Diving (SUPSALV) experts provided technical, operational, and emergency capabilities in marine salvage, pollution abatement, diving, diving system certification, and underwater ship husbandry to improve Fleet readiness and capability across the globe. SUPSALV has been the Navy's oil pollution experts

since the 1970s, as required by the Federal Water Pollution Control Act. The USN has expertise in preventing and responding to oil spills from ships. Upon the request of an On-Scene Coordinator, the USN may provide technical assistance in the ocean engineering disciplines of marine salvage, shipboard damage control, pollution abatement, diving, diving system certification, and underwater ship husbandry. The USN also owns specialized containment, collection, and removal equipment designed for salvage-related and near shore to open-sea pollution incidents. The equipment design and systems make it transportable and sustainable in the field. The USN has successfully deployed and operated its equipment at almost every major oil spill in the past 35 years.

#### **2.1.2.12 U.S. Fire Administration (USFA)**

As an entity of FEMA, USFA provides national leadership to foster a solid foundation for fire and emergency services stakeholders in prevention, preparedness, and response. The Agency was established by Public Law 93-498, the Federal Fire Prevention and Control Act of 1974, which called for: 1) the establishment of a National Fire Academy to advance the professional development of the fire service personnel and of other persons engaged in fire prevention and control activities; 2) a technology program of development, testing, and evaluation of equipment for use by the Nation's fire, rescue, and civil defense services; and 3) the operation of a National Fire Data Center for the selection, analysis, publication, and dissemination of information related to the prevention, occurrence, control and results of fires of all types; and ; 4) education of the public to overcome public indifference toward fire and fire prevention. USFA focuses on supplementing, not duplicating, existing programs of training, technology and research, data collection and analysis, and public education. While USFA does not directly conduct oil spill pollution research, it provides valuable emergency service expertise and connectivity to a number of emergency management programs.

#### **2.1.2.13 U.S. Environmental Protection Agency (EPA)**

The EPA serves as the Chair of the National Response Team (NRT), as co-chair of all the Regional Response Teams (RRTs), and as a rotating Vice Chair for ICCOPR. EPA works closely with the USCG in coastal spill response activities. In accordance with the National Contingency Plan (NCP), the EPA is the lead agency for response to spills in the U.S. inland zone. The EPA provides pre-designated On-Scene Coordinators (OSCs) for the inland zone, and maintains assets that can be used for command, control, and surveillance of oil spills. EPA also provides legal expertise on the interpretation of applicable environmental statutes.

The EPA issues and implements federal regulations regarding oil spills under the Clean Water Act, including the NCP. It implements spill prevention regulations for non-transportation-related facilities. Also, through Subpart J of the NCP, EPA maintains a Product Schedule of dispersants and other oil spill mitigating substances and regulates their use during spill response.

The EPA provides expertise on cleanup technologies and the environmental effects of oil spills. Its Environmental Response Team (ERT) is a group of highly trained scientists and engineers whose capabilities include multimedia sampling and analysis, hazard evaluation, contamination monitoring, cleanup techniques, and overall technical support to the OSCs. The EPA's R&D activities include the development of test protocols to evaluate the efficacy and toxicity of spill mitigating agents (e.g., dispersants), and research to determine the fate and effects of oil following a spill.

#### ***2.1.2.14 National Aeronautics and Space Administration (NASA)***

NASA develops and maintains several technologically advanced airborne and satellite systems suitable for spill observation and mapping. The agency's multi-disciplinary team of scientists, engineers and computer modelers also analyzes vast archives of data for insights into Earth's interconnected systems -- atmosphere, ocean, ice, land, and biosphere; and openly provides that data to the global community. They design and deploy airborne, ground-based and ocean-going field campaigns to study the earth from the heights of the stratosphere to the depths of the ocean to the remote ice caps at the poles. NASA also works with other government agencies and partner organizations to apply NASA data and computer models to improve decision-making and problem solving.

#### ***2.1.2.15 U.S. Arctic Research Commission (USARC)***

The USARC is an independent federal agency created by the Arctic Research and Policy Act of 1984, as amended. It consists of a nonpartisan advisory body of scientists, physicians, indigenous leaders, and industry representatives appointed by the President of the U.S. and supported by staff located in Washington, D.C. and Anchorage, AK. The Commission sets U.S. Arctic research policy and builds cooperative links in Arctic research including: 1) the U.S. Arctic research program; 2) to international research partners, and; 3) Alaska. The law requires the Commission to comment to Congress on the progress of the executive branch in reaching goals set by the Commission and on their adoption by the Interagency Arctic Research and Policy Committee. The Commission plays an active role in the work of several interagency committees, including the Arctic Policy Group, chaired by the U.S. Department of State, which oversees U.S. participation in the eight-nation Arctic Council. The Commission is a statutory member of: the North Pacific Research Board and the North Slope Science Initiative. USARC is also a member of: various committees of the National Ocean Governance Structure; the interagency Extended Continental Shelf Task Force; the Scientific Ice Expeditions Interagency Committee, involving U.S. Navy nuclear submarines in the Arctic; the Alaska Ocean Observing System; the International Permafrost Association; and the Consortium for Ocean Leadership.

## 2.2. Other Federal Stakeholders and Entities

Several Federal stakeholders and organizations also conduct research or affect oil pollution research. These include Federal independent organizations (i.e., committees, councils), agencies not currently members of ICCOPR, and ICCOPR member components that do not actively participate within ICCOPR. Other entities set Federal policies that guide or focus research initiatives on specific topics. ICCOPR maintains awareness of these stakeholders and works with them to coordinate research efforts.

### 2.2.1 Arctic Executive Steering Committee (AESC)

The AESC was formed in 2015 by Executive Order to provide guidance to executive departments and agencies (agencies) and enhance coordination of Federal Arctic policies across agencies and offices, and, where applicable, with State, local, and Alaska Native tribal governments and similar Alaska Native organizations, academic and research institutions, and the private and nonprofit sectors. The AESC provides guidance and coordinate efforts to implement the priorities, objectives, activities, and responsibilities identified in National Security Presidential Directive 66/Homeland Security Presidential Directive 25, Arctic Region Policy, the National Strategy for the Arctic Region (NSAR), the NSAR Implementation Plan (NSAR-IP), and related agency plans. The AESC does not conduct oil pollution research but can influence the policies guiding research in the Arctic.

### 2.2.2 Federal Oil Spill Team for Emergency Response Remote Sensing (FOSTERRS)

The Federal Oil Spill Team for Emergency Response Remote Sensing (FOSTERRS) is an interagency working group organized in 2015 to facilitate the sharing of remote sensing capabilities and to discuss improvements in disaster response using remote sensing. Specifically, FOSTERRS seeks to connect agency information on airborne and space borne asset's availability, limitations, capabilities and performance, and ancillary data needs to stake holders and responders. FOSTERRS includes members from agencies (NOAA, NASA, and USGS) with remote sensing assets and key end users. It also reaches out to the larger community involved in marine disaster response and the development and implementation of remote sensing best practices.

### 2.2.3 Federal Rail Administration (FRA)

The Department of Transportation Act of 1966 created the FRA with a mission to enable the safe, reliable, and efficient movement of people and goods for a strong America, now and in the future. It is one of ten agencies within the DOT concerned with intermodal transportation.

FRA's Office of Railroad Safety promotes and regulates safety throughout the Nation's railroad industry. The office executes its regulatory and inspection responsibilities through a diverse staff

of railroad safety experts who are responsible for five safety disciplines focusing on compliance and enforcement in:

- Hazardous Materials;
- Motive Power and Equipment;
- Operating Practices;
- Signal and Train Control; and
- Track.

#### 2.2.4 U.S. Geologic Survey (USGS)

The USGS supports an array of scientific capabilities and assets that address many elements of oil pollution research. As a science agency for DOI, the USGS provides science leadership and collaborations with other federal agencies during oil spill response. USGS research capabilities related to oil pollution include the development of objective and reliable scientific information needed to inform policies and practices that help avoid exposure to toxic substances, mitigate environmental deterioration from contaminants, provide cost-effective cleanup and waste-disposal strategies, and reduce future risk of contamination. USGS science primarily focuses on inland area but also includes near-shore and off-shore environments.

USGS oil pollution related capabilities include long-term monitoring of the Exxon Valdez, Deepwater Horizon, and inland oil spills. Also, the USGS Patuxent Wildlife Research Center has been studying the effects of crude oil and petroleum products on birds since the late 1970's. The USGS Coastal and Marine Program develops 3-D hydrodynamic models that can predict the nearshore sources, transport, and fate of oil. The USGS Energy Program provides capabilities to characterize chemical fingerprints of oil to identify sources of tar balls and support post-spill shoreline assessments.

#### 2.2.5 Gulf Coast Ecosystem Restoration Council

The RESTORE Act established a Gulf Coast Ecosystem Restoration Council (the Council), which is comprised of governors from the five affected Gulf States, the Secretaries from the U.S. Departments of the Interior, Commerce, Agriculture, and Homeland Security as well as the Secretary of the Army and the Administrator of the U.S. Environmental Protection Agency. The Gulf States recommended and President Obama appointed the Secretary of Commerce as the Council's Chair.

#### 2.2.6 Gulf of Mexico Fishery Management Council (GMFMC)

The GMFMC is one of eight regional Fishery Management Councils established by the Fishery Conservation and Management Act of 1976. The Council prepares fishery management plans designed to manage fishery resources from where state waters end, out to the 200-mile limit of the Gulf of Mexico. These waters are also known as the Exclusive Economic Zone (EEZ). The



Council consists of voting members from the NMFS, the five Gulf state marine resource management agencies, and nominees by the State governors. In addition, there are four nonvoting members representing the USCG, U.S. Fish and Wildlife Service, Department of State, and the Gulf States Marine Fisheries Commission. The GMFMC provides an advisory role in directing scientists on where to focus their research. Current priorities include research on species recovering from the Deepwater Horizon oil spill and broad research on long-term fisheries data.

#### 2.2.7 U.S. Marine Mammal Commission (MMC)

The MMC is an independent agency of the U.S. government established under Title II of the Marine Mammal Protection Act (MMPA). The Commission provides independent oversight of the marine mammal conservation policies and programs of federal agencies. The Commission's main roles with respect to oil spills are oversight of the agencies charged with response, assessment, and restoration activities, and convening of interagency working groups to coordinate those activities.

The Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has prepared a report “Assessing the Long-term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs” (2011). The objectives of the report were to (1) guide assessment of the long-term effects of the Gulf spill and associated risk factors on marine mammals, (2) guide mitigation and restoration efforts for Gulf marine mammal populations, (3) help track the changes in the Gulf ecosystem, including recovery and restoration, and (4) help guide assessment of future spills in the Gulf and elsewhere.

The Commission administers a small annual grant program that supports projects aimed at meeting the conservation and protection goals of the MMPA. In addition, the Commission has initiated an annual survey of federally funded research on marine mammals to determine the nature of research conducted or supported by each agency. Information from the survey is used to assess ways to target and enhance specific marine mammal research and conservation activities.

#### 2.2.8 National Institute of Environmental Health Sciences (NIEHS)

NIEHS is one of 27 research institutes and centers that comprise the National Institutes of Health (NIH) of the Department of Health and Human Services (DHHS). The mission of the NIEHS is to reduce the burden of human illness and disability by understanding how the environment influences the development and progression of human disease. The NIEHS, part of the NIH, activated programs throughout the institute to provide timely and responsive services following the DWH oil spill.

In June 2010, NIEHS initiated the GuLF STUDY to conduct research on the health of the workers and volunteers most directly involved in responding to the Deepwater Horizon oil spill.

The GuLF STUDY will help determine if oil spills and the exposure to crude oil and dispersants, affects physical and mental health. Almost 33,000 cleanup workers are enrolled in the 10-year health study, making a significant contribution to their communities and to answering important public health questions.

#### 2.2.9 U.S. National Response Team (NRT) - Science and Technology (S&T) Committee

The NRT is an organization of 15 federal departments and agencies responsible for coordinating emergency preparedness and response to oil and hazardous substance pollution incidents. The EPA and the USCG serve as Chair and Vice Chair respectively. The NCP and the Code of Federal Regulations (40 CFR part 300) outline the role of the NRT and Regional Response Teams (RRTs). Various federal statutes cite the NRT and RRTs including the Superfund Amendments and Reauthorization Act - Title III and the Hazardous Materials Transportation Act (HMTA).

The NRT's S&T Committee provides a forum to fulfill the NRT's NCP delegated responsibilities in R&D. Specifically, NCP regulation 40 CFR 300.110(h)(6) lists as one of the NRT's responsibilities "Monitoring response-related research and development, testing, and evaluation activities of NRT agencies to enhance coordination, avoid duplication of effort, and facilitate research in support of response activities." Additionally, 40 CFR 300.110(g) states, "the NRT may consider and make recommendations to appropriate agencies on ... necessary research, development, demonstration, and evaluation to improve response capabilities."

#### 2.2.10 National Science Foundation (NSF)

The NSF is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..." The NSF is the funding source for approximately 24 percent of all federally supported basic research conducted by America's colleges and universities. NSF fulfills their mission chiefly by issuing limited-term grants to fund specific research proposals judged to be the most promising by a rigorous and objective merit-review system. Currently, they issue about 11,000 new awards per year, with an average duration of three years. NSF-funded research addresses a number of scientific areas with applications to oil pollution research including engineering, materials science, biology, and the Arctic. NSF also has a Rapid Response Research (RAPID) mechanism that enables research on unanticipated events such as the *Deepwater Horizon* oil spill.

#### 2.2.11 NOAA RESTORE Act Science Program

In 2012, the U.S. Congress passed (P.L. 112-141) the "Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act" (RESTORE Act). The RESTORE Act transfers 80% of all administrative and civil penalties paid by responsible parties in connection with the *Deepwater Horizon* incident to a Gulf Coast Restoration Trust



Fund. The RESTORE Act also establishes several programs, funded by the Trust Fund, to aid in the ecological and economic recovery of the Gulf Coast states. Under Section 1604 of the RESTORE Act directed NOAA to establish a Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program (NOAA RESTORE Act Science Program). This program is to be funded by 2.5 percent of the Gulf Coast Ecosystem Restoration Trust Fund plus 25 percent of the Trust Fund accrued interest. The Program can expend funds for marine and estuarine research; marine and estuarine ecosystem monitoring and ocean observation; data collection and stock assessments; pilot programs for fishery independent data and reduction of exploitation of spawning aggregations; and cooperative research.

#### 2.2.12 North American Wetlands Conservation Act (NAWCA) Gulf of Mexico Funds

The NAWCA provides matching grants from the North American Wetlands Conservation Fund to organizations and individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico for the benefit of wetlands-associated migratory birds and other wildlife. As part of their criminal settlement agreement, BP paid \$100 million to the Fund for the purpose of wetlands restoration and conservation located in states bordering the Gulf of Mexico or otherwise designed to benefit migratory bird species and other wildlife affected by the Macondo oil spill. The USFWS administers the Fund. The restoration projects include research to monitor and evaluate restoration success.

### 2.3 Federal Research Laboratories and Testing Facilities

Several federal facilities and locations provide opportunities for both federal and non-federal oil pollution research.

#### 2.3.1 Ohmsett

Ohmsett, located at the Naval Weapons Station Earle Waterfront in Leonardo, New Jersey, is managed by BSEE. The facility includes an above ground concrete test tank that is one of the largest of its kind, measuring 203 meters long by 20 meters wide by 3.4 meters deep. The tank holds with 2.6 million gallons of crystal clear saltwater.

The Ohmsett test tank allows testing of full-scale oil pollution response equipment. The tank includes a wave generator that creates realistic sea environments, while state-of-the-art data collection and video systems record test results. The facility has proven to be ideal for testing equipment, evaluating acquisition options, and validating research findings.

Government agencies, academia, public and private companies use Ohmsett as a research center to test oil spill containment/clean-up equipment and techniques, to test new designs in response equipment, and to conduct training with actual oil spill response technologies.

### 2.3.2 USCG Research & Development Center (RDC)

The RDC, located in New London, Conn. is the USCG's sole facility performing research, development, and test and evaluation in support of the service's major missions. The RDC is responsible for evaluating the feasibility and affordability of mission execution solutions and providing operational and risk-management analysis at all stages of the acquisition process.

At any given time, the RDT&E program is working on more than 80 projects that support USCG requirements across all mission areas. The program also provides Coast Guard leadership with knowledge necessary for making strategic decisions. The RDT&E program leverages partnerships with academia and other government agencies. The RDC also leverages Cooperative Research and Development Agreements (CRADAs) under the Technology Transfer Act to work with private industry to anticipate and research solutions to current and future technological challenges.

### 2.3.3 USCG RDC Joint Maritime Test Facility

The USCG RDC's Joint Maritime Test Facility *In Situ* Burn Pan is working in conjunction with the Naval Research Laboratory and the BSEE to refurbish its *in-situ* burn test pan located on Little Sand Island in Mobile, Alabama. The burn pan is the nation's only permitted open air *in-situ* burn pan for fire boom research. Once refurbished, this burn pan will help the RDC's Joint Maritime Test Facility meet its mission to support the maritime safety efforts by providing full-scale tests and evaluation under close to actual operating and environmental conditions.

### 2.3.4 USCG Marine Safety Laboratory

The USCG Marine Safety Laboratory (MSL) provides forensic oil analysis and expert testimony in support of the oil pollution law enforcement efforts for Marine Investigators, Districts, Hearing Officers, National Pollution Funds Center, Department of Justice, and other federal agencies. The MSL is the USCG's sole facility for performing forensic oil analysis.

### 2.3.5 U.S. EPA National Risk Management Research Laboratory (NRMRL)

The NRMRL is EPA's premiere laboratory for risk management research. It conducts research at the basic level, as well as bench-scale and pilot-scale levels, to explore innovative solutions to pollution problems. Environmental risk management seeks to determine what environmental risks exist and how to manage those risk in a way best suited to protect human health and the environment. Its mission is to advance scientific and engineering solutions to manage current and future environmental risk.

NRMRL's research directly supports efforts to manage chemical risks, clean up hazardous waste sites, protect water, reduce greenhouse gas emissions, and improve air quality.

### 2.3.6 Cold Regions Research and Engineering Laboratory (CRREL)

CRREL, located in Hanover, New Hampshire is one of seven US Army Corps of Engineers (USACE) Engineering Research and Development Center (ERDC) laboratories. The laboratory's mission is to solve interdisciplinary and strategically important problems by advancing and applying science and engineering to complex environments, materials and processes in all seasons and climates, with unique core competencies related to the Earth's cold regions. CRREL maintains several unique and specialized research facilities at its Hanover, New Hampshire location, to include: 26 low-temperature research cold rooms; a refrigerated Ice Engineering Facility comprised of a 12,800 square foot research area, a 3,600 square foot by 8 foot deep test basin, and a 120 foot long water flume with tilting bed; a 1,320 square foot by 7 foot deep outdoor Geophysical Research Facility; a 40 foot working length portable wave tank that can be located indoors within a cold facility for year round cold research or outdoors to support in situ burn tests; and a 29,000 square foot environmentally controlled Frost Effects Research Facility. CRREL also maintains a research permafrost tunnel in Fox, Alaska, a 135-acre permafrost research site near Fairbanks, Alaska, and has project offices in Anchorage and Fairbanks, Alaska. CRREL works with partners from industry, government agencies, and educational institutions, to develop scientific tools that can aid in effective oil spill response, and provides unique facilities and cold region expertise to stake-holders to create effective spill response techniques for ice covered environments.

### 2.3.7 U.S. Army Engineer Research and Development Center (ERDC)

The ERDC is the world's largest laboratory primarily devoted to civil engineering and environmental sciences research, development, test, and evaluation. The ERDC, which includes seven laboratories located in four geographic locations, provides a broad array of services ranging from basic research to test and evaluation. The ERDC Laboratories maintain state of the art modeling and experimentation facilities which support a broad array of capabilities in oil spill response from modeling impacts to remediation techniques.

ERDC capabilities to support Oil Spill efforts are categorized into three phases. Phase 1, Emergency Response/Mitigation, includes those activities that enhance the ability to conduct emergency response and mitigation. Phase 2, Remediation, includes activities designed to support tasks such as active intervention to ameliorate the oil contamination. Phase 3, Recovery/Long Term Monitoring/Assessment, includes activities supporting the monitoring and assessment of long term environmental impacts associate with the spill.

### 2.3.8 Hollings Marine Laboratory (HML)

The Hollings Marine Laboratory is located in Charleston, SC and was established as a joint facility combining partners from NOAA, NIST, the Medical University of South Carolina, the College of Charleston, and the South Carolina Department of Natural Resources. The laboratory is operated by the NOAA National Ocean Service and houses NIST's Environmental Specimen

Bank, NIST and NOAA environmental chemistry laboratories, as well as NOAA personnel and facilities for assessing the health of living marine resources. Immediately after the Deepwater Horizon oil spill, the co-location of NOAA and NIST personnel was instrumental in planning and mounting NOAA's response to the event with regard to, sample archival, monitoring protected species and evaluating data quality being produced by different laboratories providing chemistry data related to the spill. Oil spill-related research continues at the HML with projects including aiming to understand biomarkers of oil exposure in protected species and exploring the effects of dispersants on marine organisms and humans.

### 2.2.9 U.S. Naval Research Laboratory (NRL) Stennis Space Center

The NRL detachment at Stennis Space Center focuses on marine geosciences, oceanography, and underwater acoustics. The Oceanography Division and the Marine Geosciences Division conduct studies applicable to oil pollution research.

The Oceanography Division is known for its combination of theoretical, numerical, and experimental approaches to oceanographic problems. The Division numerically models the ocean on the world's most powerful supercomputers and operates a number of highly sophisticated graphics systems to visualize ocean model results. The Division maintains two satellite receiving systems, a computer network with automated processing capabilities for ocean color and advanced optical instrumentation and calibration facilities.

The Marine Geosciences Division conducts a broadly-based, multidisciplinary program of scientific research and advanced technology development directed towards maritime and other national applications of geosciences, geospatial information and related technologies. Research includes investigations of basic processes within ocean basins and littoral regions. The Division develops models, sensors, techniques and systems to exploit this knowledge for applications to enhance Navy and Marine Corps systems, plans and operations

### 2.3.10 Pacific Northwest National Laboratory (PNNL)

The PNNL's Marine Sciences Laboratory (MSL), located in Sequim, Washington on the Strait of Juan de Fuca, provides a platform for marine and freshwater ecological research, instrument and method development, and biotechnology research. The laboratory has regional access to oceans and rivers that have experienced human impacts ranging from the uninhabited and protected coastlines of Olympic National Park to heavily developed shores around Seattle and Tacoma. The Marine Research Operations' Wet Laboratory provides a large space in which to perform innovative, water-oriented research. A variety of indoor and outdoor tank configurations provide capacity for bench-scale tests through large-scale outdoor mesocosm systems and for other studies using aquatic plants and animals.

### 2.3.11 Coastal and Ocean Research Vessels

#### 2.3.10.1 USCG Cutter *Healy*

The USCG's cutter *Healy* is designed to conduct a wide range of research activities, providing more than 4,200 square feet of scientific laboratory space, numerous electronic sensor systems, and accommodations for up to 50 scientists. HEALY is designed to break 4½ feet of ice continuously at three knots and can operate in temperatures as low as -50 °F. *Healy* substantially enhances the U.S. Arctic research capability. It serves as a platform for research activities as part of the Arctic Shield demonstrations where components of an Arctic oil spill response are tested. *Healy* is also a capable platform for supporting other potential missions in the polar regions, including logistics, search and rescue, ship escort, environmental protection, and enforcement of laws and treaties.

#### 2.3.11.2 EPA Vessels

The EPA operates two ships that monitor and assess impacts from ecological disturbances and ocean-based human activities on the ocean, Great Lakes, and coastal waters. EPA's Ocean Survey Vessel (OSV) *Bold* operates under the statutory requirement to monitor the deposition of dredged materials under the Marine Protection, Research, and Sanctuaries Act of 1972. This Act regulates intentional ocean disposal of materials, authorizes any related research and provides for the designation and regulation of marine sanctuaries. OSV *Bold* operates in the Atlantic and Pacific Oceans and the Caribbean Sea to monitor water quality, effects of dredged material, coral reef health, and other special assessments.

EPA's Great Lakes National Program Office based in Chicago, Illinois operates R/V *Lake Guardian*, which conducts monitoring programs that sample the water, aquatic life, sediments, and air in order to assess the health of the Great Lakes ecosystem.

#### 2.3.11.3 MARAD Vessels

MARAD operates the National Defense Reserve Fleet (NDRF) of 100 ships that are available for use during oil spill exercises, providing housing during a spill response, or for education and training. The NDRF is available to support emergency shipping operations during war and national emergencies. The fleet has anchorages in Fort Eustis, Virginia; Beaumont, Texas; Suisun Bay in Benicia, California; and at designated port facility berths.

#### 2.3.11.4 NOAA Vessels

NOAA's Office of Marine and Aviation Operations (OMAO) operates a wide assortment of hydrographic survey, oceanographic research, and fisheries survey vessels. Five ships located in the Pacific are managed by the Marine Operations Center, Pacific (MOC-P) in Newport, Oregon. Nine ships located in the Atlantic are managed by the Marine Operations Center,

Atlantic (MOC-A) in Norfolk, Virginia. Two ships located in Hawaii are managed by the Marine Operations Center, Pacific Islands (MOC-PI).

NOAA's research and survey ships compose the largest fleet of federal research ships in the nation. The fleet ranges from large oceanographic research vessels capable of exploring the world's deepest ocean, to smaller ships responsible for charting the shallow bays and inlets of the United States. The fleet supports a wide range of marine activities including fisheries research, nautical charting, and ocean and climate studies.

The OMAO's aircrafts operate throughout the world providing a wide range of capabilities including hurricane reconnaissance and research, marine mammal and fisheries assessment, and coastal mapping.

#### 2.3.12 Oil Spill Field Research

Federal oil pollution research is not limited to research facilities and laboratories. Oil spills can provide opportunities for federal agencies to conduct research on the fate, effects, and physical and chemical behavior of the spilled oil and the responses to the spills in the natural environment. NOAA and USGS have ongoing research projects to study the long-term fate and effects of the *Exxon Valdez* oil spill. The *Deepwater Horizon* oil spill is also providing many opportunities to study both the near-term and long-term effects of the spill and response. Other potential research locations include the Santa Barbara oil seeps off the California coast and the submerged Taylor Energy platform in the Gulf of Mexico, which is a continuing source of sheens.

Intentional releases have been used by many countries, most notably Norway, to demonstrate the effectiveness of spill control equipment or processes. Under controlled circumstances, these releases may provide an opportunity to conduct tests under actual spill conditions.

### 3. Non-Federal Oil Pollution Research Entities

Consistent with the mandates of OPA 90, ICCOPR cooperates with research programs of state governments, industry, academia, non-government organizations/institutions, and other nations. The cooperation of federal and non-federal entities provides whole community approach to oil pollution research. The following sections describe non-federal entities that conduct or sponsor oil pollution research.

#### 3.1 State Organizations

Several coastal states have established oil pollution research programs. These programs are in states affected by previous oil spills or where there are active oil exploration and production activities. Increasing shale oil production has prompted other states to study the risks of hydraulic fracturing and transporting oil by rail and pipeline. This section describes on-going state research programs.

##### 3.1.1 Alaska Department of Environmental Conservation (ADEC)

Judgments entered in the criminal cases for the *Exxon Valdez* oil spill resulted in appropriation of funds to the State of Alaska to enhance the ability of the State and industry to respond to oil spills. A total of \$2,500,000 was made available to ADEC for projects under this program. The funds are used for research programs directed toward the prevention, containment, cleanup and amelioration of oil spills in Alaska. In cooperation with other stakeholders, ADEC has developed a list of more than 30 R&D projects dealing with such subjects as cleanup technology, non-mechanical response techniques, the fate and effects of spilled oil, oil-spill contingency planning and preparedness, spill response training, incident-management systems and spill prevention. Alaskan oil-spill response cooperatives, private consultants, universities, and other state and federal agencies have conducted research under the program.

##### 3.1.2 California Office of Oil Spill Prevention and Response (CAOSPR)

As both a prevention and response organization, CAOSPR has the Department of Fish and Wildlife's public trustee and custodial responsibilities for protecting, managing and restoring the state's fish, wildlife, and plants. It is one of the few state agencies in the nation with both major pollution response authority and public trustee authority for wildlife and habitat. This mandate ensures that prevention, preparedness, restoration and response will provide the best protection for California's natural resources.

In 2014 California expanded the CAOSPR program to cover all state surface waters at risk of oil spills from any source, including pipelines, production facilities, and the increasing shipments of oil transported by railroads. This expansion provided critical administrative funding for industry preparedness, spill response, and continued coordination with local, state and federal government along with industry and non-governmental organizations.



### 3.1.3 Florida

The Oil Spill Academic Task Force (OSATF) is a consortium of scientists and scholars from institutions in the State University System as well as from five of Florida's private universities and two marine laboratories working in collaboration with the Florida Department of Environmental Protection (DEP). The OSATF brings together expertise and resources to assist the state of Florida and the Gulf region in responding to and studying the Deepwater Horizon oil spill.

The Fish and Wildlife Research Institute's work includes assessment and restoration of ecosystems and studies of freshwater and marine fisheries, aquatic and terrestrial wildlife, imperiled species, and red tides. The institute develops the information science required to analyze and disseminate research products, and engages in outreach activities to complement all programs.

The Florida Marine Spill Analysis System (FMSAS) is a powerful geographic information system (GIS) application that allows users to conduct oil spill planning activities and manage response and mitigation efforts during an actual spill. Spill planning and response activities have always relied on maps and charts to display information. From simple notes on nautical charts to specialized maps showing the location of sensitive resources or the location of an oil slick, many of the essential information components of planning and response actions require geospatial data. The FMSAS is designed to address five aspects of oil spill management:

- Contingency planning;
- On-scene spill tracking and “Resources At Risk” (RAR) analysis;
- Long-term monitoring;
- Damage assessment; and
- General oil spill GIS data management.

### 3.1.4 Louisiana Applied and Educational Oil Spill Research and Development Program (OSRADP)

The Louisiana OSRADP provided oil spill planners and response personnel with practical, scientifically-sound and cost effective spill prevention, management and mitigation tools for two decades until 2011 when OSRADP became part of the Center for Energy Studies.

### 3.1.5 Gulf States Marine Fisheries Commission (GSMFC)

The Gulf States Marine Fisheries Commission was established by an act of Congress (P.L. 81-66) in 1949 as a compact of the five Gulf States with a charge to: “to promote better utilization of the fisheries, marine, shell and anadromous, of the seaboard of the Gulf of Mexico, by the development of a joint program for the promotion and protection of such fisheries and the prevention of the physical waste of the fisheries from any cause.”

The GSMFC Oil Disaster Recovery Program (ODRP) evolved from the receipt of \$15 million dollars in October of 2010 and aims to improve the public perception and confidence in Gulf of

Mexico seafood following the 2010 *Deepwater Horizon* oil disaster. Funding for this program, like that of the post-Katrina Emergency Disaster Recovery Program (EDRP), came from the U.S. Congress following fishery disaster declarations by the U.S. Secretary of Commerce. Scheduled to be completed in September of 2015, the activities under the program are identified through an ad-hoc advisory committee consisting of the marine resource directors from each of the five Gulf of Mexico states. Under this component, multiple post-disaster recovery elements were executed to address issues relative to improving both the perception of and confidence in Gulf of Mexico seafood products.

### 3.1.6 Minnesota National Crude Oil Spill Fate and Natural Attenuation Site

The Minnesota National Crude Oil Spill Fate and Natural Attenuation Site dates back to 1979, when a dramatic pipeline rupture released 10,000 bbl of crude petroleum to the land surface and shallow subsurface. In 1983, research began at the site through the support of the USGS' Toxic Substances Hydrology Program. Continuing USGS support has allowed hundreds of scientists from across the globe to visit this "underground observatory" and study the effects of a terrestrial crude oil spill including the physical, chemical and biological processes driving the degradation and transport of crude petroleum. Research from the site has been included in more than 200 scientific papers.

In 2008 and 2009, the Minnesota Pollution Control Agency, Enbridge Energy LLC, the USGS and Beltrami County created several agreements to formally establish the "National Crude Oil Spill Research Site in Bemidji, Minn." The objective of these agreements is to create a self-sustaining research facility that brings academic researchers and practitioners (e.g., consultants, petroleum and pipeline industry representatives and pollution control officials) together thereby linking novel ideas to practical, on-the-ground applications.

### 3.1.7 Pacific States/British Columbia Oil Spill Task Force (PSBCOSTF)

In 1989, following the *Nestucca* and *Exxon Valdez* oil spills, the Governors of Alaska, Washington, Oregon, and California, and the Premier of British Columbia, signed a Memorandum of Agreement that authorized PSBCOSTF. These events highlighted their common concerns regarding oil spill risks and the need for cooperation across shared borders. In June 2001, a revised Memorandum of Cooperation was adopted to include the State of Hawaii and expand the focus to spill preparedness and prevention needs of the 21st century. Now in its third decade, the PSBCOSTF provides a forum where its members can work with stakeholders from the Western US and Canada to implement regional initiatives that protect 56,660 miles of coastline from Alaska to California and the Hawaiian archipelago.

### 3.1.8 Texas General Land Office (TXGLO)

The TXGLO is a national leader in oil spill research. The TXGLO R&D program has funded groundbreaking work on oil dispersants, shoreline cleaners, bioremediation and high-frequency

radar. The R&D program is improving response technology and developing alternative methods for removing oil from coastal waters.

Over the years, the TXGLO has coordinated with other state agencies, the state's higher education institutions and private industry to establish viable research projects for oil spill prevention and response. Funded projects have involved preventive technologies, spill detection, environmental data collection, chemical countermeasures, recovered materials management and in situ burning

The TXGLO, as a NRDA Trustee, acts on behalf of the public to identify the injured natural resources and determine the extent of the impact. They also recover damages from the responsible party to plan and carry out restoration activities. In addition to the TXGLO, two other state agencies are designated as NRDA trustees: the Texas Parks and Wildlife Department (TPWD) and the Texas Commission on Environmental Quality (TCEQ).

#### 3.1.9 Washington Department of Ecology (WADOE)

The WADOE has program offices for oil pollution prevention, preparedness, and response, which include resource damage assessments and recovery. The Department conducts studies on the risks of oil transportation through the state and provides guidance to industry and the public on oil pollution issues. WADOE also manages a Coastal Protection Fund (CPF) that collects monies from oil and hazardous materials spill damage assessments and penalties. The CPF uses the money to fund projects to: restore or enhance public natural resources; investigate long-term effects of oil spills; and develop and implement aquatic land geographic information systems. Funds may also be allocated for R&D on the causes, effects, and removal of pollution caused by the discharge of oil.

## 3.2 Industry

The oil industry plays an important part in oil pollution research. Industry approaches to exploration, production, transportation, and spill prevention evolve as new techniques are identified or new resources are found. Industry has several research programs to improve their practices to prevent oil spills and to better respond to spills when they occur.

#### 3.2.1 American Petroleum Institute Joint Industry Task Force (API JITF)

In the wake of the *Deepwater Horizon* oil spill of 2010, the petroleum industry launched four JITFs to critically assess capabilities and performance. Each JITF used subject matter experts to identify best practices in offshore drilling operations and oil spill response and to share that knowledge across industry with the goal of ensuring environmental protection through enhanced safety.

The Oil Spill Preparedness and Response JITF examined industry’s ability to respond to a “Spill of National Significance (SONS)” and the actual response to the *Deepwater Horizon* oil spill. This program covers:

- Spill Response Planning
- Oils Sensing and Tracking
- Dispersant
- In Situ Burning
- Mechanical recovery
- Shoreline protection
- Alternate response technologies

The industry has also has also begun to improve public outreach in a number of focus areas including:

- Oil spill preparedness and response framework;
- Net environmental benefit analysis (NEBA);
- Role of dispersants in oil spill response;
- Tiered preparedness and response framework;
- Incident management system; and
- Regulatory approval and use of dispersants.

The JITF also initiated subcommittees to address response issues related to inland spills including railroad spills and pipeline emergency response.

### 3.2.2 American Salvage Association (ASA)

The ASA was created in 2000 as an association of professional salvors dedicated to improving marine casualty response in North American coastal and inland waters. The ASA promotes cooperation among its members and works with Federal and state agencies to identify ways to improve salvage and firefighting response capabilities. The ASA encourages research to identify risks from sunken vessels and uses its members’ experience to identify areas for additional research or technology development.

### 3.2.3 Association of Petroleum Industry Co-op Managers (APICOM)

APICOM, founded in 1972, is an association of unaffiliated petroleum industry oil spill cooperative managers. APICOM exists for the purpose of exchanging information related to the management of an oil spill response cooperative. It also serves as a forum for the exchange of ideas related to oil spill response technologies, operations, regulations and other issues of common interest to its members.

#### 3.2.4 Industry Technical Advisory Committee (ITAC)

The ITAC includes members from the oil spill response community within the oil industry, and other organizations that have oil pollution preparedness and response as their principal goal. ITAC acts as a focal point for technical issues and as a forum for exchanging information on preparedness, oil spill response operations, response technology and response training.

#### 3.2.5 International Maritime Organization (IMO)

The IMO is a specialized agency of the United Nations, which is responsible for measures to improve the safety and security of international shipping and to prevent marine pollution from ships. It is also involved in legal matters, including liability and compensation issues and the facilitation of international maritime traffic. IMO's governing body is the assembly, made up of all 170 Member States, which meets once every two years. The Maritime Safety, Marine Environment Protection, Legal, Technical Co-operation and Facilitation Committees, and a number of sub-committees carry out the main technical work. Since 1967, the IMO has adopted a series of conventions covering prevention of marine pollution by ships, preparedness and response to incidents involving oil and hazardous and noxious substances, prevention of use of harmful anti-fouling systems and the international convention on ballast water management to prevent the spread of harmful aquatic organisms in ballast water.

#### 3.2.6 International Petroleum Industry Environmental Conservation Association (IPIECA)

IPIECA is the global oil and gas industry association for environmental and social issues. It develops, shares, and promotes good practices and knowledge to help the industry improve its environmental and social performance. It is the industry's principal channel of communication with the United Nations.

IPIECA's Oil Spill Working Group (OSWG) was established in 1987 and serves as a key international industry forum to help improve oil spill contingency planning and response around the world. The OSWG aims to improve oil spill preparedness and response around the world by:

- Enabling members to exchange information and best practices
- Supporting industry and government cooperation at all levels
- Encouraging ratification and implementation of relevant international conventions
- Promoting the principle of 'Net Environmental Benefit Analysis' and the 'Tiered Response' approach to designing response strategies; and
- Developing and communicating the industry's views and activities to external audiences'

### 3.2.7 International Spill Control Organization (ISCO)

The International Spill Control Organization (ISCO) is a not-for-profit organization incorporated in London in 1984 with membership in 36 countries around the world. ISCO aims to raise worldwide preparedness and co-operation in response to oil and chemical spills, to promote technical development and professional competency, and to provide a focus for making the knowledge and experience of spill control professionals available to IMO, United Nations Environment Programme (UNEP), European Commission (EC) and other organizations. ISCO provides organizations with information on experiences, problems solved, and lessons learned by spill responders. They also keep the spill response community informed of new developments and news through their website and newsletters.

### 3.2.8 International Tanker Owners Pollution Federation (ITOPF)

ITOPF is a not-for-profit organization established on behalf of the world's ship owners and their insurers to promote effective response to marine spills of oil, chemicals, and other hazardous substances. ITOPF provides a range of technical services including emergency response, advice on clean up techniques, pollution damage assessment, assistance with spill response planning, and training. It is recognized and respected globally as a source of objective technical expertise in the area of accidental spills of oil and chemicals from ships and ITOPF is a source of comprehensive information on marine pollution. Investing in R&D is one way ITOPF meets this objective. ITOPF invests in R&D to help fulfill their mission of promoting effective response to marine spills of oil, chemicals and other substances.

### 3.2.9 Oil Spill Response (OSR) Joint Industry Program (JIP)

The OSR JIP is an initiative of the Oil and Gas Producers (OGP) to address issues related to the Macondo well blowout. In response to the incident, the OGP formed the Global Industry Response Group (GIRG), which was tasked to identify the key issues that could prevent recurrence of such an incident and identify learning opportunities on both the causation, and the subsequent response to the incident. The OSR JIP has initiated discreet projects or supported projects of other groups in many oil spill related subject areas resulting from the OGP GIRG-OSR studies.

### 3.2.10 Petroleum Environmental Research Forum (PERF)

The PERF is a research and development joint venture, formed to provide a stimulus to and forum for the collection, exchange, and analysis of research information relating to the development of technology for health, environment and safety, waste reduction and system security in the petroleum industry. PERF is a non-profit organization of member corporations in the petroleum industry. PERF does not itself participate in research projects but provides a forum for members to collect, exchange, and research information relating to practical and

theoretical science and technology concerning the petroleum industry and a mechanism to establish joint research projects in the field.

### 3.2.11 Pipeline Research Council International (PRCI)

The PRCI was established in 1952 as the Pipeline Research Committee of the American Gas Association to address the problem of long-running brittle fractures in natural gas transmission pipelines. In substantially solving that problem within two years, the committee demonstrated the benefit of industry collaboration and leveraging voluntary industry funding. Unique among all pipeline research organizations, the mission of PRCI is to be the global leader in collaborative energy pipeline research that provides safe, reliable, environmentally conscious and efficient means of energy delivery. The committee will be used to improve current inspection and integrity assessment technologies, and to promote the development of new technologies for pipeline integrity management.

Some of PRCI's recent research has addressed:

- Corrosion — location and assessment;
- Mechanical damage — location and assessment;
- Right of Way (ROW) monitoring;
- Growth of construction defects;
- Compressor and pump station; and
- Measurement.

### 3.2.12 Spill Control Association of America (SCAA)

SCAA organized in 1973 to actively promote the interests of all groups within the spill response community. They represent spill response contractors, manufacturers, distributors, consultants, instructors, government and training institutions and corporations working in the industry. SCAA partners with the USCG and the Association of Petroleum Industry Co-op Managers (APICOM) in the quality partnership for marine safety and environmental protection, which was created to improve the effectiveness of spill response and to promote sound risk management among/between private and governmental response organizations.

## 3.3 Independent Research Interests

Several independent organizations conduct or manage oil pollution research programs. These include non-governmental organizations, non-profit organizations, and committees with a mix of memberships including citizens, industry, and government organizations.



### 3.3.1 Cook Inlet Regional Citizen's Advisory Committee (CIRCAC)

OPA 90 established CIRCAC to create an avenue for public participation in the oversight of the Cook Inlet oil industry. Since its inception, the CIRCAC has formed environmental monitoring and oil spill prevention programs to promote safe production and transportation of oil in Cook Inlet. These programs seek to develop an understanding of efficacy, fate, transport, and effects of oil and oil treated by various response methods likely to be used on oil spills in the area of concern. It also monitors the biological and chemical environment in Cook Inlet and nearby areas to detect effects of oil industry operations. The CIRCAC also has a Coastal Habitat Mapping Program to assess coastal habitats with an oil spill prevention and response tool that incorporates detailed coastal habitat data.

### 3.3.2 Gulf of Mexico Alliance (GOMA)

The Gulf State Governors established the Gulf of Mexico Alliance (GOMA) in 2004 in response to the President's Ocean Action Plan. GOMA's mission is to enhance the ecological and economic health of the Gulf region by encouraging collaboration among government agencies, businesses, education providers and non-governmental organizations. It is a state-led network of partners working together on projects related to the priority issues identified by the Governors in early discussions. The GOMA structure allows federal and state agency partners to focus funding priorities on the needs of the Gulf, and it provides a forum to share knowledge, expertise, and collaborate to reduce duplication of efforts.

### 3.3.3 Gulf of Mexico Research Initiative (GoMRI)

On May 24, 2010, shortly after the *Deepwater Horizon* oil spill, BP announced a \$500 million commitment to fund a Gulf of Mexico Research Initiative (GoMRI), a 10-year independent research program designed to study the effects of the oil spill and its associated response on the environment and public health in the Gulf of Mexico. GoMRI awards funds competitively for scientists to investigate the impacts of the oil, dispersed oil, and dispersants on the ecosystems of the Gulf of Mexico and affected coastal States in a broad context of improving fundamental understanding of the dynamics of such events and their environmental stresses and public health implications. GoMRI also seeks to develop improved spill mitigation, oil and gas detection, characterization and remediation technologies.

As directed by an independent 20-member Research Board, GoMRI issues grants for independent scientific research conducted primarily at academic institutions in the U.S. Gulf Coast States. However, institutions from outside the Gulf region, as well as for-profit entities, can participate. The funds are distributed using peer evaluations (National Science Board Process) and are used strictly for research activities such as sampling, modeling and studies, but not acquisition of infrastructure. Researchers are required to publish their results in peer-reviewed scientific journals with no requirement for BP approval.

The ultimate goal of GoMRI is to improve society's ability to understand, respond to and mitigate the impacts of petroleum pollution and related stressors of the marine and coastal ecosystems, with an emphasis on conditions found in the Gulf of Mexico. Knowledge accrued will be applied to restoration and to improving the long-term environmental health of the Gulf of Mexico.

#### 3.3.4 Gulf Restoration Science Programs Ad Hoc Coordination Forum

The Gulf Restoration Science Programs Ad Hoc Coordination Forum serves to provide regular communication and coordination on Gulf of Mexico restoration related science between the ecological sciences programs funded from criminal penalties, settlement agreements, and programs funded due to the Deepwater Horizon oil spill.

#### 3.3.5 National Academy of Sciences Gulf Research Program (GRP)

As part of the criminal settlement agreements following the *Deepwater Horizon* Oil Spill, the federal government asked the National Academy of Sciences (NAS) to establish a new program to fund and conduct activities to enhance oil system safety, human health, and environmental resources in the Gulf of Mexico and other U.S. outer continental shelf regions that support oil and gas production. The settlement agreements provide a total of \$500 million over the first five years of the 30-year program. The Gulf Research Program works to enhance oil system safety and the protection of human health and the environment in the Gulf of Mexico and other U.S. outer continental shelf areas by seeking to improve understanding of the region's interconnecting human, environmental, and energy systems and fostering application of these insights to benefit Gulf communities, ecosystems, and the Nation. Initial funding of projects began in 2015.

#### 3.3.6 National Fish and Wildlife Federation (NFWF)

Congress created NFWF in 1984. They serve as a non-profit agency to aid in the protection and restoration of fish and wildlife and their habitats. The BP and Transocean Settlement Agreements with the United States established NFWF's Gulf Environmental Benefit Fund to support projects that remedy harm to natural resources (habitats, species) where there has been injury to, or destruction of, loss of, or loss of use of those resources resulting from the *Deepwater Horizon* oil spill. The Fund will distribute \$2.544 billion for projects that contribute significantly to restoring and maintaining the ecological functions of landscape-scale coastal habitats, ensuring long-term viability and resilience of habitats, restoring and maintaining the ecological integrity of priority coastal bays and estuaries, and replenishing and protecting living resources.

#### 3.3.7 Ocean Energy Safety Institute (OESI)

The OESI was established under BSEE sponsorship to facilitate research and development, training of Federal workers to remain current on state-of-the-art technology associated with oil and gas development. It provides recommendations and technical assistance on the

determination of Best Available and Safest Technology (BAST), and implementation of operational improvements in the areas of offshore drilling safety and environmental protection, blowout containment and oil spill response. The OESI is a collaborative initiative involving government, academia and scientific experts.

The Texas A&M Engineering Experiment Station's (TEES) Mary Kay O'Connor Process Safety Center manages the OESI, in partnership with the University of Texas at Austin and the University of Houston. The OESI provides a forum for dialogue, shared learning and cooperative research among academia, government, industry, and other non-governmental organizations, in offshore energy-related technologies and activities that ensure safe and environmentally responsible offshore operations.

Specific objectives of OESI are:

- Develop a program of research, technical assistance, and education that serves as a center of expertise in offshore oil and gas exploration, development, and production technology, including technology specific to deepwater and Arctic exploration and development;
- Provide recommendations and technical assistance to the Bureau of Safety and Environmental Enforcement (BSEE) and the Bureau of Ocean Energy Management (BOEM) related to emerging technologies and the determination of BAST, and environmentally sound oil and gas development practices on the Outer Continental Shelf (OCS);
- Provide recommendations and technical assistance related to geological and geophysical sciences relevant to understanding the technical challenges of exploration and development, such as reservoir characteristics, geohazards, and worst case discharge analyses;
- Develop and maintain a domestic and international equipment failure reporting system and database of critical equipment failures related to control of the well that will allow the Institute to identify reliability issues and industry trends. This system should engage both the user and manufacturer of the equipment;
- Engage employees of the Federal agencies to participate in research and training to remain current on state-of-the-art technology associated with offshore oil and gas development;
- Promote collaboration among Federal agencies, industry, standards organizations, academia, and the National Academy of Sciences.

### 3.3.8 Oil Spill Recovery Institute (OSRI)

OPA 90 established OSRI (<http://pws-osri.org/>) in response to the 1989 *Exxon Valdez* oil spill. The Prince William Sound Science Center, a non-profit research and education organization located in Cordova, Alaska, administers and houses OSRI. The Congressional mandate given to OSRI is to: 1) identify and develop the best available techniques, equipment and materials for dealing with oil spills in the Arctic and sub-Arctic marine environment; 2) complement federal

and state damage assessment efforts and determine, document, assess and understand the long-range effects of Arctic and sub-Arctic oil spills on the natural resources of Prince William Sound; and, 3) understand and document the effects to the environment, the economy and the lifestyle and well-being of the people who are dependent on those resources. Subsequent legislation has provided OSRI with a funding mechanism to assure the research continues as long as oil exploration and development occurs in Alaska. Since 1998, OSRI has awarded approximately one million dollars a year to support a wide range of projects.

### 3.3.9 Pew Charitable Trusts (PCT) Arctic Science Program

The PCT's Arctic Science Program engages in numerous scientific activities to support conservation campaigns throughout the Arctic. These efforts include original fieldwork, analyses of existing data, and the sharing of scientific findings with a range of audiences. Scientists provide expertise on marine conservation-related issues to the U.S., Canada, Greenland, and elsewhere.

### 3.3.10 Prince William Sound Regional Citizen's Advisory Committee (PWSRCAC)

OPA 90 established the PWSRCAC to promote partnership and cooperation among local citizens, industry and government. The PWSRCAC conducts long-term environmental monitoring program and oil spill prevention programs to promote safe production and transportation of oil in Prince William Sound. Its programs include a hydrocarbon toxicity project to study and address the gaps in knowledge regarding chronic toxic effects of oil, dispersed oil, and *in-situ* burn residue under study conditions similar to the cold marine Alaskan waters.

### 3.3.11 Ship Structure Committee

Since its inception in 1943, the Ship Structure Committee has sponsored and coordinated R&D projects to improve ship design, construction, operation, inspection, maintenance, and repair methodologies. The Committee's mission is to enhance the safety of life at sea, promote technology and education advancements in marine transportation, and to protect the marine environment. This is done through advocating, participating in, and supporting cooperative R&D in structural design, life cycle risk management of marine structures, and production technologies. The Committee includes representatives from the USCG, Navy, MARAD, American Bureau of Shipping, Transport Canada, Defense Research and Development Canada Atlantic, and the Society of Naval Architects and Engineers.

## 3.4 Academia

Extensive oil pollution research is conducted at academic institutions, either individually or as part of university consortia. These entities provide opportunities to explore basic and applied scientific concepts to address oil pollution issues.

3.4.1 Gulf of Mexico Research Consortia

Several university research consortia have been created to study the effects of the Deepwater Horizon oil spill. These consortia bring together researchers from universities, research institutes and other academic entities to collaborate on scientific studies in the Gulf of Mexico. The consortia activities combine research with scientific knowledge of the ecosystems of the Gulf of Mexico to advance the understanding of interactions that occurred and continue to occur among the marine and coastal ecosystems, oil, and dispersants produced by the oil spill.

GoMRI (see Section 3.3.3) provides funding for these consortia or their individual studies. To date, GoMRI issued four one-year block grants in 2010 followed by a series of Request for Proposals (RFPs) for academic consortia and individual investigators to propose research ideas. To date, GoMRI funded 15 different consortia in two rounds of grants, as shown on Table 3-1. In their funding decisions, GoMRI emphasizes: interdisciplinary science and technology involving experts in physical, chemical, geological, and biological oceanography; marine biology; coastal and reef ecosystems, fisheries and wildlife ecology; public health; and associated development of physical, chemical, and biological instrumentation, advanced modeling, and informatics. The activities combine research with scientific knowledge of the ecosystems of the Gulf of Mexico to advance the understanding of interactions that occurred and continue to occur among the marine and coastal ecosystems, oil, and dispersants produced by the oil spill.

**Table 4-1: GoMRI-funded Consortia 2010-2014**

<b>Consortia</b>	<b>2010 Block Grants</b>	<b>2011 Consortia</b>	<b>2014 Consortia</b>
Florida Inst. of Oceanography	X		
Louisiana State University (LSU)	X		
Marine Environmental Science Consortium	X		
Northern Gulf Institute	X		
Center for Integrated Modeling and Analysis of Gulf Ecosystems (C-IMAGE)		X	X
Consortium for Advanced Research on Transport of Hydrocarbon in the Environment (CARTHE)		X	X
Consortium for the Molecular Engineering of Dispersant Systems (C-MEDS)		X	
Coastal Waters Consortium (CWC)		X	X
Gulf of Mexico Integrated Spill Response Consortium		X	

<b>(GISR)</b>		
<b>Deepsea to Coast Connectivity in the Eastern Gulf of Mexico (DEEP-C)</b>	X	
<b>Dispersion Research on Oil: Physics and Plankton Studies (DROPPS)</b>	X	X
<b>Ecosystem Impacts of Oil and Gas Inputs to the Gulf (ECOGIG)</b>	X	X
<b>Aggregation and Degradation of Dispersants and Oil by Microbial Exopolymers (ADDOMEx)</b>		X
<b>Alabama Center for Ecological Resilience (ACER)</b>		X
<b>Consortium for Oil Spill Exposure Pathways in Coastal River-Dominated Ecosystems (CONCORDE)</b>		X
<b>Consortium for Resilient Gulf Communities (CRGC)</b>		X
<b>Deep-Pelagic Nekton Dynamics of the Gulf of Mexico (DEEPEND)</b>		X
<b>Littoral Acoustic Demonstration Center - Gulf Ecological Monitoring and Modeling (LADC-GEMM)</b>		X
<b>Relationship of Effects of Cardiac Outcomes in Fish for Validation of Ecological Risk (RECOVER)</b>		X

### 3.4.2 Gulf of Mexico University Research Collaborative (GOMURC)

Universities across five U.S. Gulf of Mexico states initiated several marine research consortia over the past decades. GOMURC’s region-wide alliance of these consortia promotes large-scale, long-term research initiatives required to address Gulf ecosystem-wide stressors such as oil spills, hurricanes, and climate change. GOMURC’s mission goals and objectives include advocating for science and education activities that support science-based policies to restore and sustain Gulf natural resources and economy. The following five university consortia members of GOMURC represent 80 universities in the Gulf States:

- Alabama Marine Environmental Sciences Consortium, led by Dauphin Island Sea Lab;
- Florida Institute of Oceanography (FIO), led by University of South Florida;
- Louisiana Universities Gulf Research Collaborative, led by Louisiana State University;
- Mississippi Research Consortium, led by University of Southern Mississippi; and
- Texas Research Consortium, led by the Texas A&M University-Corpus Christi

### 3.4.3 Harte Research Institute for Gulf of Mexico Studies

The Harte Research Institute, an endowed research component of Texas A&M University-Corpus Christi, is dedicated to advancing the long-term sustainable use and conservation of the Gulf of Mexico. The Institute serves as a research center of excellence in generating and disseminating knowledge about the Gulf of Mexico ecosystem and its critical role in the economies of the North American region. The Institute's ecosystems group focuses on environmental flows and the effects of deep sea oil and gas activities.

### 3.4.4 NOAA's Sea Grant Program

NOAA's National Sea Grant College Program is a network of 33 individual programs located in universities in every coastal and Great Lakes state, Puerto Rico, Lake Champlain and Guam. These programs serve as the core of a dynamic, national university-based network of over 300 institutions involving more than 3,000 scientists, engineers, educators, students and outreach experts. The network engages the power of academia and a wide variety of partners to address issues such as coastal hazards, sustainable coastal development, and seafood safety.

### 3.4.5 National University Rail (NURail) Center

In January 2012, the U.S. Department of Transportation awarded a grant of \$3.5 million to a multi-university consortium led by University of Illinois Urbana (UIUC) to establish a rail transportation and engineering research center. Headquartered within the Department of Civil and Environmental Engineering at UICC, NURail is a consortium of seven partner colleges and universities with a combination of strengths in railway transportation engineering research and education in North America. The NURail is the first University Transportation Center (UTC) focused solely on rail and concentrates on rail education and research to improve railroad safety, efficiency and reliability. Particular focus is on challenges associated with rail corridors in which higher-speed passenger trains share infrastructure with freight trains.

The NURail has identified six thematic research topics that will be the subject of strategic development planning and ongoing technical research:

- Integrated railroad vehicle/track interaction and dynamic;
- Railroad safety and risk;
- Rail network capacity analysis and planning,
- Urban, regional and high-speed passenger rail implementation
- Multimodal freight transportation; and
- Funding, finance, community and economic development.



#### 3.4.6 Oil Spill Academic Task Force (OSATF)

The Oil Spill Academic Task Force (OSATF) is a consortium of scientists and scholars from institutions in Florida's State University System as well as from five of Florida's private universities and two marine laboratories working in collaboration with the Florida Department of Environmental Protection (DEP). The OSATF brings together expertise and resources to assist the state of Florida and the Gulf region in responding to and studying the Deepwater Horizon oil spill.

#### 3.4.7 Scripps Institution of Oceanography (SIO)

SIO, a department of the University of California San Diego, is one of the oldest and largest centers for ocean, earth and atmospheric science research, education, and public service in the world. Research at Scripps encompasses physical, chemical, biological, geological, and geophysical studies of the oceans, earth, and planets. Researchers at SIO engage in basic research to expand our knowledge and understanding of natural hazards, including earthquakes, volcanoes, tsunamis, storm waves, floods, erosion, hurricanes, tornadoes, wildfires, and harmful algal blooms, as well as their impacts.

Some important programs include: the Southern California Coastal Ocean Observing System's real-time surface current mapping network for tracking and mitigating response to oil spills and improving search and rescue operations and safe boating; and the ANZA Seismic Network, providing real-time seismic information for Southern California.

#### 3.4.8 UAA/SIT Center of Excellence for Maritime Research (CMR)

The DHS Science and Technology (S&T) Directorate selected the University of Alaska Anchorage (UAA) and the Stevens Institute of Technology (SIT) as co-leads for a Center of Excellence for Maritime Research (CMR). The CMR will provide research to identify better ways to create transparency in the maritime domain along coastal regions and inland waterways, while integrating information and intelligence among stakeholders. DHS charged the CMR to develop new ideas to address these challenges, provide a scientific basis, and develop new approaches for USCG and other DHS maritime missions.

#### 3.4.9 UAF Arctic Center for Oil-Spill Research & Education (A-CORE)

The University of Alaska-Fairbanks (UAF) A-CORE is a leading academic institution in Arctic research that focuses on research applicable to Arctic oil spills. A-CORE partners with state and federal agencies, industry, and other academic institutions to support wise decision-making concerning Arctic oil spill response and prevention by working to fill gaps in existing knowledge.

In March 2015, UAF began operating the *Sikuliaq*, a new 261-foot oceanographic research vessel owned by the National Science Foundation. The *Sikuliaq* can cut through 2.5 feet of first-

year sea ice and is the only ice-capable vessel in the U.S. academic research fleet. The ship is outfitted with state-of-the-art equipment to bring scientists to previously inaccessible ice-choked polar regions of the globe. The *Sikuliaq* will advance polar and sub-polar research. *Sikuliaq* can accommodate up to 24 scientists and students, including those with disabilities.

#### 3.4.10 U.S. Coast Guard Academy

The United States Coast Guard Academy is the Department of Homeland Security's only institution of higher education. Academy cadets as well as faculty continue to undertake academic research in oil spill science, policy, and in marine engineering. The Academy also provides education to cadets in these fields.

The United States Coast Guard established a Center for Arctic Study & Policy (CASP) at the Academy to promote academic research on Arctic policy and strategy by facilitating collaboration, partnerships, and dialogue among specialists from academia, government, tribal organizations, non-governmental organizations (NGOs), industry, and the USCG. CASP serves as an operationally-focused academic think tank to promote research, broaden partnerships, and educate future leaders about the complexities of this unique region. Through collaborative efforts, the Center will promote effective solutions to address present and future Arctic maritime challenges as the Coast Guard increases its Arctic presence.

#### 3.4.11 University of New Hampshire (UNH) Oil Spill Centers

UNH in Durham, NH, administers the Coastal Response Research Center (CRRC) and the Center for Spills in the Environment (CSE). CRRC was established in 2004 as a partnership between the NOAA Office of Response and Restoration (OR&R) and UNH. The CRRC partnership stimulates innovation in spill preparedness, response, assessment, and recovery strategies. The primary purpose of the CRRC is to bring together the resources of non-governmental scientists and the field expertise of OR&R to conduct and oversee basic and applied research, conduct outreach, and encourage strategic partnerships in spill response, assessment and restoration.

The CSE expands the scope of interaction and cooperation with the private sector, other governmental agencies and universities. The CSE involves individuals and institutions, public and private, at local, regional, national and international levels in identifying needs, evaluating and demonstrating promising technologies, and fostering their use as part of new, integrative approaches to response and restoration.

#### 3.4.12 Woods Hole Oceanographic Institution (WHOI)

WHOI is a non-profit oceanographic research organization with a mission to explore and understand the ocean and to educate scientists, students, decision-makers, and the public. WHOI scientists and engineers maintain expertise across a range of oceanographic research areas. They work collaboratively within and across six research departments to advance knowledge of the

global ocean and its fundamental importance to other planetary systems. WHOI research provides information of value to a wide range of ICCOPR research areas including pre-spill baseline studies, injury assessment and restoration, and multiple response research areas.

### 3.5 International Efforts

Oil pollution is a global issue and requires international cooperation and research to address. ICCOPR and its members work cooperatively with other nations and international entities to conduct research and to better respond to oil spills.

#### 3.5.1 Arctic Council

The Ottawa Declaration of 1996 formally established the Arctic Council as a high level intergovernmental forum to provide a means for promoting cooperation, coordination and interaction among the Arctic States, with the involvement of the Arctic indigenous communities and other Arctic inhabitants on common issues, in particular issues of sustainable development and environmental protection. Arctic Council member states are: Canada, Denmark (including Greenland and the Faroe Islands), Finland, Iceland, Norway, Russian Federation, Sweden, and the United States.

The Council established a series of guidelines intended to define a set of recommended practices and outline strategic actions for consideration by those responsible for regulation of offshore oil and gas activities (including transportation and related onshore activities) in the Arctic. The goal is for regulators to identify the key aspects related to protection of human health and safety and protection of the environment for the management of offshore activities, remaining sufficiently flexible in the application of these regimes to permit alternative regulatory approaches. In May, 2013, all member agencies of the Arctic Council signed the “Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic,” providing support for interactions between all eight parties relative to response and preparedness. The eight Arctic nations have different systems with different emphases on the division of responsibility between the operator and the regulator. The Council’s goal is to assist regulators in developing standards that are consistently applied and enforced for all offshore Arctic oil and gas operators.

The Council established an Emergency Prevention, Preparedness and Response Working Group (EPPR) to address various aspects of prevention, preparedness and response to environmental emergencies in the Arctic. The goal of the EPPR Working Group is to contribute to the protection of the Arctic environment from the threat or impact that may result from an accidental release of pollutants or radionuclides. In addition, the Working Group considers questions related to the consequences of natural disasters.

### 3.5.2 Australia

Australia’s Commonwealth Scientific and Industrial Research Organization (CSIRO) helps to unlock Australia’s offshore oil and gas resources through research focused on the safe, efficient and sustainable use of their marine natural resources. CSIRO works with industry, government agencies, and academia to provide scientific knowledge and advice for offshore oil and gas; it conducts research and provides advice on the environmental, economic and social factors associated with the entire oil and gas value chain (CSIRO 2015).

The primary objective for Australia is to develop the knowledge and technology to prevent marine incidents and understand pre-spill ecosystems so should an incident occur Australia is prepared to respond effectively. CSIRO has conducted a significant amount of research in a wide variety of areas that support a broad array of prevention and response initiatives. Recent research projects include:

- BLUElink ocean forecasting technology;
- Hydrocarbon sensor arrays to monitor the movement of hydrocarbons during an oil spill;
- Hydrocarbon fingerprinting technique;
- The Hydrates flow loop simulation techniques to help to prevent pipeline blockages;
- Microbial degradation research;
- Biomarker research;
- Dispersant assessments; and
- Ecotoxicology assessments.

The Australian Maritime Safety Authority (AMSA), a federal government self-funded maritime safety agency established in 1990, is responsible for providing a national response capability for marine pollution. The AMSA administers the “National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances”, a cooperative arrangement between the federal, state and northern territory (NT) Governments and the shipping, oil exploration and chemical industries, emergency services, and fire brigades.

The oil industry maintains resources for spills occurring at their facilities. For incidents that may require beyond individual company capabilities, the Australian Institute of Petroleum (AIP) through its Australian Marine Oil Spill Centre (AMOSC) subsidiary has established the AMOS Plan formalizing mutual aid arrangements among member companies.

### 3.5.3 Canada

Environment Canada (EC) is a diverse science-based organization that implements the Government of Canada’s environmental agenda. It provides science and technology to support decisions about the environment. The EC conducts and publishes 80 percent of its research in collaboration with external researchers. The EC operates 15 research institutes and laboratories,

seven storm prediction centers, and 32 water survey offices. The EC has worked with EPA, MMS (now BSEE), and the Navy to conduct oil pollution research at the Ohmsett facility since the early 1970s.

The Department of Fisheries and Oceans Canada (DFO) has Canada's most complex and comprehensive science programs, in terms of function and geography. Its program areas applicable to oil pollution research address ecosystem effects of energy production and operational oceanography. The DFO's research on ecosystem effects addresses expanded energy development in Canada, mainly offshore oil and gas, hydroelectricity, and oil sands. The DFO's operational oceanography programs study oceanic processes and circulation patterns to predict the ocean's present and future state, and include ocean modeling, ecosystem modeling, and near-shore processes.

#### 3.5.4 Centre of Documentation, Research and Experimentation on Accidental Water Pollution (CEDRE)

CEDRE is a not-for-profit association created as part of the measures taken in the aftermath of the Amoco Cadiz oil spill. CEDRE's headquarters, technical facilities and the majority of its personnel are based in Brest, Brittany, France. It provides advice and expertise to the authorities responsible for oil spill response for marine waters and inland surface waters. CEDRE's advice and expertise is available to foreign authorities or private companies. CEDRE conducts its own research projects and contributes to French and international research programs. Their main research and development activities focus on themes of: enhancing knowledge in the field of spill response; fate of oil and chemicals on the surface and in the water column; response equipment and product assessments; and spill impact and post-spill monitoring.

#### 3.5.5 China

The China Maritime Safety Administration (MSA), part of the Ministry of Transport, has the mandate to investigate and respond to marine pollution incidents in Chinese waters. The China MSA headquarters in Beijing provides central control with 14 subordinate bureaus and about 100 local branches along the coast and the Yangtze River. In recent years, China promulgated a series of new pollution regulations relating to ships, which progressively came into force in the period 2010-12. These cover a wide range of issues, including oil pollution response planning, pre-spill clean-up arrangements, and the emergency handling of pollution accidents. Regulations have also introduced a domestic ship-source oil pollution compensation fund.

#### 3.5.6 European Union (EU)

Since 1978, the EU has played a vital role in the response to marine pollution and today its role has become even greater with the response coordination ensured by its European Response

Coordination Center (ERRC) and with marine pollution preparedness and response services provided by the European Maritime Safety Agency (EMSA).

EMSA assumes the leading role in ensuring a uniform and effective level of maritime safety, maritime security, prevention of and response to pollution caused by ships as well as response to marine pollution caused by oil and gas installations, and provide technical and scientific assistance to the European Commission and member states. EMSA manages a network of standby at-sea oil spill recovery vessels based in all the regional seas of Europe. These normally commercial vessels that cease their normal activities and quickly move to the scene of the oil spill upon request. The agency also provides satellite imagery for detection and monitoring of oil spills, pollution response experts to give operational and technical assistance, and information service for chemical spills at sea.

In September 2008, the European Commission, the EU's executive body, issued their Communication on 'A European Strategy for Marine and Maritime Research' delineated an action plan for better integration of research between the maritime and marine communities in order to address the problems of marine degradation caused by human activities and develop new technologies for sustainable development of maritime activities.

The European Commission is currently funding projects aimed at developing new technologies to mitigate the effects of pollution in the seas and oceans. The 'Argomarine' project ('Automatic oil spill recognition and geopositioning integrated in a marine monitoring network') is one example.

### 3.5.7 France

Oil represents approximately one-third of France's total primary energy consumption and that share has been falling over the past 10 years. France imports crude oil through three major sea ports (Marseille, Le Havre, and Saint-Nazaire). France has very little domestic natural gas production, and since the French government banned the use of hydraulic fracturing, France imports natural gas through a variety of cross-border pipelines from the Netherlands, Norway, and Russia. France also imports liquefied natural gas (LNG) from countries around the world, notably Algeria, Nigeria, Qatar, and Egypt.

Response arrangements are governed by the "at sea pollution response" section of ORSEC MARITIME (Organisation de la Réponse de Sécurité Civile), France's civil defense plan. Responsibility for preparing for and conducting clean-up operations at sea lies with one of three Maritime Préfets (one for the Mediterranean Sea, one for the Atlantic and one for the North Sea/Channel). The Maritime Préfet will work in cooperation with the Secrétariat Général de la Mer who has the authority to access the various stockpiles of equipment. Coordination of sea and shoreline clean-up would be supervised locally by a permanent conference with representatives of the Maritime Préfet and the Préfet of the particular Department concerned.

### 3.5.8 Kill-Spill

Kill-Spill is an EU-funded research program with the mission to develop highly efficient, economically- and environmentally-viable biotechnological solutions for the clean-up of oil spills caused by maritime transport or offshore oil exploration and related processes. The program will deliver innovative biotechnological tools for oil spills remediation.

These new developments include biosensors to monitor hydrocarbon degradation, new environmentally-friendly dispersants and adsorbents, combined microbial and additives formulations, multifunctional bioremediation agents, and tools for sediments decontamination. The impact and toxicity of these newly developed products will be evaluated; and they will be validated in mesocosms and on actual oil spills.

### 3.5.9 Mexico

A National Contingency Plan was developed in 1981 by a sub-committee of the Mexican Inter-Departmental Commission for Environmental Health. It aims to establish a national response network and provide overall coordination of resources in the event of a spill. The Mexican navy maintains a regional and local organizational structure to implement the National Plan at these levels. Under the General Law of Ecological Equilibrium and Environmental Protection (LEGEEPA), overall responsibility for oil pollution matters in Mexican ports and territorial waters rests with the Mexican navy. Response to a spill is likely to be initiated through the Navy's Marine Environment Protection Division (PROMAM). Assistance is also likely to be sought from the national oil company, Petróleos Mexicanos (PEMEX).

### 3.5.10 Norway

As a major energy nation, Norway has a particular responsibility to ensure an adequate energy supply and to develop knowledge and technology for efficient and sustainable energy systems. Norway has significant expertise in petroleum and hydropower science and engineering. In addition, Norway is conducting important research efforts in the field of environment and climate research. Despite extensive recovery of petroleum resources during the past 30 years, the petroleum industry still represents a large potential for future value creation in Norway. Research and technological innovation, combined with strict environmental regulations and other policy instruments, are needed to make the environmental impact of the exploration and production of oil and gas as small as possible.

The Norwegian Government's goal is to be a pioneer in developing an integrated, ecosystem-based management regime for marine areas. The purpose of this management plan is to provide a framework for the sustainable use of natural resources and ecosystem services derived from the North Sea and Skagerrak and at the same time maintain the structure, functioning, productivity



and diversity of the area's ecosystems. Norway utilizes its major universities to conduct major research programs with respect to oil and gas.

### 3.5.11 Russia

The Federal Agency of Maritime and River Transport, part of the Ministry of Transport, is the federal executive body with responsibility for preparedness and response for oil spill incidents in Russia. Oil pollution response is assigned to the State Marine Pollution Control, Salvage and Rescue Administration (MPCSA). The MPCSA is responsible for the Marine Rescue Coordination Centres (MRCC), which serves as the focal point for communication during marine spill incidents at the regional level. The "Federal Contingency Plan on Oil Spill Prevention and Response at Sea" was adopted by the Ministry of Transport, the Ministry of Natural Resources and the Ministry of Civil Defense, Emergencies and Disaster Response (EMERCOM) in July 2003. The Plan complies with IMO Guidelines on contingency planning. There are three levels of planning: local, regional and federal. Ports, oil terminals, and harbors have local contingency plans and capabilities which, if exceeded, can be supplemented by regional plans and resources.

### 3.5.12 SINTEF

SINTEF is the largest independent research organization in Scandinavia, which operates in partnership with the Norwegian University of Science and Technology (NTNU) in Trondheim. NTNU personnel work on SINTEF projects, and many SINTEF staff members teach at NTNU. SINTEF is known worldwide for its work on oil spills, dispersants, and is one of the world's largest independent research organizations within the oil spill research community and offers expertise in many areas, including:

- Studies of oil weathering;
- Characterization of oil spills including thickness and chemistry;
- Oil spill identification - "fingerprinting";
- Marine environmental technology development;
- Surface water chemistry;
- Net Environmental Benefit Analysis (NEBA) oil spills in the Arctic; and
- Subsea and deepwater releases.

### 3.5.13 United Kingdom (UK)

The Department of Energy and Climate Change (DECC) works to insure that the UK has secure, clean, affordable energy supplies and promotes international action to mitigate climate change.

DECC is a ministerial department, supported by nine agencies and public bodies. The Oil and Gas Authority, an executive office of the DECC, works with government and industry to make sure that the UK gets the maximum economic benefit from its oil and gas reserves. The Oil and

Gas Authority is responsible for regulating offshore and onshore oil and gas operations in the UK including:

- Oil and gas licensing;
- Oil and gas exploration and production;
- Oil and gas fields and wells;
- Oil and gas infrastructure; and
- Carbon capture and storage (CCS) licensing.

The Maritime and Coastguard Agency (MCA) is the UK's authority responsible for the provision of response procedures designed to deal with any emergency at sea that threatens or causes actual pollution. The national contingency plan for marine pollution from shipping and offshore installations sets out revised procedures for incident response. The national contingency plan ("National Contingency Plan for Marine Pollution from Shipping and Offshore Installations") underwent a major review in 2000, was revised again in 2006 to take advantage of lessons learned during actual incidents and major exercises, and is currently under review. MCA develops and participates in maritime exercises designed to maintain the operational readiness of its staff and equipment. The Counter Pollution and Response Branch also organizes training courses for local authorities to prepare their staff when responding to shoreline pollution.

### 3.6 Non-Federal Oil Pollution Testing Facilities

Several non-federal facilities provide opportunities for oil pollution testing.

#### 3.6.1 Bedford Institute of Oceanography Center for Offshore Oil, Gas and Energy Research (BIO COOGER)

The DFO Canada's BIO COOGER, located in Dartmouth, Nova Scotia, maintains a wave tank facility for oil pollution research. Each tank measures 32 m long, 0.6 m wide, and 2 m high (1.5 m water depth; 28,800 L volume). Water from the Bedford Basin of Halifax Harbor is pumped into the tanks through a coarse (25  $\mu\text{m}$  pore size) and fine (5  $\mu\text{m}$  pore size) serial filtration system. The tanks are capable of generating various types of wave energies in either static or flow-through mode. Breaking and non-breaking waves (computer-controlled flat-type wave maker) provide mixing energies to achieve dispersant effectiveness similar to that of field conditions. The tanks are equipped with subsea injection systems from pressurized, heated canisters. Experiments benefit from the ability of the tanks to be drained and cleaned (tank walls, bottom, wave maker and absorbers) after each experiment to remove all oil and surfactants.

#### 3.6.2 CEDRE Technical Facilities

CEDRE's technical facilities cover 300 acres and constitute a completely watertight area, which includes a man-made beach, water body, and a deep-water basin. These facilities allow full scale

simulation of real life spills in an environmentally friendly manner. The CEDRE Experimentation Column (CEC) is a tool to study the behavior of a substance as it rises up or settles through the water column. The facilities include a flume tank, or Polludrome, that is designed to simulate offshore, shoreline and river conditions on a pilot scale. The facilities also include a greenhouse for experimentation on living organisms.

### 3.6.3 Churchill Marine Observatory.

A multi-government, multi-university research centre is being developed in Churchill, Manitoba, Canada. The Churchill Marine Observatory will be a multidisciplinary research facility where researchers will study the detection, impact and mitigation of oil spills in sea ice and investigate issues facing Arctic marine transportation. The research will help address technological, scientific and economic issues pertaining to Arctic marine transportation and oil and gas exploration and development throughout the Arctic. The facility is scheduled to open in 2017.

### 3.6.4 Ocean Coastal Research Engineering (OCRE)

The National Research Council of Canada's OCRE assists industry and government to develop solutions to engineering challenges within ocean, coastal and river environments with a particular focus on harsh and extreme conditions. The approach includes physical and numerical modeling, engineering analysis, technology development, as well as full scale experiments and field work conducted with the support of a comprehensive suite of world-class model test basins and tanks capable of reproducing a wide range of ice, wave, current and wind conditions. OCRE provides technology and facilities to support problems related to: the Arctic; marine infrastructure, and; marine vehicles. OCRE maintains several testing facilities that provide real world conditions:

- Coastal wave basin;
- Offshore engineering basin;
- Multidirectional wave basin;
- Large area basin;
- Ice tank;
- Coastal wave basin; and
- Multidirectional wave basin.

### 3.6.5 PRCI Technology Development Center

The Pipeline Research Council International (PRCI) opened its new Technology Development Center (TDC) in Houston, Texas in July 2015. The TDC covers eight acres, including a state-of-the-art pull test facility, an over 20,000 sq. ft. workshop, and test facility with an additional 9,000 sq. ft. of office and meeting space. The TDC will provide the industry with an independent third

party site to fully understand the capabilities of current pipeline tools and to guide the development of new technologies needed to push toward that goal.

### 3.6.6 SINTEF Sealab

SINTEF Sealab is a cooperative effort of SINTEF Fisheries and Aquaculture and the Norwegian University of Science and Technology (NTNU) and offers a variety of experimental facilities covering the key elements of marine food webs. The emphasis is on developing experimental systems that simulate natural processes and mimic the fate, behavior and effects of pollutants in the recipient.

The SINTEF Sealab provides:

- Cold climate laboratories with basin facilities;
- Chemical and microbiological laboratories;
- Ecotoxicological laboratories;
- Oil spill research facilities;
  - Shoreline basins;
  - Simulated seabed basin;
  - Dynamic and static test basins/systems; and
  - Tank facilities for subsea studies.

### 3.6.7 Southwest Research Institute (SwRI)

The Chemical Engineering Department at SwRI specializes in finding solutions to difficult problems and providing exacting services. Staff expertise and world-class facilities provide services such as wastewater cleanup, catalyst screening, pilot plant design and operation, reaction kinetics and enthalpy analyses. Typical services include;

- Analytical testing;
- Personal safety equipment testing;
- Waste disposal characterization; and
- Waste cleanup.

An Ocean Simulation Lab at SwRI provides government and commercial clients with quality facilities and experienced staff to conduct testing and performance evaluation services in more than 10,500 square feet of air conditioned laboratory space and 12 ocean simulation test chambers that range in pressures to 30,000 psig and sizes to 90-inch diameter. Capabilities are available for the complete evaluation of your marine products including: development of testing procedures; test design; test setup; and static and cyclic structural/pressure/thermal testing.

### 3.6.8 Texas A&M Corpus Christi Center for Coastal Studies (CCS)

The CCS comprises 10,000 square feet of office and laboratory space within the Carlos F. Truan

Natural Resources Center. The CCS facilities include:

- Plankton laboratory;
- Marine ecotoxicology laboratory;
- Marine invertebrate environmental physiology laboratory; and
- Benthic ecology laboratory.

The National Spill Control School (NSCS) was established in 1977 and was named as a consulting, training, and research resource for the National Response Team in OPA 90. The NSCS offers specialized hands-on OSHA mandated training for professionals and workers in the oil spill, hazardous material (HAZMAT), and emergency management industries as well as others in exploration, production, and transportation who deal with spill prevention, planning, and response.

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## 4. Structuring Oil Pollution Research

The field of oil pollution research covers an array of subjects depending on the interests and needs of researcher or the research funding institution. The focus of oil pollution research extends well beyond removing or mitigating spilled oil from the environment to involve other themes such as developing new means for preventing oil discharges, assessing impacts on the natural and human environment, and restoring an affected ecosystem as best as possible to pre-spill conditions. Each of these areas includes a broad spectrum of subjects and topics for oil pollution research, which creates challenges for tracking research activities.

ICCOPR established a new Oil Pollution Research Categorization Framework to provide a common language and planning framework that would enable researchers and interested parties to identify and track research in each topic area. This new approach will be used by ICCOPR to better facilitate communication with Congress, Federal partners, industry, academia, and the general public. It provides a basis for the 15 member organizations to translate their different research needs and perspectives into one federal voice through ICCOPR.

### 4.1 Introduction to the Oil Spill Research Framework

The Categorization Framework provides a hierarchy of terms to classify, discuss, and prioritize oil pollution research. It is analogous to the taxonomic classification of organisms (i.e., Kingdom, Phylum, Class, Order, Family, Genus, and Species). ICCOPR's oil pollution research classification scheme contains four elements:



Research Classes and Standing Research Areas (SRAs) are generally fixed while the Research Needs and Projects assigned to the SRAs will vary over time. Each of these categorization terms is defined later in this chapter. The following example shows how this new classification scheme works for one project:

**Class:** Prevention  
**SRA:** Pipeline Systems  
**Need:** Develop advanced pipeline break sensing technologies  
**Project:** Smart Pipeline Network – Seal Sensor System (PHMSA DTRT57-12-C-10050)

Chapter 9 of this OPRTTP provides a prioritized list of current Research Needs suggested for 2015-2012 for each SRA. Throughout the six-year life of this Plan, ICCOPR will monitor relevant planned, ongoing, and completed Projects to gauge how government, NGOs, industry,



and academia are addressing the published priority Research Needs. ICCOPR will use this information to provide updates on research progress in the Biennial Reports to Congress and to modify or replace existing Research Needs. At the end of the 6-year cycle, ICCOPR will revise the OPRTTP for the next 6-year cycle and include a summary of the previous version's accomplishments and a new set of prioritized Research Needs.

## 4.2 Classes

The overarching Oil Pollution Research Categorization Framework includes four Classes that represent the general groupings of oil spill research: Preparedness, Prevention, Response, and Injury Assessment and Restoration. Figure 4-1 depicts this framework of Classes. It shows that the research in each Class can inform and support the research from other Classes and that the Preparedness Class plays a central role in supporting the others. ICCOPR's member organizations may conduct or support research across one or multiple Classes depending on their specific mission, regulatory responsibilities, and/or expertise.



**Figure 4.1.** The Oil Pollution Research Categorization Framework Classes

The following section describes the research pertinent to each Class.

#### **Prevention Class**

Research that supports the development of practices and technologies designed to predict, reduce, or eliminate the likelihood of discharges, or minimize the volume of oil discharges into the environment.

#### **Preparedness Class**

Research that supports the activities, programs, and systems developed prior to an oil spill to improve the planning, decision-making and management processes needed for responding to and recovering from oil spills.

#### **Response Class**

Research that supports techniques and technologies that address the immediate and short-term effects of an oil spill and encompasses all activities involved in containing, cleaning up, treating, and disposing oil in order to: 1) maintain safety of human life; 2) stabilize a situation to preclude further damage; and, 3) minimize adverse environmental and socioeconomic effects.

#### **Injury Assessment and Restoration Class**

Research that involves the collection and analysis of information to: 1) evaluate the nature and extent of environmental, human health, and socioeconomic injuries resulting from an incident; 2) determine the restoration actions needed to restore natural resources and their services to pre-spill conditions; and, 3) make the environment and public whole after interim losses.

### **4.3 Standing Research Areas (SRAs)**

The backbone of ICCOPR's oil pollution research categorization scheme is the SRAs that exist within the four Classes. The SRAs represent the most common research themes encountered for oil spills – many of which have been studied over several decades. Their topical content supports the themes of the Classes for which they are assigned. For this OPRTP, ICCOPR identified 25 SRAs within the four Classes. The number of SRAs will, for the most part, remain consistent; however, changes may occur based on emerging research themes. Specifically, ICCOPR is monitoring on-going activities to determine whether the current SRA structure adequately addresses worker exposure and hydraulic fracturing issues. If not, ICCOPR may add additional SRAs.

Table 4.1 lists the current SRAs by Research Class. ICCOPR uses a numbering scheme to facilitate tracking of research within each SRA (1000 – 4400). The numbering series associated with each SRA is included in the SRA descriptions in the subsections below and in Appendix A.

**Table 4-1.** Standing Research Areas assigned within the four research Classes.

Prevention	Preparedness	Response	Injury Assessment & Restoration
<ul style="list-style-type: none"> <li>• Human Error Factors</li> <li>• Offshore Facilities and Systems</li> <li>• Onshore Facilities and Systems</li> <li>• Waterways Management</li> <li>• Vessel Design</li> <li>• Drilling</li> <li>• Rail &amp; Truck Transportation</li> <li>• Pipeline Systems</li> </ul>	<ul style="list-style-type: none"> <li>• Pre-spill Baseline Studies</li> <li>• Response Management Systems</li> </ul>	<ul style="list-style-type: none"> <li>• Structural Damage Assessment and Salvage</li> <li>• At Source Control and Containment</li> <li>• Chemical and Physical Behavior Modeling</li> <li>• Oil Spill Detection and Surveillance</li> <li>• In- and On-water Containment and Recovery</li> <li>• Shore Containment and Recovery</li> <li>• Dispersants</li> <li>• In-situ Burning</li> <li>• Alternative Countermeasures</li> <li>• Oily and Oil Waste Disposal</li> <li>• Bioremediation</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental Impacts and Ecosystem Recovery</li> <li>• Environmental Restoration Methods and Technologies</li> <li>• Human Safety and Health</li> <li>• Sociological and Economic Impacts</li> </ul>

#### 4.3.1 Prevention SRAs

ICCOPR has identified eight SRAs that address development of practices and technologies designed to reduce or eliminate the likelihood of oil discharges into the environment and to reduce the potential for consequences of any oil discharges on life, property, and the environment.

##### 4.3.1.1 *Human Error Factors [1000 series]*

**Description:** This SRA focuses on how human performance and factors contribute to accidents in the oil production/transportation system. It includes the development of advanced methods and systems for training operational personnel, basic research on operating personnel performance in preventing oil spills (safe navigation on vessels, proper oil transfer practices, analysis/evaluation of equipment monitoring systems, decision-making processes), and the

development of methods and technologies to evaluate the ability and knowledge of operating personnel in performing their duties. This may extend to evaluation of the overall management culture and its ability to foster the appropriate organizational safety, preparedness and response operating environment.

**Importance:** A significant proportion of accidents in oil production/transportation and related industries are attributed to “human errors.” A Coast Guard analysis of oil spill causes found that human error factors were responsible for more than one third of non-casualty discharges from ships (USCG, 2012). Non-casualty spills typically include spills from actions such as overfilling of tanks and equipment failures not related to a vessel accident. More than half of these human errors were due to inattention, but also resulted from inadequate training, management and organizational culture. Identifying and solving various human error factors can significantly reduce oil spills at far less cost than more expensive technology-based solutions once the oil is discharged into the environment.

#### **4.3.1.2 Offshore Facilities and Systems [1100 series]**

**Description:** This SRA includes: offshore exploration and development wells, platforms, and well control systems; the methods, techniques, and equipment for system reliability inspections; systems to detect, prevent, and mitigate oil and gas discharges; and equipment to regain control of a well blowout or any other accidental discharge. It also includes transfer equipment, storage units, and piping used to transfer oil within the offshore system and connect the system to transfer pipelines. This technology is relevant for the multiple operating environments of exploration and production activities (e.g., Arctic, shallow, deep and ultra-deep waters).

**Importance:** Offshore oil and gas facilities are responsible for a significant percentage of oil and natural gas production in the U.S. Globally, three of the ten largest oil spills came from offshore facilities, including the *Deepwater Horizon* oil spill, the largest marine oil spill in U.S. history. (Oil & Gas IQ, 2015) Important new and potential offshore discoveries will continue to be made in frontier environments of increasingly deeper waters and arctic conditions, creating new technical challenges. Research is needed to determine the effects of deepwater conditions, ice forces, and increasingly severe weather conditions (hurricanes, blizzards, etc.) on offshore structures built in these environments. Research is also needed to address issues due to the aging of existing offshore facility infrastructure. Older well spills result from both internal damage (chemical/mechanical corrosion) and external damage (e.g., electrochemical corrosion, mechanical damage, and structural failures). Advanced system designs and the effective application of improved inspection technologies have the potential to detect problems before failures occur, while improved leak detection and well control systems have the ability to identify leaks when they are still small and can be quickly isolated and mitigated to minimize spillage.

#### **4.3.1.3**     *Onshore Facilities and Systems [1200 series]*

**Description:** This SRA includes designs, techniques, operational procedures and equipment for fixed onshore facilities including wells. It covers inspections and systems to detect, prevent, and mitigate oil and gas discharges from the facilities and their systems, including transfer equipment, storage, and piping.

**Importance:** A significant number of discharges occur from onshore facilities, coastal bunkering facilities, and cargo transfer operations. Studies conducted by industry estimate that almost a third of oil discharges between 1998 and 2007 occurred at inland facilities subject to EPA’s Spill Prevention, Control, and Countermeasures (SPCC) program (API, 2009). Advanced system designs and the effective application of improved inspection technology have the potential to detect, or predict the likelihood of potential failures before they occur. Improved leak detection systems have the ability to identify leaks quickly, potentially reducing the size and impacts of the discharge. It is also important to understand the ability of onshore structures to withstand changes in soil bearing capacity caused by changes in the climate and other factors.

#### **4.3.1.4**     *Waterways Management [1300 series]*

**Description:** This SRA includes methods, equipment, and integrated systems designed to improve navigation at sea and in ports, rivers, and inland waterways. It includes on-board navigation systems, such as integrated navigation and bridge systems and collision avoidance systems. It also includes systems external to the vessel, such as vessel traffic and tracking systems, navigational aids and piloting systems, as well as includes general research into navigation risks, the effects of navigational safety programs, and the development of decision support tools for waterways management efforts. This SRA includes development of navigational channel maintenance programs and analysis of voyage pre-planning processes.

**Importance:** A navigation-related marine casualty, such as a collision, allision, or grounding, causes most major spills from vessels underway. Collisions are when two moving vessels run into each other. Allisions are when a moving vessel strikes a stationary object such as a bridge abutment or an anchored ship. Groundings occur when a vessel runs ashore or strikes the bottom. According to ITOPF (2015), these causes accounted for 59 percent of large tanker spills in open waters and about 99 percent of tanker spills in restricted or inland waters. Improving navigation and waterways management, particularly in congested port areas and the approaches to ports, can prevent many of these accidents. In addition, improved waterways management can facilitate safe navigation through the Arctic and other ice-infested waterways as shipping increases in these areas.

#### **4.3.1.5**     *Vessel Design [1400 series]*

**Description:** This SRA includes the development, physical and numerical modeling, and testing of advanced tanker and barge designs to make these vessels less susceptible to damage and less

likely to spill their cargoes into the waterways if an accidental grounding, collision or structural failure occurs. This SRA also includes research on non-tank vessel designs (e.g., double-hulled fuel and lube oil tanks) to minimize the possibility of spillage from collisions, allisions, and groundings.

**Importance:** OPA 90 required a phased in double-hull program for all tank vessels entering U.S. ports with all remaining tank barges having double hulls by January 1, 2014. Additional research and development is needed to verify these design approaches and investigate other measures to reduce oil spillage from tank vessel damage. IMO Regulation 12A established double-hull fuel tank construction for certain vessels. Congress has likewise considered double-hull fuel tank requirements for non-tank vessels to minimize the possibility of discharges from groundings, collisions, and allisions. In addition, the anticipated increase in shipping in the Arctic seas has created a need to evaluate and develop new vessel designs to ensure safe operations under arctic conditions where ice filled waters and icing conditions around ships and structures create additional structural stresses and corrosion hazards.

#### *4.3.1.6 Drilling [1500 series]*

**Description:** This SRA focuses on: the design, construction, and placement of wells (shallow, deepwater and ultra-deepwater, and onshore); materials, sensors, and systems needed for offshore drilling and production platforms, and well heads/risers; and techniques and equipment for well and facility monitoring and inspection under extreme pressure and temperature environments. Also included are efforts aimed at understanding the chemical and physical characteristics for the full range of petroleum oils under varying conditions of pressure and temperature; predicting their phase/state, behavior and their physical interaction with other materials in the environment (e.g., rock and sediments); and their impact on engineered systems. Example issues include: early kick detection; systems for communicating and responding to changes in downhole parameters; strategies and methods for training operational personnel on the use of advanced technology; systems to detect and prevent oil and gas discharges; and well-head systems and equipment to control wild wells and cap well blowouts.

**Importance:** The trend toward drilling in deep- and ultra-deepwater and Arctic conditions increases the difficulty in responding to a well blowout and oil spill. Systems to improve safe drilling operations and prevent loss of well control need to adjust as drilling operations advance into deeper waters and the Arctic. Of key importance is the ability to detect changes in rock and fluid properties at the bit-rock interface or even in the rock and fluids ahead of the bit so that measures can be taken to bring the well under control. Advanced system designs and materials, and the effective application of improved sensors, monitoring systems, and more in depth inspection technology have the potential to detect and measure well integrity and prevent failures, while improved leak detection and other systems have the ability to identify leaks while they are still small and can be quickly isolated and mitigated to prevent or minimize spillage. A fundamental understanding of the chemical and phase behavior, especially under extreme

conditions of pressure and temperature and effects on engineered systems is critical to effective well construction planning, long-term monitoring, and long-term well integrity.

#### **4.3.1.7 Rail & Truck Transportation [1600 series]**

**Description:** This SRA includes the development and testing of rail and truck transport system designs, operations, and infrastructure to make oil tanks less susceptible to damage and loss of cargo during normal operations, train accidents and derailments, or truck accidents. This SRA includes evaluation of vehicle designs, construction materials, spill prevention devices, and loading/unloading systems and equipment. It also includes evaluations of: the physical and chemical characteristics and behavior of the crude oils being shipped, the effects of those characteristics on the tanks during operations and under accident conditions, and systems to control these characteristics. This SRA also includes evaluations of safety systems and processes to: manage the movement and composition of trains and trucks carrying crude oil, prevent accidents and derailments, select preferred shipping routes, and respond safely to an oil spill emergency.

**Importance:** North America has experienced a rapid expansion in crude oil supply due to the growing non-conventional oil production activities such as the oil sands products (OSP) from Canada and shale oil from the Bakken fields in North Dakota and Montana as well as the Eagle Ford and Permian Basins in Texas. This expansion in supply resulted in a four-fold increase in the number of crude oil rail car shipments in the past five years. Similarly, crude oil imports from Canada have increased more than 20-fold since 2011. A series of major US crude oil unit train accidents and the Lac Mégantic, Quebec disaster, which resulted in 47 deaths and destroyed much of the town, have underscored the need for safe rail transport of crude oil. The DOT has issued a safety warning that the crude oils being shipped by rail from the Bakken region may be more flammable than traditional heavy crude oil. In May 2015, the DOT issued a final rule to strengthen safety of tank cars transporting flammable liquids.

#### **4.3.1.8 Pipeline Systems [1700 series]**

**Description:** This SRA includes the development, operation, monitoring, and inspection of offshore and onshore pipeline systems used to transport oil between facilities. It covers the pipeline system design, procedures, and equipment for pipeline operations and inspection protocols to prevent, detect, and mitigate oil discharges. Pipeline research under this SRA also includes technologies to prevent (detection/characterization and repair of anomalies before failure) and detect failures, as well as monitor/control systems that can rapidly isolate and shut down operations in order to minimize spillage when failures occur.

**Importance:** A significant number of oil discharges occur from the more than 182,000 miles of hazardous liquid pipelines in the U.S. PHMSA (2015) pipeline spill statistics document that between 1995 and 2014, there were 2,694 significant hazardous liquid pipeline incidents, 2,614 (97 percent) were onshore. These incidents accounted for the discharge of about 2.2 million



barrels and more than three billion dollars in property damages. Several major pipeline spills have occurred causing significant damage to aquatic environments and residential areas. Other pipeline spills in remote areas have gone undetected for long periods of time. Advanced system designs and the effective application of improved inspection technology have the potential to detect potential failures before they occur, while improved detection systems have the ability to identify leaks quickly, potentially reducing the size and effects of the discharge.

#### 4.3.2 Preparedness SRAs

The two SRAs under the Preparedness Class cover research that: 1) supports the collection of baseline data needed to assess the effects of oil spills under the Injury Assessment and Restoration Class, and 2) develops information management tools and systems to improve the ability of response organizations and responders to collect and analyze information during an incident.

##### 4.3.2.1 *Pre-spill Baseline Studies [2000 series]*

**Description:** This SRA includes research to characterize and analyze baseline data on the natural environment, human health, and socio-economic characteristics in areas at risk for oil spills. Research includes risk assessments conducted in areas involved in the oil production and transportation systems to identify locations most at risk from pollution events and therefore priority candidates for baseline studies. Baseline information and studies may include: location and population data on species and their habitats, especially ecologically sensitive species; the epidemiology/human health characteristics of people in potential impact areas; and potential community and economic impacts in these areas (e.g., tourism, commercial/recreational fishing, and seafood industry).

**Importance:** Having baseline information and data enables scientists to compare pre-and post-oil spill changes in natural, human health, and socio-economic systems to support response decision-making and post-spill damage assessments and restoration activities. It is common to conduct a credible post-spill environmental and economic damage assessment without pre-spill baseline information, using reference sites that were not contaminated for comparative studies. However, the availability of pre-spill baseline information makes the post-spill natural and socio-economic damage assessment task much easier, accurate, and more defensible. Essentially, the better environmental and economic systems are understood before a pollution event, the easier it will be to assess changes to those systems, estimate damage and develop appropriate restoration strategies afterward.

##### 4.3.2.2 *Response Management Systems [2100 series]*

**Description:** This SRA includes analysis and development of systems to manage how data and information are collected, analyzed, documented, and shared between and among, the planning/preparedness and response communities, the Incident Command System (ICS), and the

public. These systems are used to integrate diverse sets of narrative, graphic, and video information and many sets and types of raw and analyzed data. Examples of oil spill information systems include: ICS forms; computer systems; data management software and databases; Geographic Information Systems (GIS); routing, spill and incident management tracking systems; electronic mail and web content; documents, photographs, and video management and archiving systems; communication systems; public information messages and protocols; and graphical displays.

**Importance:** Information management and decision-making tools are critical to successfully planning for and managing a response and meeting external demands for information about an incident. These systems provide a tool for the incident command to obtain a common operating picture of an incident, to make resource management decisions, and to share appropriate information with all relevant parties. Improving the accuracy and timeliness of the data increases the ability of the incident command to stay abreast of changing situations. Efficient information systems also provide personnel with timely information to give to the public and media, which have a high demand for information to support the 24-hour news cycle.

#### 4.3.3 Response SRAs

The Response Class of research includes 11 SRAs that support improvements to the activities, technologies, techniques, and equipment used during response operations. These SRAs cover all areas from oil detection, behavior modeling, cleanup, and waste disposal.

##### 4.3.3.1 *Structural Damage Assessment and Salvage [3000 series]*

**Description:** This SRA includes the development of methodologies and equipment to assess the extent of damage to a stricken vessel caused by collision, allision, grounding, or improper hull stresses during cargo transfers or explosion. This area also includes development of methods and technology to graphically present the implications of various measures that can be implemented to stabilize the vessel's condition, reduce the potential for further pollution, and allow it to be moved safely for repairs or disposal.

**Importance:** A critical consideration in responding to a casualty is stabilizing the condition of the vessel to prevent loss of life, minimize loss of property, and prevent or minimize discharges of oil. To accomplish this, on-scene personnel must be able to rapidly assess the overall structural integrity and hydrodynamic stability of the vessel to determine the appropriate response measures.

##### 4.3.3.2 *At Source Control and Containment [3100 series]*

**Description:** This SRA includes the development of methods, systems, and equipment for containing and recovering the oil at or from the source and for mitigating oil flow from a damaged vessel, onshore/offshore pipeline, and an exploration or production platform,

temporarily abandoned (plugged) well, or well head once the spill has begun. Such technologies include well-head capping systems, remotely operated vehicles (ROVs) for subsea containment activities, and patching, plugging and sealing systems. This technology is applicable to all geographic/environmental areas (Arctic, terrestrial, water surface, subsurface shallow, and deep and ultra-deep water).

**Importance:** The logistical difficulties, enormous costs, and limited success experienced during on-water and shoreline cleanup operations make clear the advantages of containing or recovering oil within, or at least near, the source of the oil flow. Recent technological breakthroughs arose from experiences acquired during the 2010 *Deepwater Horizon* oil spill incident. Additional advances in this area could provide substantial return on R&D investment to contain/recover oil at the source and thereby reduce the extent of contamination and ecological and socio-economic impacts if a spill occurs.

#### **4.3.3.3**     *Chemical and Physical Behavior Modeling [3200 series]*

**Description:** This SRA includes laboratory and theoretical research and field studies aimed at understanding the behavior and characteristics of the full range of petroleum oils including: behavior and transport in the environment, partitioning of hydrocarbon constituents, and physical interaction with other materials in the environment (rock, sediments, and ice). It includes studies of oil behavior and changes throughout the water column from deepwater blowouts. There is particular interest in non-conventional oils such as those produced in the Bakken and Canadian Tars sands (diluted bitumen (dilbit) and synthetic bitumen (synbit)). It also includes the development and verification of numerical models to predict the surface and subsurface movement and weathering (i.e., spreading, evaporation, dispersion, and dissolution) of oil spills. This SRA also includes methodologies to provide accurate model input data to verify model outputs. This SRA includes development of user-friendly programs to enhance contingency planning and to serve as training aides for spill response teams. Models should be available for various spill scenarios at specific locations for different tidal, current, and weather conditions to pre-plan potential boom deployment strategies and estimate response resource needs.

**Importance:** Predicting the trajectory (movement) and the weathering of spilled oil, its resultant physical properties and behavior in the water, and the extent of contamination are all critical to identifying the appropriate mix of spill response equipment and countermeasures. A fundamental understanding of the fate (chemical behavior and transport) and effects of oil in the environment is critical to effective contingency planning, response operations management, long-term monitoring, and restoration. In addition, knowledge of longer-term fractionation and transport of hydrocarbons, coupled with potential effects on aquatic resources, provide valuable information to help focus monitoring efforts and develop environmentally-relevant restoration plans.

#### **4.3.3.4**     *Oil Spill Detection and Surveillance [3300 series]*

**Description:** This SRA principally refers to methods and equipment for characterizing and monitoring oil pre- and post-implementation of response options, and the detection of unknown discharges. This SRA includes surface and subsurface oil spill surveillance including devices, sensors, and systems for detecting and tracking oil spills, determining the area and thickness of the oil slick, and measuring the physical properties of the oil. Examples of equipment considered in this area are: surface oil spill tracking buoys; airborne remote sensors and data analysis systems; fluorometers and light-scattering sensors; and satellite remote sensing data and on/in-water oil detection devices with the ability to conduct nighttime and low light recovery operations. It includes research that provides information to support development of monitoring protocols for subsea and surface responses or improvements to existing ones such as the NRT Atypical guidance or the SMART guidance, as applicable. This SRA also includes evaluation of techniques for autonomous sensing operations and reporting from remote locations where logistical challenges limit human accessibility.

**Importance:** Finding and characterizing areas of subsurface or submerged oil in onshore (inland) and offshore waters remains a significant research and technology need. Surveillance technologies provide opportunities to locate spills and their source, determine their extent and volume, provide important data to support response operations, and determine the effectiveness of response. The ability to locate concentrations of oil and track slick movements for countermeasures and cleanup planning supports response operations. Thickness and physical properties measurement allow responders to determine the feasibility of mechanical recovery, *in situ* burning and dispersant use. The data obtained from the surveillance can facilitate the efficient deployment of resources for response operations. Surveillance data from response operations can also be useful for improving and validating spill behavior models.

#### **4.3.3.5**     *In- and On-water Containment and Recovery [3400 series]*

**Description:** This SRA includes the development of methods, equipment, and materials for physically containing and removing oil from the surface of the water, the water column, or on the bottom of the sea/river bed. This SRA focuses on improving traditional equipment such as booms, skimmers, and sorbent materials, as well as developing new approaches to surface containment, and equipment and systems specific to containment and recovery of subsurface oils.

**Importance:** Mechanical recovery is often the preferred option to physically remove oil from the environment because the use of these devices to respond to oil spills generally does not pose the potential for additional environmental harm. Containment booms are subject to entrainment and splash over when they encounter certain current velocities or wave heights, thereby reducing their containment effectiveness. Developing new boom designs could improve oil containment across a wider range of environmental conditions, including ice-infested and brash-ice infested

waters. Mechanical recovery is often the most viable recovery option since it is not subject to agency pre-approval requirements (as are the use of dispersant and *in situ* burning (ISB)). The total average on-water recovery effectiveness for larger spills ranges from 5-30 percent of the oil spilled depending upon the type of oil spilled, ambient conditions, and available equipment. Improvements in the speed of skimmer advance and encounter rates, onboard separation/decanting, and enhanced skimming abilities at higher speeds and wave heights, and rapid systems for temporary oil storage of skimmers could significantly improve mechanical recovery efficiencies. Existing technologies have limited success in recovering oil suspended in the water column or located on the sea/river bed.

#### **4.3.3.6**     *Shoreline Containment and Recovery [3500 series]*

**Description:** This SRA covers new methods, treating agents, and equipment for removing oil from shorelines, as well as mitigating the environmental impact of oil that cannot be removed. Specifically, this SRA includes water washing and flooding techniques, the use of chemical treating agents, and novel applications of mechanical removal techniques and equipment. It also includes analysis, evaluation and decision-making (risk and benefits) for the use of active shoreline oil removal techniques versus passive naturally-occurring processes.

**Importance:** Oil spills that impact shorelines often result in oiling of natural resources (e.g., beaches, marshes, coral reefs, mangroves) and man-made structures (e.g., breakwaters, seawalls, piers, vessels). Removing the oil or mitigating the impacts of the oil requires a range of viable technologies that can remove/mitigate the oil while minimizing environmental damage from the technology. Implementing technologies also requires knowledge of the relative benefits of foregoing cleanup activities and allowing natural processes to remove the oil.

#### **4.3.3.7**     *Dispersants [3600 series]*

**Description:** This SRA addresses the use of chemical products designed to interact with marine oil slicks by reducing the oil/water interfacial tension and breaking up the slick into tiny droplets with the aid of wave or other energy sources. Research areas for dispersants include: developing appropriate dispersant applications for cold weather and deep sea environments; increasing dispersant effectiveness for water surface and subsurface applications (e.g., effective on a wider viscosity and emulsification range, and calm sea conditions); reducing ecological effects of individual dispersant components and combined components in the water column; refining vessel, aircraft, and subsurface application methodologies and equipment; developing enhanced monitoring methods and systems for determining the effectiveness of surface and subsurface application of dispersants; determining how to distinguish physically versus chemically dispersed oil; studying the distribution and impact of the chemicals and dispersed oil in the environment; and understanding regional variations in dispersant performance and environmental effects. This SRA may include characterization to enhance the ability to predict dispersant effectiveness on various oil types and at varying application rates, including the

effectiveness of dispersants on weathered/emulsified oils and in a range of water salinities. This SRA also encompasses studies to determine the suitability of subsea application of dispersants in the Arctic region where the unique conditions (e.g., shallow depths, water salinity, ice-infested water, under-ice discharges) could influence their fate and effects. An important supporting activity is the development of an information database on dispersant product effectiveness, application procedures, and effects. Since dispersants shift the risk from the surface to the water column, additional research is needed to address questions about the potential acute and chronic effects of dispersants on water column organisms and populations at various depths.

**Importance:** Dispersants are an important tool in spill response when it is critical to mitigate oil slicks, especially those that are large and offshore. Refinements in dispersant formulations to improve their effectiveness, reduce environmental effects, and/or increase understanding about their potential benefits and risks, can allow dispersants to remain a viable option, especially for large offshore spills and other areas where mechanical techniques can fall short in reaching desired levels of effectiveness to remediate spilled oil. Research is needed to address environmental tradeoffs, worker and public health exposures and provide the conditions under which they may be used appropriately.

#### **4.3.3.8 *In-situ Burning [3700 series]***

**Description:** This SRA includes equipment and techniques required to ignite and sustain combustion of oil spills on the water, along shorelines, and on land. A source of ignition must be present for the mix of fuel (e.g., oil) and oxidant (e.g. oxygen) in a slick to burn. Because slick thickness is a key variable in determining whether the oil will burn, this research area includes development of equipment such as fire-resistant booms and herders to concentrate the slick thickness, and improved ignition devices. This SRA also includes developing knowledge of the conditions under which this equipment and technique can be applied effectively, including evaluation of use in frigid (i.e., Arctic) environments, where cold conditions and ice limit operational effectiveness of mechanical containment and recovery of spilled oil. This SRA also includes research to develop new methods to enhance burn efficiency and burn weathered, emulsified, and more viscous oils. Research into the production of residuals including soot and other ISB residues, and the techniques and equipment to recover these residues is also included in this SRA.

**Importance:** The *Deepwater Horizon* incident demonstrated that ISB is a very promising technique for removing large amounts of oil from the surface of the water. For example, on a single day (on June 18, 2010), 16 on-water ISBs resulted in removal of approximately 60,000 barrels of oil from the Gulf of Mexico (USCG, 2011). Another benefit of this technology is that it also reduces the extent of onshore disposal of recovered oil. In addition it can be an effective method of mitigating spills on land and in coastal areas by removing the spilled oil from the surface in lieu of the potential for damage caused by certain mechanical removal techniques or



longer-term, passive natural degradation processes. An important consideration in Arctic regions is how soot deposition affects the thickness of snow and ice.

#### **4.3.3.9**     *Alternative Countermeasures [3800 series]*

**Description:** This SRA includes the development and use of various spill response chemicals to treat oil slicks on the surface of the water making the oil more amenable to other recovery techniques, such as mechanical recovery and ISB. These chemicals include solidifiers, herding agents, elasticity modifiers, shoreline pre-treatment agents, and emulsion treating agents (demulsifiers). Development activities include improving chemical formulations, refining application techniques, and conducting studies of effectiveness and environmental effects.

**Importance:** Alternative countermeasure employing chemicals to treat oil slicks are not frequently used but, in certain cases, can be very effective in improving oil recovery and oil impact mitigation. At present, the countermeasures included in this SRA would typically be used on smaller spills close to shore due to the logistics involved in using them. Their use for larger spills is currently limited. However, development of new formulations of these agents has the potential to increase their utility. Emulsion breakers used on recovered oil could decrease the amount of material for disposal.

#### **4.3.3.10**    *Oily and Oil Waste Disposal [3900 series]*

**Description:** This SRA includes study and development of analytical methods, procedures, equipment and techniques to manage and dispose of oil, oily water, oiled soils, and oiled debris recovered during both on-water and on land oil pollution incidents. Specific technologies include, but are not limited to, waste segregation, temporary storage, solidification and stabilization prior to landfill disposal or recycling, oil reclamation, incineration, and biological treatment (i.e., land farming and composting). It also includes techniques and equipment for onsite oil-water separation, filtration, and decanting operations that would reduce the volumes of oil/water material that would need to be handled, transported, and disposed.

**Importance:** Disposal of oil and oiled debris can be a significant problem during major spills, particularly in remote areas. Oil in water tends to emulsify (wave action results in water becoming incorporated into the oil forming “mousse”). Emulsified oil generally occupies a larger volume than the same amount of fresh oil, making waste disposal a significant issue during spill response. In addition to waste recovered during the active response, waste is also generated by decontamination activities, such as cleaning of oiled vessels, hard booms and skimmers, and mechanical shoreline cleanup equipment. Disposal of decontamination waste will likely include the oil, water, and cleaning agents, which further complicates waste disposal options. Research is needed to advance recycling opportunities and disposal treatment technologies for recovered oil waste and reduce the overall waste following a significant oil spill.



#### 4.3.3.11 *Bioremediation [4000 series]*

**Description:** This SRA includes research and technology to exploit the capabilities of microorganisms and plants to accelerate the rate of degradation of oil typically through aerobic degradation, but also through anaerobic degradation processes. Bioremediation is largely an *in-situ* technology as *ex-situ* use requires excavation and further manipulations that may have a greater potential for environmental harm. Research and development opportunities include the development of methodologies for the use of nutrient enrichment and possibly microbes to accelerate the biodegradation process on land, a process called bio-augmentation. This topic area also covers research to understand the conditions needed for effective bioremediation in the presence or absence of dispersants, herders, and other chemical agents. In areas such as coastal wetlands, where stranded oil may have penetrated into the anaerobic subsurface, this research area would include studies to wick the oil up to the surface where aerobic conditions and nutrient enrichment may result in enhanced biodegradation. This SRA also includes development of methodologies to apply bioremediation for more effective response and restoration efforts. For purposes of this OPRTTP, bioremediation includes phytoremediation (remediation using plants), a longer-term restoration technique.

**Importance:** Bioremediation in many cases is used as a polishing step to follow mechanical recovery or other *ex-situ* treatment strategies. Bioremediation is a less-intrusive alternative to mechanical recovery techniques. This is especially important in environmental habitats and sensitive areas that could be seriously damaged by the use of mechanical recovery techniques

#### 4.3.4 *Injury Assessment and Restoration SRAs*

The four SRAs in the Injury Assessment and Restoration Class address the development of strategies to recovery from the effects of an oil spill by determining the level of effects and the implications of those effects on the environmental and sociological resources of the affected area. These SRAs primarily support the Natural Resource Damage Assessment (NRDA) process as well as the need to improve restoration techniques and determine ways to minimize the adverse effects of response activities.

##### 4.3.4.1 *Environmental Impacts and Ecosystem Recovery [4100 series]*

**Description:** This SRA includes laboratory research, field studies, and modeling efforts to better understand and predict the short- and long-term effects of oil spills at the ecosystem level. It includes research into the short- and long-term recovery of various types of environments and the chronic effects of oil spills on habitat, species, recovery and rehabilitation of wildlife, and community structures. This SRA includes the effects of the oil and the countermeasures and cleanup techniques used to remove the oil. It also includes research to determine the rate of ecosystem recovery both with and without countermeasures and cleanup.

**Importance:** This research provides important feedback on the effectiveness of past responses, forms the basis for future decision-making during spill response, and provides input for damage assessment, restoration planning, and development of decision support tools. Knowledge of the environmental and ecosystem effects of different response measures provides decision-makers the opportunity to identify and select methods that maximize recovery and reduce the adverse effects of response.

#### *4.3.4.2 Environmental Restoration Methods and Technologies [4200 series]*

**Description:** This SRA includes development of methods and technologies to facilitate and accelerate the recovery of resources following an oil spill. It includes research into the effectiveness of approaches for environmental restoration. It also includes evaluations and comparisons of the factors affecting success of the restoration methods and technologies. It also involves studying previous restoration efforts, as well as natural recovery, to better understand ways to improve or enhance future recovery from oil spills.

**Importance:** OPA 90 mandated restoration activities and specifically required that funds obtained through damage assessment and compensation litigation be expended on restoration activities. However, very few proven methods, technologies, or monitoring protocols exist to support restoration activities. Knowing the conditions affecting the success of the methods and technologies provides decision makers with tools for selecting the approaches that would enhance the chance for successful restoration.

#### *4.3.4.3 Human Safety and Health [4300 series]*

**Description:** This SRA includes studies on the effects of spilled oil and oil spill response activities on human health and safety for both workers and the public. It includes the study of oil weathering throughout the water column and the potential concerns relative to worker health and safety. It focuses on the development of monitoring instruments, procedures, and processes to inform personnel engaged in oil spill response activities, as well as the general public, who could be affected by the oil spill and response options. It also includes studies of the safety of fish and shellfish in a spill area to determine if they are safe to market and consume. Research on seafood safety may include petrochemical toxicology and profiling, risk analysis, sampling and testing methodology development, and risk communications.

**Importance:** Protecting the health and safety of responders and the public is the highest priority during a response. Potential hazards in dealing with oil include fire and explosion, vapor toxicity, and danger from dermal exposure. Physical health hazards can be acute or chronic. There are processes and procedures that can be implemented to reduce these potential hazards. However, some hazards require a further understanding of how oil behaves to inform the potential concerns relative to worker health and safety. Benzene, for example, can present a potential for chronic health hazards such as leukemia, for which an understanding of oil weathering would inform the needed levels of protection. Response operations conducted on the water or shoreline present

inherent dangers to personnel health and safety ranging from trips, falls, and cuts; injuries from equipment accidents; working in extreme weather conditions (e.g., heat stroke and freezing); and working around environmental hazards. Some response options present additional health concerns such as: the chemicals in dispersants and oil, other chemical countermeasures; bioremediation; and ISB fires. An additional aspect of human health and safety is seafood safety, which is a complex topic involving sampling and analytical plans, equipment and methods, and data interpretation to assess the potential effects on the health of consumers. Development of health and safety techniques and equipment to mitigate these hazards helps the incident command meet its fundamental responsibility to safeguard both responders and the public.

#### **4.3.4.4**     *Sociological and Economic Impacts [4400 series]*

**Description:** This SRA includes studies on how oil spills and the response to oil spills affect the sociological fabric of communities and their economies. Disciplines encompassed in this research area include sociology, economics, behavioral sciences, political science, and law. It also involves studies on risk communication and community resilience.

**Importance:** Research is needed to improve communication of risk, decrease scientific uncertainty, and address socioeconomic concerns associated with oil spills. Oil spills and spill response may cause high levels of stress and psychological trauma, including post-traumatic stress. These effects may begin at the individual level and frequently spread to other members of families, and communities whose culture and livelihood are dependent upon the waters and shorelines near an oil spill. Unemployment and loss of income are additional stressors on peoples' lives. Oil spills can also adversely affect social relationships and have disastrous effects on specific individuals and communities in areas where livelihoods depend on use of renewable resources (e.g., fishing). An oil spill can affect the economic livelihood and aspirations of a family as well as an entire community. Typically, the commercial and recreational fisheries and tourism industries experience the greatest economic effects, although a significant number of other economic sectors also may be affected. Research that supplies a broad understanding of the human dimensions of oil spill hazards and identifies better ways to engage and share information using risk communication principles could enhance future decisions concerning sociological and economic effects on community stakeholders and assist those communities in successfully overcoming these obstacles.

## **4.4**     **Research Needs**

This category represents the research gaps that ICCOPR identified within the SRAs. ICCOPR identifies oil pollution Research Needs during the OPRTP planning cycle through a number of means, including:

- Reports on research programs and results;

- Analyses of lessons learned from recent oil spill incidents;
- Data and information shared at various workshops, conferences, and technical and policy meetings;
- Development or enactment of new regulations;
- Input shared and collected from correspondence, quarterly meetings, or scheduled public meetings;
- Numbers and types of research projects conducted/managed by industry, academia, and non-governmental organizations; and
- Forecasts of issues or problems associated with changes or expansion in any aspect of the energy distribution system.

For this FY2015-2021 version of the OPRTP, ICCOPR compiled a new baseline list of Research Needs that incorporates those needs identified in previous versions and new ones identified since 1997 as described in Chapter 9. Future versions of the OPRTP will: 1) update the needs to remove those already addressed; and, 2) add new needs that ICCOPR identifies through the needs identification process.

## 4.5 Projects

Projects are the specific research experiments and studies conducted by a primary investigator that addresses a Research Need. Projects involve a methodological study or technology development with assigned budgets, resources, and personnel. ICCOPR tracks projects conducted by any entity, not just those conducted specifically by ICCOPR member organizations. ICCOPR recognizes the value of research projects by other entities and encourages its partners from industry, NGOs, state research programs, research institutions, academia, and international organizations to identify and pursue projects that address the needs.

ICCOPR will monitor oil pollution research projects from any identified source and classify identified needs within the Research Categorization Framework by SRA. ICCOPR will use the lists of projects and information on the research results as a basis for assessing how well the Research Needs were addressed.

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## 5. Knowledge Transfer and Advancement

ICCOPR's ultimate goal for the research and technology (R&T) program is to advance information, technologies and regulations that increase the effectiveness of oil spill prevention, preparedness, response, and injury assessment and restoration efforts. The R&T planning process emphasizes and strengthens the roles and responsibilities of the member agencies to assure that research advances the capabilities to reduce oil pollution. The degree to which practitioners implement the results of the R&T program will depend upon the success of the research and how well results are communicated to the oil spill response community. As part of the program, ICCOPR promotes continuous improvement by monitoring the state of knowledge and adjusting the program to meet changing needs.

### 5.1 Factors Affecting Research and Technology Program Success

The success of the federal oil pollution R&T program depends on several factors: 1) funding; 2) continuity of research; 3) field testing; 4) regional issues; 5) development of new researchers; and, 6) public perception. The importance of these factors to the success of the federal program is discussed below.

#### 5.1.1 Funding

A steady funding stream at appropriate levels is a primary factor to support a successful R&T program. Funding for oil pollution research has been a recognized challenge since the passage of OPA 90. In their review of the 1992 OPRTP, the NAS Marine Board (1993) acknowledged the need for steady funding:

“An important unresolved issue is funding. The continued evolution and effectiveness of the (OPRTP) plan is in doubt because the additional funding authorized by Congress has not been appropriated. Moreover, little funding under OPA 90 is expected. This short term funding approach poses a significant barrier to most multi-year research. For example, scientists cannot undertake basic research dealing with the nature of oil and sea water mixtures and their response to mechanical and chemical treatment, oceanic environments, and time, because several years of laboratory work and additional time for field testing would be required.” (NAS, *Marine Board Commission on Engineering Technical Systems, 1993*)

The Marine Board also noted the problems caused by the boom and bust cycle of research and funding efforts for oil spill cleanup technology:

“Research and development (R&D) related to oil spills follows a boom-and-bust cycle. After catastrophic spills, when the acute effects of oiled beaches, polluted waterways, and dying wildlife are featured in all the media, there is public outcry and political interest, accompanied by calls for action, for more research, and for better prevention and control measures. Later, as acute effects fade, but longer term and less obvious

problems may continue, public interest-and with it political interest-fade. By the time the calls for action are translated into R&D plans, the interest is gone, and the plans typically are neither supported nor funded. When the next catastrophe occurs, everyone wonders why no one has learned more about how to deal with the problem since the last spill. The phenomenon of cyclical attention and lack of sustained interest and resources, coupled with the natural distribution of research assignments among a group of agencies with different underlying responsibilities, has made it difficult to create a coherently planned R&D program.” (*NAS, Marine Board Commission on Engineering Technical Systems, 1993*)

Similarly, the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (2011) discussed the continued need for funding at an appropriate level:

“The technology available for cleaning up oil spills has improved only incrementally since 1990. Federal research and development programs in this area are underfunded: In fact, Congress has never appropriated even half the full amount authorized by the Oil Pollution Act of 1990 for oil spill research and development. In addition, the major oil companies have committed minimal resources to in-house research and development related to spill response technology. Oil spill removal organizations are underfunded in general and dedicate few if any resources to research and development...”

“Recommendation: Congress should provide mandatory funding for oil spill response research and development and provide incentives for private-sector research and development.” (*National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011*)

The oil production and distribution system is constantly changing, posing new challenges to managing oil pollution. Wells are being drilled at increasingly greater water depths and in more challenging environments. A warming Arctic Ocean is expected to lead to greater activity there, both in exploration and transportation. Exploration of onshore shale oils and oil sands products, along with transportation by rail and pipeline is also increasing. The ability of research and technology efforts to keep pace with the challenges will be affected by long-term funding levels.

ICCOPR does not receive funding for research. Instead, ICCOPR members fund research using their agency’s annual budget appropriations or the Oil Spill Liability Trust Fund (OSLTF) R&T funds. At this time, ICCOPR agencies with access to the OSLTF R&T funds are the USCG, EPA, BSEE, and PHMSA. However, federal budgetary rules count any funds withdrawn from the OSLTF for research purposes against an agency’s overall budget, which means that oil pollution research initiatives still must compete against other agency missions to obtain funding. The National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (2011) made the following comment on the funding levels for oil pollution research:



“Specifically, Congress should provide mandatory funding (i.e. funding not subject to the annual appropriations process) at a level equal to or greater than the amount authorized by the Oil Pollution Act of 1990 to increase federal funding for oil spill response research by agencies such as Interior, the Coast Guard, EPA, and NOAA—including NOAA’s Office of Response and Restoration.”

While mandatory funding, not subject to appropriations, may be impractical, Federal funding for coordinated Federal research, presumably through ICCOPR, is generally recognized as beneficial to the goal of improved prevention of and response to oil spills.

ICCOPR initially used Regional Research Grants authorized by Section 7001(c)(8) of OPA 90 to address regional oil spill issues. The objective of the Regional Research Program was to “coordinate a program of competitive grants to universities or other research institutions, or groups of universities or research institutions, for the purposes of conducting a coordinated research program related to the regional aspects of oil pollution, such as prevention, removal, mitigation, and the effects of discharged oil on regional environments.” Congress authorized funding for the program for the fiscal years 1991 through 1995 but not for subsequent years. ICCOPR will consider additional Regional Research Grants if Congress authorizes funding in the future.

#### 5.1.2 Continuity of Research

The ability of research programs or projects to continue to their logical conclusion is an important factor in successfully addressing oil pollution research needs. Changing agency missions, funding priorities, staffing, or site access may interrupt research programs. Breaks in research continuity, if long enough, can result in a “hiatus effect” where key knowledge or learning opportunities are lost. Particularly vulnerable are studies that measure trends over time (i.e., baseline and impact assessment biological studies, oil fate and effects studies, ocean current monitoring). The institutional knowledge resulting from research efforts can also be lost when program lapses or changes prompt employees to leave their federal positions.

#### 5.1.3 Field Testing

ICCOPR recognizes that field testing is a valuable tool to validate laboratory results and to study techniques, treatments and equipment *in situ*. In 1993, the NAS Marine Board recommended that the federal R&T program include controlled field experiments that involve a deliberate, limited discharge of oil to advance research areas (i.e., oil dispersants, ISB, incineration, and bioremediation). The NAS Marine Board noted that laboratory experiments alone cannot replicate real-world process interactions and variables, and accidental spills provide limited learning opportunities because data on pre-spill conditions and/or spill volume usually are lacking. An independent report, “Responding to Oil Spill in the U.S. Arctic Marine Environment”, also echoed the need for field testing (NRC, 2014). The report noted that

countries such as Norway have consistently supported this type of research by permitting controlled spills when clear research needs, methods, and goals have been identified, and responsible cleanup and monitoring plans have been established.

Field tests may be justified when laboratory or other simulated settings (e.g., test tanks) cannot address specific Research Needs and no other open water research projects have addressed them. Experiments in large test tanks (i.e., Ohmsett) provide opportunities to simulate real environmental conditions and bridge the gap between laboratory and actual field experiments; however, they cannot completely replicate actual field conditions. ICCOPR will continue working with policy makers and permitting authorities to explore field testing opportunities. Field tests may be justified when laboratory or other simulated settings (e.g., test tanks) cannot address specific Research Needs and no other open water research projects have addressed them.

#### 5.1.4 Building the Next Generation of Researchers

The federal oil pollution R&T program needs an adequate pool of researchers and policy makers interested in oil pollution research to replace those that are retiring or leaving for other opportunities. College students need to view the oil pollution management and research fields as a viable career path. Interest in pursuing these areas is strongest in the years following a major spill (i.e. *Exxon Valdez*, *Deepwater Horizon*) and decreases as events fade from national consciousness. Thus, generating and maintaining interest by college students about to enter the workforce in oil spill R&T careers is an important element of ICCOPR's efforts.

Several of the ICCOPR member agencies have programs to encourage students to become interested in oil pollution research or management. NOAA and the University of New Hampshire's Coastal Response Research Center (CRRC), educate students on issues related to oil spills and response and works with other university programs to encourage academic interest in the field. The U.S. Coast Guard Academy includes environmental protection and marine safety topics across its curriculum in many forms ranging from drilling technology and petroleum chemistry to the history of spills of national significance. In particular the Marine and Environmental Science major includes specific courses in geochemistry, analytical chemistry, and petroleum and oil spill science, and the Engineering Department offers marine engineering courses focused on the needs of the prevention community. Cadet research projects, which are part of their curriculum, from the Science and Engineering Departments often address oil spill issues.

NASA's DEVELOP National Program fosters an interdisciplinary research environment for students, where applied science research projects are conducted under the guidance of the agency and its partner science advisors. DEVELOP is unique in that young professionals lead projects that utilize NASA Earth observations to address community concerns and public policy issues, including oil pollution research.

The International Oil Spill Conference (IOSC) Executive Committee, which includes several ICCOPR members, offers a scholarship program and student awards to promote interest in oil pollution research.

ICCOPR also provides annual advice to the NAS GRP on the direction of the GRP program, which includes education and training. A key program objective of the GRP is to support the development of future professionals and leaders in science, industry, health, policy, and education who can apply cross-boundary approaches to critical issues that span oil system safety, human health, and environmental resources.

The DOI's Youth Initiative includes outreach to students at the Ohmsett facility and at the annual Clean Gulf Conference. At the 2014 Clean Gulf Conference several ICCOPR members participated in a day-long outreach session with a local high school's Advanced Placement environmental science class.

#### 5.1.5 Public Perceptions

The NAS Marine Board observed that public reactions and perceptions can play a significant part in making oil spill response decisions, regardless of their scientific validity. Adverse reactions to the use of a technology can lead to political pressures to limit its use. In 2010, public concerns about the use of dispersants during the *Deepwater Horizon* oil spill response prompted interest groups and state agencies to oppose the use of dispersants. Such opposition may increase the need for research to provide additional validation of dispersant safety and efficacy before approval as a response option. The ICCOPR agencies' research programs need to recognize public perceptions about different technologies and factor them into decisions about research initiatives.

## 5.2 Communicating Research and Technology Efforts

Researchers must effectively communicate their results to the broader oil spill research and response communities to provide the greatest benefit from their efforts. There are many avenues for transferring research knowledge (i.e., meetings, conferences, workshop, seminars, papers, presentations, journal publications, consensus-based best practice reports, and websites of organizations involved or interested in spill response). ICCOPR views communication as a two-way street and uses a variety of mechanisms, discussed below, to transfer research knowledge to stakeholders and to learn of advances by non-federal researchers.

### 5.2.1 ICCOPR OPRTP

OPA 90 established the ICCOPR OPRTP as the mechanism to inform Congress and the public on the status of oil pollution technologies, research needs and priorities, and agency roles and responsibilities. The 1992 and 1997 versions of the OPRTP provided ICCOPR's assessments of the state of knowledge at that time. This 2015 version updates the assessment of oil pollution

R&T. ICCOPR intends for future versions of the OPRTP to serve as information sharing documents that provide the current federal perspective on oil pollution research. ICCOPR plans to update the OPRTP every six years to maintain timely information and may publish supplements if warranted.

#### 5.2.2 ICCOPR Biennial Reports to Congress

Section 7001(e) of OPA 90 requires that ICCOPR submit a report biennially on its activities and those of its members during the previous two fiscal years and the anticipated activities for the next two fiscal years. The ICCOPR Biennial Reports to Congress serve as a reference document on ICCOPR activities, member initiatives, and planned activities. Appendices to the reports provide listings of publications by ICCOPR member agencies and descriptions of their research projects.

#### 5.2.3 ICCOPR Meetings

ICCOPR conducts quarterly membership meetings and special meetings with interested stakeholders. The quarterly meetings include a session for agencies to present updates and share results of their research and development efforts. These sessions promote coordination and collaboration among member agencies. The quarterly meetings also include time for presentations from invited speakers to discuss subjects of interest to the membership.

ICCOPR conducts public and other special meetings with outside organizations to discuss their issues and share oil pollution related information. ICCOPR conducted public meetings to gather input as part of efforts to revitalize ICCOPR and to identify areas of concern for future oil pollution research.

#### 5.2.4 Meetings with Non-Federal Entities

ICCOPR participates in meetings with industry, state governments, NGOs, associations, academia, and other nations to exchange information and promote collaboration and cooperation. Stakeholders frequently ask ICCOPR to address these bodies to explain federal research priorities and initiatives. ICCOPR will continue participating in these meetings and encourage the entities to address the ICCOPR priority Research Needs.

#### 5.2.5 Demonstration Projects

Section 7001(c)(6) of OPA 90 directed that ICCOPR conduct Port Oil Pollution Minimization Demonstration Projects in New York, New Orleans, and Los Angeles/Long Beach. The Great Lakes Oil Pollution Research and Development Act of 1990 amended OPA 90 to include a fourth demonstration in ports of the Great Lakes. ICCOPR conducted two demonstration projects in New Orleans (December 1994) and New York (October 1995). After these first two projects were completed, the USCG determined that they were cost prohibitive and ICCOPR

agreed that the objectives for the demonstration projects requirement could be met through other means (ICCOPR, 2003). Since 1995, ICCOPR has addressed the objectives through interagency participation in, and support for, regularly scheduled domestic and international oil spill conferences (i.e., IOSC, Interspill, Spillcon).

In 2014, BSEE sponsored a demonstration of oil spill response processes at the 2014 IOSC in Savannah, Georgia. The theme of the On Water and Aerial Technical Demonstration was “A Complete Spill Response System.” The objective is to demonstrate oil spill response resources involving new and existing technology configured to increase the response effectiveness through improved detection, tracking and increased encounter and recovery rates.

The 45-minute demonstration on the Savannah River followed a scripted, simulated spill scenario that included: a remote oil detection device that initiated an oil spill alert message with coordinates to the responsible party, spill management team, identified OSROs, and USCG Sector or Captain of the Port and interested parties. Surface oil spill response vessels, unmanned aerial vehicles and submersible response equipment all participated in the joint response effort. A mobile command center managed the demonstration and broadcast information via a live feed to conference participants.

ICCOPR and its member agencies will consider future demonstrations of response technologies within budgetary considerations.

#### 5.2.6 Conferences

Participation in conferences is an important way to communicate research results, showcase technology, and provide opportunities for researchers and response professionals to interact. ICCOPR and its member agencies sponsor, support, and participate in several oil spill-related conferences domestically and internationally. Primary conferences promoted by ICCOPR include:

- International Oil Spill Conference (triennial in U.S.),
- Interspill (triennial in Europe),
- Spillcon (triennial in Australia),
- Clean Pacific (biennial) and Clean Gulf Conferences (annual),
- Offshore Technology Conference (annual),
- Gulf Oil Spill & Ecosystem Science Conference (annual), and
- Arctic Marine Oilspill Program Technical Seminars (annual).

These domestic and international conferences include both technical programs and equipment tradeshow that present the latest issues, products, and technologies available for oil spill and hazardous materials response, spill prevention, marine salvage, cleanup and remediation,

professional services, and regulatory compliance.

The American Petroleum Institute (API) and the IOSC Executive Committee, which includes several of the ICCOPR agency representatives, worked to make all papers presented at the IOSC since its inception in 1969 available free of charge on the internet (<http://ioscproceedings.org/loi/>). This service provides a wealth of information specific to the oil spill research community.

#### 5.2.7 Workshops and Seminars

Workshops and seminars are widely used in the oil pollution control community to bring together professionals to discuss specific topics and challenges. ICCOPR member agencies sponsor workshops on a wide variety of topics that address priority research issues.

#### 5.2.8 Publications

The researchers funded by ICCOPR are encouraged to publish their research in peer reviewed journals, conference proceedings, books, special reports, and other publications. Literature generated from research could be from researchers within the traditional oil spill community or from academic scientists and engineers. Research published in peer-review journals, especially ones with high impact factors have value in oil spill litigation cases.

Examples of high impact factor peer-review journals and publications that address marine pollution topics include:

- *Applied and Environmental Microbiology*,
- *Environmental Science & Technology (SETAC)*,
- *Environmental Toxicology and Chemistry*,
- *Human and Environmental Risk Assessment*,
- *Journal of the American Medical Association*,
- *Journal of Petroleum Technology*
- *Journal of Toxicology and Environmental Health*,
- *Marine Pollution Bulletin*,
- *Microbial Ecology Journal of Environmental Monitoring*,
- *Nature*,
- *Science*, and
- *Water Research*.

#### 5.2.9 Newsletters

ICCOPR monitors newsletters published by many organizations that announce news of their activities, highlight specific programs or initiatives, or summarize advancements in R&T. In addition, several of the ICCOPR member agencies also publish newsletters addressing elements of their oil pollution research missions.

#### 5.2.10 Internet and Social Media

ICCOPR and the member agencies use the internet as a tool to provide oil spill research results and news to stakeholders and other users. ICCOPR maintains an internet site ([www.uscg.mil/iccopr](http://www.uscg.mil/iccopr)) to: share documents, provide links to other programs and resources, distribute research reports, announce conferences and other events, and provide news about research developments.

Some of the ICCOPR member agencies maintain websites and are using blogs and social media platforms (i.e., Facebook and Twitter) to share information with the public and researchers.

### 5.3 Monitoring the Status of Oil Pollution Technologies

The 2015-2021 version of the OPRTP marks a new baseline in ICCOPR's oil pollution research planning efforts, documenting the status of oil pollution Research Needs at the start of the planning process. Future OPRTP revisions, to be issued every six years, will include revised assessments of the status of oil pollution R&T.

Throughout each six-year planning cycle, ICCOPR will track newly identified Research Needs conducted by members, federal partners, NGOs, academia, and industry. ICCOPR will use the Oil Pollution Research Characterization Framework and research protocol described in Chapter 6 of this OPRTP, to compile information on studies that address future priority Research Needs.

ICCOPR will also assess the compiled information to determine the degree to which the priority Research Needs from the previous plan were addressed and then develop a new set of research priorities for the subsequent planning period. ICCOPR may also issue supplements to the OPRTP during a planning cycle to address emerging Research Needs that increase in priority. ICCOPR may periodically review after action reports, GAO reports, and other sources of identified gaps to inform the Oil Pollution Research Characterization Framework for future research needs



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## PART TWO – ESTABLISHING RESEARCH PRIORITIES

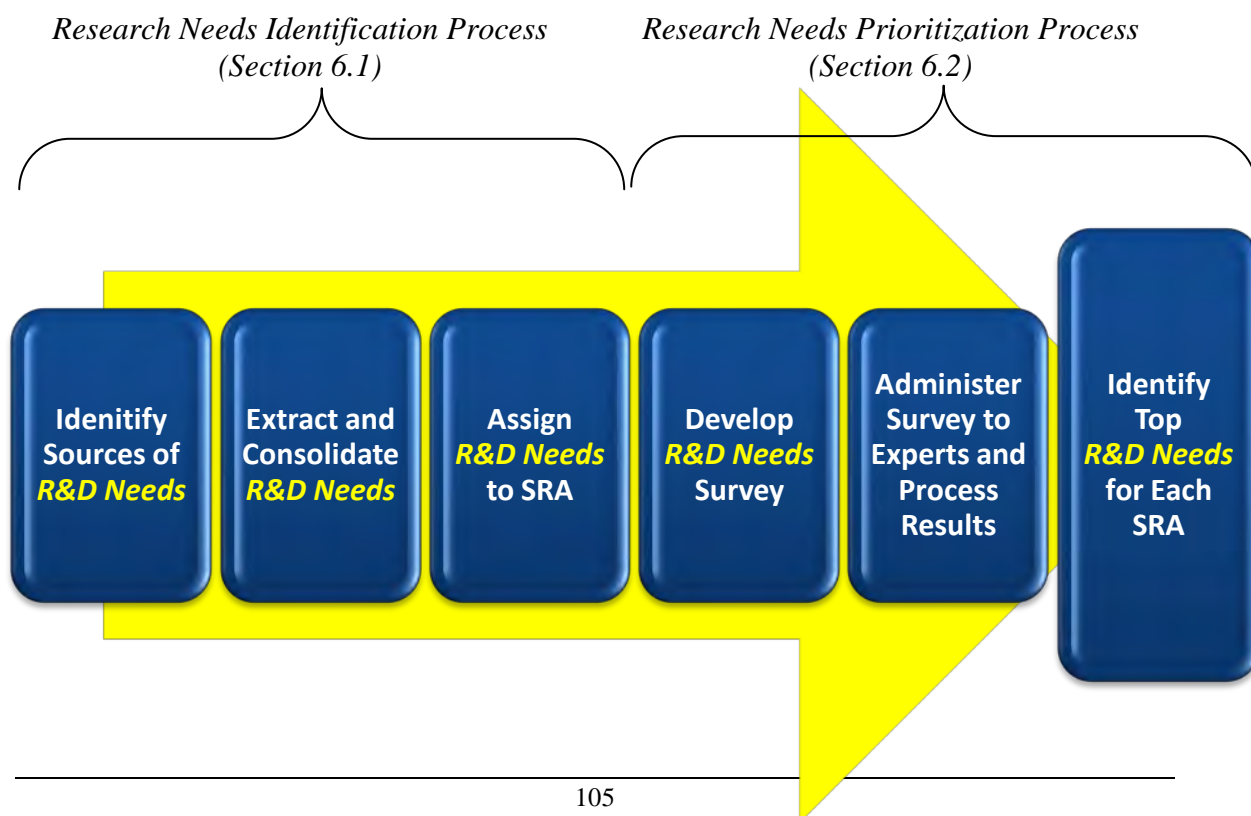
### 6. Oil Pollution Research Needs Identification and Prioritization Process

A significant number of oil pollution incidents have occurred and a substantial amount of research has been conducted since the completion of the 1997 version of the Oil Pollution Research and Technology Plan (OPRTP). In order to update the OPRTP, ICCOPR needed to develop a process for reviewing the lessons learned from these incidents and addressing any recommendations and gaps noted in the completed research.

ICCOPR established a Research and Technology (R&T) Workgroup with representatives from BSEE, DOE, EPA, NOAA, and USCG to lead development of the revised OPRTP and the Needs Identification and Prioritization Process. The R&T Workgroup was responsible for defining the SRAs, reviewing the Research Needs, and developing the proposed list of research priorities for overall ICCOPR approval.

This chapter describes the systematic process used by the R&T Workgroup to identify and prioritize the nation’s future oil pollution Research Needs. Sections 6.1 and 6.2 describe in detail the elements of the process (Figure 6-1). Appendices B through E provide supporting information to the process.

**Figure 6-1. Major steps in the Research Needs Identification and Prioritization Processes**



## 6.1 Research Needs Identification Process

The Research Needs identification process consisted of three steps: 1) identification of Research sources; 2) extracting Research Needs and consolidating them into a database; and, 3) assigning Research Needs to SRAs (Figure 6-1). Research Needs were identified through internet searches; discussions with experts; and detailed review of reports, meeting notes and workshop summaries. The R&T Workgroup considered sources that were published prior to initiation of the identification process in 2013. Needs identified in sources published after the process began will be evaluated and prioritized in the next planning cycle.

### 6.1.1 Identification of Sources of Research Needs

The first step was to identify all possible sources of new Research Needs published since the 1997 version of the OPRT Plan was released. For purposes of this plan, ICCOPR defined sources as: accident case studies; published papers; research reports; workshop or meeting proceedings; white papers; lessons learned; and agency or organizational opinions. More than 50 unique sources were identified as describing Research Needs that should be included in the database. Examples of sources reviewed include: oil spill incident after-action reports; the 1992 and 1997 versions of the OPRTTP; Coastal Response Research Center (CRRC) workshop reports; ICCOPR Public Meeting transcripts; interagency reports; research solicitations and publications.

A complete list of the initial sources reviewed can be found in Table 6-1 and Appendix C. Although it was not possible to review every potential source of oil pollution Research Needs since 1997, the sources used in this plan addressed all of the initial set of 23 SRAs and were viewed as representing a comprehensive list.

**Table 6-1. List of Sources Reviewed for Research Needs**

<b>Sources Reviewed for the ICCOPR Research Needs (by date)</b>
<b>Title 33 U.S. Code Chapter 40 Subchapter IV 2761 (Aug 1990)</b>
<b>Interagency Coordinating Committee on Oil Pollution Research and Technology Plan (April 1992)</b>
<b>Interagency Coordinating Committee on Oil Pollution Research and Technology Plan (1997)</b>
<b>Coastal Response Research Center - Research and Development Priorities: An Oil Spill Workshop (November 2003)</b>

Coastal Response Research Center – Workshop: Research & Development Needs For Making Decisions Regarding Dispersing Oil (September 2005)

National Research Council. Oil Spill Dispersants: Efficacy and Effects. Washington, DC: The National Academies Press (2005)

Potentially Polluting Wrecks in Marine Waters: An Issue Paper Prepared for the 2005 International Oil Spill Conference (2005)

EPA Act 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program (2005)

Coastal Response Research Center – Workshop: R&D Needs for Addressing the Human Dimensions of Oil Spills (June 2006)

Coastal Response Research Center - Submerged Oil Workshop Report (December 2006)

DOE 2007 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report (January 2008)

DOE 2009 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report (December 2008)

Coastal Response Research Center - R&D Priorities: Oil Spill Workshop (March 2009)

House of Representatives, Committee on Science & Technology "A New Direction for Federal Oil Spill Research & Development" (June 2009)

DOE 2010 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report (December 2009)

Wreck Oil Removal Program Overview (2009)

Prince William Sound Oil Spill Recovery Institute Research Plan 2011-2015 (February 2010)

Gulf of Mexico Research Initiative: Research Themes (May 2010)

Interagency Coordinating Committee on Oil Pollution Research Public Meetings - West (May 2010)

Pacific States/British Columbia Oil Spill Task Force Letter to Interagency Coordinating Committee on Oil Pollution Research (May 2010)

House of Representatives, Committee on Science & Technology "Deluge of Oil Highlights Research & Technology Needs for Effective Cleanup of Oil Spills" (June 9, 2010)

U.S. Arctic Research Commission - White Paper (July 2010)

Interagency Coordinating Committee on Oil Pollution Research Public Meetings - East (September 2010)

Marine Mammal Commission Letter to Interagency Coordinating Committee on Oil Pollution Research (September 2010)

National Science and Technology Council Joint Subcommittee on Ocean Science and Technology - DWH Oil Spill Principal Investigator Conference Report (October 2010)

Interagency Coordinating Committee on Oil Pollution Research Public Meetings - Gulf (November 2010)

National Academy of Sciences Institutes of Medicine Research priorities for Assessing Health Effects from the Gulf of Mexico Oil Spill (2010)

Deepwater Horizon Incident Specific Preparedness Review (January 2011)

Environmental Protection Agency Draft Oil Spill Research Strategy (January 2011)

National Commission on BP Deepwater Horizon - Final Report (January 2011)

Ultra-Deepwater Advisory Committee 2011 Plan: Comments, Findings and Recommendations (April 2011)

Coastal Response Research Center - Coordinating R&D on Oil Spill Response In the Wake of Deepwater Horizon (July 2011)

Assessing the Long-term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs (August 2011)

DOE 2011 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress (August 2011)

U.S. Department of Energy - 2011 Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (August 2011)

Science Advisory Board Review of Environmental Protection Agency's Draft Oil Spill Research Strategy (September 2011)

National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology - Deepwater Horizon Oil Spill Principal Investigator Conference Final Report (October 2011)

Oil Spill Preparedness and Response Joint Industry Task Force (November 2011)

U.S. Geological Survey. An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)

International Association of Oil and Gas Producers - Joint Industry Programme Solicitation for Expression of Interest (EOI) on Arctic Oil Spills (February 2012)

Coastal Response Research Center - The Future of Dispersant Use in Oil Spill Response Initiative (March 2012)

Ultra-Deepwater Advisory Committee 2012 Plan: Comments, Findings and Recommendations (March 2012)

OESC Letter Recommendations to BSEE Department of the Interior (April 2012)

U.S. Government Accountability Office Oil Dispersants Report (May 2012)

Government and Industry Pipeline Forum (July 2012)

DOE 2012 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress (August 2012)

OESC Letter Recommendations to BSEE Department of the Interior (August 2012)

U.S. Department of Energy - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (August 2012)

Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations (November 2012)

Center for Spills in the Environment Alberta Oil Sands Workshop for Maine DEP and U.S. EPA Region 1 (December 2012)

Bureau of Safety and Environmental Enforcement - BAA Proposed Research on Oil Spill Response Operations (2012)

OESC Letter Recommendations to BSEE Department of the Interior (January 2013)

Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)
Oil Spill Simulants Materials: Workshop Proceedings (March 2013)
University of Washington Transporting Alberta Oil Sands Products: Defining the Issues and Assessing the Risks (March 2013)
Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)
DOE 2013 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress (June 2013)
NRC An Ecosystem Approach to Assessing the Impact of the Deepwater Horizon Spill in the Gulf of Mexico (2013)
TRB Effect of Diluted Bitumen on Crude Oil Transmission Pipelines Special Report 311 (2013)

During the Prioritization Process, the R&T Workgroup increased the number of SRAs to 25 by adding a new “Rail and Truck Transport” SRA and redefining the Onshore and Offshore facilities SRAs to create a new “Pipeline” SRA. The R&T Workgroup reviewed the new and revised SRAs and determined that additional review of sources for the Rail and Truck Transport SRA and the Onshore Facilities SRA were needed. The R&T Workgroup used experts at PHMSA and the EPA to obtain information on potential missing needs for these two SRAs. Table 6-2 lists the supplemental sources reviewed to determine additional Research Needs.

**Table 6-2. List of Supplemental Sources Reviewed for Research Needs**

<b>Supplemental Sources Reviewed for the ICCOPR Research Needs (by date)</b>
FRA Research Review Conference (2012)
USDOT Emergency Order on Transport of Bakken Crude Oil (2014)
Federal Railroad Administrator Prepared Remarks - 50th Meeting of the Railroad Safety Advisory Committee (2014)
Discussions with U.S. EPA Office of Solid Waste (2014)



**Discussions with PHMSA Office of Pipeline Safety (2014)**

6.1.2 Extraction and Consolidation of R&D Needs

A searchable Excel database was created to record information on the source, the applicable environment and the frequency the Research Need was mentioned in the sources reviewed. Initially, more than 900 Research Needs were identified from the source material. After elimination of duplicated Research Needs, the final list consisted of 570 separate Research Needs. This list of 570 Research Needs is located in Appendix B. The original list of more than 900 Research Needs was archived for future use.

6.1.3 Assignment of Research Needs to an SRA

The last step in the Needs Identification Process involved assigning each of the 570 Research Needs to one of the 25 SRAs described in Chapter 4 of this based on the definition of each SRA. Some SRAs had a much larger number of Research Needs than others. SRAs with a large number of needs were further divided into SRA subcategories. The rationale for using subcategories is described in Section 6.2. Figure 6-2 shows an example of the column headings for a typical entry in the Research Needs database.

**Figure 6-2 Sample from the Research Needs Database**

<b>Standing Research Area (SRA)</b>	<b>SRA Subcategory</b>	<b>Research Need and Key Research Concept</b>	<b>Sources</b>	<b>Physical Location</b>	<b>Sources</b>
Dispersants	Behavior	Constituents - Study chemistry data for individual dispersant components in the oil droplets during the DWH spill.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine and Estuarine	1

6.2 Research Need Prioritization Process

The ICCOPR R&T Workgroup determined that the most effective Needs prioritization process for this OPRTP was to develop a survey (Figure 6-1) that could be distributed to Subject Matter Experts (SMEs) (e.g., scientists, policy makers) familiar with current oil spill research needs. In some areas, there was a need to include state agency, academic, or industry experts in order to find the right expertise to address the R&D Needs

questions. The Workgroup determined, however, that in no SRA category or subgroup should non-federal employees exceed the number of Federal SMEs. The survey results helped ICCOPR identify and prioritize the most important Research Needs within each SRA.

The R&T Workgroup created subcategories for 11 SRAs with a large number of Research Needs to reduce the number of Research Needs that each SME was required to evaluate. The decision to use this approach was based on the experience of UNH Survey Center experts (managers of the survey) who indicated that “survey fatigue” often occurs if a participant is asked to answer a large number of questions, thus affecting the validity of the results. Appendices D through F provide the survey technical report and examples of the survey instrument and results.

The Workgroup compiled a set of proposed priority research Needs for the SRAs and SRA subcategories and presented them to the whole ICCOPR for approval.

### 6.2.1 Development of Research Needs Survey

The R&T Workgroup developed and debated a series of key questions that reflected the various aspects of the research process and selected the following questions for the survey:

Question 1 - How important is this Research Need in improving any or all of the following: spill prevention, preparedness, response, and/or impact assessment/restoration? (Via sliding scale)



Question 2 - Some research is designed to answer a small detail which refines our understanding of a research problem while other research answers key questions that become the building blocks for further advancements. Please estimate where this Research Need fits in this spectrum of oil pollution research (Via sliding scale)

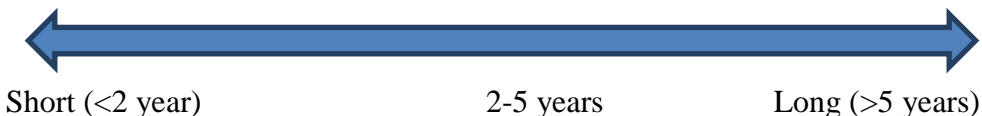


Question 3 - What would be the estimated cost of the research to answer this Research Need? (Via text box)

*Fill in blank text box*

Example 50000000; no commas or dollar sign

Question 4 - How soon would the results of this specific Research Need improve any or all of the following: spill prevention, preparedness, response, or impact assessment/restoration? (Via sliding scale)



Question 5 - Solving research problems can require multiple steps. Some research projects take the initial steps while others will be the final step. Please estimate where this Research Need fits in the lifespan of solving a research problem. (Via sliding scale)



Questions 1-5 were designed to refer to a specific Research Need within the SRA or SRA subcategory that a SME was assigned. Questions 6 and 7 were designed to be asked at the end of the survey and refer to all of the Research Needs evaluated by an SME.

Question 6 - Of the research needs that you reviewed today, which rise to the top? For each, list (up to 3) impediments (other than cost or time to completion) for these top research Needs you identified. (Answers via text box)

*Fill in blank text box*

Question 7 - Are there any research needs related to this subject area that you feel need to be addressed, but were not on this list? (Answers via text box)

*Fill in blank text box*

In addition to the questions described above, the R&T Workgroup decided to ask each SME to provide a range of dollar values that they would expect for research projects associated with their assigned SRA or SRA subcategory. This information was intended to allow the R&T Workgroup to calibrate the difference in project costs between SMEs with different backgrounds and different types of research experience. Unfortunately, the number of responses to the inquiry on potential costs were limited and too variable to be

of significant value to the decision making process.

The UNH Survey Center built and designed the survey instrument, in conjunction with the CRRC and the R&T Workgroup. A total of 46 separate surveys were developed, one for each SRA or SRA subcategory. Appendix E provides a sample of the survey for one of the Research Needs.

#### 6.2.2 Administration of Survey to SMEs

The R&T Workgroup recruited 285 SMEs to provide at least five SMEs for each of the SRAs and SRA subcategories. These SMEs were selected for their knowledge and expertise in particular SRAs. Responses were received from 223 of these experts; 185 federal employees and 38 non-federal personnel. Survey groups were designed to include a majority of federal employees to avoid Federal Advisory Committee Act (FACA) issues. The UNH Survey Center administered the confidential survey and tabulated the scores.

#### 6.2.3 Processing of Survey Results

In order to determine the highest priority Research Needs, the Survey Center calculated a mean and standard deviation for each of the questions using the answers provided by the SMEs. Questions #3 about costs could not be used in the final scoring because many SMEs did not answer it. The R&T Workgroup weighted the remaining questions based on its knowledge of their importance.

1. How important is this Research Need in improving any or all of the following: spill prevention, preparedness, response, and/or impact assessment/restoration? Weighting **55%**
2. Some research is designed to answer a small detail which refines our understanding of a research problem while other research answers key questions that become the building blocks for further advancements. Weighting **30%**
3. What would be the estimated cost of the research to answer this Research Need? Weighting **0%**
4. How soon would the results of this specific Research Need improve any or all of the following: spill prevention, preparedness, response, or impact assessment/restoration? Weighting **15%**

#### 6.2.4 Identification of Top Priority Research Needs for Each SRA

The priority Research Needs were established based on a review and vote by ICCOPR on the recommended priorities selected by the R&T Workgroup during a series of working sessions during the summer of 2014. The R&T Workgroup's iterative process to select

the recommended priorities consisted of the following steps:

- Evaluate statistical ranking and analysis of survey results. The UNH Survey Center provided a ranking of Research Needs by the raw and weighted scores and the standard deviations of both scores. The R&T Workgroup used these initial rankings as a starting point for discussions.
- Review missing Needs. Several SMEs identified potentially missing Research Needs in their responses to Question 7. The R&T Workgroup reviewed the suggestions to determine whether a different SRA or SRA subcategory included the Research Need. The R&T Workgroup added missing Research Needs to the appropriate SRA or SRA subcategory and assigned an appropriate rank based on the members' expert opinion.
- Consolidate research Needs. In many cases, an SRA or SRA subcategory listed similar Research Needs. The R&T Workgroup reviewed these similarities and consolidated them where appropriate. The draft ranking was adjusted to reflect the importance of the consolidated Research Need.
- Determine top three recommended priority Needs. The R&T Workgroup considered several factors in making its final recommendation on the three most important Research Needs for each SRA or SRA subcategory: 1) whether the impediments as listed by the SMEs in answer to Question 6 would prevent or severely limit the potential research to resolve the Need; 2) whether completed or ongoing research had already addressed the Research Need; and 3) did the results of Question 5 and 6 distinguish between similarly ranked Research Needs (however, this last factor was rarely necessary). The R&T Workgroup unanimously agreed upon the top three suggested priority Research Needs for each SRA or SRA subcategory before they were presented to the full ICCOPR.
- Develop the final description of each recommended priority Research Need. The R&T Workgroup reviewed the language of each SRA and the associated priority Research Needs to ensure each description was clearly articulated and consistent with the SRA definition.
- Obtain ICCOPR member feedback. The R&T Workgroup sent its draft list of priorities to the full ICCOPR membership for review and comment. The R&T Workgroup adjudicated the comments through discussions with commenting members and a meeting of the R&T Workgroup.

- Finalize recommended priorities. The R&T Workgroup made its final edits to the recommendations based on the comment adjudication process and met on August 19, 2014 to formally vote on a final set of recommended priorities. The recommendations were sent to the full ICCOPR membership for consideration and adoption.

The full ICCOPR membership discussed the proposed SRA descriptions and the priority Research Needs at the Quarterly Meeting on September 17, 2014. Minor wording changes were made to two Research Needs based on the discussions, and by unanimous vote, ICCOPR adopted the top three priority Needs for each SRA and SRA subcategory as presented in Chapter 9.

## 7. Noteworthy Oil Spill Incidents

This chapter provides a summary review of noteworthy oil spills since ICCOPR released the 1997 version of the OPRTP. The case studies describe the incidents, the significant causal factors, response issues, and the identified Research Needs. This section is organized chronologically by the type of incident as classified by the National Response Center:

- Vessel Spills (tank and non-tank),
- Offshore Drilling Operations,
- On-shore Pipeline Spills,
- Facility Spills, and
- Railroad Spills.

Information on the spill and response measures described in the case studies was acquired from various sources including: NOAA's Office of Response and Restoration's IncidentNews ([www.incidentnews.noaa.gov](http://www.incidentnews.noaa.gov)) for open water spills; the EPA's OSC website ([www.epaosc.gov](http://www.epaosc.gov)) for inland spills; and State agency information and DOT reports. The Research Needs listed below the incident summaries were taken from Incident Specific Preparedness Reviews (ISPRs), NOAA OR&R reports; and contracted After Action Reviews (AARs) where available. In cases where specific no Research Needs were identified, the R&T Workgroup reviewed the case study information for applicable Research Needs.

### 7.1 Vessels Spills

Major spills from tankers have been declining globally for several decades according to ITOPF (2015). However, Spills from all vessels remain an on-going concern. The USCG (2012) reported that between 2001 and 2010 there were 20,710 spills from vessels responsible for more than 6.6 million gallons of oil. Tank barges accounted for more than 60 percent of the volume spilled.

#### ***TB Penn***

In July 2000, the Tank Barge *Penn 460* ruptured and released ~12,600 gallons of No. 6 fuel oil into Narragansett Bay, Rhode Island, an active fishing and lobstering location. The spill oiled two miles of shoreline and numerous birds. Response measures included: the booming of heavily contaminated areas and surface skimming; low pressure flushing of shoreline and sediments; the use of sorbents and snares (passive collection) near the McAllister Hazardous Waste Landfill; a bird capture program for oiled birds;



informational handouts on tar balls to the public; and fishery closures in the immediate area.

This incident is an example of a barge tank rupture that leaked heavy fuel oil into an estuary important for fishing and recreation. There were no specific research recommendations following the spill; however, the response action emphasized the need for further research in the following SRA areas:

- **In- and On-water Containment and Recovery (SRA 3400)** - improve boom and surface skimming equipment.
- **Shore Containment and Recovery (SRA 3500)** - develop improved methods for shoreline cleanup.
- **Environmental Impacts and Recovery (SRA 4100)** - develop improved methods of impact assessment and recovery (for fisheries and avian species).
- **Sociological and Human Impacts (SRA 4400)** - determine impacts to humans related to estuarine spills.

#### *T/V Athos I*

In November 2004, the single hull tanker *T/V Athos I* struck a submerged object and spilled approximately 264,000 gallons of heavy Venezuelan crude oil into the Delaware River creating a 20-mile slick that affected 214 miles of shoreline across four states (Pennsylvania, Delaware, New Jersey, and Maryland), with some of the oil submerged below the surface. The investigation by the USCG concluded that the vessel struck a submerged U-shaped pipeline while maneuvering en-route to its berth. The pipeline punctured the vessel's bottom plating in the ballast and cargo tanks.

Response included vessel stabilization and prevention of further discharge; facilitation of vessel traffic, as needed; deployment of protective booms and snares; skimming, collection and recovery of floating oil; enforcement of a safety zone; and collection and rehabilitation of injured wildlife. Economic losses were incurred due to delays in transportation on the Delaware River. The Salem Nuclear Power Plant shut down two reactors because submerged oil was identified in the sediment below some water intakes. The Plant shutdown affected regional electrical generation.

This incident was important for its identification of needed technology improvements including: subsurface object detection and the detection, tracking, mapping and recovery of subsurface and submerged oil. Although there were no specific recommendations for future research as a result of the spill and response actions, this spill highlighted the need for research in the following SRAs:

- **Vessel Design (SRA 1400)** - develop double hull designs.

- **Structural Damage Assessment (SRA 3000)** - develop methods to determine vessel damage.
- **Environmental Impacts and Recovery (SRA 4100)** - develop better methods of wildlife rehabilitation.
- **Sociological and Economic Impacts (SRA 4400)** - study impacts related to primary and secondary economic impacts and costs.

### ***M/V Selendang Ayu***

During a large storm in December 2004, the *M/V Selendang Ayu*, carrying a cargo of soybeans, lost power and grounded on the west side of Unalaska Island, Alaska, where it broke into two and released 337,000 gallons of IFO-380 fuel oil, marine diesel, a small amount of lube oil as well as its soybean cargo. Most of the oil was carried onto the rocky shorelines of Makushin and Skan Bays. Half of the vessel sank, while the other half remained afloat, harboring fuel with the potential for additional releases.

Response measures included employing SCAT, an assessment process used for all spills where shorelines are impacted, and manual shoreline cleanup. The potential of an additional release from the floating half of the vessel triggered testing and approval for dispersants and *in situ* burning (ISB), which were not employed. After the initial response, cleanup was halted until April 2005 due to deteriorating winter weather conditions. In the spring, most shorelines were manually cleaned and dry mechanical tilling and berm relocation techniques were used where appropriate. Response actions continued during the weather-permitting seasons until June 2006.

This incident highlighted the difficulty of response operations in the Arctic environment and the availability of suitable response technologies in cold, icy conditions. The After Action Review for the *M/V Selendang Ayu* incident discussed the following specific R&D Needs (Wood & Associates, 2005):

- **Response Management Systems (SRA 2100)** - improve information sharing, including identification of response equipment and resource availability.
- **Chemical/Physical Modeling (SRA 3200)** - develop methods to determine the transportation and fate of oil in Arctic waters.
- **In and On-water Containment and Recovery (SRA 3400)** - develop measures of containment for application in Arctic conditions.
- **Shoreline Containment and Recovery (SRA 3500)** - develop technology improvements for Arctic shorelines and weather conditions.

### ***T/V Bow Mariner***

In February 2004, the *T/V Bow Mariner* crew was engaged in cleaning residual Methyl Tertiary Butyl Ether (MTBE) from a cargo tank while in transit. The MTBE caught fire

and exploded and the ship sank about 45 nautical miles east of Virginia. Twenty-one men died in the incident and all the cargo was lost. The vessel was carrying 3,188,711 gallons of ethanol, 192,904 gallons of No. 6 fuel oil, and 48,266 gallons of diesel, which were all released during the incident. An ignition of a fuel/air mixture, either on deck or in the cargo tanks, caused this casualty; the precise source was not determined. The ethanol, which is miscible in water and diesel oil were dispersed rapidly. The fuel oil created an oil slick that required mechanical recovery. Response actions included fishery closures, and mechanical recovery using skimmers; the vessel was not salvaged. Corexit 9527 was tested for dispersants; however, it was not used due to the cold temperatures and the degree of oil weathering.

A significant contributing factor to this casualty was the failure of the operator, Ceres Hellenic Enterprises, Ltd., and the senior officers of the *Bow Mariner*, to properly implement the company and vessel Safety, Quality and Environmental Protection Management System (USCG, 2005). Although specific R&D Needs were not identified, this incident highlighted the need for research in key SRAs:

- **Human Error Factors (SRA 1000)** - study explosion hazards related to tank cleaning operations
- **Human Error Factors (SRA 1000)** - develop manuals for safe tank cleaning procedures.
- **Human Error Factors (SRA 1000)** - develop adequate training on tank cleaning procedures for crews of vessels carrying explosive materials.
- **Human Error Factors (SRA 1000)** - develop adequate training for multicultural crew cohesiveness.
- **In- and On-water Containment and Recovery (SRA 3400)** - study methods of containment and recovery of ethanol and alternative fuels.
- **Dispersants (SRA 3600)** - study the effectiveness of dispersants in cold water and with weathered oil.

### ***M/V Cosco Busan***

In November 2007, the container ship *M/V Cosco Busan* spilled 53,569 gallons of heavy fuel oil from its bunker tanks into San Francisco Bay after the vessel struck the San Francisco-Oakland Bay Bridge in thick fog. The source of the incident was not a tanker transporting crude oil as a component of the oil production and transportation system, but rather a non-tank vessel engaged in maritime commerce spilling oil used to fuel the ship. Investigators concluded that the vessel's pilot was impaired from his use of prescription pharmaceuticals, while piloting the container vessel, which rendered him unable to properly use the onboard radar and electronic navigation charts. The USCG Vessel Traffic Service (VTS) failed to warn the pilot that the vessel was headed for the bridge.

The master of the *M/V Cosco Busan* did not implement several procedures found in the company safety management system related to safe vessel operations, which placed the vessel, crew and environment at risk.

The spill oiled about 200 miles of coastline. The near shore location, the type of oil, and proximity to sensitive and valuable coastal resources resulted in a substantial response. Response activities included: deployment of containment boom; mechanical collection and removal; natural attenuation; beach closures due to health and safety concerns with the fuel oil and; and oiled bird capture and cleaning programs.

This incident was an important driver for research needs involving human error, crew fitness, and waterways management because of the potential to prevent this incident and others like it had these needs been addressed. The ISPR for the *M/V Cosco Busan* (USCG, 2008a,b) noted these specific R&D Needs:

- **Human Error Factor (SRA 1000)** - develop protocols to report changes in crew fitness to the USCG, in a timely manner, including any substantive changes in their medical status or medications.
- **Waterways Management (SRA 1300)** - develop technology improvements to improve vessel traffic monitoring and communications.
- **Response Management Systems (SRA 2100)** - develop improvements to information management systems that provide timely and accurate information for the Federal On-scene Coordinator about the extent of the spill.
- **Environmental Impacts and Recovery (SRA 4100)** - develop improvements to aid in effective bird capture techniques and identify priorities and resources needed to provide the most effective wildlife rescue.
- **Environmental Impacts and Recovery (SRA 4100)** - develop a framework to make beach closure and reopening decisions and incorporate those into local government plans (coordinated through the Area Contingency Plan (ACP)).
- **Human Health and Safety (SRA 4300)** - develop protocols needed to close, open or restrict fisheries after a spill that are written into emergency plans and develop expedited tests to check whether impacted fish are a health risk.
- **Sociological and Economic Impacts (SRA 4400)** - evaluate proper use of and methods to monitor the use of social media during and after spills.

## 7.2 Offshore Drilling Operations

The explosion and collapse of the *Deepwater Horizon* drilling platform resulted in the largest marine oil spill in history and revealed several Research Needs associated with offshore drilling operations.

### ***Deepwater Horizon (DWH) Oil Spill***

In April 2010, an estimated 205.8 million gallons of oil began flowing from a subsea well blowout that followed an explosion and collapse of the *Deepwater Horizon* platform (also called the Macondo 252 well) during exploratory drilling. The platform was located approximately 50 miles south of the coast of Louisiana in waters about 5,000 ft. deep. The explosion on the drill rig killed 11 men and injured 17 others. For approximately three months, efforts to stop the flow at the source were unsuccessful until response operations temporarily capped the well on July 15, 2010. The complete well closure occurred on September 18, 2010. The resultant oil spill caused damage to deepwater and nearshore marine and wildlife habitats across the Gulf States and to the Gulf's fishing and tourism industries.

This spill was declared a Spill of National Significance (SONS). Response to the *Deepwater Horizon* spill was diverse and conducted on a larger scale than any previous efforts. Different response mechanisms were deployed depending on the day, the weather conditions, and the amount and location of oiled shoreline. This included: ISB, subsea and surface dispersant use, booming, and skimming. Application of 1.84 million gallons of dispersants, both aerially and sub-sea at the wellhead, was unprecedented, as was the use of controlled ISB (a global record of 411 individual burns were conducted). This spill was the first where dispersants were applied subsea at the wellhead. Existing options failed to satisfy the public expectations, which led to the testing and evaluation of more than 120,000 response technologies through the Alternative Response Technologies Evaluation System (ARTES) Program.

The magnitude and spatial extent of this spill resulted in the collection of a large amount of monitoring and experimental data. A substantial amount of research studying the effects of the spill and the response on the Gulf of Mexico are ongoing. The incident report (USCG, 2011) highlighted the following R&D Needs:

- **Pre-Baseline (SRA 2000)** - ensure minimum standards and consistency for Gulf of Mexico Area Contingency Plans (ACPs).
- **Pre-Baseline (SRA 2000)** - identify Environmentally Sensitive Areas (ESAs).
- **Source Control and Containment (SRA 3100)** - develop improved technology and response protocols for well blowouts.
- **Response Management Systems (SRA 2100)** - develop systems to better meet the needs of oil spill response organizations.
- **Response Management Systems (SRA 2100)** - establish standards and processes for rapid collection, processing, correlation, analysis and distribution of satellite imagery and oil thickness sensors to direct spill response operations with real-time data.

- **Oil Spill Detection and Surveillance (SRA 3300)** - develop improvements for subsea oil detection.
- **Oil Spill Detection and Surveillance (SRA 3300)** - develop and use enhanced SMART monitoring technologies and protocols in offshore environments.
- **Oil Spill Detection and Surveillance (SRA 3300)** - develop technology to determine oil slick thickness.
- **In- and On-water Containment and Recovery (SRA 3400)** - develop improved and more efficient skimmers and mechanical recovery equipment.
- **In- and On-water Containment and Recovery (SRA 3400)** - use a fully operational Common Operating Picture (COP) available during drills, exercises, and actual events.
- **In- and On-water Containment and Recovery (SRA 3400)** - develop protocols for thorough, independent testing and evaluation of response technologies prior to being used on a spill.
- **Dispersants (SRA 3600)** - study the toxicity of dispersants as a function of oil and dispersant types, and different environments.
- **Dispersants (SRA 3600)** - study dispersant efficacy including volumetric limitations of applications.
- **Dispersants (SRA 3600)** - study dispersant efficacy in mitigation of environmental impacts.
- **Dispersants (SRA 3600)** - develop methods and programs to monitor and track large, dispersed oil plumes.
- **Dispersants (SRA 3600)** - conduct a case study analysis of all aspects of dispersant use including environmental effects of dispersants and dispersed oil.
- **Dispersants (SRA 3600)** - study the effectiveness of dispersants under different environmental conditions (e.g., subsea).
- **ISB (SRA 3700)** - study where ISB can be used as a response option and areas where it can be subject to expedited approval.
- **ISB (SRA 3700)** - study the performance of various fire boom designs and improve technologies for water-cooled and reusable booms.
- **Sociological and Economic Impacts (SRA 4400)** - develop outreach programs for, and incorporate state and local emergency managers into, spill preparedness and response.
- **Sociological and Economic Impacts (SRA 4400)** - Spill of National Significance (SONS) doctrine should be adapted to be more inclusive of state, local and tribal governments in a response.

### 7.3 On-Shore Pipeline Spills

There are more than 300 oil and hazardous liquid spills annually along the more than 199,000 miles of hazardous liquid pipelines in the U.S. according to PHMSA statistics. Three such spills illustrate the types of Research Needs for pipeline spills.

#### *Enbridge Pipeline*

In July 2010, an Enbridge Energy Partners LLP pipeline (30-in. diameter) ruptured near Marshall, Michigan and spilled an estimated 843,000 gallons of crude oil produced from bitumen sands, also known as oil sands products (OSP). The rupture released the oil into Talmadge Creek and it then flowed into the Kalamazoo River, a Lake Michigan tributary. Heavy rains at the time of the incident affected spill behavior and transport causing the river to overtop existing dams and carry the OSP downstream contaminating 35 miles of the Kalamazoo River. The rains resulted during a 25-year flood event that also carried the OSP into the adjacent floodplain.

At the height of the response, more than 2,500 people were working along the impacted river and shoreline. Response measures for this spill included: fish advisories, river closure for dredging operations to remove sunken oil and oil in sediments, and deployment of sediment traps for oil that was not removed during dredging. A significant portion of the oil submerged in the river making detection and recovery difficult. Numerous methods were tried to recover the submerged oil because globules continued to rise from the bottom when bottom sediments were disturbed. Identification of submerged oil was determined by manually disturbing the sediments with a pole. Oil sheens would form where there was submerged oil. Vacuums or passive methods removed the oil. Passive methods of recovery in place continued for a long period after the spill.

Research Needs influenced by this spill included submerged oil detection and recovery for large areas, and cleanup methods for OSP in floodplains. Additional research needs identified by the NRDA team included:

- **Pipeline Systems (SRA 1700)** - develop new advanced technology for sensing pipeline leaks that will reduce leak detection false alarms for new construction and existing pipelines.
- **Pipeline Systems (SRA 1700)** - improve and develop in-line inspection (ILI) to locate and size defects in girth welds and for long seam defects including cracks in electric resistance welded pipe (ERW).
- **Chemical and Physical Modeling and Behavior (SRA 3200)** - study the behavior of OSP when spilled into rivers including weathering and interactions with sediments.



- **Oil Spill Detection and Surveillance (SRA 3300)** - improve technology for detection of submerged oil in rivers.
- **Environmental Impacts and Recovery (SRA 4100)** - study the lethal and sublethal impacts of OSP on biota.
- **Environmental Impacts and Recovery (SRA 4100)** - study the impacts of cleanup activity on subtidal and floodplain habitats.
- **Human Health and Safety (SRA 4300)** - study the impacts of air quality on the community and responders from OSP spills.
- **Sociological and Economic Impacts (SRA 4400)** - study the impacts related to lost recreational opportunities from spills.

### *Yellowstone River Pipeline*

On July 1, 2011, a break occurred in a 12 in. pipeline, owned by ExxonMobil Pipeline Company, under the Yellowstone River, 20 miles upstream from Billings, Montana. The ruptured pipeline leaked an estimated 63,000 gallons into the river before the pipeline was closed. USEPA led the response in close coordination with the State of Montana and other federal agencies. EPA's primary concern was protecting people's health and the environment. The river also is known for Yellowstone River cutthroat trout, a Montana fish of concern.

When the Yellowstone River dropped below pre-spill water levels, oil residue was visible in many areas, including some agricultural lands. Farmers were given instructions for crops and livestock. USEPA held ExxonMobil, the responsible party, accountable for assessment, cleanup and restoration. Cleanup crews recovered only about 420 gallons of crude.

As in the case of the Kalamazoo River, the amount of oil spilled was much higher than it might have been due to that lack of coordination and communication among the pipeline operators. In both cases, there was a substantial delay in closing the valves to shut off the flow. In the Yellowstone River incident, it was estimated two-thirds of the spill volume were attributable to the delay. Although there were no specific recommendations for R&D, this spill emphasized the need for:

- **Human Error Factor (SRA 1000)** - better training and coordination for operators.
- **Pipeline Systems (SRA 1700)** - research on methods of inspection of buried pipelines for erosion.
- **Pipeline Systems (SRA 1700)** - improve existing leak detection technology and health monitoring sensors that are miniaturized, automatic, and robust enough to withstand harsh environments.

- **Environmental Impacts and Recovery (SRA 4100)** - research on the potential impacts of OSP on freshwater fisheries.
- **Environmental Impacts and Recovery (SRA 4100)** - research on the potential impacts and restoration of OSP on crops and livestock.

### ***Pegasus Pipeline***

ExxonMobil's Pegasus pipeline carries 3,990,000 gallons per day of crude oil a distance of 850 miles from Patoka, Illinois to Nederland, Texas. The spill occurred on March 29, 2013, when the pipeline carrying Canadian Wabasca heavy crude from the Athabasca oil sands ruptured in Mayflower, Arkansas, about 25 miles northwest of Little Rock. A reported 210,000 - 294,000 gallons of crude were spilled. Approximately 3,990,000 gallons of oil mixed with water were recovered by March 31. Twenty-two homes were evacuated. The EPA classified the leak as a major spill.

The crude oil entered a suburban neighborhood through a leak in the 20 in. pipeline, which was buried an average of two feet below ground. The oil flowed into storm drains leading to nearby Lake Conway, used for recreational fishing. First responders, including fire fighters, city employees, county road crews and police built dikes to block culverts and stop the crude from further fouling the lake. ExxonMobil deployed 3,600 feet of containment boom around the lake. By early morning on March 30, there was no more oil spilling from the pipeline.

The EPA and ExxonMobil conducted air quality monitoring. Overall, air emissions in the community were below levels likely to cause health effects to the public. The Arkansas Division of Environmental Quality (ADEQ) closely reviewed the cleanup, continued to monitor the surface water in the affected areas, and posted regular updates. Although reports identified no specific Research Needs, those that were evident from the Mayflower pipeline spill are similar to Research Needs from the Enbridge Kalamazoo OSP spill:

- **Pipeline Systems (SRA 1700)** - improve and develop in-line inspection (ILI) to locate and size defects in girth welds and long seam defects including cracks in electric resistance welded pipe (ERW).
- **Chemical and Physical Modeling and Behavior (SRA 3200)** - research on OSP weathering and interactions with sediments.
- **Environmental Impacts and Recovery (SRA 4100)** - more research on the impacts of cleanup on habitats.
- **Health and Safety (SRA 4300)** - research on air quality monitoring protocols for OSP spills.

## 7.4 Facility Spills

Severe weather events, most notably hurricanes in the Gulf of Mexico and the East Coast, were responsible for several spills from facilities in the inland areas in recent years.

### *Hurricanes Katrina and Rita*

Gulf of Mexico Hurricanes Katrina and Rita caused multi-state pollution events in 2005. In total, there were over 500 spills resulting from these storms. Storm damage caused above ground storage facilities to spill an estimated 8 million gallons of oil. The largest spill totaled 3.78 million gallons. It came from facilities operated by Bass Enterprises Production Company in Cox Bay, just east of Port Sulphur in Plaquemines Parish, LA. Another Bass Enterprises spill totaling 461,000 gallons occurred near Pointe a la Hache, LA. The second-largest spill, 1,050,000 gallons, was from a broken pipeline owned by Shell Pipeline Co. near Pilot Town, LA. Chevron Oil is believed to have spilled 991,000 gallons near Empire, LA and 53,000 gallons near Port Fourchon, LA, while Venice Energy Services Co. is believed responsible for the discharge of 840,000 gallons near Venice, LA. Shell also was responsible for 13,440 gallons discharged near Nairn, also in Plaquemines.

These incidents indicated a significant need to have more effective response plans for spills caused by natural disasters. In 2005, the National Response Plan (NRP) was revised into the National Response Framework (NRF), which established a single, comprehensive approach to domestic incident management to prevent, prepare for, respond to, and recover from all hazards including terrorist attacks, major natural disasters, and other emergencies.

The response actions during these storms although not specifically identified in reports, indicate the need for R&D in the following areas:

- **Pre-Spill Baseline (SRA 2000)** - research to identify ESA species and other sensitive or important resources near fixed petroleum facilities.
- **Response Management Systems (SRA 2100)** - develop systems that support response actions for multiple spills during natural disasters.
- **In- and On-water Containment and Recovery (SRA 3400)** - identify and pre-place equipment to support facility responses during natural disasters.

### *Super Storm Sandy*

On October 29, 2012, Hurricane Sandy, also known as Super Storm Sandy, made landfall in New Jersey and caused severe damage in the New York and New Jersey metropolitan area. Official estimates indicate that 336,000 gallons of diesel fuel from the Motiva oil tank facility in Woodbridge, N.J spilled into the Arthur Kill, a tidal strait, after the Sandy

storm surge lifted a storage tank and it ruptured. The USCG reported that a secondary containment tank caught most of the oil and that the liquid that escaped moved into the Arthur Kill where booms contained the oil. Two hundred responders were on scene to contain the spill. Initially, an acrid stench filled the air. Air samples collected by the USCG at Arthur Kill showed levels within acceptable thresholds within two days. On the adjacent land, a vacuum truck removed a diesel-and-water mixture next to a local park along the Arthur Kill. Although not specifically identified, the response to this type of storm reflected the research needs for:

- **Response Management Systems (SRA 2100)** - ability to rapidly respond to multiple spills during natural disasters.
- **In- and On-water Containment and Recovery (SRA 3400)** - establish pre-placed equipment to respond to onshore facility spills.

## 7.5 Railroad Spills

Increased oil production of Bakken crude and Canadian Tar Sands along with limitations on pipeline capacity has resulted in a four-fold increase in rail shipments of crude oil between 2010 and 2014. Two derailments illustrate the types of issues that arise with spills from railroad accidents.

### *Parkers Prairie Train Accident*

On March 27, 2013, a mile-long train hauling oil from Canada derailed in western Minnesota and leaked its crude; the leak was the first major spill of the newly developed North American crude. Fourteen of the 94 cars of the Canadian Pacific mixed freight train left the tracks about 150 miles northwest of Minneapolis near the town of Parkers Prairie. The Minnesota Pollution Control Agency reported three tank cars ruptured and leaked an estimated 20,000 to 30,000 gallons. Cold weather made the crude thicker, hindering the ability to recover the oil.

This incident indicates the need for R&D in the following areas:

- **Rail and Truck Transportation (SRA 1600)** - evaluate accident and incident trends to identify ways to minimize the incident rate of leaks, spills, and damage to the environment due to oil spills.
- **Rail and Truck Transportation (SRA 1600)** - evaluate alternative tank car designs and modifications to minimize risk of oil spills during accidents.
- **In and On-water Containment and Recovery (SRA 3400)** - conduct field tests of cleanup techniques and create protocols for various habitats and conditions.

***Lac-Mégantic Train Accident***

On July 5, 2013, a unit train with 72 cars of Bakken crude oil stopped at Nantes, Quebec. The engineer parked and left the train in accordance with an expected shift change. At approximately 00:56 hours on July 6, 2013, the train started to move down the track. It rolled down the approximately 1.2% grade into the center of the small tourist town of Lac-Mégantic, derailed and the locomotives detached from the rest of the train. Since there were no signals or track circuits, the rail traffic controller had no initial indication of the runaway train. Many of the derailed tank cars full of oil exploded and burned in the heart of the commercial district. The accident killed forty-seven people.

Canada's Transportation Safety Board investigated the incident and determined "the braking was insufficient to hold" the runaway train and that the crude was very volatile. The Board also found the tank cars were mislabeled and the crude was more flammable than originally thought. The deadly accident spurred USDOT's Federal Railroad Administration (FRA), to improve safety standards, specifically for the transport of hazardous materials. "No train or vehicles transporting specified hazardous materials can be left unattended on a mainline track or side track outside a yard or terminal, unless specifically authorized." New safety procedures are now in place in the U.S. to reduce the potential for any future incidents occurring. These procedures include requirements for notification prior to leaving an unattended train and mandatory safety inspections by first responders. FRA (2015) also proposed new regulations regarding rail cars carrying crude oil.

This incident indicates additional Research Needs for trains carrying oil in these SRAs:

- **Human Error Factor (SRA 1000)** - increase training in the areas of communication and safety for trainman and dispatchers.
- **Human Error Factors (SRA 1000)** - develop programs for vessel crews to improve their understanding of automated vessel functions.
- **Railway and Truck Transport (SRA 1600)** - analyze hazards and develop corresponding mitigation methods and technologies for headspace gases in tank cars.
- **Railway and Truck Transport (SRA 1600)** - evaluate and determine minimum crew size requirements for safe operations of unit trains.
- **Human Safety and Health (SRA 4300)** - develop protocols for first responders and railroad workers to improve safety and communications in locations where railroads are carrying hazardous cargos.
- **Human Safety and Health (SRA 4300)** - study the impacts of burning crude oil on first responders and residents.
- **Sociological and Economic Impacts (SRA 4400)** - study the economic impacts of a major train disaster on a small community.

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## 8. Current State of Oil Pollution Knowledge

The ICCOPR research and technology planning process involves continually assessing the current state of oil pollution knowledge. ICCOPR and its members continue to monitor and participate in a wide range of studies, workshops, and other events to gain insight into the state of knowledge regarding oil spill prevention, preparedness, response, and impact assessment and restoration. This chapter highlights some of the major sources of information since the 1997 version of the OPRTP was issued.

### 8.1 National Research Council - Oil Spill Dispersants: Efficacy and Effects

In 2005, the MMS, NOAA, USCG, and API funded the National Research Council (NRC) to convene a committee of experts to review the state of knowledge on the use of dispersants as a response technology for oil spills. They asked NRC to identify the adequacy of existing information and ongoing research regarding the efficacy and effects of dispersants. The study focused on: understanding the limitations imposed by the various methods used in previous studies; recommending steps to better understand the efficacy of dispersant use; and the effect of dispersed oil on freshwater, estuarine, and marine environments. The NRC completed the report well before the *Deepwater Horizon* oil spill and therefore did not envision the extensive use of dispersants during that response.

The NRC Committee emphasized the need to conduct bench-scale and meso-scale testing in order to be able to better control the environmental factors that are present in large-scale field experiments. They specifically recommended:

- Studies to better predict the effectiveness of dispersants for different oil types and environmental conditions;
- Bench-scale experiments to test effectiveness over a wide range of operating conditions;
- Investigations of the kinetics and transformation products of dispersed oil biodegradation at conditions that represent those that follow significant dilution of the dispersed oil plume;
- Toxicity studies to determine the mechanisms of acute and sublethal toxicity to key organisms from exposure to dispersed oil;
- Wave-tank studies that specifically address the chemical treatment of weathered oil emulsions; and
- Studies to quantify the weathering rates and final fate of chemically dispersed oil droplets compared with undispersed oil.



## 8.2 The Coastal Response Research Center Workshops

The Coastal Response Research Center (CRRC) was established as a partnership between the NOAA OR&R, and the University of New Hampshire (UNH) in 2003. The CRRC's complementary organization is the Center for Spills in the Environment (CSE). CSE receives funding from sources other than NOAA.

The primary purpose of the CRRC and CSE is to bring together the resources of a research-oriented university and the expertise of governmental agencies, NGOs, academia and industry to conduct and oversee basic and applied research, conduct outreach, and encourage strategic partnerships in spill response, assessment and restoration. The CRRC and CSE hosted numerous workshops that brought together national and international oil spill experts to discuss future R&D Needs. The following workshops identified Research Needs that are important to the improvement of oil spill response and the understanding of potential effects:

- Research & Development Priorities: An Oil Spill Workshop (November 2003)
- Research & Development Needs For Making Decisions Regarding Dispersing Oil (September 2005)
- R&D Needs for Addressing the Human Dimensions of Oil Spills (June 2006)
- Submerged Oil Workshop Report (December 2006)
- R&D Priorities: Oil Spill Workshop (March 2009)
- Coordinating R&D on Oil Spill Response In the Wake of *Deepwater Horizon* (July 2011)
- A Forum – Oil Spill Research (January 2012)
- The Future of Dispersant Use in Oil Spill Response Initiative (March 2012)
- Oil Spill Dispersant Research Forum (March 2013)
- Alberta Oil Sands Workshop (April 2013) Washington State Department of Ecology, the Regional Response Team 10 and Pacific States/British Columbia Oil Spill Task Force (April 2013)
- Environmental Disaster Data Management Workshop (September 2014)

### ***Research and Development Priorities: An Oil Spill Workshop (November 2003)***

This CRRC workshop provided a foundation for a NOAA R&D strategic plan and a road map for funding decisions for five years. The participants considered Research Needs and then prioritized them in terms of short- and long-term research objectives, cost effectiveness, and applicability to response and restoration actions.

The topics were grouped into themes because many overlapped or were similar:

- Physical Transport Forecasting;
- Oil Weathering: Data Development and Modeling;

- Ecosystem Services: Identification and Valuation;
- Communication: Public and Stakeholder Participation in Response and Restoration;
- Restoration Review;
- Chronic Effects of Oil at Individual and Habitat Levels;
- Methods and Techniques; and
- New Tools for Restoration and Recovery.

***Research & Development Needs For Making Decisions Regarding Dispersing Oil (September 2005)***

This CRRC workshop used the major topic recommendations from the 2005 NRC study on dispersant efficacy and effects to serve as the basis for the workshop discussion. The NRC report provided recommendations for major research topic areas within six R&D categories:

- chemical effectiveness of dispersant formulations;
- operational effectiveness parameters;
- hydrodynamics and integration of data needed to develop modeling capabilities to predict and evaluate dispersant effectiveness;
- short- and long-term toxicity of dispersants and dispersed oil;
- long-term fate of dispersants and dispersed oil, including biodegradation; and
- development of relevant exposure regimes.

***R&D Needs for Addressing the Human Dimensions of Oil Spills (June 2006)***

The goal of the CRRC Human Dimensions of Oil Spills Workshop was to bring together a broad spectrum of human dimensions researchers and oil spill practitioners, including industry representatives and regulators, to develop a list of research needs on human dimensions that the Center could use in Request for Proposals (RFPs) and announcements from other funding entities. CRRC specifically designed the workshop to gather holistic perspectives and feedback from all stakeholder groups involved in oil spill response and restoration.

Six research topics were noted as critical components to incorporate into NRDA and other spill response processes. They were:

- Human Use Dimensions;
- Risk Communication;
- Valuing Natural Resources;
- Social Impacts;
- Subsistence;

- Coordination in Response and Restoration; and
- Environmental Ethics.

***Submerged Oil Workshop (December 2006)***

The overall goal of this CRRC workshop was to identify Research Needs information on submerged oil pertaining to the following response and restoration topics:

- Detection and Monitoring;
- Fate and Transport;
- Containment and Recovery (including Protection of Water Intakes); and
- Effects and Restoration.

***R&D Priorities: Oil Spill Workshop (March 2009)***

This CRRC workshop focused on areas where significant Research Needs still existed. This was a follow-up to the 2003 CRRC five-year R&D Needs Workshop. Participants were asked to discuss the needs in the areas of:

- **Spill Response During Disasters** - This area addressed issues that are encountered during natural (e.g., earthquakes, hurricanes, floods) or anthropogenic (e.g., accidents) disasters resulting in nearshore and offshore oil spills. Planning and implementation gaps and health and safety issues were the primary focus.
- **Response Technologies** - This research area addressed planning, implementation, technology and effectiveness issues for response (i.e., bioremediation, surface washing agents, solidifiers, sorbents, dispersants, and ISB).
- **Acquisition, Synthesis and Management of Information** - This research topic focused on practices and methodologies for accessing and using remote-sensing data, real-time observational data systems, electronic data collection via field surveys, and geographic information systems (GIS).
- **Human Dimensions** - This research topic addressed the human dimension as part of a response, including: 1) minimizing social impacts and subsequent response activities; 2) developing strategies to address the long-term socioeconomic effects oil spills have on a region's culture and vitality; 3) translating and incorporating social science research, methodologies, and initiatives into individual and collective response plans; and 4) assessing where social science research "fits" into the spill management structure.
- **Ecological Monitoring and Recovery Following Spills** – This research area focused on: 1) understanding long-term ecological recovery to make informed

- decisions from response to restoration; 2) understanding the ecological factors affecting recovery rates; 3) developing ecological ‘metrics’ that can be applied by resource managers to develop restoration projects that best compensate for lost resources.
- **Biofuels** – This topic addressed research on first generation biofuel blends in terms of spill response technologies and determination of fate and effects after a spill.
  - **Ecological Effects of Oil Spills** – This topic addressed issues around the long-term effects of residual oil in the environment, including the levels and types of adverse effects resulting when oil remains, and the effects of an oil spill that may be magnified by the clean-up technologies.
  - **Environmental Forensics** - This topic focused on chemical fingerprinting methods to determine the source and extent of oil resulting from an incident. This information can be important for clean-up, assessment, recovery, monitoring, and associated liability issues.

***Coordinating R&D on Oil Spill Response in the Wake of Deepwater Horizon (April 2011)***

The CSE organized this workshop to bring together experts from across a broad spectrum of organizations to address the state of future oil spill response research and practices. The overarching goals were to: (1) develop an updated list of Research Needs for response related to dispersant efficacy and effects, spill trajectory modeling, detection of surface and subsurface oil, human dimensions in spill response, seafood safety monitoring and information management; and (2) create a dialogue between researchers and responders in order to ensure translation of research results into practice.

***A Forum –Oil Spill Research (January 2012)***

The goal of this forum is to encourage dialogue among Principal investigators (PI's) of current research related to oil spill response (e.g., GoMRI, NSF) and industry and government representatives in order to coordinate R&D activities regarding future oil spill response in the wake of the *Deepwater Horizon*.

The objectives of this forum were to review previous and on-going R&D conducted by academic, governmental agencies and industry; present newly funded projects so that everyone is aware of what types of research are being conducted; and evaluate mechanisms for scientific exchange and coordination of oil spill response R&D efforts going forward.

As defined for this forum, oil spill response R&D encompassed any of the following topics:

- Physical, Chemical and Biological Fate and Transport;
- Biological Effects - Resources at Risk;
- Response Technologies;
- Oil Spill Modeling;
- Monitoring and Detection of Surface, Subsurface and Dispersed Oil;
- Human Dimensions and Risk Communication.

***The Future of Dispersant Use in Oil Spill Response Initiative (March 2012)***

CRRC convened this workshop with the goal of bringing together federal and state representatives, academic scientists, responders, and other stakeholders to discuss the future of dispersant use in spill response in the United States. The overall goals for the workshop were to:

- Build a fact-based consensus on the trade-offs associated with dispersant use;
- Evaluate the current state-of-knowledge on the monitoring, behavior, effects, and fate of dispersants;
- Identify information gaps; and
- Recommend R&D topics to help inform dispersant use in future spill response.

***Oil Spill Dispersant Research Forum (March 2013)***

Coordination with research, technology, application, and response is needed to optimize dispersant efficacy and effectiveness. After the *Deepwater Horizon* oil spill, there was an increase of research on dispersants and dispersed oil, with a large amount of research coming from the Gulf of Mexico Research Initiative (GoMRI), BSEE, and industry.

This workshop focuses on enhancing communication about dispersant related research and its application, use, and transition to spill response efforts. It was convened with the goal of encouraging, opening, and continuing dialogue among principal investigators (PIs) of research related to dispersant use and response practitioners. The overall objective was to review prior and current research and development (R&D) conducted by academia, government agencies and industry and evaluate mechanisms for scientific exchange and coordination of these efforts. Specific objectives were to:

- Learn about on-going and newly funded R&D on dispersants and dispersed oil (DDO);
- Determine how on-going and new R&D on DDO can improve dispersant use (assuming that dispersants will continue to be a tool in some spill responses);

- Develop mechanisms for information exchange/interaction among researchers, practitioners and public/nongovernmental organizations regarding DDO;
- Explore data needs, tradeoffs, and decisions of practitioners regarding DDO before, during and after spills; and
- Identify potential R&D efforts on DDO that could improve dispersant use during future spills offshore. Other goals were to (1) encourage and continue dialogue on DDO among researchers, spill practitioners and NGO's; and 2) foster mechanisms to enhance public understanding;
- Common themes across breakout groups at the meeting included: enhancing and continuing communication between researchers and responders regarding DDO; increasing public outreach and education; and improving comprehensive and transparent transition of research from laboratory to field application. Modeling is a tool that could act as a potential bridge between laboratory research and field application.

***Alberta Oil Sands Workshop (April 2013)***

The Washington Department of Ecology contacted the University of New Hampshire's CSE to conduct a workshop for relevant state and Federal agencies on the important issues related to OSP characteristics, transportation and response planning. A similar training was conducted for the State of Maine related to transport of OSP and Bakken crude through that State.

The first day of the workshop was an open forum, which provided information to a broad group of stakeholders from the region. The second day was a working session for response practitioners to focus on issues related to potential OSP spill scenarios. Task groups were given four potential scenarios to test the current understanding of OSP and identify future information and other needs. The breakout groups identified actions that could be taken to improve both near- and longer-term OSP spill response.

***Environmental Disaster Data Management Workshop (September 2014)***

In the wake of the *Deepwater Horizon* oil spill, the significant body of information, including new research, has highlighted the need for improved coordination of data management. It is common for multiple organizations to collect data that vary significantly in quality, collection methods, access, and other factors that affect use by others. These differences result in limitations for use of the data including comparing results or making inferences.

The Environmental Disasters Data Management (EDDM) Workshop, organized by NOAA's OR&R with assistance from CRRC, was the beginning of a project to foster communication between collectors, managers, and users of with a goal to identify and

establish best practices for orderly collection, storage, and retrieval of data. The objectives of the EDDM project are to:

- Engage the community of data users, data managers, and data collectors to foster a culture of applying consistent terms and concepts, data flow, and quality assurance and control;
- Provide oversight in the establishment and integration of foundational, baseline data collected prior to an environmental event;
- Provide best-practice guidance for data and metadata management
- Suggest infrastructure design elements to facilitate quick and efficient search, discovery, and retrieval of data; and
- Define the characteristics of a “gold standard” data management plan for appropriate data sampling, formatting, reliability, and retrievability.

### **8.3 Department of Energy (DOE) Programs**

DOE’s ongoing research within the Office of Fossil Energy is focused on the prudent development of domestic oil and gas resources. Onshore research is coordinated with the USEPA and the Department of the Interior (DOI)/US Geological Survey (USGS). The three agencies jointly developed a framework for Federal research that addresses how to safely and prudently develop the Nation’s unconventional oil and gas resources. The unique and specific core research competencies of each agency underpin the synergy of this research effort. This multiagency research strategy includes key research questions the agencies will address in a coordinated fashion. These research questions focus on protecting groundwater and air quality, reducing, reusing, and recycling water used in upstream exploration and production operations, reducing the surface and subsurface impacts of oil and gas exploration and production activities, and improve the understanding for the purpose of mitigating induced seismicity.

Offshore research is coordinated with the DOI/Bureau of Safety and Environmental Enforcement (BSEE). Prior to the BP Deepwater Horizon oil spill, DOE’s offshore research had been directed at maximizing the value of the Nation’s offshore oil and gas resources while protecting the environment. A recommendation of the President’s National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling was that DOE should refocus its offshore research activities. In working with the DOI/BSEE Ocean Energy Safety Advisory Committee, DOE refocused its offshore research program on oil spill prevention. DOE’s focus has since been on assessment and mitigation of the risk of loss of well control so as to prevent oil spills. Research pathways include: identification of geologic hazards, well control during the drilling and completion process, integrity of the surface facilities and umbilicals, and subsea reliability and automation.



## 8.4 Ultra-Deepwater Advisory Committee Annual Plan Reviews

The Ultra-Deepwater Advisory Committee (UDAC) was formed in 2007 to advise the Secretary of Energy on the development and implementation of programs related to ultra-deepwater (UDW). The Committee, sunset in 2013, provided recommendations for incorporation into DOE's annual plan of research.

In 2011, the UDAC suggested that, because of the *Deepwater Horizon* accident, there should be projects aimed at placing additional measuring instruments in the well and/or at the wellhead to determine the nature of the well fluids, pressures, and their flow status in real time. They recommended that this work be combined with development of secure methods for transmitting the data to the surface and providing timely interpretation. Analysis of the *Deepwater Horizon* incident indicated that a lack of reliable information hampered control efforts from the initial blowout to the final capping of the well. The UDAC also recommended conducting studies of current subsea containment and capture technologies (hardware), including gap analyses and needs for future technologies with emphasis on subsea capture systems that are independent of surface facilities. Because a number of behavioral factors associated with operations, maintenance, and training contributed to the *Deepwater Horizon* incident, the UDAC recommended research aimed at discovering the fundamental attitudes of rig personnel and associated groups to health and safety issues.

In the 2012 review of the DOE offshore research plan, the UDAC indicated that there was a strong emphasis on the engineering aspects of increasing safety, but little attention was given to the aspects of human behavior regarding safety. However, given the causal factors in the *Deepwater Horizon* incident, research into how to conduct the human aspect of operations safety and how to use advanced decision support and backup systems is not only prudent, but also mandatory.

The UDAC indicated that information is limited regarding methods to prevent and respond to catastrophic events, and mitigate the negative impacts of spills in remote, harsh and sensitive environments. Environmental protection and personnel health and safety working in harsh, unique and sensitive marine habitats, such as Arctic waters and tropical coral reef areas, requires additional focus. To accomplish this, the UDAC recommended that a gap analysis be conducted to catalog and characterize the salient differences between operations in the Gulf of Mexico and those environments encountered in drilling and completion in unique and sensitive marine habitats, such as Arctic waters and tropical coral reef environments, to assess the risks that demand more research.

Finally to further improve safety, the UDAC recommended the present scope of expert (case-based) systems be determined, and then benefits and limitations be identified, as

well as other applications (e.g., cementing, completions, wellbore design), that would reduce the risk when operating in deepwater.

## **8.5 Deepwater Horizon Oil Spill Principal Investigator Conferences**

The *Deepwater Horizon* oil spill focused unprecedented attention on the Gulf of Mexico ecosystem. During the response to the *Deepwater Horizon* event, resource managers and researchers from across the country collaborated to conduct science, monitoring, and response activities to understand impacts from the spill. The data and information collected from those efforts have since been used to make progress towards the long-term goal of protecting and restoring public health and natural resources in the Gulf of Mexico.

In 2010 and 2011, the National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology (NSTC JSOST) convened two major workshops in St. Petersburg, Florida of Principal Investigators (PIs) actively involved in research, sampling, and monitoring activities in response to the *Deepwater Horizon* incident. Each of the workshops was an opportunity for PIs to foster new collaborations, compare initial results, interact with federal agencies, and discuss recommendations for longer-term research activities.

The October 2010 Conference had six breakout groups. Five groups addressed oil/dispersant: fate and extent; impacts and mitigation in the offshore; impacts and mitigation in coastal areas; impacts and mitigation on living marine resources; and impacts and mitigation on human health and socio-economic systems. The sixth group addressed the use of *in situ* and remote sensors, sampling, and systems for assessing the extent, fate, impacts, and mitigation of oil/dispersant.

The follow-on workshop in October 2011 was an opportunity for researchers to present results of studies that were in progress during the first conference in October 2010. The second conference provided a significant amount of information regarding the spill impacts, early recovery, and the scientific efforts to capture that information. Researchers presented numerous potential research needs going forward. As in the initial 2010 conference, the participants identified a series of overall recommendations and observations about gaps and needs for continued research and ways to improve scientific understanding of Gulf of Mexico science issues.

## **8.6 Deepwater Horizon Incident Specific Preparedness Review**

In January 2011, the USCG Commandant chartered the Incident Specific Preparedness Review (ISPR) for the response to the *Deepwater Horizon* oil spill in 2010 to examine the implementation and effectiveness of the preparedness and response to the incident as

it related to the National Contingency Plan, Area Contingency Plans, and other oil spill response plans. The report was divided into three main chapters: Planning and Plan Execution, Organization, and Resources and Readiness. The ISRP also provided a list of lessons learned and recommendations.

- **Planning and Preparedness** - There was a general weakness in the USCG's ability to respond to this type of large spill. The problems were the result of budget reductions organizational structure. The agency needs to reassess its readiness programmatically and reinvest to the extent that Marine Environmental Response (MER) is, once again, firmly established as one of the USCG's core competencies.
- **Area Contingency Plans** - The ISPR found these plans to be inadequate for this size of incident. The USCG needs to provide service-wide direction to all Area Committees, develop minimum standards for contingency plans, and establish an oversight, review, and compliance program.
- **Environmentally Sensitive Areas** - In some planning areas, the ESAs were not identified. In some plans where the areas were listed, they were not prioritized. In a few instances, ESAs did have protection strategies for the heavily affected areas. There must be a national planning process that identifies ESAs and ensures that there are trained personnel, equipment, and strategies adequate to protect these resources.
- **Alternative Response Technologies** - The use of two alternative response technologies, dispersants and ISB, proved critical to preventing wholesale impacts to ESAs. This was possible because the spill characteristics, location, and distribution of ESAs were favorable to the use of these technologies. However, important concerns and questions remain about their impacts on the environment, and more research is necessary before bringing them into the mainstream of spill response options. The use of dispersants during the *Deepwater Horizon* incident identified a need for a thorough review of this response option, its efficacy in minimizing environmental impacts, its overall effect on the environment, and conditions under which they are most effective. Dispersant protocols and authorization procedures should be established and articulated in ACPs. The National Response Team should require that all RRTs establish ISB guidelines as a viable response option in their area of responsibility, consistent with public health and safety issues.
- **Effective Daily Recovery Capacity (EDRC)** - EDRC is the planning standard used to estimate the rate at which mechanical means (e.g., skimmers) can recover an amount of oil and rate capabilities of oil spill removal organizations (OSROs). Revised EDRC requirements could stimulate OSROs to invest in response research and development, with the goal of developing skimmers and other recovery equipment that are more efficient.

- **Funding** - Many of the recommendations provided in the report require additional or new funding. The *Deepwater Horizon* incident showed the response community and the public that a “business as usual” approach to funding would not work.
- **National Response Framework (NRF)** - The USCG should fully implement its policy on connectivity with the NRF, including an expanded outreach program to state and local emergency managers through sector participation with Local Emergency Planning Committees, and District participation with Regional Interagency Steering Committees.
- **Crisis Leadership** - The *Deepwater Horizon* incident placed individuals into crisis management roles, and not all were able to demonstrate the required leadership. The National Incident Command concept worked very well during this incident, and it provides a model for selecting individuals with the necessary crisis management skills to lead response efforts and to manage effectively future national incidents.
- **Lessons Learned** - The USCG needs to formally address lessons learned, institutionalize them through programmatic changes, and in some cases, through cultural changes.

## 8.7 National Commission on BP Deepwater Horizon - Final Report

In January 2011, the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (Commission) issued their Report to the President – *Deepwater: The Gulf Oil Disaster and the Future of Offshore Drilling*. The Commission’s complete recommendations in the report reflect the government’s sweeping sovereign authority as owner of the seabed and water column and, as the regulator of activities there, with the overriding responsibility to manage and protect the valuable resources of the outer continental shelf (OCS) on behalf of current and future generations. The Commission’s report grouped recommendations in nine distinct areas:

- Improving the safety of offshore operations through greater government oversight and control including a new regulatory organizational structure;
- Improving the safety of offshore operations by industry through greater emphasis on a more risk based approach to operations and safety;
- Safeguarding the environment;
- Strengthening oil spill response, planning, and capacity;
- Advancing well-containment capabilities;
- Overcoming the impacts of the *Deepwater Horizon* spill and restoring the Gulf;
- Ensuring financial responsibility;
- Promoting Congressional engagement to ensure responsible offshore drilling; and

- Developing approaches for frontier regions to incorporate lessons learned during the *Deepwater Horizon* oil spill.

Within each of the major categories, the Commission had additional specific actions and recommendations to improve offshore drilling prevention, preparedness, response and environmental protection and restoration.

The Commission Staff Working Paper No. 7, “Response/Clean-up Technology Research & Development and the BP Deepwater Horizon Oil Spill,” documented the state of research and development by the private sector and federal government specific to containment and well-control technology. The paper was provided to the full Commission for consideration as it deliberated its report to the President. The paper discussed three basic questions:

- Does the private sector invest less than the socially optimal amount in response/cleanup technology?
- Do federal agencies lack adequate long-term funding to maintain response/cleanup preparedness?
- Can the federal government and industry create a set of incentives for private companies and government agencies that would optimize levels of investment in response/cleanup technology?

The paper concluded that there was a response R&D gap. The paper suggested that the National Commission consider:

- Recommending language in OPA 90 to guarantee the full oil spill research authorization provided in the Act as originally intended.
- Recommending OPA 90 be amended to guarantee sustained and additional funding for O&G.
- Recommending ways to stimulate the cleanup technology market and incentivize related R&D,
- Recommending that the EDRC regulations be revised to give an incentive for response companies to employ the most efficient recovery equipment.
- Recommending that EPA streamline the permitting process for open-water testing and that EPA loosen its oiled-water discharge requirements for technology testing purposes.

## **8.8 Public Meetings, Letters, and Reports Submitted to ICCOPR**

As part of the R&T planning process, ICCOPR held three public meetings in 2010 to solicit input on future oil pollution research needs. ICCOPR advertised the public meetings in the Federal Register and conducted them on the West, East, and Gulf Coasts to obtain different regional interests and perspectives.

In addition to the public meetings, ICCOPR also received letters from the Pacific States/British Columbia Oil Spill Task Force, the U.S. Arctic Research Commission, and the Marine Mammal Commission and a report entitled “Assessing the Long-term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs.”

## **8.9 National Research Council: Responding to Oil Spills in the U.S. Arctic Marine Environment**

A group of organizations requested that the National Research Council of the National Academy of Sciences conduct a study of the current capabilities to respond to oil spills in the Arctic. ICCOPR sponsors included the USCG, BSEE, BOEM, NOAA, and USARC. Other sponsors included API, Marine Mammal Commission, and OSRI. The report had four main sections: 1) Environmental Conditions and Natural Resources in the U.S. Arctic; 2) Arctic Oil Spill Response Research; 3) Operations, Logistics, and Coordination in an Arctic Oil Spill; and, 4) Strategies for Response and Mitigation. Each section described the current state of knowledge or capabilities of the U.S. response organizations and made recommendations for an effective prevention, preparedness, and response system.

NRC released the report after ICCOPR had completed the Research Needs Identification Process (see section 6.1) and was in the Needs Prioritization Process (see section 6.2). The R&T Plan Workgroup reviewed the NRC report and determined that the recommendations were consistent with the Research Needs already under consideration. The Workgroup used the NRC recommendations as a factor in selecting priority Research Needs.

## **8.10 National Petroleum Council: Arctic Potential – Realizing the Promise of U.S. Arctic Oil and Gas Resources**

In 2013, the Secretary of Energy commissioned the National Petroleum Council (NPC) to conduct a comprehensive study considering the research and technology opportunities to enable prudent development of U.S. Arctic oil and gas resources. The study included an in-depth assessment of available offshore oil and gas technology, ongoing research, and research opportunities, in six areas:

- Ice characterization
- Oil and gas exploration and development
- Logistics and infrastructure
- Oil spill prevention and response
- Ecology, and
- Human environment.

The report includes extensive information on the state of knowledge on Arctic technologies and operations, spill prevention and response capabilities, and the ecological and human environment. The NPC issued the Executive Summary of the report in March 2015 after ICCOPR had completed the prioritization process and was in the final stages of developing the text of this OPRTP. As such, the NPC report was issued too late for ICCOPR to consider it in developing this version of the Plan. However, ICCOPR will continue to review the NPC report and use it as a source of information.

## 8.11 Industry Reports

The oil and gas industry convened the Joint Industry Oil Spill Preparedness and Response (OSPR) Task Force (JITF) in June 2010 to evaluate procedures and lessons learned during the *Deepwater Horizon* oil spill response. The initial focus of the JITF was to identify potential opportunities for improvement to oil spill response systems in the areas of planning and coordination, optimization of each response tool, R&D, technology advancement, and training/education of all parties preparing for or responding to an oil spill. The JITF spent several months developing and prioritizing project plans to address each preliminary recommendation, and subsequently received approval and Industry funding for a multi-year work program. The JITF divided its recommendations into seven categories, or work streams:

- Planning;
- Dispersants;
- Shoreline protection and cleanup;
- Oil sensing and tracking;
- *In-situ* burning;
- Mechanical recovery; and
- Alternative technologies.

Nine oil and gas companies established the Arctic Oil Spill Response Technology Oil Joint Industry Programme (JIP) to further build on existing research and improve the technologies and methodologies for Arctic oil spill response. The goal of the JIP was to advance Arctic oil spill response strategies, improve equipment and increase understanding of potential impacts of oil on the Arctic marine environment. There were seven key areas of research addressed by the JIP specifically for the Arctic:

- Dispersants;
- Environmental effects;
- Trajectory modeling;
- Remote sensing;



- Mechanical recovery;
- *In-situ burning*; and
- Field research.

## 8.12 Prince William Sound Oil Spill Recovery Institute (OSRI) Research Plan 2011-2015 (February 2010)

The Prince William Sound (PWS) Oil Spill Recovery Institute (OSRI) was authorized in 1990 by the United States Congress to “identify and develop the best available techniques, equipment, and materials for dealing with oil spills in the Arctic and sub-Arctic marine environments” (Title V, Section 5001, Oil Pollution Act of 1990). OPA 90 amendments in 1996 and 2005 expanded the area of emphasis and extended the life of OSRI programs until one year after the completion of oil exploration and development efforts in Alaska.

OSRI sponsors research programs on physical oceanography and meteorology designed to improve the ability to forecast weather and ocean conditions. OSRI works with a wide array of industry and agency organizations to sponsor technological improvements for oil spill response. This includes contributing to the testing of new skimmer technologies, sensitivity index maps, and sponsoring workshops to identify best practices and research needs. It supports K-12 classroom programs and recently worked to include more technology in the education programs. With the increased desire by industry to develop offshore regions of the Arctic, there is greater emphasis on improving technologies for oil spill response in ice-laden waters.

OSRI’s 2011-2015 Research Plan outlines the priority research areas that it will be funding:

- Interdisciplinary approaches to understanding the fate and effects of an oil spill in the Arctic and the recovery of that oil;
- Development of response tools to assist responders to mitigate the impact of spills in the Arctic; and
- Communication and education of the public on the issues related to oil spills in the Arctic.

## 9. Oil Spill Research and Technology Priorities

ICCOPR selected 150 priority oil pollution Research Needs to address the 25 SRAs and SRA subcategories using the deliberative process described in Chapter 6. These priorities represent the federal opinion on where federal research programs should focus in order to make the most progress to addressing the overall Research Needs. Each federal agency should consider these priorities as they make their research investments. ICCOPR encourages non-federal research programs to use these priorities as well. ICCOPR will track progress toward addressing these priorities during the next planning cycle and establish a new set of priorities at that time.

ICCOPR organized the priority Research Needs by the four major Classes of research: Prevention, Preparedness, Response, and Injury Assessment and Restoration (Figure 9-1)



**Figure 9-1 - The Oil Spill Research Categorization Framework**

As discussed in Section 4.1, this framework embodies the concept that the research in each Class can inform and support the research from other classes; and that the Preparedness class plays a central role in supporting them all. Member organizations may conduct or support research in a single Class or multiple Classes depending on their specific mission, regulatory responsibilities, and/or expertise.

Table 9-1 lists the Classes and the SRAs they encompass. The following sections present the top priority Research Needs by Class and SRA or SRA subcategory. The order of the three priorities listed within an SRA or SRA subcategory is not indicative of their relative importance. All three are of equal importance. The Classes are:

**Prevention Class** - Research that supports the development of practices and technologies designed to reduce the likelihood of releases or minimize the volume of oil released into the environment.

**Preparedness Class** - Research that determines baseline conditions or supports the activities, programs, and systems typically developed prior to an oil spill to improve the

planning, decision-making, and management processes needed for responding to and recovering from oil spills.

**Response Class** - Research that supports techniques and technologies that address the immediate and short-term effects of an oil spill and encompasses all activities involved in containing, cleaning up and treating oil in order to: 1) maintain safety of human life; 2) stabilize a situation to preclude it from worsening, and 3) minimize adverse environmental and socioeconomic effects.

**Injury Assessment and Restoration Class** - Research that involves the collection and analysis of information to evaluate the nature and extent of environmental, human health, and socioeconomic injuries resulting from an incident, and determine and refine the restoration actions needed to bring injured natural resources and services back to pre-spill conditions and make the environment and public whole after interim losses.

**Table 9-1 Standing Research Areas (SRAs) by Research Class**

Prevention	Preparedness	Response	Injury Assessment & Restoration
<ul style="list-style-type: none"> <li>• Human Error Factors</li> <li>• Offshore Facility and Systems</li> <li>• Onshore Facilities and Systems</li> <li>• Waterways Management</li> <li>• Vessel Design</li> <li>• Drilling</li> <li>• Rail &amp; Truck Transportation</li> <li>• Pipeline Systems</li> </ul>	<ul style="list-style-type: none"> <li>• Pre-spill Baseline Studies</li> <li>• Response Management Systems</li> </ul>	<ul style="list-style-type: none"> <li>• Structural Damage Assessment and Salvage</li> <li>• At Source Control and Containment</li> <li>• Chemical and Physical Behavior Modeling</li> <li>• Oil Spill Detection and Surveillance</li> <li>• In- and On-water Containment and Recovery</li> <li>• Shore Containment and Recovery</li> <li>• Dispersants</li> <li>• In-situ Burning</li> <li>• Alternative Countermeasures</li> <li>• Oily and Oil Waste Disposal</li> <li>• Bioremediation</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental Impacts and Ecosystem Recovery</li> <li>• Environmental Restoration Methods and Technologies</li> <li>• Human Safety and Health</li> <li>• Sociological and Economic Impacts</li> </ul>

## 9.1 Prevention Priority Research Needs



### 9.1.1 Human Error Factors Priorities (Section 4.3.1.1)

This SRA focuses on how human performance and factors contribute to accidents in the oil production/transportation system. It includes the development of advanced methods and systems for training operational personnel, basic research on operating personnel performance in preventing oil spills (safe navigation on vessels, proper oil transfer practices, analysis/evaluation of equipment monitoring systems, decision-making processes), and the development of methods and technologies to evaluate the ability and knowledge of operating personnel in performing their duties. This may extend to evaluation of the overall management culture and its ability to foster the appropriate organizational safety, preparedness and response operating environment.

The priorities selected focus on improving the performance of individuals to reduce potential spills through better technology and improved training methods. ICCOPR selected Research Needs that emphasized development of innovative training methods by using simulations and gaming. At the operational level, improvements in instrumentation and data interpretation technology are essential to allow better decisions to be made on vessels, in ports, and on railway and pipeline transportation systems.

- Improve performance and decision-making by developing innovative training methods including readiness evaluations, gaming and simulators.
- Conduct research to determine current level of expertise for operators within modern transportation systems including marine, rail, truck, and pipeline.
- Improve and develop sensors; instrumentation; command electronics; and advanced data interpretation technologies and alert systems, including data analysis and expert systems to enhance decision-making capabilities.

9.1.2 Offshore Facilities and Systems Priorities (Section 4.3.1.2)

This SRA includes: offshore exploration and development wells, platforms, and well control systems; the methods, techniques, and equipment for system reliability inspections; systems to detect, prevent, and mitigate oil and gas discharges; and equipment to regain control of a well blowout or any other accidental discharge. It also includes transfer equipment, storage units, and piping used to transfer oil within the offshore system and connect the system to transfer pipelines. This technology is relevant for the multiple operating environments of exploration and production activities (e.g., Arctic, shallow, deep and ultra-deep waters).

One of the selected priorities acknowledges the special conditions that occur in the Arctic. Another priority recognizes the need to address material integrity in deepwater, the Arctic and other frontier drilling locations.

- Evaluate corrosion and corrosion mitigation processes at the splash zone for offshore platforms.
- Study effects of ice forces, scour and gouging with respect to prevention of oil spills from offshore facilities.
- Conduct studies related to the longevity and integrity of metallic materials used under extreme conditions in relation to new surface treatments and alloys.

9.1.3 Onshore Facilities and Systems Priorities (Section 4.3.1.3)

This SRA includes designs, techniques, operational procedures and equipment for fixed onshore facilities including wells. It covers inspections and systems to detect, prevent, and mitigate oil and gas discharges from the facilities and their systems, including transfer equipment, storage, and piping.

The priorities for this SRA emphasize the need to improve the integrity and operations of onshore facilities. As in other SRAs, the priorities for Onshore Facilities recognize the need to address the effects of emerging crude and Arctic environments on facility infrastructure. There are two subcategories under this SRA: 1) Tank and Piping Inspection, Operations, Design, and Data; and, 2) Emerging Issues.

**TANK AND PIPING INSPECTION, OPERATIONS, DESIGN, AND DATA**

- Analyze upstream and/or downstream causes and magnitude of discharges from tanks, appurtenances, and associated piping.
- Develop improved methods and protocols used to determine the imperviousness of secondary containment structures.
- Evaluate the efficacy of sorbent and similar technologies used as oil spill control measures for storm water filtration and secondary containment shut-off drains.

**EMERGING ISSUES**

- Identify the effects of an aging oil storage infrastructure (tanks, appurtenances, and piping systems) and develop methodologies/protocols to predict/minimize failures.
- Assess the effects of emerging crude oils and alternative fuels on tanks, appurtenances and piping.
- Assess the effects of Arctic and cold weather environments on the operation and maintenance of tanks, appurtenances, and associated piping.

9.1.4 Waterways Management Priorities (Section 4.3.1.4)

This SRA includes methods, equipment, and integrated systems designed to improve navigation at sea and in ports, rivers, and inland waterways. It includes on-board navigation systems, such as integrated navigation and bridge systems and collision avoidance systems. It also includes systems external to the vessel, such as vessel traffic and tracking systems, navigational aids and piloting systems, as well as includes general research into navigation risks, the effects of navigational safety programs, and the development of decision support tools for waterways management efforts. This SRA includes development of navigational channel maintenance programs and analysis of voyage pre-planning processes.

The priorities selected recognize the special nature of operations and navigation in ice-infested waters of the Arctic. They also focus on the need to improve technology on ships and in ports for traffic control.

- Improve navigation through enhanced piloting systems, electronic charts and information systems.
- Improve systems and protocols needed for traffic control in ports.
- Improve Arctic waterways management/vessel accident prevention, including improvements in (a) Arctic communications, (b) emergency response paradigms for vessel accidents (e.g., vessel foundering), (c) ice piloting requirements/qualifications, (d) Arctic weather, and (e) ice forecasting.

9.1.5 Vessel Design Priorities (Section 4.3.1.5)

This SRA includes the development, physical and numerical modeling, and testing of advanced tanker and barge designs to make these vessels less susceptible to damage and less likely to spill their cargoes into the waterways if an accidental grounding, collision or structural failure occurs. This SRA also includes research on non-tank vessel designs



(e.g., double-hulled fuel and lube oil tanks) to minimize the possibility of spillage from collisions, allisions, and groundings.

The selection of priorities recognizes the significant progress made because of the double hull tanker design mandated by OPA '90. The priorities in this SRA emphasize the design of vessels for survivability during accidents and the tools and models necessary to assess the effectiveness of ship structures to estimate spill potential. ICCOPR recognizes the need for design improvements for operating in the extreme environments of the Arctic.

- Develop designs and methods to improve survivability of ships and structures in damaged condition.
- Develop improved analytical tools (procedures, computer models, and software) to evaluate performance of structures in collisions, allisions, and groundings, so that estimates of damage extent and loss of oil-tight boundaries are available.
- Develop improved designs and analytical tools (procedures, computer models, and software) for design and operation of ships and marine structures in extreme environments.

#### 9.1.6 Drilling Priorities (Section 4.3.1.6)

This SRA focuses on: the design, construction, and placement of wells (deepwater and ultra-deepwater, and onshore); materials, sensors, and systems needed for offshore drilling and production platforms, and well heads/risers; and techniques and equipment for well and facility monitoring and inspection under extreme pressure and temperature environments. Also included are efforts aimed at understanding the chemical and physical characteristics for the full range of petroleum oils under varying conditions of pressure and temperature; predicting their phase/state, behavior and their physical interaction with other materials in the environment (e.g., rock and sediments); and their impact on engineered systems. Example issues include: early kick detection; systems for communicating and responding to changes in downhole parameters; strategies and methods for training operational personnel on the use of advanced technology; systems to detect and prevent oil and gas discharges; and well-head systems and equipment to control wild wells and cap well blowouts.

ICCOPR again recognizes the need to prioritize research that focuses on operational differences in the Arctic. Other research priorities focus on improving drilling systems and the knowledge of complex reservoir conditions to better assess potential incidents related to stratigraphy and hydrocarbon pathways. There are two subcategories to this SRA: Deepwater Drilling and Technology and Reservoir Characterization.

**DEEPWATER DRILLING AND TECHNOLOGY**

- Evaluate subsea blowout preventer control pod batteries including assessments of battery design, life expectancy, performance, and reliability with respect to different manufacturers.
- Conduct a gap analysis on current managed pressure drilling (MPD) techniques to identify future critical needs.
- Study the interaction and potential for failure at the interface of each system (formation - cement - instrumentation) and develop advanced downhole tools to assess the integrity of the system *in situ*.

**RESERVOIR CHARACTERIZATION**

- Conduct research, including improved modeling, on the conditions (e.g., *in-situ* stress, sediment rheology, fluid pressure, flow rate, and blowout duration) where hydrocarbon pathways to the sea floor are established through hydraulic fractures and reactivated natural faults.
- Characterize reservoirs to identify geologic conditions, such as bounding strata weaknesses that need special engineering considerations to ensure hydrocarbon containment.
- Characterize reservoir conditions associated with offshore Arctic oil and gas provinces to identify potential issues in areas of offshore clathrates, sea ice, and other effects.

9.1.7 Rail and Truck Transportation Priorities (Section 4.3.1.7)

This SRA includes the development and testing of rail and truck transport system designs, operations, and infrastructure to make oil tanks less susceptible to damage and loss of cargo during normal operations, train accidents and derailments, or truck accidents. This SRA includes evaluation of vehicle designs, construction materials, spill prevention devices, and loading/unloading systems and equipment. It also includes evaluations of: the physical and chemical characteristics and behavior of the crude oils being shipped, the effects of those characteristics on the tanks during operations and under accident conditions, and systems to control these characteristics. This SRA also includes evaluations of safety systems and processes to: manage the movement and composition of trains and trucks carrying crude oil, prevent accidents and derailments, select preferred shipping routes, and respond safely to an oil spill emergency.

The selection of priorities under this SRA recognizes the increased volume of crude oil transported by rail and truck in response to the energy renaissance in the U.S. and

Canada. ICCOPR also recognizes the unique characteristics of the crude oils transported by rail and trucks and the hazards they pose under accident conditions.

- Analyze hazards and develop corresponding mitigation methods/technologies for head space gases in tank cars.
- Evaluate accident and incident trends to identify ways to minimize the incident rate of leaks, spills, and damage to the environment due to oil spills.
- Evaluate alternative designs and modifications to minimize risk of oil spills during accidents.

#### 9.1.8 Pipeline Systems Priorities (4.3.1.8)

This SRA includes the development, operation, monitoring, and inspection of offshore and onshore pipeline systems used to transport oil between facilities. It covers the pipeline system design, procedures, and equipment for pipeline operations and inspection protocols to prevent, detect, and mitigate oil discharges. Pipeline research under this SRA also includes technologies to prevent (detection/characterization and repair of anomalies before failure) and detect failures, as well as monitor/control systems that can rapidly isolate and shut down operations in order to minimize spillage when failures occur.

ICCOPR in the selection of priorities recognized the need for better detection technology to prevent incidents and protect human health. In the area of ensuring pipeline integrity, ICCOPR recognized the need to develop technology that will detect potential anomalies and failures in pipeline materials. There are two subcategories for this SRA: Materials and Integrity.

#### **MATERIALS**

- Develop new advanced technology for sensing pipeline leaks that will reduce leak detection false alarms for new construction and existing pipelines.
- Improve existing leak detection technology and health monitoring sensors so that they are miniaturized, automatic, robust and withstand harsh environments.
- Evaluate the performance, reliability and failure mechanisms of the use of composites technology for pipelines.

#### **INTEGRITY**

- Develop technology that detects the presence, location and separation between multiple utilities (underground, through various soil conditions) in a common corridor.

- Improve and develop in-line inspection (ILI) to locate and size defects in girth welds and long seam defects including cracks in electric resistance welded (ERW) pipe.
- Assess the remaining integrity of pipelines that have multiple different anomalies in proximity.

## 9.2 Preparedness Priority Research Needs



### PREPAREDNESS

#### 9.2.1 Pre-spill Baseline Studies Priorities (4.3.2.1)

This SRA includes research to characterize and analyze baseline data on the natural environment, human health, and socio-economic characteristics in areas at risk for oil spills. Research includes risk assessments conducted in areas involved in the oil production and transportation systems to identify locations most at risk from pollution events and therefore priority candidates for baseline studies. Baseline information and studies may include: location and population data on species and their habitats, especially ecologically sensitive species; the epidemiology/human health characteristics of people in potential impact areas; and potential community and economic impacts in these areas (e.g., tourism, commercial/recreational fishing, and seafood industry).

ICCOPR divided this SRA into three subcategories: Habitat and Species Baselines; Oceanographic and Geological Baselines; and Environmental Baseline Planning. In the area of habitat and species planning, there is an emphasis on the need to understand more about important Arctic species, intertidal habitats and species that are often impacted by oil spills, and the deepwater and ultra-deepwater habitats and microbiological assemblages (about which little is known). Some of these environments are or soon will be subject to drilling operations (e.g., Arctic, ultra-deepwater). ICCOPR also identified research needs related to understanding currents and coastal processes in areas where oil and gas extraction occurs to aid in future oil spill response or coastal protection should an incident occur. Research on the amount of variability that exists in baseline data is extremely important in order to document change, identify potential Natural Resource Damages, and establish restoration goals.

#### **HABITATS AND SPECIES BASELINES**

- Study ecological structure and population of key Arctic indicator species and protected species (including those with subsistence and ecosystem importance) particularly in areas that are likely to be explored/developed for oil and gas extraction in the near to mid- term.

- Study and synthesize existing information for intertidal habitats (i.e., sand beaches, rocky and cobble habitats) regarding productivity, species diversity, community structure, and the effects of oil on these parameters, including recovery time, with consideration for regional variation.

- Study ecological structure and population of key indicator and protected species in deepwater and ultra-deepwater (including those with subsistence and ecosystem importance), particularly in areas that are likely to be explored/developed for oil and gas extraction in the near to mid-term.

#### **OCEANOGRAPHIC AND GEOLOGICAL BASELINES**

- Conduct a series of large-scale Arctic studies of oceanographic exchanges, shelf-basin exchanges via wind and eddies, coastal boundaries, under-ice river plumes, and sea-ice boundaries to better inform pre- and post-spill modeling and response.

- Develop a better understanding of coastal processes unique to the Gulf of Mexico (i.e., changing shorelines due to erosion, deposition from the Mississippi River) to help inform protection and recovery strategies for oil spills.

- Develop methodologies for using baseline flow characteristic data (such as tidal energy mapping and other energy sources) to support shallow water inlet protection strategies during oil spills.

#### **ENVIRONMENTAL BASELINE PLANNING**

- Develop models of background variability relative to habitat and species data in various environments where oil is transported or extracted so that the impacts from oil or other stressor(s) can be delineated from those of natural variation.

- Evaluate the adequacy of existing ecosystem-based scientific studies for legal defense of Natural Resource Damage Assessment (NRDA) injury assessments for Outer Continental Shelf areas that are currently in production or likely to be explored/developed.

- Conduct baseline studies of microbial communities in a variety of areas where oil is transported or extracted (e.g., Great Lakes, rivers, ports, offshore) and their potential for hydrocarbon degradation in the event of a spill.

### 9.2.2 [Response Management Systems Priorities \(Section 4.3.2.2\)](#)

This SRA includes analysis and development of systems to manage how data and information are collected, analyzed, documented, and shared between and among, the planning/preparedness and response communities, the Incident Command System (ICS), and the public. These systems are used to integrate diverse sets of narrative, graphic, and

video information and many sets and types of raw and analyzed data. Examples of oil spill information systems include: ICS forms; computer systems; data management software and databases; Geographic Information Systems (GIS); routing, spill and incident management tracking systems; electronic mail and web content; documents, photographs, and video management and archiving systems; communication systems; public information messages and protocols; and graphical displays.

ICCOPR priorities under this SRA recognize the need to upgrade information management systems, develop more rapid methods of incorporating data prior to and during a spill, and improve spill response planning tools. Improved pre-spill planning, development of information management tools, and incorporation of baseline data from current oil and gas extraction areas and potential frontier areas will greatly enhance response should an incident occur.

- Develop techniques and/or software for automatically translating data collected from different sources into common, usable formats.
- Develop spill planning and response tools based on gap analysis of the availability of countermeasures in different Arctic locations and seasons.
- Develop improved information systems for decision-making, including the use of data from coastal mapping, baseline data, and other data related to the environmental effects of oil discharges and cleanup technologies.



## 9.3 Response Priority Research Needs



### 9.3.1 Structural Damage Assessment and Salvage Priorities (Section 4.3.3.1)

This SRA includes the development of methodologies and equipment to assess the extent of damage to a stricken vessel caused by collision, allision, grounding, or improper hull stresses during cargo transfers or explosion. This area also includes development of methods and technology to graphically present the implications of various measures that can be implemented to stabilize the vessel's condition, reduce the potential for further pollution, and allow it to be moved safely for repairs or disposal.

The priorities in this SRA include the need to improve technology to determine the oil and water interface in tanks and develop remote vehicles capable of assessing external integrity of vessel hulls. Another important priority is to evaluate existing wrecks that have the potential to leak petroleum products into marine water.

- Study methods for remotely and rapidly determining whether a cargo tank contains sea water and the extent of the water bottom (height of the oil/water interface from the bottom of the tank).
- Develop technologies and techniques to better determine the presence of oil and the probability of its release from specific sunken vessels.
- Develop improved use of remotely operated vehicles (ROVs) and emerging technologies for underwater assessment of vessel and marine structure integrity.

### 9.3.2 At-Source Control and Containment Priorities (Section 4.3.3.2)

This SRA includes the development of methods, systems, and equipment for containing and recovering the oil at or from the source and for mitigating oil flow from a damaged vessel, onshore/offshore pipeline, and an exploration or production platform, temporarily abandoned (plugged) well, or well head once the spill has begun. Such technologies include well-head capping systems, remotely operated vehicles (ROVs) for subsea

containment activities, and patching, plugging and sealing systems. This technology is applicable to all geographic/environmental areas (Arctic, terrestrial, water surface, subsurface shallow, and deep and ultra-deep water).

ICCOPR selected priorities that reflect the difficulties in containing the well during the *Deepwater Horizon* oil spill. The priorities also reflect an anticipated need to provide at source containment in more extreme environments.

- Study the range of failure states and flow rates for which subsea containment may be required.
- Develop subsea containment equipment for integration into spill response operations, including relevant procedures and standards for training personnel.
- Determine how extreme environmental conditions affect at-source containment and control (including Arctic, ultra-deep and other extreme conditions).

### 9.3.3 Chemical and Physical Modeling and Behavior Priorities (4.3.3.3)

This SRA includes laboratory and theoretical research and field studies aimed at understanding the behavior and characteristics of the full range of petroleum oils including: behavior and transport in the environment, partitioning of hydrocarbon constituents, and physical interaction with other materials in the environment (rock, sediments, and ice). It includes studies of oil behavior and changes throughout the water column from deepwater blowouts. There is particular interest in non-conventional oils such as those produced in the Bakken and Canadian Tars sands (diluted bitumen (dilbit) and synthetic bitumen (synbit)). It also includes the development and verification of numerical models to predict the surface and subsurface movement and weathering (i.e., spreading, evaporation, dispersion, and dissolution) of oil spills. This SRA also includes methodologies to provide accurate model input data to verify model outputs. This SRA includes development of user-friendly programs to enhance contingency planning and to serve as training aides for spill response teams. Models should be available for various spill scenarios at specific locations for different tidal, current, and weather conditions to pre-plan potential boom deployment strategies and estimate response resource needs.

ICCOPR recognized the importance of addressing research needs related to understanding how oil behaves under differing conditions in both fresh and saltwater, and developing models to use during oil spills. ICCOPR specifically identified priority Research Needs to improve the understanding of how oil behaves in the Arctic and how new emerging oils such as oil sands products and Bakken crude oils behave in the environment. There are five subcategories for this SRA: 1) Arctic Behavior and

Modeling; 2) Oil Behavior Models; 3) Transport Models; 4) Oceanographic Models; and, 5) Emerging Crudes.

### **ARCTIC BEHAVIOR AND MODELING**

- Develop improved modeling tools and trajectory models in order to predict spreading of oil in different weather and ice conditions in the Arctic.
- Study the fate of oil in Arctic conditions; including open water, ice infested water and oil trapped in ice, particularly as it relates to the effectiveness of spill response countermeasures and the potential for ecosystem exposure.
- Study Arctic-based indigenous microbial populations in the water column and benthic sediment, and define rates of microbial processes to determine the role such communities have in the oil weathering process.

### **OIL BEHAVIOR MODELS**

- Study the oil droplet size from deepwater blowouts, the thickness of surfacing oil and the behavior of dissolvable components.
- Study bottom substrate dynamics that might affect submerged oil fate and behavior.
- Study how oil degrades in intertidal and shallow subtidal habitats (e.g., cobble, pebble, sand, mud, mussel beds, mangrove, and marsh).

### **TRANSPORT MODELS**

- Use best available scientific data on oil weathering and fate to develop and improve transport model parameters (e.g., volatilization, solubilization, emulsification, biodegradation).
- Develop/improve oil trajectory and fate models that can be used during spill response to predict the behavior and transport of dispersed oil and verify/validate them in an appropriately designed experimental setting or during actual spills.
- Develop a decision template or conceptual model of the conditions under which oil might become submerged that considers oil properties and environmental characteristics.

### **OCEANOGRAPHIC MODELS**

- Link ocean circulation models to observations (e.g., ocean observing systems) to better incorporate real-time data.
- Increase development and availability of high resolution nearshore models.

- Integrate upper sea-surface turbulence, with particular emphasis on quantifying horizontal and vertical diffusivities and the rate of energy dissipation, to improve 3D and 4D spill transport models.

**EMERGING CRUDE (including oil sands products (OSP) and Bakken, etc.)**

- Conduct research on the fate and transport of oil sands products in freshwater and marine environments.
- Study the persistence of oil sands products in marine and freshwater environments.
- Conduct research on the chemical and physical characteristics of various crudes (including blends of dilbit, synbit and Bakken crude) to better understand how to address spills.

9.3.4 Oil Spill Detection and Surveillance Priorities (Section 4.3.3.4)

This SRA principally refers to methods and equipment for characterizing and monitoring oil pre- and post-implementation of response options, and the detection of unknown discharges. This SRA includes surface and subsurface oil spill surveillance including devices, sensors, and systems for detecting and tracking oil spills, determining the area and thickness of the oil slick, and measuring the physical properties of the oil. Examples of equipment considered in this area are: surface oil spill tracking buoys; airborne remote sensors and data analysis systems; fluorometers and light-scattering sensors; and satellite remote sensing data and on/in-water oil detection devices with the ability to conduct nighttime and low light recovery operations. It includes research that provides information to support development of monitoring protocols for subsea and surface responses or improvements to existing ones such as the NRT Atypical guidance or the SMART guidance, as applicable. This SRA also includes evaluation of techniques for autonomous sensing operations and reporting from remote locations where logistical challenges limit human accessibility.

The priorities for this SRA focus on the development of improved technologies that can more rapidly and effectively identify the presence and the characteristics of oil in the water column and on the seafloor. These priorities would address some of the issues that arose from the *Deepwater Horizon* spill and may assist responders to react more effectively to future incidents. There are three subcategories for this SRA: Remote Detection, Monitoring, and Submerged Oil Detection.

### **REMOTE DETECTION**

- Develop technologies that enable remote oil spill detection and mapping in low visibility conditions (e.g., night, fog).
- Develop enhanced technology for detecting oil under ice, encapsulated in ice, and floating within broken ice fields.
- Identify specific characteristics of crude oil exposed to the full microwave radiation spectrum (at hyperspectral intervals) and develop high resolution sensors for oil spill visualization, detection and quantification.

### **MONITORING**

- Develop a refined SMART or equivalent protocol and operational procedures for use during subsea and surface responses based on recent experiences.
- Develop technology to rapidly analyze physio-chemical properties of spilled oil to improve decision-making regarding dispersant use and *in situ* burning (ISB).
- Develop new technologies to improve oil, dispersant, and oil/dispersant detection in the water column and on the seafloor, and for monitoring dispersant effectiveness in the field.

### **SUBMERGED OIL DETECTION**

- Study the potential of acoustic systems and Light Detection and Ranging (LiDAR), both individually and as packaged suites, to detect submerged oil on the seafloor and in the water column.
- Develop new or improve existing chemical sensors for detecting submerged oil.
- Develop methods to calibrate the degree of oiling on snare sampling systems with the amount of oil on the seafloor or in the water column.

#### 9.3.5 In- and On-water Containment and Recovery Priorities (Section 4.3.3.5)

This SRA includes the development of methods, equipment, and materials for physically containing and removing oil from the surface of the water, the water column, or on the bottom of the sea/river bed. This SRA focuses on improving traditional equipment such as booms, skimmers, and sorbent materials, as well as developing new approaches to surface containment, and equipment and systems specific to containment and recovery of subsurface oils.

The priority Research Needs in this SRA focus on the Arctic and other northern areas where cold water and ice will require innovative methods and technologies. There was

also recognition of the need for better technologies to control and recover submerged oil given the greater emphasis on deep and ultra-deep water drilling. ICCOPR acknowledged the need for better testing protocols for new technologies and methods and identified research priorities that could improve laboratory and field testing. ICCOPR identified priorities in two subcategories: Control and Recovery Technology, and Recovery Operations and Testing.

**CONTROL AND RECOVERY TECHNOLOGY**

- Develop new mechanical recovery methods/technologies for logistically challenging (e.g., cold water, ice, broken ice) Arctic conditions.
- Develop new tools to control and recover oil that is submerged, suspended in the water column, or on the seafloor.
- Develop control and recovery capabilities for oil in river conditions with pack ice and ice flows.

**RECOVERY OPERATIONS AND TESTING**

- Develop/improve standardized testing protocols (especially for wave tanks) that yield cross-comparability of results and establish practical oil recovery limits that are achievable during response operations.
- Conduct field tests of cleanup techniques and create protocols for various habitats and conditions, including Arctic conditions.
- Develop surrogates for different types of oil to be used for training and for research and development testing.

9.3.6 Shore Containment and Recovery Priorities (Section 4.3.3.6)

This SRA covers new methods, treating agents, and equipment for removing oil from shorelines, as well as mitigating the environmental impact of oil that cannot be removed. Specifically, this SRA includes water washing and flooding techniques, the use of chemical treating agents, and novel applications of mechanical removal techniques and equipment. It also includes analysis, evaluation and decision-making (risk and benefits) for the use of active shoreline oil removal techniques versus passive naturally-occurring processes.

ICCOPR recognizes the difficulty of relying solely on physical recovery on shorelines. Therefore, priorities in this SRA focus on developing chemicals that prevent shoreline contact.

- Study the effectiveness of a range of technologies for shoreline or nearshore cleanup; including dispersants, bioremediation agents, shoreline cleaners, and mechanical methods.
- Study the effectiveness of surface washing for shoreline cleanup and develop standards for surface washing.
- Conduct research to assess the ability of chemicals to prevent oil from reaching or sticking to shorelines.

### 9.3.7 Dispersants Priorities (Section 4.3.3.7)

This SRA addresses the use of chemical products designed to interact with marine oil slicks by reducing the oil/water interfacial tension and breaking up the slick into tiny droplets with the aid of wave or other energy sources. Research areas for dispersants include: developing appropriate dispersant applications for cold weather and deep sea environments; increasing dispersant effectiveness for water surface and subsurface applications (e.g., effective on a wider viscosity and emulsification range, and calm sea conditions); reducing ecological effects of individual dispersant components and combined components in the water column; refining vessel, aircraft, and subsurface application methodologies and equipment; developing enhanced monitoring methods and systems for determining the effectiveness of surface and subsurface application of dispersants; determining how to distinguish physically versus chemically dispersed oil; studying the distribution and impact of the chemicals and dispersed oil in the environment; and understanding regional variations in dispersant performance and environmental effects. This SRA may include characterization to enhance the ability to predict dispersant effectiveness on various oil types and at varying application rates, including the effectiveness of dispersants on weathered/emulsified oils and in a range of water salinities. This SRA also encompasses studies to determine the suitability of subsea application of dispersants in the Arctic region where the unique conditions (e.g., shallow depths, water salinity, ice-infested water, under-ice discharges) could influence their fate and effects. An important supporting activity is the development of an information database on dispersant product effectiveness, application procedures, and effects. Since dispersants shift the risk from the surface to the water column, additional research is needed to address questions about the potential acute and chronic effects of dispersants on water column organisms and populations at various depths.

The *Deepwater Horizon* spill resulted in a very widespread use of dispersants and the first application of subsurface dispersants near the well head. This use of dispersants resulted in a significant interest in the effectiveness of dispersant use and its potential impacts. The importance of this SRA to future oil response is demonstrated by the large



number of research needs identified. It is important to understand how dispersants behave in the environment and what their potential impacts are when applied. Specifically, ICCOPR identified Research Needs such as: dispersant use in Arctic conditions; the behavior of dispersants and dispersed oil in the environment; the toxicity of dispersants and dispersed oil; efficacy and effectiveness of dispersants; fate of dispersants and dispersed oil; and the application of subsurface dispersants.

This SRA includes six subcategories: Cold Weather and Ice Conditions, Behavior, Impacts, Efficacy and Effectiveness, Fate, and Subsurface. The Research Needs for this SRA include formulations appropriate for dispersant applications in cold weather and deep sea environments, and increasing dispersion effectiveness for water surface and subsurface applications.

### **COLD WEATHER AND ICE CONDITIONS**

- Understand the “window of opportunity” for potential deployment of all dispersants in the Arctic and sub-Arctic.
- Study the best dispersants for different types of crude oil over a range of environmental conditions, including ice infested waters.
- Study the fate and effects of subsea application of dispersants in Arctic waters, including in ice infested water and under ice.

### **BEHAVIOR**

- Study the transport and detection of oil, dispersants, and oil/dispersants in surface and subsurface environments, including deepwater.
- Study the impact of natural processes such as flocculation and hydrate encapsulation on oil and dispersed oil.
- Quantify degradation rates of chemically dispersed, physically dispersed, and undispersed oil, including biodegradation kinetics.

### **IMPACTS**

- Improve protocols for testing toxicity of dispersants and other chemical agents to better represent real world exposure scenarios.
- Study and evaluate dispersant and dispersed oil chronic and sub-lethal effects on key species, and subsequent long-term ecological effects for varying real world exposure scenarios and durations.
- Collect existing dispersed oil toxicity data and studies to aid in risk-based decision-making regarding use of dispersants at spills.

**EFFICACY AND EFFECTIVENESS**

- Study the relative effectiveness of various surface dispersant delivery techniques/systems.
- Study the effects of subsea dispersant application on subsequent mechanical recovery of oil.
- Develop methods and quantify the factors needed to scale results of laboratory and wave tank experiments so that they become more accurate indicators of real world effectiveness.

**FATE**

- Develop studies to quantify the weathering rates and final fate of chemically dispersed vs. physically-dispersed oil droplets under different scenarios.
- Study the differences in the effects of photolysis on undispersed, chemically dispersed, and physically dispersed oil droplets.
- Study the adhesiveness of physically and chemically dispersed oil on organisms and habitats, including how adhesion changes over time and with oil type.

**SUBSURFACE**

- Study the relationship between subsurface application of dispersants, the characteristics of oil at the surface, and the fate of oil constituents, including Volatile Organic Compounds (VOCs), in the water column and at the surface.
- Develop conditions of operability for dispersant use in the subsea, including the characteristics of the most effective dispersant, application methods, and dispersant to oil ratios.
- Conduct research involving the application of dispersants at high pressure and low temperatures including quantifying the mixing energy at the wellhead.

9.3.8 *In Situ* Burning (ISB) Priorities (Section 4.3.3.8)

This SRA includes equipment and techniques required to ignite and sustain combustion of oil spills on the water, along shorelines, and on land. A source of ignition must be present for the mix of fuel (e.g., oil) and oxidant (e.g. oxygen) in a slick to burn. Because slick thickness is a key variable in determining whether the oil will burn, this research area includes development of equipment such as fire-resistant booms and herders to concentrate the slick thickness, and improved ignition devices. This SRA also includes developing knowledge of the conditions under which this equipment and technique can

be applied effectively, including evaluation of use in frigid (i.e., Arctic) environments, where cold conditions and ice limit operational effectiveness of mechanical containment and recovery of spilled oil. This SRA also includes research to develop new methods to enhance burn efficiency and burn weathered, emulsified, and more viscous oils. Research into the production of residuals including soot and other ISB residues, and the techniques and equipment to recover these residues is also included in this SRA.

The priorities for this SRA address issues related to potential public health and environmental health from the burning of oil. The ICCOPR priorities also emphasize the need for improved technology to address containment, sustain burning and understand the potential for application of ISB in Arctic and other special environments. There are two subcategories: 1) Effectiveness and 2) Impacts and Planning and Technology.

#### **EFFECTIVENESS AND IMPACTS**

- Develop improved pre- and post-spill plume modeling to determine whether an *in situ* burn should be conducted and facilitate decisions on measures to protect local populations, including the potential effect of "fall-out" from a smoke plume that goes over land-based subsistence resources.
- Study *in situ* burning residues, especially toxicity, physical properties, and bioavailability of contaminants contained within the residue matrix, especially regarding potential benthic community effects.
- Conduct additional research to improve *in situ* burning effectiveness in the Arctic and better define its applicability under various conditions.

#### **PLANNING AND TECHNOLOGY**

- Conduct a comparative study of *in situ* burning vs. mechanical, chemical and natural attenuation methods in cleanup of wetlands or marshy areas.
- Develop enhanced designs for containment of burning oil, such as reusable and high seas capable booms.
- Develop methods to improve and sustain combustion of emulsions.

#### 9.3.9 [Alternative Chemical Countermeasures Priorities \(Section 4.3.3.9\)](#)

This SRA includes the development and use of various spill response chemicals to treat oil slicks on the surface of the water making the oil more amenable to other recovery techniques, such as mechanical recovery and ISB. These chemicals include solidifiers, herding agents, elasticity modifiers, shoreline pre-treatment agents, and emulsion treating agents (demulsifiers). Development activities include improving chemical formulations,

refining application techniques, and conducting studies of effectiveness and environmental effects.

ICCOPR priorities in this SRA recognize the potential of alternate chemical treatments to break emulsions and herd oil slicks to enhance other response techniques.

- Study the potential use of chemical herders to enhance response capabilities of *in situ* burning, recovery of oil-in-ice, or recovery of oil in confined/covered spaces.
- Study the value and impact of chemical herders with respect to the timing for deployment of various countermeasures, particularly with respect to a second-stage recovery effort during ice melt to target oil that had previously been entrained in sea ice.
- Conduct laboratory and field tests of chemical agents for breaking or inhibiting emulsions.

#### 9.3.10 Oily and Oil Waste Disposal Priorities (Section 4.3.3.10)

This SRA includes study and development of analytical methods, procedures, equipment and techniques to manage and dispose of oil, oily water, oiled soils, and oiled debris recovered during both on-water and on land oil pollution incidents. Specific technologies include, but are not limited to, waste segregation, temporary storage, solidification and stabilization prior to landfill disposal or recycling, oil reclamation, incineration, and biological treatment (i.e., land farming and composting). It also includes techniques and equipment for onsite oil-water separation, filtration, and decanting operations that would reduce the volumes of oil/water material that would need to be handled, transported, and disposed.

ICCOPR priorities for this SRA focus on storage, waste issues and recycling.

- Develop innovative techniques for oil/water separation decanting systems for various oil types.
- Develop methods to recycle sorbents and reduce the waste created by using sorbents as a recovery option.
- Develop methods to temporarily store or dispose of recovered oil/pollutants in remote or harsh environments.

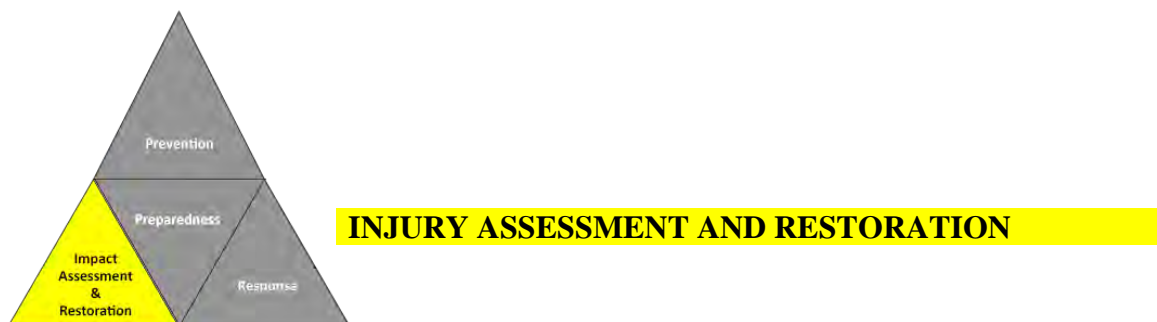
9.3.11 Bioremediation and Biodegradation Priorities (Section 4.3.3.11)

This SRA includes research and technology to exploit the capabilities of microorganisms and plants to accelerate the rate of degradation of oil typically through aerobic degradation, but also through anaerobic degradation processes. Bioremediation is largely an *in-situ* technology as *ex-situ* use requires excavation and further manipulations that may have a greater potential for environmental harm. Research and development opportunities include the development of methodologies for the use of nutrient enrichment and possibly microbes to accelerate the biodegradation process on land, a process called bio-augmentation. This topic area also covers research to understand the conditions needed for effective bioremediation in the presence or absence of dispersants, herders, and other chemical agents. In areas such as coastal wetlands, where stranded oil may have penetrated into the anaerobic subsurface, this research area would include studies to wick the oil up to the surface where aerobic conditions and nutrient enrichment may result in enhanced biodegradation. This SRA also includes development of methodologies to apply bioremediation for more effective response and restoration efforts. For purposes of this OPRTP, bioremediation includes phytoremediation (remediation using plants), a longer-term restoration technique.

ICOCPR priorities under this SRA focus on gaining a better understanding of the bioremediation process and the factors associated with its use in oil spill remediation.

- Study the relative effectiveness and environmental impacts of bioremediation technologies.
- Develop an improved understanding of bioremediation processes with a wider range of conditions/environments (e.g., cold water), multiple types of oil, nutrient enrichment, toxicity and eutrophication.
- Study the factors controlling bioavailability of petroleum hydrocarbons in estuarine and freshwater sediments.

## 9.4 Injury Assessment and Restoration Priority Research Needs



### 9.4.1 Environmental Impacts and Ecosystem Recovery Priorities (Section 4.3.4.1)

This SRA includes laboratory research, field studies, and modeling efforts to better understand and predict the short- and long-term effects of oil spills at the ecosystem level. It includes research into the short- and long-term recovery of various types of environments and the chronic effects of oil spills on habitat, species, recovery and rehabilitation of wildlife, and community structures. This SRA includes the effects of the oil and the countermeasures and cleanup techniques used to remove the oil. It also includes research to determine the rate of ecosystem recovery both with and without countermeasures and cleanup.

The priorities selected by ICCOPR reflect the continued need to assess the short- and long-term effects of the *Deepwater Horizon* oil spill through the NRDA process. ICCOIPR identified priorities within six subcategories for this SRA due to the large number of identified Research Needs: 1) Species Impacts; 2) Toxicological and Sub-lethal Impacts; 3) Submerged and Submerged Oil Impacts; 4) Ecosystem and Habitat Impacts; 5) Recovery; and 6) Risk Assessment and Impact Metrics.

#### SPECIES IMPACTS

- Study the effect of exposure to oil on: physiological functions of organisms (immune, reproductive, and other vital systems); potential impacts on individual fitness; and population vitality rates, abundance and trends.
- Develop an increased understanding of the environmental effects of *in situ* burning, chemical dispersants and herding agents on Arctic ecology.
- Conduct research that examines the state of knowledge of specific NRDA metrics that would help identify specific population, physiological, habitat, and exposure data to support future NRDA activities in Arctic areas that are likely to be explored/developed for oil and gas extraction in the near to mid-term.

### **TOXICOLOGICAL AND SUB-LETHAL IMPACTS**

- Develop relevant biological markers of exposure and guidelines for their use.
- Conduct research on key species to determine the long-term, sub-lethal effects of short-term exposure to oil.
- Study the bioavailability and toxicity of oil sands products in freshwater and marine environments.

### **SUNKEN AND SUBMERGED OIL IMPACTS**

- Develop an understanding of the pathways of exposure and mechanisms of chronic toxicity of submerged oil to benthic communities.
- Develop approaches for long-term monitoring of the impacts of submerged oil spills after termination of cleanup efforts.
- Develop an understanding of the potential threats of chronic releases from sediments containing oil and oily residues.

### **ECOSYSTEM AND HABITAT IMPACTS**

- Develop relevant exposure conditions (spatially and temporally) and examine connections between exposure and ecological effects.
- Develop an understanding of trophic and habitat linkages among organisms to incorporate into models predicting cascading effects.
- Develop an understanding of the difference between oil effects and natural stressors by assessing community structure and function for different habitats.

### **RECOVERY**

- Study recovery rates of injured habitats using different types of oils and methods (e.g., previous spills, mesocosm, field studies).
- Develop conceptual models of service loss and recovery from key habitats, and gather the information necessary to parameterize recovery models.
- Conduct a study comparing environmental injury footprints and ecosystem recovery times after implementation of various response technologies and techniques.



**RISK ASSESSMENT AND IMPACT METRICS**

- Develop models to estimate injury to natural resources encompassing a range of exposure scenarios to biota at different life stages.
- Conduct research to determine the best metrics for assessing injury and damages to natural resources.
- Conduct single species toxicity research to assess population effects and help risk-based decision-making during an event.

9.4.2 Environmental Restoration Methods and Technologies Priorities (Section 4.3.4.2)

This SRA includes development of methods and technologies to facilitate and accelerate the recovery of resources following an oil spill. It includes research into the effectiveness of approaches for environmental restoration. It also includes evaluations and comparisons of the factors affecting success of the restoration methods and technologies. It also involves studying previous restoration efforts, as well as natural recovery, to better understand ways to improve or enhance future recovery from oil spills.

ICCOPR recognized that the *Deepwater Horizon* oil spill, as well as other marine and onshore spills, offer opportunities to assess restoration techniques and improve the state of the art.

- Develop methods for restoration assessment (including establishing indicators and applying performance metrics) and estimation of restoration cost.
- Conduct comparative analysis of restoration vs. natural attenuation.
- Study the factors associated with long-term restoration success.

9.4.3 Human Safety and Health Priorities (Section 4.3.4.3)

This SRA includes studies on the effects of spilled oil and oil spill response activities on human health and safety for both workers and the public. It includes the study of oil weathering throughout the water column and the potential concerns relative to worker health and safety. It focuses on the development of monitoring instruments, procedures, and processes to inform personnel engaged in oil spill response activities, as well as the general public, who could be affected by the oil spill and response options. It also includes studies of the safety of fish and shellfish in a spill area to determine if they are safe to market and consume. Research on seafood safety may include petrochemical

toxicology and profiling, risk analysis, sampling and testing methodology development, and risk communications.

The research priorities focus on worker safety and human exposure, as well as on seafood safety. The *Deepwater Horizon* spill has provided opportunities for short- and long-term monitoring of workers and the public related to these topics. There are two subcategories to this SRA: Safety and Human Exposure.

<b>SAFETY</b>
➤ Develop technologies, methods, and standards for protecting on-scene personnel, including the incorporation of training, adequate supervision, information databases, protective equipment, maximum exposure limits, and decontamination procedures.
➤ Study the levels of oil constituents, including Volatile Organic Compounds (VOCs), throughout the water column under different dispersant application scenarios (e.g., subsea, surface) and establish their contribution to potential worker health and safety issues.
➤ Conduct research on the short- and long-term safety of seafood following a spill or fisheries closure and develop methods to communicate these to the public.
<b>HUMAN EXPOSURE</b>
➤ Develop the framework needed to conduct rapid research response on human exposure during oil spills.
➤ Study the short- and long-term impacts to humans from exposure to contaminants from oil spills (e.g., dermal, oral (through seafood), and respiratory).
➤ Study the toxicological effects and the causal or correlative relationships between chemical (i.e., oil and dispersants) exposure and human health.

#### 9.4.4 Sociological and Economic Impacts Priorities (Section 4.3.4.4)

This SRA includes studies on how oil spills and the response to oil spills affect the sociological fabric of communities and their economies. Disciplines encompassed in this research area include sociology, economics, behavioral sciences, political science, and law. It also involves studies on risk communication and community resilience.

The priorities in this SRA identify the need for improving communication methods and understanding the human and community impacts of a spill, particularly by improving

research frameworks and studying previous spills. There are two subcategories in this SRA: Community and Economic Impacts, and Human Impacts.

<b>COMMUNITY AND ECONOMIC IMPACTS</b>
➤ Develop more effective models/frameworks for community/stakeholder involvement in oil spill planning, response and restoration.
➤ Develop improved methods for communicating risks and tradeoffs to various audiences, including tradeoffs of mechanical recovery, dispersant use, and other technologies.
➤ Study cumulative community vulnerability and resilience to past spills, including social impacts.
<b>HUMAN IMPACTS</b>
➤ Study the resilience of social-ecological systems to environmental disasters, including the degree of impact on human well-being from ecosystem services losses.
➤ Determine human/community impacts associated with a spill, including subsistence losses and culturally-significant natural resource injuries.
➤ Study the effects of media and community groups in shaping individual and public perceptions of a spill's impact.

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## APPENDICES

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- A. Numbered List of Standing Research Areas (SRAs)
- B. ICCOPR Standing Research Areas – 2014 Database
- C. ICCOPR Standing Research Areas – 2014 Sources
- D. Survey Technical Report
- E. Sample of Research Priority Survey
- F. Sample of Survey Data

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# **Appendix A**

## Numbered List of Standing Research Areas (SRA)



## Numbering System for SRA Survey

### PREVENTION (1000 Series)

Revised #	SRA Name	Subtopic Name
1000	Human Error Factors	
1100	Offshore Facilities and Systems	
1201	Onshore Facilities and Systems	Tank/Piping Inspection, Operations, Design and Data
1202	Onshore Facilities and Systems	Emerging Issues
1300	Waterways Management	
1400	Vessel Design	
1501	Drilling	Deepwater Drilling/Technology
1502	Drilling	Reservoir Characterization
1600	Rail and Truck Transportation	
1701	Pipeline Systems	Materials
1702	Pipeline Systems	Integrity

### PREPAREDNESS (2000 Series)

Revised #	SRA Name	Subtopic Name
2001	Pre-spill Baseline Studies	Habitats and Species Baselines
2002	Pre-spill Baseline Studies	Oceanographic/Geologic Baselines
2003	Pre-spill Baseline Studies	Environmental Baseline Planning
2100	Information Management and Decision Systems	

### RESPONSE (3000 Series)

Revised #	SRA Name	Subtopic Name
3000	Structural Damage Assessment and Salvage	
3100	At-Source Control and Containment	
3201	Chemical and Physical Modeling and Behavior	Arctic Behavior and Modeling
3202	Chemical and Physical Modeling and Behavior	Oil Behavior Models
3203	Chemical and Physical Modeling and Behavior	Transport Models
3204	Chemical and Physical Modeling and Behavior	Oceanographic Models
3205	Emerging Crude (including oil sands products (OSP) and Bakken etc.)	
3301	Oil Spill Detection and Surveillance	Remote Detection
3302	Oil Spill Detection and Surveillance	Monitoring
3303	Oil Spill Detection and Surveillance	Submerged Oil Detection
3401	In and On-water Containment and Recovery	Control and Recovery Technology
3402	In and On-water Containment and Recovery	Recovery Operations and Testing
3500	Shore Containment and Recovery	
3601	Dispersants	Cold Water and Ice Conditions
3602	Dispersants	Behavior
3603	Dispersants	Impacts
3604	Dispersants	Efficacy and Effectiveness
3605	Dispersants	Fate
3606	Dispersants	Subsurface
3701	<i>In situ</i> Burning	Effectiveness and Impacts
3702	<i>In situ</i> Burning	Planning and Technology
3800	Alternative Chemical Countermeasures	
3900	Oily and Oil Waste Disposal	

### IMPACT ASSESSMENT AND RESTORATION (4000 Series)

Revised #	SRA Name	Subtopic Name
4000	Bioremediation and Biodegradation	
4101	Environmental Impacts and Ecosystem Recovery	Species Impacts
4102	Environmental Impacts and Ecosystem Recovery	Toxicological and Sublethal Impacts
4103	Environmental Impacts and Ecosystem Recovery	Sunken and Submerged Oil Impacts
4104	Environmental Impacts and Ecosystem Recovery	Ecosystem and Habitat Impacts
4105	Environmental Impacts and Ecosystem Recovery	Recovery
4106	Environmental Impacts and Ecosystem Recovery	Risk Assessment and Impact Metrics
4200	Environmental Restoration Methods and Technologies	
4301	Human Safety and Health	Safety
4302	Human Safety and Health	Human Exposure
4401	Sociological and Economic Impacts	Community and Economic Impacts
4402	Sociological and Economic Impacts	Human Impacts

#### Number system

1000	Major Category -SRA Framework
100	SRA number
001	Subcategory for SME breakdown





# **Appendix B**

## ICCOPR Standing Research Areas

### 2014 Database



ICCOPR Standing Research Areas  
2014 Database

ICCOPR Standing Research Areas	Subcategory	R&D Need	Source	Physical Location	Sources
<b>PREVENTION - 1000 SERIES</b>					
1000-Human Error Factors	No Subcategory	<b>CREW FITNESS</b> - Create improvements to fitness for fatigue and sleep loss by developing and testing alternative work schedules.	ICCOPR R&T Plan (1997)	All	1
1000-Human Error Factors	No Subcategory	<b>CREW FITNESS</b> - Develop instrumentation for real-time testing of fitness for duty.	ICCOPR R&T Plan (1997)	All	1
1000-Human Error Factors	No Subcategory	<b>CREW FITNESS</b> - Develop standards to minimize human error on vessels, for fatigue, watch standing, stress, organizational relationships, teamwork and training.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1000-Human Error Factors	No Subcategory	<b>HUMAN BEHAVIOR</b> - Study hazards and risks from the human perspective.	1) Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations (November 2012) 2) Ultra-Deepwater Advisory Committee 2012 Plan: Comments, Findings and Recommendations (March 2012)	Marine	2
1000-Human Error Factors	No Subcategory	<b>HUMAN BEHAVIOR</b> - Study human behavior as related to the high risk conditions of ultra-deepwater drilling and production operations with emphasis on the "human-machine" interface. Models can be found in training or simulator programs utilized by nuclear and aviation industries.	1) DOE 2013 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress (June 2013) 2) Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations (November 2012) 3) Ultra-Deepwater Advisory Committee 2012 Plan: Comments, Findings and Recommendations (March 2012)	Marine	3
1000-Human Error Factors	No Subcategory	<b>PILOT LICENSING AND CERTIFICATION</b> - Develop surveys to ensure uniform level of expertise commensurate with modern transportation systems.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1000-Human Error Factors	No Subcategory	<b>"SPILLS OF NATIONAL SIGNIFICANCE" (SONS) SIMULATOR</b> - Develop, test, and evaluate a SONS system.	ICCOPR R&T Plan (1997)	Marine/Estuarine	1
1000-Human Error Factors	No Subcategory	<b>TRAINING</b> - Develop programs for vessel crews to improve their understanding of automated vessel functions.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
1000-Human Error Factors	No Subcategory	<b>TRAINING</b> - Develop protocols, systems and teamwork for vessel crews.	ICCOPR R&T Plan (1997)	All	1
1000-Human Error Factors	No Subcategory	<b>TRAINING</b> - Improve spill response utilizing innovative methods, including readiness evaluations.	ICCOPR R&T Plan (1992)	All	1
1100-Offshore Facilities and Systems	No Subcategory	<b>BLOWOUT PREVENTERS</b> - Study design modifications to blowout preventer stacks that would allow for more expeditious hook-ups of injection and evacuation networks and hoses.	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
1100-Offshore Facilities and Systems	No Subcategory	<b>OFFSHORE FACILITY DESIGN</b> - Study the effects of ice forces and year round metocean conditions with respect to facility design.	BSEE Alaska Regional Director (2013)	Marine/Arctic	1
1100-Offshore Facilities and Systems	No Subcategory	<b>OFFSHORE MATERIALS</b> - Develop an in situ electrochemical corrosion probe for monitoring risers and other metallic components in deep marine environments in order to improve the integrity, safety, and performance of these systems.	EPAct 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program	Marine	1
1100-Offshore Facilities and Systems	No Subcategory	<b>OFFSHORE MATERIALS</b> - Expand information base related to the longevity and integrity of metallic materials used under extreme conditions in relation to these new surface treatments and alloys.	EPAct 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program	Marine/Estuarine	1
1100-Offshore Facilities and Systems	No Subcategory	<b>OFFSHORE PIPELINE DESIGN</b> - Study ice scour and gouging, and permafrost effects with respect to pipeline and wellhead placement and design.	BSEE Alaska Regional Director (2013)	Marine/Arctic	1
1100-Offshore Facilities and Systems	No Subcategory	<b>OFFSHORE PIPELINE OPERATIONS</b> - Develop improvements to infrastructure, leak detection, rapid shutdown procedures and computer based systems.	ICCOPR R&T Plan (1992)	All	1
1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design and Data	<b>PIPELINE LEAK DETECTION TECHNOLOGY</b> - Research needed on the use of leak detection systems at storage facilities located near navigable waters.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1

ICOPR Standing Research Areas  
2014 Database

1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design, and Data	<b>TANK INSPECTION</b> - Evaluate and improve of risk-based inspections, similar service protocols and in-service non-destructive tank testing technologies.	US EPA OSWER OEM Personal Communication (2014)	Terrestrial	1
1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design, and Data	<b>TANK/PIPELINE OPERATIONS</b> - Evaluate the efficacy of oleophilic materials used as an oil spill control technology.	US EPA OSWER OEM Personal Communication (2014)	All	1
1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design, and Data	<b>TANK/PIPELINE OPERATIONS</b> - Develop improved methods and protocols used to determine the imperviousness of secondary containment structures.	US EPA OSWER OEM Personal Communication (2014)	Terrestrial	1
1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design, and Data	<b>TANK/PIPELINE OPERATIONS</b> - Conduct a comparative analysis of overflow prevention equipment/procedures to identify technology gaps/limitations.	US EPA OSWER OEM Personal Communication (2014)	Terrestrial	1
1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design, and Data	<b>TANK/PIPELINE OPERATIONS</b> - Evaluate the cost effective security and safety measures for unmanned upstream production facilities.	US EPA OSWER OEM Personal Communication (2014)	Terrestrial	1
1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design, and Data	<b>DATABASE DEVELOPMENT</b> - Develop a consolidated database and GIS platform of aboveground oil storage tanks based on federal, tribal, state and local data sources and analyze the data gaps.	US EPA OSWER OEM Personal Communication (2014)	Terrestrial	1
1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design, and Data	<b>DATABASE DEVELOPMENT</b> - Develop a consolidated database and corresponding GIS platform of oil discharges from onshore facilities.	US EPA OSWER OEM Personal Communication (2014)	Terrestrial	1
1201-Onshore Facility and Systems	Tank/Piping Inspection, Operations, Design, and Data	<b>TANK/PIPELINE OPERATIONS</b> - Analyze upstream and/or downstream causes of discharges, including an analysis of the tanks, appurtenances and associated piping.	US EPA OSWER OEM Personal Communication (2014)	Terrestrial	1
1202-Onshore Facility and Systems	Emerging Issues	<b>EMERGING ISSUES FOR TANKS AND PIPING OPERATIONS</b> - Identify the impacts of an aging oil storage infrastructure (tanks, appurtenances and piping systems) and develop methodologies/protocols to predict/minimize failures.	US EPA OSWER OEM Personal Communication (2014)	Terrestrial	1
1202-Onshore Facility and Systems	Emerging Issues	<b>EMERGING ISSUES FOR TANKS AND PIPING OPERATIONS</b> - Evaluate the impacts of emerging crude oils and alternative fuels on tanks, appurtenances and piping.	US EPA OSWER OEM Personal Communication (2014)	All	1
1202-Onshore Facility and Systems	Emerging Issues	<b>EMERGING ISSUES FOR TANKS AND PIPING OPERATIONS</b> - Assess the impacts of Arctic and cold weather environments on the operation and maintenance of tanks, appurtenances, and associated piping.	US EPA OSWER OEM Personal Communication (2014)	All	1
1300-Waterways Management	No Subcategory	<b>PORT FACILITES DESIGN</b> - New designs needed to improve facilities and vessel traffic infrastructure (e.g., storage tanks, pipes, pumps, channels).	ICOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1300-Waterways Management	No Subcategory	<b>SHIPBOARD EXPERT PILOTING SYSTEMS (SEPS)</b> - Improved piloting systems, electronic chart display and information systems (ECDIS) integration development needed to improve navigation.	ICOPR R&T Plan (1997)	te	1
1300-Waterways Management	No Subcategory	<b>TANK VESSEL ALTERNATIVES ASSESSMENT</b> - Research needed on the level of risk for various sizes of vessels, numbers of vessels in operation, types of ports, terminals, probability of accidents and the rate of production to improve vessel assessment.	ICOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1300-Waterways Management	No Subcategory	<b>TRAINING SIMULATOR</b> - Simulator development needed for port operations.	ICOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1300-Waterways Management	No Subcategory	<b>VESSEL TRAFFIC SYSTEMS</b> - Systems needed for control in ports, including surveillance of vessel traffic.	ICOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1400-Vessel Design	No Subcategory	<b>LIQUID CARGO SAFETY SYSTEMS</b> - Develop and test passive onboard countermeasures to minimize the discharge of oil from damaged vessels prior to arrival of outside response equipment.	ICOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1

ICCOPR Standing Research Areas  
2014 Database

1400-Vessel Design	No Subcategory	<b>LIQUID CARGO SAFETY SYSTEMS</b> - Develop improved liquid cargo systems to minimize spilled oil from damaged tanks.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1400-Vessel Design	No Subcategory	<b>LIQUID CARGO SAFETY SYSTEMS</b> - Develop technologies to measure prevention of discharges from tanks on vessels, discharges from tank vents, discharges during lightering and bunkering operations, discharges on the deck of a vessel, discharges through the use of vacuums in tanks.	Title 33 Chapter 40 Subchapter IV 2761 (OPA 1990)	Marine/Estuarine/Freshwater	1
1400-Vessel Design	No Subcategory	<b>LIQUID CARGO SAFETY SYSTEMS</b> - Study capabilities of product off-loading and onboard countermeasures.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1400-Vessel Design	No Subcategory	<b>TANKER DESIGN</b> - Develop advanced models for evaluating tanker designs.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
1400-Vessel Design	No Subcategory	<b>TANKER DESIGN</b> - Develop improved vessel designs and various alternative vessel designs.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
1400-Vessel Design	No Subcategory	<b>TANKER DESIGN</b> - Develop, test and evaluate alternatives to double hulls.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER FLUIDS DATABASE</b> - Expand the experimental database on critical fluid properties for hydrocarbons at high pressure and temperature, extending the current work to multi-phase and multi-component fluids (hydrocarbons, etc), which is key to predicting their behavior in situ conditions in the deep subsurface.	EPAct 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Characterize experimentally the properties and behavior of foam cement samples at in situ conditions to improve the safe use and emplacement of these barriers in deep offshore settings.	EPAct 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Conduct research on complex fluid phase behaviors that occur under conditions of extreme pressure and temperature, and develop advanced models of hydrocarbon behavior.	DOE 2012 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress (August 2012)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Conduct research on methods of Managed Pressure Drilling (MPD) and, in particular, Dual Gradient Drilling. Conduct a gap analysis to identify future critical needs.	Ultra-Deepwater Advisory Committee 2012 Plan: Comments, Findings and Recommendations (March 2012)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Conduct research on the viability of activation of BOPs and other submerged well-control equipment in the deepwater, including the feasibility and viability of integrating the use of acoustics and ROV technology.	OESC Letter Recommendations to BSEE Department of Interior (August 2012)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Conduct research related to the containment of hydrocarbons throughout the entire lifecycle of an oil or gas field to include mitigating leakage in and around the borehole from reservoir fluids and gas as well as any injected liquids and materials; long term borehole stability; plugging and abandoning technology for long term containment of hydrocarbons; and long term monitoring systems (i.e. down hole and well head pressure sensors, time lapse seismic surveying, sea bed monitoring, etc.).	Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations (November 2012)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Develop an ROV to rapidly determine hydrocarbon composition and volume of leaks at high pressures and low temperatures (UDW seafloor conditions) in order to improve deepwater drilling safety and spill response efficacy.	EPAct 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Develop design criteria to address and mitigate the impact of storms on deepwater operations identifying suitable vessel designs for drilling and production, including FPSOs.	Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations (November 2012)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Develop enhanced shearing technologies to completely cut drill pipe, tool joints, and casing strings, and to assure that the blind shear rams installed in the blowout preventer (BOP) stack are capable of shearing the pipe and/or sealing the wellbore under maximum anticipated pressures.	OESC Letter Recommendations to BSEE Department of Interior (August 2012)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Develop geophysical imaging techniques (e.g., seismic reflection surveys, and possibly passive microseismic monitoring) for remotely monitoring oil and gas leakage rates and upward migration below the sea floor and external to the wellbore.	OESC Letter Recommendations to BSEE Department of Interior (January 2013)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Develop improved casing and cementing design for ultra-deepwater wells.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2011)	Marine/Estuarine	1

ICCOPR Standing Research Areas  
2014 Database

1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Develop improved quantitative models for reservoir response and cross flow during blowouts to better understand subsurface behavior in a cross-flow situation.	OESC Letter Recommendations to BSEE Department of Interior (January 2013)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Develop improved subsea ultra-deepwater measurement and monitoring instrumentation, including technologies for "seeing" through the casing via downhole tools to gauge the cement top and in-situ cement characteristics (thickness, channeling, density (gas or liquid pockets), etc.) to better determine potential failure pathways.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2012)	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Evaluate the feasibility of using existing geophysical measurements for rapid identification of fluid influx into the borehole near the bit to reduce loss of control risks associated with drilling into over-pressured intervals	EPAct 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Research sensors; instrumentation; command electronics; and advanced data interpretation technologies and alert systems to improve decision-making capabilities. Include data analysis and expert systems.	1) DOE 2013 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress (June 2013) 2) Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations (November 2012) ;DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2012) 3) OESC Letter Recommendations to BSEE Department of Interior (January 2013)	Marine	3
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Study expert (case based) systems, and then identify benefits and limitations as well as other applications (such as cementing, completions, wellbore design, etc.) that would reduce the risk when operating in deepwater.	1) Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations (November 2012) 2) Ultra-Deepwater Advisory Committee 2012 Plan: Comments, Findings and Recommendations (March 2012)	Marine	2
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Study the interaction and potential for failure between the in situ formation (and fluids), cement, and casing, including the physical, chemical, and temporal integrity of formation, cement and casing systems.	EPAct 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>DEEPWATER TECHNOLOGY</b> - Evaluate subsea blowout preventer control pod batteries including assessments of battery design, life expectancy, performance and reliability with respect to different manufacturers.	DOE personal communication	Marine	1
1501-Drilling	Deepwater Drilling/Technology	<b>GOM DRILLING</b> - Conduct a gap analysis to characterize the salient differences between operations in the GOM environment and those to be encountered in drilling and completion in unique and sensitive marine habitats, such as arctic waters and tropical coral reef areas to assess the risks that demand more research.	Ultra-Deepwater Advisory Committee 2012 Plan: Comments, Findings and Recommendations (March 2012)	Marine	
1501-Drilling	Deepwater Drilling/Technology	<b>WELL FLOW</b> - Develop improved flow assurance, expediting the completion of well control efforts, and reduce the risk of environmental impacts from hydrate plugging related ruptures during producing operations.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2011)	Marine/Estuarine	1
1502-Drilling	Reservoir Characterization	<b>DEEPWATER CHARACTERIZATION</b> - Conduct research on the conditions (e.g., in-situ stress, sediment rheology, fluid pressure, flow rate and blowout duration) where hydrocarbon pathways to the sea floor established through hydraulic fractures and reactivated natural faults can heal	OESC Letter Recommendations to BSEE Department of Interior (January 2013)	Marine	1
1502-Drilling	Reservoir Characterization	<b>DEEPWATER CHARACTERIZATION</b> - Conduct research on the physical processes controlling upward propagation and arrest of two-phase (oil/gas) hydraulic fractures in poorly consolidated marine sediments, leading to improved numerical models for leakage volumes required for a sea-floor broach under different geological settings.	OESC Letter Recommendations to BSEE Department of Interior (January 2013)	Marine	1
1502-Drilling	Reservoir Characterization	<b>DEEPWATER CHARACTERIZATION</b> - Conduct reservoir characterization research, including bounding strata to ensure hydrocarbon containment within the geologic and engineered system.	DOE 2013 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress (June 2013)	Marine	1
1502-Drilling	Reservoir Characterization	<b>DEEPWATER CHARACTERIZATION</b> - Expand the research on reservoir characterization to include overburden characterization with emphasis on technology and methods for geological and geomechanical characterization of the subsurface from sea bed to the reservoir.	Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations (November 2012)	Marine	1

ICOPR Standing Research Areas  
2014 Database

1502-Drilling	Reservoir Characterization	<b>OFFSHORE DRILLING DATABASE</b> - Develop consistent global dataset for offshore drilling incidents to help prevent future incidents.	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
1502-Drilling	Reservoir Characterization	<b>OIL SANDS PRODUCTS EXTRACTION</b> - Conduct research on improving setting times of fines in process water to enhance water reuse and reduce settling pond restoration time.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Terrestrial	1
1502-Drilling	Reservoir Characterization	<b>OIL SANDS PRODUCTS EXTRACTION</b> - Conduct research to develop <i>insitu</i> OSP extraction processes that use less water.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Terrestrial	1
1502-Drilling	Reservoir Characterization	<b>OIL SANDS PRODUCTS EXTRACTION</b> - Conduct research to improve the efficiency and reduce energy use from <i>insitu</i> extraction processes.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Terrestrial	1
1502-Drilling	Reservoir Characterization	<b>RESERVOIR CHARACTERIZATION</b> - Develop better reservoir characterization which results in lower dependence on new field developments and new wells, thus reducing the physical and environmental footprint.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2012)	Marine	1
1502-Drilling	Reservoir Characterization	<b>RESERVOIR CHARACTERIZATION</b> - Characterize reservoir conditions associated with offshore Arctic oil and gas provinces to identify potential issues in areas of offshore cathates, sea ice and other effects.	DOE personal communication	Marine	
1502-Drilling	Reservoir Characterization	<b>SITE IMPACTS</b> - Study methods for reducing the site impact of drilling individual wells and increasing the reach associated with multiple wells drilled from a single pad.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2012)	Terrestrial/Freshwater	1
1600-Rail and Truck Transportation	No Subcategory	<b>HEADSPACE GAS RISKS</b> - Evaluate methods to reduce the volatility of headspace gas in rail cars.	PHMSA - Personal Communication (2014)	Terrestrial/Freshwater	1
1600-Rail and Truck Transportation	No Subcategory	<b>HEADSPACE GAS CHARACTERISTICS</b> - Determine the volume and characteristics of headspace gas during transport and the factors affecting these characteristics.	PHMSA - Personal Communication (2014)	Terrestrial/Freshwater	1
1600-Rail and Truck Transportation	No Subcategory	<b>TANK CAR INTEGRITY</b> - Evaluate the potential for different oil sands-derived crude oils (i.e., dilbit, synbit, and Bakken crudes) to cause corrosion or other failure mechanisms for rail tanker car operating parameters (e.g., temperature) and physical standards (e.g., wall thickness).	PHMSA - Personal Communication (2014)	Terrestrial/Freshwater	1
1600-Rail and Truck Transportation	No Subcategory	<b>TANK CAR SAFETY</b> - Evaluate alternative designs and modifications to minimize risk of oil spills during accidents.	PHMSA - Personal Communication (2014)	Terrestrial/Freshwater	1
1600-Rail and Truck Transportation	No Subcategory	<b>ACCIDENT ANALYSES</b> - Evaluate accident and incident trends to identify ways to minimize the incident rate of leaks, spills, and damage to the environment due to oil spills.	FRA Objectives ( <a href="http://www.fra.dot.gov/Page/P0151">http://www.fra.dot.gov/Page/P0151</a> )	Terrestrial/Freshwater	1
1600-Rail and Truck Transportation	No Subcategory	<b>TANK CAR INTEGRITY TESTING</b> - Investigate non-destructive detection technologies to improve methods to inspect tank cars for damage.	FRA Objectives ( <a href="http://www.fra.dot.gov/Page/P0151">http://www.fra.dot.gov/Page/P0151</a> )	Terrestrial/Freshwater	1
1600-Rail and Truck Transportation	No Subcategory	<b>OIL CLASSIFICATION</b> - Determine the chemical and other characteristics of crude oils for proper classification before shipping by rail or truck, including gas content, corrosivity, toxicity, flammability, Reid Vapor Pressure, hydrogen sulfide content and composition/concentration of entrained gases.	PHMSA, Safety Alert-January 2, 2014. Preliminary Guidance from OPERATION CLASSIFICATION.	All	1
1600-Rail and Truck Transportation	No Subcategory	<b>CREW SIZE</b> - Evaluate and determine minimum operating requirements for safe operation of unit trains transporting crude oil.	78 Federal Register 48224, FRA, PHMSA, Lac Megantic Railroad Accident Discussion and DOT Safety Recommendations.	Terrestrial/Freshwater	1
1701 Pipeline Systems	Materials	<b>PIPELINE MATERIALS</b> - Research needed on strain based design and assessment of segments of pipelines with and without fittings.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>PIPELINE MATERIALS</b> - Research needed on the effects of hydrocarbon permeation on plastic pipe strength and fusion performance.	Government and Industry Pipeline Forum (2012)	Terrestrial	1

ICCOPR Standing Research Areas  
2014 Database

1701 Pipeline Systems	Materials	<b>PIPELINE MATERIALS</b> - Research needed on the fatigue of steels and welds in a hydrogen environment.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>PIPELINE MATERIALS</b> - Research needed on the interaction of high longitudinal strain and anomalies from corrosion and mechanical damage.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>PIPELINE MATERIALS</b> - Research required on high toughness steels to characterize line pipe toughness for fracture arrest assessment.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>PIPELINE THREAT/ANOMALY MITIGATION PROCESS</b> - Research needed to improve the decision making process.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>WELL CONSTRUCTION MATERIAL TESTING</b> - Research needed to improve cement evaluation and pressure testing wireline tools to assure casing and cementing integrity.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>PIPELINE LEAK DETECTION TECHNOLOGY</b> - Advanced technology needed for sensing pipeline breaks.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>PIPELINE LEAK DETECTION TECHNOLOGY</b> - Develop improvements to mobile based LDS (leak detection systems) that are tested for accuracy on moving platforms (e.g., aerial, mobile vehicles).	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>PIPELINE LEAK DETECTION TECHNOLOGY</b> - Leak detection technology and health monitoring sensors needed that are miniaturized, automatic, robust and withstand harsh environments.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1701 Pipeline Systems	Materials	<b>PIPELINE LEAK DETECTION TECHNOLOGY</b> - Technology improvements needed to reduce leak detection false alarms.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1702 Pipeline Systems	Integrity	<b>PIPELINE INDUSTRY DATABASE</b> - Consolidated database needed for pipelines installed in the ground.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1702 Pipeline Systems	Integrity	<b>PIPELINE TECHNOLOGY</b> - Technology needed to effectively locate plastic pipe.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1702 Pipeline Systems	Integrity	<b>PIPELINE TECHNOLOGY</b> - Develop trenchless renewal/rehabilitation methods for piping systems.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1702 Pipeline Systems	Integrity	<b>PIPELINE TECHNOLOGY</b> - Investigate aerial surveillance technology (manned and unmanned) for pipelines with ROW encroachment.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1702 Pipeline Systems	Integrity	<b>PIPELINE TECHNOLOGY</b> - Technology needed for documenting the type of pipe materials installed in the ground.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
1702 Pipeline Systems	Integrity	<b>PIPELINE TECHNOLOGY</b> - Technology needed that detects the presence and location of multiple utilities (underground, through various soil conditions) in a given area.	Government and Industry Pipeline Forum (2012)	Terrestrial	1
<b>PREPAREDNESS - 2000 SERIES</b>					
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>ARCTIC BASELINE STUDIES</b> - Collect baseline data specifically for ESA's in underrepresented environments including the Arctic (Chukchi Sea, Bristol Bay), particularly in areas that are likely to be developed for oil and gas extraction in the near to mid-term.	1) NSTC JSOST - DWH Oil Spill PI Conference Report (2011) 2) National Commission on BP DWH - Final Report (2011) 3) ICCOPR R&T Plan (1992) 4) ICCOPR Public Meeting - East (2010)	Marine/Estuarine	4
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>ARCTIC BASELINE STUDIES</b> - Collect species and habitat inter-annual variability data in the Arctic nearshore zone and create high-resolution maps.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>ARCTIC BASELINE STUDIES</b> - Conduct fundamental scientific research on regional living marine resources, ecology, spatial habitat of flora and fauna.	US Arctic Research Commission White Paper (2010)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>ARCTIC BASELINE STUDIES</b> - Develop integrated information about the composition, structure and functioning of the arctic ring ecosystem.	ICCOPR Public Meeting - West (2010)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>ARCTIC BASELINE STUDIES</b> - Develop maps of sub-tidal habitats in Arctic.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>ARCTIC BASELINE STUDIES</b> - Study ecological structure and population of Arctic key indicator species (include subsistence & ecosystem importance).	US Arctic Research Commission White Paper (2010)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>ARCTIC BASELINE STUDIES</b> - Study living marine resources and their vulnerability to oil spills, including consideration of the nature and potential severity of worst case scenarios [in the Arctic].	ICCOPR Public Meeting - East (2010)	Marine/Estuarine	1



ICOPR Standing Research Areas  
2014 Database

2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>AVIAN BASELINE STUDIES</b> - Develop a better understanding of bird beaching rates including seasonal variabilities.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>AVIAN BASELINE STUDIES</b> - Study the feasibility of using genetic labeling (DNA) to identify local populations of colonial seabirds at risk from oil spills.	ICOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>BASELINE HABITAT STUDIES</b> - Collect baseline data on species abundance in key habitats (e.g., mangroves, corals).	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>BASELINE HABITAT STUDIES</b> - Collect data to fill data gaps on living marine resources and their habitats including (phytoplankton, invertebrates, fish stocks, waterfowl, and marine mammals).	Marine Mammal Commission Letter to ICOPR (2010)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>BASELINE HABITAT STUDIES</b> - Study bacterial communities inhabiting natural seeps, and the role of deep natural seeps in the ecological communities.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>BASELINE HABITAT STUDIES</b> - Study location, intensity, frequency of convergence zones both as sentinels for otherwise undetectable oil and as high risk sites for biota.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>ECOTOXICITY BASELINES</b> - Develop ecotoxicity benchmarks for benthic organisms.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine/Freshwater	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>GOM BASELINE HABITAT STUDIES</b> - Develop benthic mapping of sensitive/important habitats in the GOM.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>GOM FISHERIES BASELINE STUDIES</b> - Develop improved understanding of GOM fisheries especially migratory species and habitat use characteristics.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>INTERTIDAL BASELINE STUDIES</b> - Study and synthesize existing information for rocky and cobble habitats regarding productivity, species diversity, and community structure. Study the effects of oil on these parameters, including recovery time with consideration for regional variation	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine	1
2001-Pre-spill Baseline Studies	Habitats and species baselines	<b>INTERTIDAL BASELINE STUDIES</b> - Study and synthesize existing information for sand beaches regarding productivity, species diversity, and community structure, and the effects of oil on these parameters, including recovery time with consideration for regional variation.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>ARCTIC BASELINE STUDIES</b> - Develop a redundant meteorological sensor system to enhance Arctic coast-wide spill response goals and a series of large-scale studies of oceanographic exchanges, shelf-basin exchanges via wind and eddies, coastal boundary, under-ice river plumes, and sea-ice boundary to better inform pre- and post-spill modeling and response	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>ARCTIC BASELINE STUDIES</b> - Investigate ice hazards associated with operations in Arctic environment.	ICOPR R&T Plan (1997)	Marine/Estuarine	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>BASELINE GEOLOGICAL STUDIES</b> - Collect info on bathymetry and shoreline conditions and natural and human hazards.	Marine Mammal Commission Letter to ICOPR (2010)	Marine/Estuarine	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>GOM GEOLOGIC BASELINE STUDIES</b> - Develop a better understanding of how coasts naturally work (relationship between floods breaching natural levees and the health of marshland and barrier islands fed by the sediment).	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>GULF OF MEXICO SUSPENDED SEDIMENTS</b> - Conduct research on the baseline sediment loads in the GOM.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>OCEANOGRAPHIC BASELINE STUDIES</b> - Develop tidal and current flow baselines and scientifically based strategies focused on determining shallow water inlet flow characteristics.	Oil Spill Preparedness and Response JITF (2011)	Shoreline	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>OCEANOGRAPHIC BASELINE STUDIES</b> - Study climactic/oceanic conditions, ice conditions, and their variations.	Marine Mammal Commission Letter to ICOPR (2010)	Marine/Estuarine	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>OCEANOGRAPHIC/ATMOSPHERIC BASELINE STUDIES</b> - Develop a better understanding of cloud and ice coverage in various environments, GOM and Arctic	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
2002-Pre-spill Baseline Studies	Oceanographic/geological Baselines	<b>OCEANOGRAPHIC/ATMOSPHERIC BASELINE STUDIES</b> - Study atmospheric baselines to examine the exchange with the water surface. There is natural variability, e.g., how much methane is released from marsh systems. There is a need for the active monitoring of volatiles (e.g., H2S)	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	All	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>BASELINE PLANNING</b> - Conduct comprehensive, ecosystem-based scientific reviews of OCS areas that are currently or will likely be open for oil and gas leasing. Focus on (1) decision-making related to future leasing, exploration, and development; (2) measuring and monitoring impacts on ecological resources; and (3) providing necessary data for natural resource damage assessment should an oil spill occur.	National Commission on BP DWH - Final Report (2011)	All	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>BASELINE PLANNING</b> - Conduct research to improve the understanding of the potential for environmental impacts in frontier ultra-deepwater areas where a well-established infrastructure for spill containment does not exist (e.g., Alaskan Arctic offshore and Eastern GOM)	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2011)	Marine/Estuarine	1

ICCOPR Standing Research Areas  
2014 Database

2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>BASELINE PLANNING</b> - Develop statistics for strategically planning for different risks, their location and therefore who has what stake; develop stats for risk profiles and pre-position equipment.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>ENVIRONMENTAL BASELINE STUDIES</b> - Collect data on prevailing environmental conditions on a broad geographic scale, not just at individual lease sites.	National Commission on BP DWH - Final Report (2011)	All	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>ENVIRONMENTAL BASELINE STUDIES</b> - Collect ecological baseline information and construct a long term dataset of condition of relevant ecosystems prior to spill incidents.	1) National Commission on BP DWH - Final Report (2011) 2) CRRC - Dispersant Workshop (2013)	All	2
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>ENVIRONMENTAL BASELINE STUDIES</b> - Collect environmental baseline data in ecologically sensitive areas at particular risk to oil discharges where such data are insufficient	Title 33 Chapter 40 Subchapter IV 2761 (OPA 1990)	All	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>ENVIRONMENTAL BASELINE STUDIES</b> - Develop baseline data by conducting long-term monitoring and an integrated natural system research approach at a variety of spatial scales. Develop a broad suite of indicators that can be used to evaluate an ecosystem's response and recovery.	SAB Review of EPA Research Strategy (2011)	All	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>ENVIRONMENTAL BASELINE STUDIES</b> - Study linkages between systems, including life history information and trophic linkages. Take a holistic perspective	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>ENVIRONMENTAL BASELINE STUDIES</b> - Study the signal-to-background-noise ratio in various environments so that the impacts from oil or other stressor(s) can be delineated from natural variation. This requires adequate sampling.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	All	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>GOM BASELINE HABITAT STUDIES</b> - Conduct baseline studies for critical habitats in Texas and Louisiana.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
2003-Pre-spill Baseline Studies	Environmental Baseline Planning	<b>GREAT LAKES BASELINE STUDIES</b> - Study the potential impacts from oil discharged into the Great Lakes near shore habitats, including potential bioaccumulation of petroleum products and byproducts, early life history stages of Great Lakes fish, wetland vegetation, aquatic biota risk assessment.	ICCOPR R&T Plan (1992)	Freshwater	1
2100-Information Management and Decision Systems	No Subcategory	<b>DATA COLLECTION AND ANALYSIS</b> - Collect and synthesize existing data in a format useful for making decisions during spill events.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	All	1
2100-Information Management and Decision Systems	No Subcategory	<b>DATA COLLECTION AND ANALYSIS</b> - Collect spill data, re-examine statistical approaches used in the application of non-Arctic analogs (see Eschenbach and others, 2010), and develop and incorporate climate influenced forecasts on factors such as storms, vessel traffic, or other fault-tree model adjustments that would provide improved understanding of and confidence in spill risk estimates over the proposed project life.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
2100-Information Management and Decision Systems	No Subcategory	<b>DATA COLLECTION AND ANALYSIS</b> - Develop standards and processes for the expedited collection, processing, correlation, analysis, and distribution of satellite imagery and oil thickness sensors to provide for real-time data.	DWH ISPR (2011)	All	1
2100-Information Management and Decision Systems	No Subcategory	<b>DATA COLLECTION METHODS</b> - Develop methods for automatically transferring collected data into a usable format.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
2100-Information Management and Decision Systems	No Subcategory	<b>DATA COLLECTION METHODS</b> - Develop new information tools to have easier access to individual response teams (e.g., SCAT team, skimming crews, disposal crews) in Arctic spill response.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1
2100-Information Management and Decision Systems	No Subcategory	<b>DECISION SUPPORT SYSTEMS</b> - Develop a coordinated platform to allow for the rapid evaluation and assessment of risks and potential impacts associated with offshore deepwater operations for the GOM to produce science-based predictions, and evaluate potential future adaptation for application to other areas of the Outer Continental Shelf.	EPAct 2005 Section 999A(b)(4) DOE National Energy Technology Laboratory Complementary Research Program	Marine	1
2100-Information Management and Decision Systems	No Subcategory	<b>DECISION SUPPORT SYSTEMS</b> - Develop data repositories to be more user friendly/intuitive.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
2100-Information Management and Decision Systems	No Subcategory	<b>DECISION SUPPORT SYSTEMS</b> - Develop decision support and data systems, such as the Arctic Emergency Response Management Application, the Alaska Ocean Observing System, and the State-Federal Alaska Data Integration Working Group. Field testing of assets and data systems as was done in the 2009 "Sound Predictions" experiment in Prince William Sound, Alaska, that could significantly improve preparedness by highlighting significant data and operational needs	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
2100-Information Management and Decision Systems	No Subcategory	<b>DECISION SUPPORT SYSTEMS</b> - Develop improved information systems for decision-making, including the use of data from coastal mapping, baseline data, and other data related to the environmental effects of oil discharges, and cleanup technologies.	Title 33 Chapter 40 Subchapter IV 2761 (OPA 1990)	Marine/Estuarine	1

ICCOPR Standing Research Areas  
2014 Database

2100-Information Management and Decision Systems	No Subcategory	<b>DECISION SUPPORT SYSTEMS</b> - Develop Structured Decision Making and supporting tools to spill response to provide a more transparent and quantitative discipline to technical or value based deliberations.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
2100-Information Management and Decision Systems	No Subcategory	<b>GOM DATA</b> - Develop a unified structure of all data sets and approaches within GOMRI so all data are consistent and have documentation that is available to other researchers.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine	1
2100-Information Management and Decision Systems	No Subcategory	<b>ICE DYNAMICS</b> - Develop short-term ice dynamics forecasts to inform windows for mechanical recovery operations and to improve recovery technologies in the "ice gap" (about 30 to 70 percent ice coverage).	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
2100-Information Management and Decision Systems	No Subcategory	<b>SPATIAL PLANNING</b> - Study potential for using marine spatial planning for ocean uses including offshore drilling, shipping, national defense, sustainable fisheries, and conservation.	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
2100-Information Management and Decision Systems	No Subcategory	<b>SPILL PLANNING</b> - Develop spill planning and response based on Response Gap analysis of countermeasures, a rigorous analysis of the likelihood of the availability of a multi-countermeasure suite in different Arctic locations and seasons, and the forecasting of climate change influences on the Response Gap.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
<b>RESPONSE - 3000 SERIES</b>					
3000-Structural Damage Assessment and Salvage	No Subcategory	<b>REMOTE DAMAGE ASSESSMENT</b> - Develop improved remotely operated vehicles (ROV) for underwater assessment of hull damage.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
3000-Structural Damage Assessment and Salvage	No Subcategory	<b>REMOTE DAMAGE ASSESSMENT</b> - Study methods for remotely determining whether a cargo tank contains sea water and the height of the oil/water interface from the bottom of the tank.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
3000-Structural Damage Assessment and Salvage	No Subcategory	<b>WRECK POLLUTION</b> - Collect baseline data on the potentially polluting wrecks in marine waters.	Potentially Polluting Wrecks in Marine Waters: An Issue Paper for the International Oil Spill Conference (2005)	Marine/Estuarine	1
3000-Structural Damage Assessment and Salvage	No Subcategory	<b>WRECK POLLUTION</b> - Conduct a wreck identification, evaluation and risk assessment.	Wreck Oil Removal Program Overview (2009)	Marine/Estuarine	1
3100-At-Source Control and Containment	No Subcategory	<b>SHIP CONTAINMENT TECHNOLOGY</b> - Test plugging and patching vessel leak technologies.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
3100-At-Source Control and Containment	No Subcategory	<b>WELL CONTAINMENT TECHNOLOGY</b> - Develop and integrate subsea containment equipment including relevant procedures and training of skilled personnel.	DWH ISPR (2011)	Marine/Estuarine	1
3100-At-Source Control and Containment	No Subcategory	<b>WELL CONTAINMENT TECHNOLOGY</b> - Develop capping and containment options to contain blowouts from platform wells.	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
3100-At-Source Control and Containment	No Subcategory	<b>WELL CONTAINMENT TECHNOLOGY</b> - Develop containment technology that is compatible with deepwater wells.	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
3100-At-Source Control and Containment	No Subcategory	<b>WELL CONTAINMENT TECHNOLOGY</b> - Develop improved technology and response protocols to adequately address source control and containment objectives arising from an uncontrolled well blowout.	DWH ISPR (2011)	Marine/Estuarine	1
3100-At-Source Control and Containment	No Subcategory	<b>WELL CONTAINMENT TECHNOLOGY</b> - Develop subsea containment equipment, vessels, personnel, & capabilities for collecting flow from pipelines, risers, blowout preventers, flanges, & other subsea equipment at any water depth at which exploration and development activities are taking place.	DWH ISPR (2011)	Marine/Estuarine	1
3100-At-Source Control and Containment	No Subcategory	<b>WELL CONTAINMENT TECHNOLOGY</b> - Study the range of failure states under which blowout preventers (BOPs) must perform.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2011)	Marine/Estuarine	1
3201-Chemical and Physical Behavior Modeling	Arctic Behavior/Modeling	<b>ARCTIC OCEANOGRAPHIC DATA</b> - Investigate surface circulation using HF radar and satellite track drifters in the Arctic.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1

ICOPR Standing Research Areas  
2014 Database

3201-Chemical and Physical Behavior Modeling	Arctic Behavior/Modeling	<b>ARCTIC OCEANOGRAPHIC MODELS</b> - Develop and validate hydrologic model for Prince William Sound.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1
3201-Chemical and Physical Behavior Modeling	Arctic Behavior/Modeling	<b>ARCTIC OCEANOGRAPHIC MODELS</b> - Develop improved modeling tools and trajectory models in order to predict spreading of oil in different ice conditions.	ICOPR Public Meeting - West (2010)	Marine/Estuarine/Freshwater	1
3201-Chemical and Physical Behavior Modeling	Arctic Behavior/Modeling	<b>ARCTIC OCEANOGRAPHIC MODELS</b> - Develop spill trajectory and weather models based on Arctic conditions.	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
3201-Chemical and Physical Behavior Modeling	Arctic Behavior/Modeling	<b>ARCTIC OIL BEHAVIOR</b> - Identify fate of specific oils in ice conditions if left in the environment until open water season.	Marine Mammal Commission Letter to ICOPR (2010)	Marine/Estuarine/Freshwater	1
3201-Chemical and Physical Behavior Modeling	Arctic Behavior/Modeling	<b>ARCTIC OIL BEHAVIOR</b> - Study oil-in-ice weathering, particularly as it relates to the effectiveness of spill response countermeasures and the potential for ecosystem exposure. Oil-water partitioning is recognized as needing further study, especially the potential toxicity of the partitioned phases.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3201-Chemical and Physical Behavior Modeling	Arctic Behavior/Modeling	<b>ARCTIC OIL BEHAVIOR</b> - Study the fate and behavior of oil in broken ice.	1) PWS OSRI - Research Plan 2011-2015 (2010) 2) ICOPR Public Meeting - East (2010)	Marine/Estuarine/Freshwater	2
3201-Chemical and Physical Behavior Modeling	Arctic Behavior/Modeling	<b>ARCTIC OIL WEATHERING</b> - Study Arctic-based indigenous microbial populations in the water column and benthic sediment, and define rates of microbial processes. This will ultimately allow for the full characterization of the role such communities have in the oil weathering process.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>BIODEGRADATION MODELS</b> - Develop biodegradation models for incorporation into ADIOS3.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>DEEPWATER OIL BEHAVIOR</b> - Develop improved capability to develop accurate flow rate estimates from uncontrolled well blowouts.	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>DEEPWATER OIL BEHAVIOR</b> - Study the complex fluid phase behaviors that occur under conditions of extreme pressure and temperature, and develop advanced models of hydrocarbon behavior under these conditions.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2011)	Marine/Estuarine	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>INTERTIDAL OIL WEATHERING</b> - Study how oil degrades in intertidal and shallow subtidal habitats (e.g., cobble, pebbles, sands, mud, mussel beds, mangroves, marshes).	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>MARINE SNOW</b> - Study the formation of marine snow and its role in oil spills using different oils and utilizing field experiments.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OCEANOGRAPHIC MODELS</b> - Study the upper sea-surface turbulence with particular emphasis on quantifying horizontal and vertical diffusivities and the rate of energy dissipation.	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL BEHAVIOR</b> - Develop conceptual model of the "life history of an oil droplet".	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL BEHAVIOR</b> - Develop improved methods to determine rates of microbial degradation in different environments, both in preparation for a response and during response (e.g., temperature-dependent rates, bioassays, and prioritized methods).	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL BEHAVIOR</b> - Study bottom substrate dynamics that might affect submerged oil behavior and fate.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL BEHAVIOR</b> - Study droplet size of deepwater blowouts, thickness of surfacing oil and behavior of dissolvable components.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL BEHAVIOR</b> - Study the fate and transport of heavy oil releases from land.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL WEATHERING</b> - Study how oil grounding processes both physical and biological, affect oil degradation, persistence, and toxicity.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1

ICCOPR Standing Research Areas  
2014 Database

3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL WEATHERING</b> - Study how the properties of oil impact emulsification.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL WEATHERING</b> - Study the long term fate of chemically and/or naturally dispersed oil including its interactions with fine suspended or bottom sediments, and biological and chemical degradation.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
3202-Chemical and Physical Behavior Modeling	Oil Behavior Models	<b>OIL WEATHERING</b> - Study the long term fate of oil in various conditions in the environment (e.g., tar balls, solution, micells) including photolysis and biodegradation, use results to inform models.	1) CRRC - R&D Priorities: An Oil Spill Workshop (2003) 2) Gulf of Mexico Research Initiative (2010)	Marine/Estuarine/Freshwater	2
3203-Chemical and Physical Behavior Modeling	Transport models	<b>GOM OIL TRANSPORT</b> - Conduct research to improve understanding of vertical movement of hydrocarbon in order to advance ability to predict diffusivity.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>GOM OIL TRANSPORT</b> - Study the fate and transport of contaminants associated with the DWH spill.	Gulf of Mexico Research Initiative (2010)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>GOM OIL TRANSPORT</b> - Study the interactions of dispersed and non-dispersed oil components with marine snow particles and resuspended sediments.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>GOM OIL TRANSPORT</b> - Study the long-term fate of sunken oil including hydrocarbons and metals.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine/Freshwater	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>GOM OIL TRANSPORT</b> - Study the remobilization of oil after storm events.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)		1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED DISPERSANT MODELS</b> - Study the integration of fate and toxicity models with population models to predict short- and long-term effects of dispersant application.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop data/method needs to improve trajectory modeling, 2D, 3D (surface and subsurface), real time comparison/validation, integrate surface and fate modeling. Include checklists of monitoring needs	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop improved evaporation models to include a wider range of temperatures and wind speeds and other conditions.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop improved models predicting dispersability using information on the physiochemical properties of oil.	BSEE BAA Proposed Research on Oil Spill Response Operations (2012)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop improved oil weathering and fate information for models (e.g., volatilization, solubilization, emulsification, biodegradation).	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	Marine/Estuarine/Freshwater	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop improved physical transport models to accommodate different oil types, oil interactions with suspended particulates, 3-D capabilities, differential spatial scales, calibration and validation in the field, and intercomparisons with other existing modeling environments.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop models for: shoreline cleanup, near shore and ocean transport, emulsions in water.	ICCOPR R&T Plan (1992)	Shoreline	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop oil trajectory and fate models used during spill response to predict the behavior of dispersed oil and verify and validate them in an appropriately designed experimental setting or during actual spills	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop standards to validate trajectory models to improve site specific models.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Develop understanding of the size, composition, and distribution of particles, both oil and sediment, which are key to developing better models for forecasting, observing, understanding, and hindcasting submerged oil behavior	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Improve oil trajectory models by conducting a directed synthesis and sensitivity analysis on spreading, advection, evaporation, mixing, etc.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1

ICCOPR Standing Research Areas  
2014 Database

3203-Chemical and Physical Behavior Modeling	Transport models	<b>IMPROVED OIL TRANSPORT MODELS</b> - Study how dispersed oil transport mechanisms relate to an oil's migration to the benthic environment.	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	Marine/Estuarine/Freshwater	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>SUBSURFACE OIL TRANSPORT MODELS</b> - Develop a decision template or conceptual model of the conditions under which oil might become submerged that includes oil properties and environmental characteristics.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3203-Chemical and Physical Behavior Modeling	Transport models	<b>SUBSURFACE OIL TRANSPORT MODELS</b> - Study technologies to model subsurface oil trajectory.	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine/Freshwater	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>NEARSHORE MODELING</b> - Develop high resolution nearshore models.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine/Freshwater	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>OCEAN CIRCULATION MODELS</b> - Determine the sensitivity of large General Circulation Models to variations in the boundary conditions and forcing.	ICCOPR R&T Plan (1992)	Marine/Estuarine	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>OCEAN CIRCULATION MODELS</b> - Develop new 4D numerical circulation models that can be used to map oil tracking.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine/Freshwater	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>OCEAN CIRCULATION MODELS</b> - Develop optimal methods for stitching together small-scale and large-scale hydrodynamic models.	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	All	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>OCEAN CIRCULATION MODELS</b> - Link models to observation to incorporate real-time data and ocean state.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>OCEAN CIRCULATION MODELS</b> - Study and validate ocean circulation models for use in spill transport models.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>OCEANOGRAPHIC DATA STUDIES</b> - Study forecasting ability with new technology - feasibility study of circulation mapping using drift buoys, LIDAR, Doppler radar.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>OCEANOGRAPHIC MODELS</b> - Develop improved capacity to model in 3D.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3204-Chemical and Physical Behavior Modeling	Oceanographic models	<b>OCEANOGRAPHIC MODELS</b> - Develop updated Parameter-elevation Regressions on Independent Slopes Model (PRISM).	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1
3205-Chemical and Physical Behavior Modeling	Emerging Crude	<b>OIL SANDS PRODUCTS CHARACTERISTICS</b> - Conduct research on the chemical and physical characteristics of various blends of dilbit and synbit to better understand how to address spills.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	
3205-Chemical and Physical Behavior Modeling	Emerging Crude	<b>OIL SANDS PRODUCTS DISPERSION</b> - Conduct research on OSP-sediment interactions and dispersion.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	
3205-Chemical and Physical Behavior Modeling	Emerging Crude	<b>OIL SANDS PRODUCTS DISPERSION</b> - Conduct research on the dispersion of OSP in water (droplet size, coalescence, rise time).	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	

ICCOPR Standing Research Areas  
2014 Database

3205-Chemical and Physical Behavior Modeling	Emerging Crude	<b>OIL SANDS PRODUCTS DISPERSION</b> - Conduct research on the resuspension and remobilization potential of OSP in freshwater and marine environments.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	
3205-Chemical and Physical Behavior Modeling	Emerging Crude	<b>OIL SANDS PRODUCTS WEATHERING</b> - Conduct research and develop models of the changes in dilbit chemistry due to evaporation.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	
3205-Chemical and Physical Behavior Modeling	Emerging Crude	<b>OIL SANDS PRODUCTS WEATHERING</b> - Develop models for the photooxidation of OSP.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	
3205-Chemical and Physical Behavior Modeling	Emerging Crude	<b>OIL SANDS PRODUCTS WEATHERING</b> - Develop models of water uptake and retention by OSP.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	
3205-Chemical and Physical Behavior Modeling	Emerging Crude	<b>OIL SANDS PRODUCTS WEATHERING</b> - Study the persistence of OSP in the marine and freshwater environments.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ALTERNATIVE TECHNOLOGIES</b> - Develop improved methods for detecting thick oil (i.e., large collections of oil) to assist in recovery operations (alternative sensor technologies, improved acoustic survey cost effective laser fluorometers and hyper spectral systems).	1) CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011) 2) DWH ISPR (2011)	Marine/Estuarine/Freshwater	2
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ALTERNATIVE TECHNOLOGIES</b> - Develop refined frequency scanning radiometer.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ALTERNATIVE TECHNOLOGIES</b> - Further develop and test laser fluorosensor.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ICE/OIL DETECTION</b> - Develop airborne systems for detecting oil in ice.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine/Freshwater	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ICE/OIL DETECTION</b> - Develop AUV mounted sensors for detection of oil under ice.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine/Freshwater	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ICE/OIL DETECTION</b> - Develop enhanced technology for oil detection under ice and in broken ice and in low visibility.	ICCOPR Public Meeting - East (2010)	Marine/Estuarine/Freshwater	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ICE/OIL DETECTION</b> - Develop the use of laser fluorosensor, given its potential to detect oil in the presence of ice and snow. However, to facilitate broader use of this sensor and its incorporation into multi-sensory packages that can be deployed from a variety of platforms, a reduction in the size and energy consumption is needed.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ICE/OIL DETECTION</b> - Study enhanced satellite remote sensing and surface validation capabilities, including development and (or) refinement of satellite-based oil detection algorithms for ice-covered areas.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1

ICCOPR Standing Research Areas  
2014 Database

3301-Oil Spill Detection and Surveillance	Remote Detection	<b>ICE/OIL DETECTION</b> - Test latest evolution of acoustic system over a realistic mix of first year sea ice under field conditions, and at the same time test the capabilities of the latest generation of ground-penetrating radars in areas of bottom-fast ice where the interface is ice to frozen sediment rather than ice to water.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop and test multi-sensor systems to inform remote-sensing operations for spill response. In particular, expanded testing of unmanned aircraft systems is needed to augment observations from trained observers.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop enhanced aerial detection sensor capability to locate concentrations of oil necessary for ISB operations.	DWH ISPR (2011)	All	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop improved aerial surveillance for identifying thick oil.	1) CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012) 2) DWH ISPR (2011)	Marine/Estuarine/Freshwater	2
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop improved satellite tracking of ice movement and divergence (National Ice Center Purview).	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop improvements to our ability to track oil at night consistently on a local and global level 24/7.	ICCOPR Public Meeting - Gulf (2010)	Marine/Estuarine/Freshwater	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop improvements to remote sensing technologies that facilitate the efficiency of various response countermeasures.	BSEE BAA Proposed Research on Oil Spill Response Operations (2012)	Marine/Estuarine	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop methods for oil spill detection and mapping in low visibility and ice conditions.	1) OGP - JIP Solicitation for Expression of Interest (EOI) on Arctic Oil Spills (2012) 2) US Arctic Research Commission White Paper (2010)	Marine/Estuarine/Freshwater	2
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop programs to monitor and track large dispersed oil plumes.	DWH ISPR (2011)	Marine/Estuarine	1
3301-Oil Spill Detection and Surveillance	Remote Detection	<b>REMOTE TECHNOLOGIES</b> - Develop remote "survey" technologies for rapid and accurate detection of oil and plumes in deep- and mid-water over larger distances.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>ALTERNATIVE TECHNOLOGIES</b> - Study the quality of data from new detection/monitoring technology/instruments.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>ALTERNATIVE TECHNOLOGIES</b> - Develop high resolution microwave sensor research for oil spill detection and monitoring.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>CHEMICAL MONITORING</b> - Develop advanced field monitoring techniques and rapid chemical analysis.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>CHEMICAL MONITORING</b> - Develop fine-scale plume sampling and analytical methodologies that accurately characterize the plume, e.g. Polycyclic Aromatic Hydrocarbon (PAH), TPH, water-accommodated fraction, with respect to chemical constituents of concern that are directly relevant for ecological risk assessments.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine/Freshwater	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>CHEMICAL MONITORING</b> - Develop improved methods for in situ monitoring of biological and chemical data (e.g., dissolved oxygen).	1) NSTC JSOST - DWH Oil Spill PI Conference Report (2011) 2) ICCOPR R&T Plan (1992)	Marine/Estuarine	2
3302-Oil Spill Detection and Surveillance	Monitoring	<b>CHEMICAL MONITORING</b> - Develop technology to rapidly analyze physio-chemical properties of spilled oil.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>CONTAMINATED SEDIMENT MONITORING</b> - Develop improved techniques for locating and sampling contaminated sediments, including both onshore and offshore.	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	Marine/Estuarine/Freshwater	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>CONTROLLED SPILL</b> - Study system performance under real-world conditions during a future offshore controlled spill exercise. Such an exercise would provide information essential to refining these capabilities from an operational standpoint.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1



ICCOPR Standing Research Areas  
2014 Database

3302-Oil Spill Detection and Surveillance	Monitoring	<b>DISPERSANT MONITORING</b> - Develop new technologies for monitoring dispersant effectiveness in the field.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>DISPERSANT MONITORING</b> - Develop technologies to improve oil and dispersant detection in the water column and seafloor.	1) Oil Spill Preparedness and Response JITF (2011) 2) DWH ISPR (2011)	Marine/Estuarine	2
3302-Oil Spill Detection and Surveillance	Monitoring	<b>IN-SITU TECHNOLOGY</b> - Study the use of in-situ measuring instruments or synthetic materials for monitoring exposure of specific contaminants over time.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)		1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>MONITORING PLATFORMS</b> - Develop improved longevity of marine measurement platforms (i.e., monitoring vessels).	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>MONITORING PLATFORMS</b> - Develop shallow water gliders that can transit large vertical density gradients.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>SENSOR INTEGRATION</b> - Develop sensor integration and data analysis techniques.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
3302-Oil Spill Detection and Surveillance	Monitoring	<b>SMART PROTOCOL</b> - Develop a refined SMART protocol and operational need/value during subsea and surface response based on recent experiences.	1) CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012) 2) DWH ISPR (2011) 3) EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine	3
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBMERGED OIL DETECTION</b> - Develop capability to determine the presence or absence of submerged oil over a large area (on the seafloor or in the water column) on a coarse scale. (Although focus was on sonar and laser fluorosensor technologies, all potential technologies across the spectral range should be considered.)	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBMERGED OIL DETECTION</b> - Develop improved confidence in ability to estimate the areal extent and amount of submerged oil since actual locations and amounts are not visible.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBMERGED OIL DETECTION</b> - Develop method to calibrate the degree of oiling on snare sampling systems with the amount of oil on the seafloor or in the water column.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBMERGED OIL DETECTION</b> - Develop observation systems that can be deployed on scene at spills of submerged oil to help validate or calibrate models and direct sampling and monitoring.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBMERGED OIL DETECTION</b> - Develop surrogates for different types of submerged oil to be used for testing and training.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBMERGED OIL DETECTION</b> - Develop the capability to confirm and refine the location and quantity of submerged oil detected on a coarse scale.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBMERGED OIL DETECTION</b> - Develop understanding of when and which in-water chemical sensors would be useful for detecting submerged oil.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBMERGED OIL DETECTION</b> - Study the potential of acoustic systems and LiDAR, both individually and as packaged suites, to detect submerged oil on the seafloor and in the water column.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBSURFACE OIL DETECTION</b> - Develop improved methods for sampling and monitoring the transport of subsurface oil.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3303-Oil Spill Detection and Surveillance	Submerged Oil Detection	<b>SUBSURFACE OIL DETECTION</b> - Study the use of acoustics for tracking subsurface oil plumes.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>ALCOHOL FUEL RECOVERY</b> - Develop new types of mechanical recovery technologies and CTAs to more effectively respond to alcohol based fuel spills.	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine/Freshwater	1

ICCOPR Standing Research Areas  
2014 Database

3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop control and recovery capabilities for icy river conditions with pack ice and ice flows.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop improved ice processing capabilities of skimmers.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine/Freshwater	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop improved methods of mechanical recovery in arctic conditions (e.g., cold water, ice, broken ice).	1) BSEE BAA Proposed Research on Oil Spill Response Operations (2012) 2) OGP-JIP Solicitation for Expression of Interest on Arctic Oil Spills (2012) 3) ICCOPR R&T Plan (1992) 4) ICCOPR Public Meeting - East (2010) 5) ICCOPR Public Meeting - West (2010) 6) USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011) 7) PWS OSRI Research Plan 2011-2015 (2010) 8) National Commission on BP DWH - Final Report (2011) 9) US Arctic Research Commission White Paper (2010)	Marine/Estuarine/Freshwater	9
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop techniques to artificially thicken ice to increase its oil retention capabilities.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Further develop mechanical recovery systems to recover oil accumulated under ice.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Need to develop mechanical recovery equipment and documentation of this capacity in different ice scenarios.	ICCOPR Public Meeting - West (2010)	Marine/Estuarine/Freshwater	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Study Arctic-specific response (environmental baseline, unique conditions/logistics).	US Arctic Research Commission White Paper (2010)	Marine/Estuarine	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop improved high seas containment devices including booms and skimmers.	1) ICCOPR R&T Plan (1992) 2) ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	2
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop improved large volume skimming platforms.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop improved mechanical recovery to increase capture rate and capacity.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2011)	Marine/Estuarine/Freshwater	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop improved strategies for removal of suspended oil from the water column using trawling systems.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop innovative techniques for containment.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine/Freshwater	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop methods to increase the encounter rate of skimming and in situ burning operations, by increasing amount/thickness of oil on the surface (methods could involve use of chemicals, innovative mechanical systems, new operational procedures).	1) BSEE BAA Proposed Research on Oil Spill Response Operations (2012) 2) ICCOPR R&T Plan (1992) 3) CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine/Freshwater	3
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop new tools to recover submerged oil, both suspended and on the seafloor.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1

ICCOPR Standing Research Areas  
2014 Database

3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Develop, test and evaluate containment booms and recovery systems.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>SUBSEA OIL RECOVERY</b> - Conduct research to evaluate new or innovative mechanical technologies that contain or remove subsea oil releases.	BSEE BAA Proposed Research on Oil Spill Response Operations (2012)	Marine/Estuarine	1
3401-In and On-water Containment and Recovery	Control/Recovery Technology	<b>SUBSEA OIL RECOVERY</b> - Refine techniques for removal of subsurface oil.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Study the presence or lack of standardized testing approaches (especially wave tanks), the cross-comparability of results, and collaborative development of protocols that would establish the practical recovery limits that are achievable during response operations, and refine our understanding of the appropriate setting and scale at which these devices could be effectively deployed.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>ARCTIC CONTROL AND RECOVERY TECHNOLOGIES</b> - Test response equipment in Arctic.	ICCOPR Public Meeting - East (2010)	Marine/Estuarine	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>CONTROL AND RECOVERY TECHNOLOGIES</b> - Study response options and determine which were most successful during DWH.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>CONTROL TECHNOLOGY FIELD TESTING</b> - Conduct field test of cleanup techniques and create protocols for various habitats and conditions.	ICCOPR R&T Plan (1992)	All	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>CONTROL TECHNOLOGY FIELD TESTING</b> - Control technology field testing.	Title 33 Chapter 40 Subchapter IV 2761 (OPA 1990)	Marine/Estuarine	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>OIL SIMULANTS</b> - Conduct simulant toxicity testing for wildlife, fish and ESA species.	Oil Spill Simulants Materials: Workshop Proceedings (March 2013)	Marine/Estuarine	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>OIL SIMULANTS</b> - Develop a decision-making framework regarding potential risks for all types of simulants.	Oil Spill Simulants Materials: Workshop Proceedings (March 2013)	Marine/Estuarine	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>OIL SIMULANTS</b> - Identify case histories of the use of simulants in field exercises to identify potential environmental impacts.	Oil Spill Simulants Materials: Workshop Proceedings (March 2013)	Marine/Estuarine	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>SORBENT USAGE</b> - Study the use of sorbents for smaller spills under various conditions and oil types.	ICCOPR R&T Plan (1992)	All	1
3402-In and On-water Containment and Recovery	Recovery Operations and Testing	<b>SPILL RESPONSE CAPACITY</b> - Develop improved capability to do 24/7 spill response.	Pacific States/BC OSTF Letter to ICCOPR (2010)	All	1
3500- Shore Containment and Recovery	No Subcategory	<b>NATURAL ATTENUATION</b> - Study natural attenuation as an option for spill response using spills of opportunity and field trials.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1
3500- Shore Containment and Recovery	No Subcategory	<b>SHORELINE CLEANUP METHODOLOGIES</b> - Develop technologies to improve "sandy" beach mechanized, mechanical cleanup.	Oil Spill Preparedness and Response JITF (2011)	Shoreline	1
3500- Shore Containment and Recovery	No Subcategory	<b>SHORELINE CLEANUP METHODOLOGIES</b> - Conduct research to assess the ability of chemicals to prevent oil impact on shorelines.	ICCOPR R&T Plan (1992)	Marine/Estuarine	1
3500- Shore Containment and Recovery	No Subcategory	<b>SHORELINE CLEANUP METHODOLOGIES</b> - Study the effectiveness of surface washing and develop standards.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Shoreline	1
3500- Shore Containment and Recovery	No Subcategory	<b>SHORELINE CLEANUP METHODOLOGIES</b> - Study the use of dispersants vs. shoreline cleaners vs. mechanical recovery in near-shore and shoreline zones.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)		1
3500- Shore Containment and Recovery	No Subcategory	<b>SHORELINE IMPACTS</b> - Study impacts of foot traffic on shoreline cleanup.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1

ICOPR Standing Research Areas  
2014 Database

3601-Dispersants	Cold weather and Ice Conditions	<b>ARCTIC APPLICATION</b> - Study the understanding of the "window of opportunity" for potential deployment of all dispersants in the Arctic.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3601-Dispersants	Cold Weather and Ice Conditions	<b>ARCTIC EFFECTIVENESS</b> - Study best dispersant for different environmental conditions including ice.	Marine Mammal Commission Letter to ICOPR (2010)	Marine/Estuarine	1
3601-Dispersants	Cold Weather and Ice Conditions	<b>ARCTIC EFFECTIVENESS</b> - Study dispersant fate and effectiveness in open water versus ice conditions.	Marine Mammal Commission Letter to ICOPR (2010)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>BIODEGRADATION</b> - Develop a detailed investigation on the kinetics of dispersed oil biodegradation at low oil-water ratios to simulate conditions that represent those that follow significant dilution of the dispersed oil plume.	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>BIODEGRADATION</b> - Develop biotransformation products of high-molecular-weight PAH using indigenous microbial communities from seawater	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>BIODEGRADATION</b> - Develop droplet-scale models of biodegradation kinetics and estimate the appropriate kinetic parameters.	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>BIODEGRADATION</b> - Study and quantify biodegradation kinetics of dispersed oil.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>BIODEGRADATION</b> - Study the toxic and sub-lethal effects and ramifications for microbial communities (and the natural biodegradation of oil).	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>CONSTITUENTS</b> - Conduct a literature review of dispersant constituents for dispersants listed on the NCP product schedule to determine relevant information such as chemical makeup, environmental fate, kinetics, toxicity, bioconcentration factor, and bioaccumulation factor (BCF/BAF) in order to identify constituents of concerns or chemical markers.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>CONSTITUENTS</b> - Develop appropriate chemical (analytical) methods for detecting and quantifying dispersant constituents in environmental samples to assess biodegradation and bioaccumulation.	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	Marine/Estuarine/Freshwater	1
3602-Dispersants	Behavior	<b>CONSTITUENTS</b> - Study chemistry data for individual dispersant components in the oil droplets during the DWH spill.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL ANALYSIS</b> - Develop methods for collection and analysis of samples of dissolved phase and particulate/oil-droplet phase PAH in environmental samples	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Conduct field trials with dispersants that include tracking and monitoring concentrations.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the behavior of chemically treated oil in terms of vertical movements in interstitial spaces.	ICOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the degree, rate, and consequence of surfactant leaching from chemically dispersed oil droplets.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the degree, rate, and consequences of surfactant leaching from surface slicks and chemically dispersed oil droplets.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the fate and transport of dispersed oil and dispersants in the surface, subsurface and deep water.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the impact of chemical dispersants on the dissolution/degradation of water soluble hydrocarbons including VOCs from subsea releases	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the interactions of chemically dispersed oil droplets with suspended particulate matter (SPM) and how these processes affect the rate of oil biodegradation and ultimate fate of dispersed oil.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the role of dispersants on the dissolution process (short and long term).	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the variables affecting coalescence and resurfacing of dispersed oil droplets to develop models for tracking movement at surface, subsurface and deepwater.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine	1
3602-Dispersants	Behavior	<b>DISPERSED OIL BEHAVIOR</b> - Study the quantification of degradation rates of chemically dispersed, physically dispersed, and undispersed oil.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSANT INTERACTIONS</b> - Conduct research on benthic species interactions with oil, oil/dispersants and dispersant contaminated sediments.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine/Freshwater	1

ICCOPR Standing Research Areas  
2014 Database

3603-Dispersants	Impacts	<b>DISPERSANT INTERACTIONS</b> - Conduct research on dispersants, oil only, and dispersed oil interactions with algae, sediments and particles.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine	1
3603-Dispersants	Impacts	<b>DISPERSANT WEATHERING</b> - Study the impact of flocculation on oil and dispersants.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine/Freshwater	1
3603-Dispersants	Impacts	<b>DISPERSED OIL FATE</b> - Collect available data on dispersant bioaccumulation and assess whether more info is needed.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL FATE</b> - Gain better understanding of long term impact of dispersants on fisheries etc.	ICCOPR Public Meeting - Gulf (2010)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL FATE</b> - Study and evaluate dispersant and dispersed oil chronic and sub-lethal effects on key species for varying, real world exposure scenarios and durations	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL FATE</b> - Study and improve understanding of long-term ecological effects of dispersed oil.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL FATE</b> - Study whether dispersants or changes in oil chemistry are effective in reducing marine species' exposure to oil and its constituents.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL FATE</b> - Study worldwide, synthesis, and analysis of biological effects from dispersed oil under controlled and uncontrolled oil spills	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL TOXICITY</b> - Develop and implement focused toxicity studies to: (1) provide data that can be used to parameterize models to predict photo-enhanced toxicity; (2) estimate the relative contribution of dissolved and particulate oil phases to toxicity with representative species, including sensitive species and life stages; and (3) expand toxicity tests to include an evaluation of delayed effects.	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL TOXICITY</b> - Develop focused toxicity studies to determine the mechanisms of both acute and sub lethal toxicity to key organisms from exposure to dispersed oil	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL TOXICITY</b> - Develop standard methods for toxicity testing of dispersed oil appropriate for coastal regimes.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL TOXICITY</b> - Study chronic testing, testing of indigenous species, and testing of specific oil types in combination with specific dispersant types with specific water bodies and set appropriate temporal, spatial, and volumetric standards.	DWH ISPR (2011)	Marine/Estuarine/Freshwater	1
3603-Dispersants	Impacts	<b>DISPERSED OIL TOXICITY</b> - Study the ecotoxicological effects of oil dispersant products and dispersed oil on surface and deep sea species.	1)EPA Draft Oil Spill Research Strategy (2011) 2)Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>DISPERSED OIL TOXICITY</b> - Study whether dispersants increase bioavailability of toxic oil compounds.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>RISK-BASED DECISION MAKING</b> - Collect existing dispersed oil toxicity data and studies to support risk-based decision making for use of dispersants at spills.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>RISK-BASED DECISION MAKING</b> - Conduct research to improve understanding of the efficiency of dispersion into the water column and plume transport dynamics to inform exposure and risk assumptions.	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>RISK-BASED DECISION MAKING</b> - Develop an ecosystem consequence analysis (ECA) for dispersant usage that considers key populations at risk, recovery rates, and food web consequences, using population sensitivity tables that inform many decisions (e.g., ecological to economic), identify data gaps and identify key species that drive tradeoff decisions.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>RISK-BASED DECISION MAKING</b> - Develop localized integrative models and decision support tools for dispersant planning and response.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>TOXICITY</b> - Conduct toxicological studies of sub-chronic and chronic exposures to the variable complex dispersant mixtures.	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>TOXICITY</b> - Develop protocols for testing efficacy and toxicity of commercially available dispersants and other chemical agents which may become commercially available	ICCOPR R&T Plan (1992)	Marine/Estuarine	1
3603-Dispersants	Impacts	<b>WILDLIFE EFFECTS</b> - Study long-term effects of short-term exposures to dispersed oil on wildlife.	SAB Review of EPA Research Strategy (2011)	All	1
3604-Dispersants	Efficacy and Effectiveness	<b>ALCOHOL-HYDROCARBON SPILLS</b> - Study the use of dispersants on blended alcohol-hydrocarbon fuel spills.	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>ALTERNATIVE FORMULATIONS</b> - Develop alternative dispersant products that have a "lighter" environmental footprint than petroleum based products	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>ALTERNATIVE FORMULATIONS</b> - Develop innovative "next generation" dispersants.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine	1

ICOPR Standing Research Areas  
2014 Database

3604-Dispersants	Efficacy and Effectiveness	<b>ALTERNATIVE FORMULATIONS</b> - Develop new highly effective dispersants for use in different extremes.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>ALTERNATIVE FORMULATIONS</b> - Study and evaluate the efficacy of dispersant alternatives solvent-free formulations.	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>ALTERNATIVE FORMULATIONS</b> - Study availability and effectiveness of alternative dispersants.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>WEATHERED OIL EMULSIONS</b> - Develop a detailed investigation of wave-tank studies that specifically address the chemical treatment of weathered oil emulsions	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Conduct a comparison study on various oil types and their dispersability.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Conduct a study comparing methods for measuring droplet size distribution and energy dissipation rate in different dispersant effectiveness test systems	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Develop and implement focused series studies to better predict the effectiveness of dispersants for different oil types and environmental conditions based on climatology data supplemented with real-time in situ observations.	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Develop experimental systems for bench-scale effectiveness to: 1) determine the energy dissipation rates that prevail over a wide range of operating conditions; 2) measure chemical effectiveness over a range of energy dissipation rates to characterize the relationship between these variables; and 3) include measurement of the droplet-size distribution of the dispersed oil.	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Develop improved instrumentation for measuring dispersant effectiveness on the surface and subsurface.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Develop improved models to predict dispersant effectiveness and oil fate.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Develop optimal operational effectiveness of dispersant applications.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Study best dispersant for crude oil.	Marine Mammal Commission Letter to ICCOPR (2010)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Study dispersant use in calm sea surface conditions.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Study the effect of dispersants on droplet size/bubble size distribution and the trapping height of plumes.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Study the effectiveness and net environmental benefits of subsea dispersant application.	DWH ISPR (2011)	Marine/Estuarine	1
3604-Dispersants	Efficacy and Effectiveness	<b>EFFECTIVENESS</b> - Study the physical and chemical properties of oils that determine the overall effectiveness of dispersant application.	CRRC - R&D Needs for Making Decisions Regarding Dispersing Oil (2005)	Marine/Estuarine	1
3605-Dispersants	Fate	<b>DISPERSED OIL FATE</b> - Conduct transport and fate studies with the CTAs in conjunction with the particular oils with which they would most likely be used (address important conditions: high pressure to model under ice and deep sea).	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine	1
3605-Dispersants	Fate	<b>DISPERSED OIL FATE</b> - Develop and implement steps to ensure that future wave-tank or spill-of-opportunity studies implement a field program to measure both dissolved-phase PAH and particulate/oil-droplet phase PAH concentrations for comparison to PAH thresholds measured in toxicity tests and predicted by computer models for oil spill fate and behavior	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3605-Dispersants	Fate	<b>DISPERSED OIL FATE</b> - Develop studies to quantify the weathering rates and final fate of chemically dispersed oil droplets compared with undispersed oil.	NRC Oil Spill Dispersants: Efficacy and Effects (2005)	Marine/Estuarine	1
3605-Dispersants	Fate	<b>DISPERSED OIL FATE</b> - Study anticipated fate of spilled oil dispersants and dispersed oil from different operations in geographical locations.	ICCOPR Public Meeting - East (2010)	Marine/Estuarine	1
3605-Dispersants	Fate	<b>DISPERSED OIL FATE</b> - Study the differences in the effects of photolysis on chemically and physically dispersed oil droplets.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3605-Dispersants	Fate	<b>DISPERSED OIL FATE</b> - Study the interactions of chemically dispersed oil droplets with suspended particulate matter and the effect of these processes on the rate of oil biodegradation and fate.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3605-Dispersants	Fate	<b>FATE AND EFFECTS</b> - Study the long-term fate and effects of dispersant applications.	Pacific States/BC OSTF Letter to ICCOPR (2010)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE APPLICATION</b> - Study how subsurface application of dispersants affects characteristics of that oil at the surface.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE BEHAVIOR</b> - Study the effect of dispersant on deposition, partitioning, toxicity and degradation (deep sea and in presence of high flow rates).	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1

ICCOPR Standing Research Areas  
2014 Database

3606-Dispersants	Subsurface	<b>SUBSURFACE DISPERSANTS</b> - Conduct research involving the application of dispersants at high pressure and low temperatures with the potential for significant turbidity.	Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report (March 2013)	Marine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE EFFECTIVENESS</b> - Develop conditions of operability for dispersant use in the subsea, including characteristics of most effective dispersant, physical parameters of when to apply, considering flow rate.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE EFFECTIVENESS</b> - Develop confirmation of volatile organic compound reduction at the surface from subsurface dispersant use.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE EFFECTIVENESS</b> - Study and correlate quantitative info on subsurface dispersant effectiveness and dispersant application time series.		Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE EFFECTIVENESS</b> - Study dispersant use in the subsea.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE EFFECTIVENESS</b> - Study the correlation of the subsurface injection with emulsification at the surface.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE EFFICACY</b> - Develop improved capacity to measure the efficacy of dispersants injected at subsurface.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE EFFICACY</b> - Study the subsea application of dispersants, including methods, application ratios, injection nozzle design, location of nozzle.	BSEE BAA Proposed Research on Oil Spill Response Operations (2012)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE FORMULATIONS</b> - Study the need for separate subsea specific dispersant.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
3606-Dispersants	Subsurface	<b>SUBSURFACE TANK TESTING</b> - Study the feasibility of conducting subsea dispersant research at Ohmsett.	BSEE BAA Proposed Research on Oil Spill Response Operations (2012)	Marine/Estuarine	1
3701-In Situ Burning	Effectiveness and Impacts	<b>AERIAL PLUME IMPACTS</b> - Develop methods to mitigate airborne pollutants during burning.	ICCOPR R&T Plan (1992)	All	1
3701-In Situ Burning	Effectiveness and Impacts	<b>AERIAL PLUME IMPACTS</b> - Develop simplified air plume models.	ICCOPR R&T Plan (1997)	All	1
3701-In Situ Burning	Effectiveness and Impacts	<b>AERIAL PLUME IMPACTS</b> - Develop soot reduction techniques.	ICCOPR R&T Plan (1997)	All	1
3701-In Situ Burning	Effectiveness and Impacts	<b>AERIAL PLUME IMPACTS</b> - Study the impact of volatile plumes from in-situ burning on natural resources (e.g., birds).	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1
3701-In Situ Burning	Effectiveness and Impacts	<b>ARCTIC ISB</b> - Conduct additional research to improve ISB effectiveness in the Arctic and better define the applicability of ISB under various conditions.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3701-In Situ Burning	Effectiveness and Impacts	<b>ARCTIC ISB</b> - Develop improved pre- and post-spill plume modeling to inform whether or not an ISB should be conducted and would facilitate decisions on measures to protect local populations, including potential effect of "fall-out" from a smoke plume that goes over land based subsistence resources.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3701-In Situ Burning	Effectiveness and Impacts	<b>ARCTIC ISB</b> - Develop improved understanding of in situ burn operations in ice.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine/Freshwater	1
3701-In Situ Burning	Effectiveness and Impacts	<b>ARCTIC ISB</b> - Conduct additional research to better define the applicability of ISB under various conditions in the Arctic.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3701-In Situ Burning	Effectiveness and Impacts	<b>ISB BIOAVAILABILITY</b> - Study ISB residues, especially toxicity, physical properties, and bioavailability of contaminants contained within the residue matrix; especially with potential benthic community effects.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3701-In Situ Burning	Effectiveness and Impacts	<b>ISB EFFECTIVENESS</b> - Develop better means of quantifying ISB effectiveness. Unburned oil or other residue from burning operations should be recovered and accounted for when evaluating the effectiveness of in situ burning.	DWH ISPR (2011)	All	1
3702-In Situ Burning	Planning and Technology	<b>ISB CONTAINMENT TECHNOLOGY</b> - Conduct research and development programs on ISB to develop more robust booming systems with greater oil encounter rates and expand the weather/sea state of opportunity in which ISB can effectively be used.	DWH ISPR (2011)	Marine/Estuarine/Freshwater	1
3702-In Situ Burning	Planning and Technology	<b>ISB CONTAINMENT TECHNOLOGY</b> - Develop enhanced designs for containment and burning oil.	BSEE BAA Proposed Research on Oil Spill Response Operations (2012)	Marine/Estuarine/Freshwater	1
3702-In Situ Burning	Planning and Technology	<b>ISB CONTAINMENT TECHNOLOGY</b> - Develop improved fire boom design and materials, develop test protocols and test.	NSTC JSOST - DWH Oil Spill PI Conference Report (2010)	Marine/Estuarine/Freshwater	1

ICCOPR Standing Research Areas  
2014 Database

3702-In Situ Burning	Planning and Technology	<b>ISB CONTAINMENT TECHNOLOGY</b> - Develop more efficient fire boom for high sea states and faster advancing speeds.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine/Freshwater	1
3702-In Situ Burning	Planning and Technology	<b>ISB CONTAINMENT TECHNOLOGY</b> - Study the performance of various fire boom designs and improve technologies for water-cooled and reusable boom types	DWH ISPR (2011)	Marine/Estuarine/Freshwater	1
3702-In Situ Burning	Planning and Technology	<b>ISB PLANNING</b> - Develop improved procedures for in-situ burning under various conditions, develop protocols, improve field verification of airborne constituent behaviors	ICCOPR R&T Plan (1992)	All	1
3702-In Situ Burning	Planning and Technology	<b>ISB PLANNING</b> - Study appropriate level of ISB equipment for responding to worst case spills and to determine the means of enhancing equipment stockpiles of ISB equipment	DWH ISPR (2011)	All	1
3702-In Situ Burning	Planning and Technology	<b>ISB TECHNOLOGY</b> - Develop methods to improve and sustain combustion of emulsions.	ICCOPR R&T Plan (1992)	All	1
3702-In Situ Burning	Planning and Technology	<b>ISB TECHNOLOGY</b> - Develop new technology for recovering sunken burn residue.	BSEE BAA Proposed Research on Oil Spill Response Operations (2012)	Marine/Estuarine/Freshwater	1
3702-In Situ Burning	Planning and Technology	<b>ISB TECHNOLOGY</b> - Study aerial ignition techniques for in situ burns far offshore.	ICCOPR Public Meeting - East (2010)	Marine/Estuarine	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>ALTERNATIVE FUELS</b> - Study usability of current response technologies on alternative fuels.	EPA Draft Oil Spill Research Strategy (2011)	All	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>ARCTIC CHEMICAL HERDERS</b> - Develop toxicological data for Arctic species of interest that would better define the relative value and impact of chemical herders within the countermeasure suite of available tools.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>ARCTIC CHEMICAL HERDERS</b> - Study the value and impact of chemical herders to improve oil-spill response scenarios and the timing for deployment of various countermeasures, particularly given the potential for a second-stage recovery effort during ice melt to target oil that had previously been entrained in sea ice.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>ARCTIC CHEMICAL HERDERS</b> - Study use of oil herders to enhance response capability for in situ burning and other uses.	ICCOPR Public Meeting - East (2010)	Marine/Estuarine/Freshwater	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>BIOFUEL RECOVERY</b> - Study the recovery of biofuels using chemical methods.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>BIOFUEL RECOVERY</b> - Study the recovery of biofuels using mechanical methods.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>CHEMICAL HERDERS</b> - Study and characterize chemical herders and potential areas of use.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine/Freshwater	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>EMULSION AGENTS</b> - Field test emulsion treating agents.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>ISB AND CHEMICAL HERDERS</b> - Study the potential for enhancing burn operations with the use of herding agents and demulsifiers.	DWH ISPR (2011)	Marine/Estuarine/Freshwater	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>NEW TECHNOLOGIES</b> - Determine if trenching is a feasible response option.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>NEW TECHNOLOGIES</b> - Develop innovative techniques for remediation/cleanup.	EPA Draft Oil Spill Research Strategy (2011)	All	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>NEW TECHNOLOGIES</b> - Study and develop techniques for recovery of submerged oils and emulsions.	ICCOPR R&T Plan (1997)	Marine/Estuarine/Freshwater	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>NEW TECHNOLOGIES</b> - Study emerging technologies for use in 24 hour operations.	CRRC - Coordinating R&D on Oil Spill Research in the Wake of DWH (2011)	All	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>OIL SOLIDIFIER</b> - Study solidifiers and their effectiveness in various conditions and a full range of oils.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1



ICCOPR Standing Research Areas  
2014 Database

3800-Alternative Chemical Countermeasures	No Subcategory	<b>OIL/MINERAL AGGREGATES</b> - Conduct research to improve understanding of oil mineral aggregate (OMA) use including in cold climates.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>SUBMERGED OIL</b> - Develop enhanced recovery of submerged oil by changing its properties.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3800-Alternative Chemical Countermeasures	No Subcategory	<b>SUBMERGED OIL</b> - Study potential use of chemical countermeasures to improve response to submerged oil spills.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
3900-Oily and Oil Waste Disposal	No Subcategory	<b>OIL AND WATER SEPARATION</b> - Develop innovative techniques for oil/water separation decanting systems for various oil types.	1) ICCOPR R&T Plan (1992) 2) CRRC - Submerged Oil Workshop Report (2006)	All	2
3900-Oily and Oil Waste Disposal	No Subcategory	<b>SORBENTS</b> - Develop methods to recycle sorbents and reduce the waste created by using sorbents as a recovery option.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1
3900-Oily and Oil Waste Disposal	No Subcategory	<b>WATER TREATMENT</b> - Develop improved best practices for oil and gas field water treatment and water management.	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2012)	Terrestrial/Freshwater	1
<b>IMPACT ASSESSMENT AND RESTORATION - 4000 SERIES</b>					
4000-Bioremediation and Biodegradation	No Subcategory	<b>BIOAVAILABILITY</b> - Study the factors controlling bioavailability of petroleum hydrocarbons in estuarine and freshwater sediments.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4000-Bioremediation and Biodegradation	No Subcategory	<b>BIOREMEDIATION EFFECTIVENESS</b> - Develop an improved understanding of bioremediation processes with a wider range of conditions/environments (e.g., cold water), and multiple types of oil, nutrient enrichment, and toxicity and eutrophication	1) CRRC - R&D Priorities: Oil Spill Workshop (2009) 2) ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	2
4000-Bioremediation and Biodegradation	No Subcategory	<b>BIOREMEDIATION EFFECTIVENESS</b> - Study the recovery of biofuels using biological methods.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1
4000-Bioremediation and Biodegradation	No Subcategory	<b>BIOREMEDIATION EFFECTIVENESS</b> - Study the relative effectiveness and environmental impacts of bioremediation technologies.	Title 33 Chapter 40 Subchapter IV 2761 (OPA 1990)	Marine/Estuarine/Freshwater	1
4000-Bioremediation and Biodegradation	No Subcategory	<b>SHORELINE CLEANUP</b> - Conduct research to improve understanding of nutrient enrichment as a shoreline cleanup method.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine	1
4000-Bioremediation and Biodegradation	No Subcategory	<b>SHORELINE CLEANUP</b> - Study microbial usage in bioremediation as a shoreline cleanup method.	Oil Spill Preparedness and Response JITF (2011)	Shoreline	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>ARCTIC IMPACTS</b> - Conduct research of the present Environment Resource Area OSRA that would examine the state of knowledge of specific NRDA metrics could help identify specific population, physiological, habitat, and exposure data for future NRDA activities.	USGS An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas (2011)	Marine/Estuarine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>ARCTIC IMPACTS</b> - Develop a Response Gap Analysis framework to assess the impacts of response actions in the Arctic.	US Arctic Research Commission White Paper (2010)	All	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>ARCTIC IMPACTS</b> - Develop an increased understanding of environmental effects of in situ burning, chemical dispersants and herding agents on Arctic ecology.	1) US Arctic Research Commission White Paper (2010) 2) DWH ISPR (2011)	Marine/Estuarine	2
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>ARCTIC IMPACTS</b> - Develop response guide and restoration guide for oil in ice.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>ARCTIC SHORELINE IMPACTS</b> - Study the hydrocarbon impacts and recovery to intertidal species in Arctic environments.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>ARCTIC WILDLIFE IMPACTS</b> - Study effects of oil on wildlife and effective response intervention in Arctic environment.	1) US Arctic Research Commission White Paper (2010) 2) OGP-JIP Solicitation for Expression of Interest on Arctic Oil Spills (2012)	All	2
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>AVIAN IMPACTS</b> - Study the long-term effects of oil on birds, including toxicology and food web accumulation.	1) ICCOPR R&T Plan (1992) 2) CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	2

ICCOPR Standing Research Areas  
2014 Database

4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>FISHERIES IMPACTS</b> - Study metabolism/depuration/relay of oil contaminants in fish.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>FISHERIES IMPACTS</b> - Study the pathological effects of water soluble fractions of oil on fishes.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>MAMMALIAN IMPACTS</b> - Determine the biological effects in mammalian systems of dispersant oil mixtures and compare to those predicted of measured by exposure to individual components alone.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine/Freshwater	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>MAMMALIAN IMPACTS</b> - Study the long-term effects of oil on mammals.	ICCOPR R&T Plan (1992)	All	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>MARINE MAMMAL IMPACTS</b> - Conduct research on how oil and/or response activities may have led to ecosystem changes that are harmful to marine mammals (e.g., harmful algal blooms, hypoxia or anoxia).	Marine Mammal Commission: Assessing the Long-Term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs (2011)	Marine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>MARINE MAMMAL IMPACTS</b> - Conduct research on the extent to which exposure to oil and/or response activities leads to a reduction in status of marine mammal populations involving individual fitness, population vitality rates (survival and reproduction), and population abundance and trends.	Marine Mammal Commission: Assessing the Long-Term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs (2011)	Marine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>MARINE MAMMAL IMPACTS</b> - Study oil and/or response-related changes in the ecosystem resulting in a reduction in prey availability for marine mammals, including looking for changes in diet and prey surveys over space and time.	Marine Mammal Commission: Assessing the Long-Term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs (2011)	Marine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>MARINE MAMMAL IMPACTS</b> - Study the effect of exposure to oil or dispersant-related contaminants on physiological functions (immune, reproductive, and other vital systems), including assessing the health status and contaminant loads of stranded or live-captured animals.	Marine Mammal Commission: Assessing the Long-Term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs (2011)	Marine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>MICROBES</b> - Study the effects of oil discharges on microbial communities.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>MICROBES</b> - Study the value of microbial services.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>PLANKTONIC IMPACTS</b> - Study the impact on neuston organisms from spilled oil.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>PLANKTONIC IMPACTS</b> - Study the impact on plankton communities including young squid from spilled oil.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>REPTILE AND AMPHIBIAN IMPACTS</b> - Study the effects of oil on amphibians and reptiles.	ICCOPR R&T Plan (1992)	Freshwater/Terrestrial	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>REPTILE IMPACTS</b> - Develop research on acute and chronic effects of oil exposure to turtles and other reptiles.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>WILDLIFE IMPACTS</b> - Conduct research for oiled wildlife response and practices, including laboratory-based R&D for spill response tactics.	ICCOPR Public Meeting - West (2010)	All	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>WILDLIFE IMPACTS</b> - Study the effects of oil on physiological and immunological processes in wildlife.	ICCOPR R&T Plan (1992)	All	1
4101-Environmental Impacts and Ecosystem Recovery	Species Impacts	<b>WILDLIFE IMPACTS</b> - Study the transport and fate of marine wildlife carcasses to assist in NRDA.	PWS OSRI - Research Plan 2011-2015 (2010)	Marine/Estuarine	1

ICCOPR Standing Research Areas  
2014 Database

4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>CHEMICAL ANALYSIS</b> - Develop more sensitive analytical tests to assess damage.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>CHEMICAL ANALYSIS</b> - Study the TPH hump in chemical analysis.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>EXPOSURE METHODOLOGIES</b> - Develop DNA fingerprinting of fish and mammals to assess long-term effects.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>EXPOSURE METHODOLOGIES</b> - Develop relevant biological markers of exposure and guidelines for responsible use of biomarkers.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>EXPOSURE METHODOLOGIES</b> - Study genomic signatures to different oil types and weathering states as a way of monitoring for exposure to aquatic life.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>OIL SANDS PRODUCTS IMPACTS</b> - Conduct research on the dissolution in water and the bioavailability of OSP.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>OIL SANDS PRODUCTS IMPACTS</b> - Study the toxicity of OSP in freshwater and marine environments.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>SUBLETHAL IMPACTS</b> - Study relevant endpoints (e.g., growth, behavior, inhibit reproduction, physiological aberrations) and appropriate organisms to use as indicators for different habitats.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>SUBLETHAL IMPACTS</b> - Study the sub-lethal effects for various habitats and organisms from 1ppb oil.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>SUBLETHAL METHODOLOGIES</b> - Develop assay for measuring effects on reproduction, fecundity, lifespan, biomarkers more sensitive than Microtox.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>SUBLETHAL METHODOLOGIES</b> - Study, develop and validate robust markers of petroleum impacts.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>TOXICOLOGICAL IMPACTS</b> - Conduct research to identify toxicologically-relevant analytes by habitat and organism.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>TOXICOLOGICAL IMPACTS</b> - Develop correlation of spilled oil (regardless of the degree of weathering) to residues in biological matrices to assist in establishing a direct link to exposure levels.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>TOXICOLOGICAL IMPACTS</b> - Develop rapid screening methods to assess the toxicological potency of complex oil mixtures.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>TOXICOLOGICAL IMPACTS</b> - Study the effects of oil on vertebrate species using tissue culture assay.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>TOXICOLOGICAL IMPACTS</b> - Study the fate and toxicity of chemically treated oils.	ICCOPR R&T Plan (1992)	Marine/Estuarine	1
4102-Environmental Impacts and Ecosystem Recovery	Toxicological/ Sublethal Impacts	<b>TOXICOLOGICAL IMPACTS</b> - Study the genotoxicity of petroleum hydrocarbons in sediments following an oil spill.	ICCOPR R&T Plan (1992)	All	1

ICCOPR Standing Research Areas  
2014 Database

4102-Environmental Impacts and Ecosystem Recovery	Toxicological/Sublethal Impacts	<b>TOXICOLOGICAL IMPACTS</b> - Study the toxicity of oil constituents of non-aqueous phase oil to benthic organisms.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>DEEPWATER ENVIRONMENTAL IMPACTS</b> - Study and quantify the risks of environmental impacts from deepwater oil and gas exploration, drilling, and production activity, to include modeling and evaluation of industry systems, based on newly developed technologies	DOE - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program (2012)	Marine/Estuarine	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>DISPERSED OIL IMPACTS</b> - Conduct research to evaluate the long-term/chronic impacts of chemically/naturally dispersed oil on invertebrates, anadromous fish, corals, etc. - focus on long exposures to low concentrations, environmentally relevant exposure scenarios.	1) CRRC - R&D Priorities: An Oil Spill Workshop (2003) 2) Pacific States/BC OSTF Letter to ICCOPR (2010)	Marine/Estuarine/Freshwater	2
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>DISPERSED OIL IMPACTS</b> - Study the adhesiveness of physically and chemically dispersed oil to fur, feathers and other biological substrates - how adhesion changes over time.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>DISPERSED OIL IMPACTS</b> - Study the impact of dispersed oil on organisms, how it is taken up, end products, effects on benthic primary production.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>SUBMERGED OIL IMPACTS</b> - Develop approaches for long-term monitoring of the impacts of submerged oil spills after termination of cleanup efforts.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>SUBMERGED OIL IMPACTS</b> - Develop effective rapid-assessment protocols to determine impacts of submerged oil spills.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>SUBMERGED OIL IMPACTS</b> - Develop understanding of oil interaction, impacts, and cleanup options for different seafloor habitats, similar to the sensitivity ranking of intertidal habitats.	1) CRRC - Submerged Oil Workshop Report (2006) 2) ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	2
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>SUBMERGED OIL IMPACTS</b> - Develop understanding of the chronic toxicity and pathways of exposure leading to toxicity of submerged oil to benthic resources.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>SUBMERGED OIL IMPACTS</b> - Develop understanding of the potential threats of chronic releases from oiled sediments and oily residues.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>SUBMERGED OIL IMPACTS</b> - Study data from past submerged oil spills to understand potential effects and identify data gaps.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>SUBMERGED OIL IMPACTS</b> - Study the non-PAH in submerged oils that have toxicity implications.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4103-Environmental Impacts and Ecosystem Recovery	Submerged oil/Dispersed Oil Impacts	<b>SUBMERGED OIL IMPACTS</b> - Study the specific polynuclear aromatic hydrocarbons (PAH) in submerged oils that have toxicity implications.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>ECOSYSTEM IMPACTS</b> - Collect data and evaluate long-term environmental effects of oil discharges larger than 250,000 gallons or if the discharged occurred after Jan 1, 1989.	Title 33 Chapter 40 Subchapter IV 2761 (OPA 1990)	All	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>ECOSYSTEM IMPACTS</b> - Collect data on ecological impacts that occurred in sensitive coastal ecosystems due to the DWH spill.	EPA Draft Oil Spill Research Strategy (2011)	Marine/Estuarine	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>ECOSYSTEM IMPACTS</b> - Conduct laboratory research and mesoscale studies of impact and recovery from different oil types.	ICCOPR R&T Plan (1997)	All	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>ECOSYSTEM IMPACTS</b> - Develop detailed exposure conditions (spatially and temporally) and connections between exposure and ecological effects.	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine/Freshwater	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>ECOSYSTEM IMPACTS</b> - Develop methods to assess oil spill injury to wetland communities, submerged vegetation, benthic invertebrates, and waterfowl.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>ECOSYSTEM IMPACTS</b> - Develop understanding of the difference between oil effects and natural stressors by assessing community structure and function for different habitats.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1

ICCOPR Standing Research Areas  
2014 Database

4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>ECOSYSTEM IMPACTS</b> - Develop understanding of trophic and habitat linkages among organisms to incorporate into models looking at cascading indirect effects.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat impacts	<b>LONG-TERM ECOSYSTEM IMPACTS</b> - Collect data with sustained sampling to assess long-term impacts.	NSTC JSOST - DWH Oil Spill PI Conference Report (2010)	All	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat impacts	<b>LONG-TERM ECOSYSTEM IMPACTS</b> - Conduct long-term comprehensive study of selected oil spills to determine the environmental effects independent of the mandated NRDA studies.	ICCOPR R&T Plan (1992)	All	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>LONG-TERM ECOSYSTEM IMPACTS</b> - Study long-term chronic exposure direct and indirect impacts on the food chain - fish eggs, bottom feeders, birds, mammals.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>SHORELINE IMPACTS</b> - Study sampling methodologies for determining oil spill effects on intertidal communities.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat impacts	<b>SHORELINE IMPACTS</b> - Study the persistence of oil in mudflats including research on physical, geochemical and biological processes of recovery.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	Terrestrial/Estuarine/Marine	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>WETLAND IMPACTS</b> - Study effects of crude oil on freshwater marsh plant growth and survival.	ICCOPR R&T Plan (1992)	Freshwater	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>WETLAND IMPACTS</b> - Study natural recovery in mangrove habitats (how long does oil persist in mangrove habitats and what are its long-term impacts?).	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
4104-Environmental Impacts and Ecosystem Recovery	Ecosystem/Habitat Impacts	<b>WETLAND IMPACTS</b> - Study the impacts of spilled oil on coastal wetlands.	ICCOPR R&T Plan (1992)	Marine/Estuarine	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>ECOSYSTEM RECOVERY</b> - Develop conceptual models of service loss and recovery from key habitats, and the information necessary to parameterize recovery models.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>ECOSYSTEM RECOVERY</b> - Study data collection efforts for spill impact assessment and evaluation of ecological recovery rates for offshore, near-shore, coastal and estuarine areas impacted by spills.	Oil Spill Preparedness and Response JITF (2011)	Marine/Estuarine	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>ECOSYSTEM RECOVERY</b> - Study recovery rates of injured habitats from previous spills.	CRRC - R&D Priorities: Oil Spill Workshop (2009)	All	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>ECOSYSTEM RECOVERY</b> - Study the environmental effects of contaminants on ecosystems in the Gulf region and the science of ecosystem recovery.	Gulf of Mexico Research Initiative (2010)	Marine/Estuarine	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>ECOSYSTEM RECOVERY</b> - Study the rates of ecosystem recovery after submerged oil spills.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>RESPONSE TECHNOLOGY METRICS</b> - Study effectiveness of response technologies on inland spills (e.g., burning, chemical treatment).	EPA Draft Oil Spill Research Strategy (2011)	Terrestrial	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>RESPONSE TECHNOLOGY IMPACTS</b> - Conduct a study comparing environmental footprints of various response technologies.	EPA Draft Oil Spill Research Strategy (2011)	All	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>RESPONSE TECHNOLOGY IMPACTS</b> - Study the effects from various cleanup techniques.	ICCOPR R&T Plan (1992)	All	1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>RESPONSE TECHNOLOGY METRICS</b> - Develop regional performance metrics (evaluation of response effectiveness) that are scientifically valid.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)		1
4105-Environmental Impacts and Ecosystem Recovery	Recovery	<b>WASHING AGENTS</b> - Study the impacts of washing agents on various habitats and ecosystems.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1

ICCOPR Standing Research Areas  
2014 Database

4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>IMPACT METRICS</b> - Collect, synthesize and evaluate current data on impacts from a range of exposure scenarios to biota at different life stages. Determine feasibility of using compiled data in determining potential ecological impacts from oil spills	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>IMPACT METRICS</b> - Conduct research to determine best metrics for assessing impact/damage.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>IMPACT METRICS</b> - Develop methods for assessment of the ecological value and services of benthic habitats and resources.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>IMPACT METRICS</b> - Develop models to estimate injury to natural resources.	ICCOPR R&T Plan (1992)	All	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>IMPACT METRICS</b> - Develop standardized biological metrics.	ICCOPR R&T Plan (1992)	All	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>IMPACT METRICS</b> - Study the application of life-history strategies to characterize source-sink for various habitats.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>RISK ASSESSMENT</b> - Conduct a NEBA on DWH that includes the total life-cycle of different CTAs and other response technologies to better understand trade-offs and inform decision making.	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>RISK ASSESSMENT</b> - Conduct single species toxicity research on endpoints to assess population effects and help risk-based decision-making during an event as part of restoration efforts.	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine/Freshwater	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>RISK ASSESSMENT</b> - Develop a risk assessment based on key exposure-response relationships from lab tests where conditions reflect ambient exposures.	SAB Review of EPA Research Strategy (2011)	Marine/Estuarine/Freshwater	1
4106-Environmental Impacts and Ecosystem Recovery	Risk Assessment/ Impact Metrics	<b>RISK ASSESSMENT</b> - Study risk assessment in coastal environments and include data from a variety of sources to model environmental response.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>ACTIVE VS. NATURAL ATTENUATION RESTORATION</b> - Conduct a net-benefit analysis of restoration vs. natural attenuation using case histories.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	All	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>ACTIVE VS. NATURAL ATTENUATION RESTORATION</b> - Study the relationship between natural recovery and restoration.	ICCOPR R&T Plan (1992)	All	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>AVIAN RESTORATION</b> - Study methods of luring colonial nesting birds from oil spill impacted wetlands.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>BEACH RESTORATION</b> - Study the role of beach renourishment as a strategy for restoration.	ICCOPR R&T Plan (1992)	Marine/Estuarine	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>BENTHIC RESTORATION</b> - Develop methods to recolonize benthic algal and invertebrate communities on oil impacted intertidal and subtidal bottoms.	ICCOPR R&T Plan (1992)	Marine/Estuarine	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>BIVALVE IMPACT</b> - Study the viability of intrusive restoration approaches to bivalve communities for ecological and economic concern.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>MEASURING RESTORATION SUCCESS</b> - Conduct a retrospective case study of restoration sites.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	All	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>MEASURING RESTORATION SUCCESS</b> - Develop methods for assessing success/progress, potential negative impacts, and total cost of restoration activities.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	All	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>MEASURING RESTORATION SUCCESS</b> - Develop restoration indicators and measures of effectiveness.	ICCOPR R&T Plan (1997)		1

ICCOPR Standing Research Areas  
2014 Database

4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>MEASURING RESTORATION SUCCESS</b> - Study and identify sentinel organisms to measure the success of oil spill restoration.	ICCOPR R&T Plan (1992)	All	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>MEASURING RESTORATION SUCCESS</b> - Study long-term restoration issues and develop and apply performance measures and indicators of long-term restoration.	National Commission on BP DWH - Final Report (2011)	All	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>MEASURING RESTORATION SUCCESS</b> - Study whether ecosystem service losses can be regained through remediation.	EPA Draft Oil Spill Research Strategy (2011)	All	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>OIL SANDS PRODUCTS RESTORATION</b> - Conduct research to improve reclamation of mining areas and settling ponds from OSP operations.	Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force (April 2013)	Terrestrial	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>RESTORATION METHODOLOGIES</b> - Develop innovative techniques for restoration.	1) EPA Draft Oil Spill Research Strategy (2011) 2) CRRC - R&D Priorities: An Oil Spill Workshop (2003) 3) ICCOPR R&T Plan (1992)	All	3
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>RESTORATION METHODOLOGIES</b> - Study the pairing of restoration methods and its impact negative or positive on different types of habitats.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	All	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>SEAGRASS RESTORATION</b> - Study methods of restoring seagrass communities following losses related to oil spills.	ICCOPR R&T Plan (1992)	Marine/Estuarine	1
4200-Environmental Restoration Methods and Technologies	No Subcategory	<b>WILDLIFE RESTORATION</b> - Study the impacts of rehabilitating and releasing oil injured wildlife on population restoration.	ICCOPR R&T Plan (1992)	All	1
4301-Human Safety and Health	Safety	<b>COMMUNICATION</b> - Study communication methods to educate stakeholder groups (general public) with regard to dispersants and oil spills, environmental trade-offs, human health and seafood safety issues.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	All	1
4301-Human Safety and Health	Safety	<b>HUMAN EXPOSURE TO OIL</b> - Study whether current monitoring methods for oil exposure to humans are effective.	EPA Draft Oil Spill Research Strategy (2011)	All	1
4301-Human Safety and Health	Safety	<b>PROTECTIVE TECHNOLOGIES</b> - Develop technologies and methods to protect public health and safety from oil discharges, including the population directly exposed to an oil discharge	Title 33 Chapter 40 Subchapter IV 2761 (OPA 1990)	All	1
4301-Human Safety and Health	Safety	<b>SEAFOOD SAFETY</b> - Conduct research on the short-term and long-term safety of seafood in the GOM following the DWH spill and communicate it to the public	NAS- Research Priorities for assessing Health Effects from gulf of Mexico Oil Spill (2010)	Marine/Estuarine	1
4301-Human Safety and Health	Safety	<b>SEAFOOD SAFETY</b> - Correlate organoleptic testing with analytical procedures for oil contaminants in fish.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4301-Human Safety and Health	Safety	<b>SEAFOOD SAFETY</b> - Determine attitudes and behaviors relative to consumption of seafood in restaurants and household purchases in different regions	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
4301-Human Safety and Health	Safety	<b>SEAFOOD SAFETY</b> - Develop improved analytical capabilities for assessing seafood safety.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4301-Human Safety and Health	Safety	<b>SEAFOOD SAFETY</b> - Study the safety of fisheries from oil discharges.	ICCOPR R&T Plan (1992)	Marine/Estuarine/Freshwater	1
4301-Human Safety and Health	Safety	<b>WORKER SAFETY</b> - Develop technologies, methods, and standards for protecting removal personnel, including training, adequate supervision, information databases, protective equipment, maximum exposure limits, and decontamination procedures.	1) Title 33 Chapter 40 Subchapter IV 2761 (OPA 1990) 2) ICCOPR R&T Plan (1997)	All	2
4301-Human Safety and Health	Safety	<b>WORKER SAFETY</b> - Study surface VOC levels in dispersant application scenarios, subsea and surface, to assess worker safety.	BSEE BAA Proposed Research on Oil Spill Response Operations (2012)	All	1
4301-Human Safety and Health	Safety	<b>WORKER SAFETY</b> - Study the health and safety issues associated with spill response, and develop protocols for personnel protection (e.g., training, fitness, stress management).	ICCOPR R&T Plan (1992)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN BEHAVIORAL EFFECTS OF DWH</b> - Conduct research on the psychological and behavioral effects of DWH.	NAS- Research Priorities for assessing Health Effects from gulf of Mexico Oil Spill (2010)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN DISPERSANT EXPOSURE</b> - Develop an upper bound of exposure of the variable exposure scenarios associated with the dispersant use.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN DISPERSANT EXPOSURE</b> - Develop models to estimate exposure to dispersant and/or dispersed oil to human populations.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	All	1

ICOPR Standing Research Areas  
2014 Database

4302-Human Safety and Health	Human Exposure	<b>HUMAN DISPERSANT EXPOSURE</b> - Study the health effects in known potentially exposed human populations .	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE DURING DWH</b> - Collect long-term monitoring data of health (human) of coastal communities impacted by DWH.	National Commission on BP DWH - Final Report (2011)	Marine/Estuarine	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE DURING DWH</b> - Conduct clinical evaluations, diagnostics and documentation for individuals affected from the DWH spill	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE DURING DWH</b> - Study the human health impacts from harmful algal blooms and toxins associated with the DWH spill.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO ISB</b> - Conduct research on the cardiovascular effects associated with exposure to smoke plumes from in situ burns	EPA Draft Oil Spill Research Strategy (2011)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO ISB</b> - Conduct research on the effects associated with exposure to oil, dispersants, and by-products from in situ burns during the DWH spill	NAS- Research Priorities for assessing Health Effects from gulf of Mexico Oil Spill (2010)	Marine/Estuarine	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE RESEARCH PLANNING</b> - Conduct research on the framework needed to deploy a rapid research response for future oil spills.	NAS- Research Priorities for assessing Health Effects from gulf of Mexico Oil Spill (2010)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO OIL</b> - Conduct long-term monitoring of the general health and changing conditions in hydrocarbon extraction, processing, and transportation	SAB Review of EPA Research Strategy (2011)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO OIL</b> - Conduct Research on neurological effects from exposure to a mixture of hydrocarbon vapors compared to the sum of the effects of exposure to individual vapors.	EPA Draft Oil Spill Research Strategy (2011)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO OIL</b> - Conduct research on the dose-response function for acute exposures to hydrocarbon vapors.	EPA Draft Oil Spill Research Strategy (2011)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO OIL</b> - Conduct research on the effects of dermal contact with oil.	EPA Draft Oil Spill Research Strategy (2011)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO OIL</b> - Develop a database on health effects relating to oil.	ICOPR R&T Plan (1992)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO OIL</b> - Study the interactions between added stressors (e.g., health, anxiety) and health effects caused by direct exposure to oil spill related components	EPA Draft Oil Spill Research Strategy (2011)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO OIL</b> - Study the short and long terms impacts to humans from exposure to contaminants from an oil spills, dermal, orally (through seafood), and respiratory	SAB Review of EPA Research Strategy (2011)	All	1
4302-Human Safety and Health	Human Exposure	<b>HUMAN EXPOSURE TO OIL AND DISPERSANTS</b> - Study the toxicological effects and the causal or correlative relationships between chemical (i.e., oil and dispersants) exposure and human health.	1) EPA Draft Oil Spill Research Strategy (2011) 2) National Commission on BP DWH - Final Report (2011)	All	2
4302-Human Safety and Health	Human Exposure	<b>WORKER HEALTH AFTER DWH</b> - Collect long-term monitoring data on Deepwater Horizon responders' health.	National Commission on BP DWH - Final Report (2011)	All	1
4302-Human Safety and Health	Human Exposure	<b>WORKER HEALTH AFTER DWH</b> - Determine the neurological effects in cleanup workers or nearby residents exposed to the DWH contaminants.	EPA Draft Oil Spill Research Strategy (2011)	All	1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>COMMUNITY IMPACTS OF RESTORATION</b> - Study the extent to which restoration practices promote community development and meet other ethical criteria	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>COMMUNITY IMPACTS OF SPILLS</b> - Develop an improved understanding of community tolerance of ecological disturbances.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	All	1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>COMMUNITY IMPACTS OF SPILLS</b> - Study community vulnerability and resilience to past spills including social impacts.	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>COMMUNITY IMPACTS OF SPILLS</b> - Study past support services and aid in communities impacted by past spills.	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>COMMUNITY PREPAREDNESS</b> - Conduct a needs assessment research (survey) of external stakeholders for spill response literacy, dispersant information needs and expectations and recommendations for future preparedness and response.	CRRC - The Future of Dispersant Use in Oil Spill Response Initiative (2012)	Marine/Estuarine	1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>COMMUNITY PREPAREDNESS</b> - Develop more effective models for community/stakeholder involvement in oil spill planning, response and restoration	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>COMMUNITY PREPAREDNESS</b> - Study organizational culture and its influence on preparedness, response and restoration.	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>ECONOMIC ANALYSIS OF ALTERNATIVES</b> - Study the cost/benefit of alternative measures that prevent subsequent events vs. direct application of resources to the injuries themselves (e.g. meteorological station to provide wind data to guide ship traffic in restricted environment; channel markers to prevent groundings).	CRRC - R&D Priorities: An Oil Spill Workshop (2003)		1
4401-Sociological and Economic Impacts	Community/Economic Impacts	<b>ECONOMIC IMPACTS</b> - Conduct an assessment of the economic, recreational, and commercial effects of submerged oil spills.	CRRC - Submerged Oil Workshop Report (2006)	Marine/Estuarine/Freshwater	1



ICCOPR Standing Research Areas  
2014 Database

4401-Sociological and Economic Impacts	Community/ Economic Impacts	<b>ECONOMIC IMPACTS</b> - Study far-reaching effects of large oil spills on other businesses dependent on the region's resources.	National Commission on BP DWH - Final Report (2011)	All	1
4401-Sociological and Economic Impacts	Community/ Economic Impacts	<b>NRDA HUMAN USE VALUES</b> - Develop estimates of human use values and the loss due to oil spills. Consider environmental psychology/perception	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	All	1
4401-Sociological and Economic Impacts	Community/ Economic Impacts	<b>RISK COMMUNICATION</b> - Conduct case study comparing risk communication strategies and goals used during past oil spills. Assess risk communication messages vs. perceptions from previous spills including DWH.	1)CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006) 2)NAS Research Priorities for Assessing Health Effects from the Gulf of Mexico Spill	All	2
4401-Sociological and Economic Impacts	Community/ Economic Impacts	<b>RISK COMMUNICATION</b> - Develop improved methods for communicating risks and tradeoffs to various audiences, including tradeoffs of dispersant use vs. alternative technologies.	1) CRRC - R&D Priorities: An Oil Spill Workshop (2003) 2) CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	2
4401-Sociological and Economic Impacts	Community/ Economic Impacts	<b>RISK COMMUNICATION</b> - Study potential strategies to communicate risk of oil spills, especially inland spill affecting drinking water	SAB Review of EPA Research Strategy (2011)	Freshwater/Terrestrial	1
4402-Sociological and Economic Impacts	Human Impacts	<b>HUMAN IMPACTS</b> - Determine the likely degree of impact on human well-being from ecosystem service losses.	1) EPA Draft Oil Spill Research Strategy (2011) 2) CRRC - R&D Priorities: An Oil Spill Workshop (2003)	All	2
4402-Sociological and Economic Impacts	Human Impacts	<b>HUMAN IMPACTS</b> - Study cumulative social impacts of chronic and long lasting spills.	SAB Review of EPA Research Strategy (2011)	All	1
4402-Sociological and Economic Impacts	Human Impacts	<b>HUMAN IMPACTS</b> - Study regional differences in perceptions and responses to spills.	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4402-Sociological and Economic Impacts	Human Impacts	<b>HUMAN IMPACTS</b> - Study the resilience of social-ecological systems to environmental disasters.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
4402-Sociological and Economic Impacts	Human Impacts	<b>NRDA HUMAN USE VALUES</b> - Determine social and cultural values associated with natural resource injuries due to spills.	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4402-Sociological and Economic Impacts	Human Impacts	<b>NRDA HUMAN USE VALUES</b> - Develop ability to assess non-market value of resources and the loss of value from oil spills.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4402-Sociological and Economic Impacts	Human Impacts	<b>RESOURCE TRADEOFFS</b> - Conduct resource tradeoff research on (e.g., different types of restoration, regional differences, social value).	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4402-Sociological and Economic Impacts	Human Impacts	<b>SUBSISTENCE IMPACTS</b> - Conduct research to fill data gap in subsistence fishing in urban areas.	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4402-Sociological and Economic Impacts	Human Impacts	<b>SUBSISTENCE IMPACTS</b> - Develop meta analysis of subsistence research literature.	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1
4402-Sociological and Economic Impacts	Human Impacts	<b>SUBSISTENCE IMPACTS</b> - Develop methods to assess subsistence use losses during oil spills.	CRRC - R&D Priorities: An Oil Spill Workshop (2003)	Marine/Estuarine/Freshwater	1
4402-Sociological and Economic Impacts	Human Impacts	<b>SUBSISTENCE IMPACTS</b> - Study how subsistence harvesting could be impacted by a spill.	Marine Mammal Commission Letter to ICCOPR (2010)	All	1
4402-Sociological and Economic Impacts	Human Impacts	<b>SUBSISTENCE IMPACTS</b> - Study the impact from DWH spill on subsistence use.	NSTC JSOST - DWH Oil Spill PI Conference Report (2011)	Marine/Estuarine	1
4402-Sociological and Economic Impacts	Human Impacts	<b>SUBSISTENCE IMPACTS</b> - Study the restoration of subsistence resources and services after spills.	CRRC - R&D Needs for Addressing the Human Dimensions of Oil Spills (2006)	All	1



# **Appendix C**

## ICCOPR Standing Research Areas

### 2014 Sources



## Sources for Research & Technology Needs Database

1. [Title 33 Chapter 40 Subchapter IV 2761 \(Aug 1990\)](#)
2. [Interagency Coordinating Committee on Oil Pollution Research Research and Technology Plan \(1992\)](#)
3. [Interagency Coordinating Committee on Oil Pollution Research Research and Technology Plan \(1997\)](#)
4. [Coastal Response Research Center - Research and Development Priorities: An Oil Spill Workshop \(Nov 2003\)](#)
5. [Coastal Response Research Center - Research & Development Needs For Making Decisions Regarding Dispersing Oil \(Sept 2005\)](#)
6. [National Research Council. Oil Spill Dispersants: Efficacy and Effects. Washington, DC: The National Academies Press \(2005\)](#)
7. [Potentially Polluting Wrecks in Marine Waters: An Issue Paper Prepared for the 2005 International Oil Spill Conference \(2005\)](#)
8. [EPA Act 2005 Section 999A\(b\)\(4\) DOE National Energy Technology Laboratory Complementary Research Program](#)
9. [Coastal Response Research Center - R&D Needs for Addressing the Human Dimensions of Oil Spills \(June 2006\)](#)
10. [Coastal Response Research Center - Submerged Oil Workshop Report \(December 2006\)](#)
11. [DOE 2007 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report \(January 2008\)](#)
12. [DOE 2009 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report \(December 2008\)](#)
13. [Coastal Response Research Center - R&D Priorities: Oil Spill Workshop \(March 2009\)](#)
14. [House of Representatives, Committee on Science & Technology "A New Direction for Federal Oil Spill Research & Development" \(June 4, 2009\)](#)
15. [DOE 2010 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report \(December 2009\)](#)
16. [Wreck Oil Removal Program Overview \(2009\)](#)
17. [Prince William Sound Oil Spill Recovery Institute Research Plan 2011-2015 \(Feb 2010\)](#)
18. [Gulf of Mexico Research Initiative: Research Themes \(May 2010\)](#)
19. [Interagency Coordinating Committee on Oil Pollution Research Public Meetings - West \(May 2010\)](#)
20. [Pacific States/British Columbia Oil Spill Task Force Letter to Interagency Coordinating Committee on Oil Pollution Research \(May 2010\)](#)
21. [House of Representatives, Committee on Science & Technology "Deluge of Oil Highlights Research & Technology Needs for Effective Cleanup of Oil Spills" \(June 9, 2010\)](#)
22. [U.S. Arctic Research Commission - White Paper \(July 2010\)](#)
23. [Interagency Coordinating Committee on Oil Pollution Research Public Meetings - East \(Sept 2010\)](#)
24. [Marine Mammal Commission Letter to Interagency Coordinating Committee on Oil Pollution Research \(Sept 2010\)](#)

25. [National Science and Technology Council Joint Subcommittee on Ocean Science and Technology - DWH Oil Spill PI Conference Report \(Oct 2010\)](#)
26. [Interagency Coordinating Committee on Oil Pollution Research Public Meetings - Gulf \(Nov 2010\)](#)
27. [National Academy of Sciences Institutes of Medicine Research priorities for Assessing Health Effects from the Gulf of Mexico Oil Spill \(2010\)](#)
28. [Deepwater Horizon Incident Specific Preparedness Review \(Jan 2011\)](#)
29. [Environmental Protection Agency Draft Oil Spill Research Strategy \(Jan 2011\)](#)
30. [National Commission on BP Deepwater Horizon - Final Report \(Jan 2011\)](#)
31. [Ultra-Deepwater Advisory Committee 2011 Plan: Comments, Findings and Recommendations \(April 2011\)](#)
32. [Coastal Response Research Center - Coordinating R&D on Oil Spill Response In the Wake of Deepwater Horizon \(July 2011\)](#)
33. [Assessing the Long-term Effects of the BP Deepwater Horizon Oil Spill on Marine Mammals in the Gulf of Mexico: A Statement of Research Needs \(Aug 2011\)](#)
34. [DOE 2011 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress \(August 2011\)](#)
35. [U.S. Department of Energy - 2011 Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program \(Aug 2011\)](#)

36. [Science Advisory Board Review of Environmental Protection Agency's Draft Oil Spill Research Strategy \(Sept 2011\)](#)
37. [National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology - Deepwater Horizon Oil Spill Principal Investigator Conference Final Report \(Oct 2011\)](#)
38. [Oil Spill Preparedness and Response Joint Industry Task Force \(Nov 2011\)](#)
39. [U.S. Geological Survey. An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas \(2011\)](#)
40. [International Association of Oil and Gas Producers - Joint Industry Programme Solicitation for Expression of Interest \(EOI\) on Arctic Oil Spills \(Feb 2012\)](#)
41. [Coastal Response Research Center - The Future of Dispersant Use in Oil Spill Response Initiative \(Mar 2012\)](#)
42. [Ultra-Deepwater Advisory Committee 2012 Plan: Comments, Findings and Recommendations \(March 2012\)](#)
43. [OESC Letter Recommendations to BSEE Department of Interior \(April 2012\)](#)
44. [U.S. Government Accountability Office Oil Dispersants Report \(May 2012\)](#)
45. [Government and Industry Pipeline Forum \(Jul 2012\)](#)
46. [DOE 2012 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress \(August 2012\)](#)
47. [OESC Letter Recommendations to BSEE Department of Interior \(August 2012\)](#)
48. [U.S. Department of Energy - Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources R&D Program \(Aug 2012\)](#)
49. [Ultra-Deepwater Advisory Committee 2013 Draft Plan: Findings and Recommendations \(November 2012\)](#)
50. [Center for Spills in the Environment Alberta Oil Sands Workshop for Maine DEP and U.S. EPA Region 1 \(December 2012\)](#)
51. [Bureau of Safety and Environmental Enforcement - BAA Proposed Research on Oil Spill Response Operations \(2012\)](#)
52. [OESC Letter Recommendations to BSEE Department of Interior \(January 2013\)](#)
53. [Center for Spills in the Environment Oil Spill Dispersant Research Workshop Report \(March 2013\)](#)
54. [Oil Spill Simulants Materials: Workshop Proceedings \(March 2013\)](#)
55. [University of Washington Transporting Alberta Oil Sands Products: Defining the Issues and Assessing the Risks \(March 2013\)](#)
56. [Center for Spills in the Environment Alberta Oil Sands Workshop for Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force \(April 2013\)](#)
57. [DOE 2013 Annual Plan Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research and Development Program, Report To Congress \(June 2013\)](#)
58. [NRC An Ecosystem Approach to Assessing the Impact of the Deepwater Horizon Spill in the Gulf of Mexico \(2013\)](#)
59. [TRB Effect of Diluted Bitumen on Crude Oil Transmission Pipelines Special Report 311 \(2013\)](#)
60. [http://www.crrc.unh.edu/workshops/oil\\_sands\\_washington/index.html](http://www.crrc.unh.edu/workshops/oil_sands_washington/index.html)
61. BSEE Alaska Regional Director- Personal Communication (2013)

**Websites Used:**

[BP Gulf of Mexico Restoration](#)

[Bureau of Safety and Environmental Enforcement Technology Assessment and Research](#)  
[Dauphin Island Sea Lab](#)  
[Deepwater Horizon Oil Spill Research and Monitoring Database \(GOM Sea Grant\)](#)  
[Gulf of Mexico Alliance](#)  
[HARTE Institute](#)  
[Louisiana Universities Marine Consortium](#)  
[National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling](#)  
[National Institute of Environmental Health, Gulf Oil Spill Response Efforts](#)  
[National Institute of Undersea Science and Technology, University of Mississippi](#)  
[National Institutes of Health, Research Portfolio Online Reporting Tools](#)  
[Northern Gulf Institute](#)  
[US Department of Agriculture Current Research Information System](#)  
[US Department of Energy, Office of Scientific and Technical Information](#)  
[US Environmental Protection Agency Research](#)  
[US Environmental Protection Agency, Gulf of Mexico Program](#)

**Other Available Resources:**

[Thibodeaux et al \(2011\), Marine Oil Fate: Knowledge Gaps, Basic Research, and Development Needs; A Perspective Based on the Deepwater Horizon Spill, Environmental Engineering Science, Vol. 28, No. 2, pp. 87-93.](#)  
[Response to the Montara Wellhead Platform Incident Report of the Incident Analysis Team March 2010](#)  
[Analysis of U.S. Oil Spillage, API Publication 356 \(August 2009\)](#)  
[2008 IOSC paper 'Systematic Analysis of Oil Spill Response' by Mark VanHaverbeke, USCG & Bernard Cottonm Jr \(SAIC\)](#)  
[Hazardous Materials Employee Resource Book, US Dept of Transportation \(2007\)](#)  
[U. S. Coast Guard Oil Spill Response Research & Development Program A Decade of Achievement \(2003\)](#)  
[Marine Board Review-Final Report-1994](#)  
[Marine Board Review-First Report-1993](#)  
[1992 International Oil Spill R&D Forum Proceedings](#)



# **Appendix D**

## Survey Technical Report



## **SME SURVEY TECHNICAL REPORT**

### **1.0 Survey Instrument Development**

The University of New Hampshire Survey Center (UNHSC), in collaboration with the University of New Hampshire Coastal Response Research Center (CRRC) and the Interagency Coordinating Committee on Oil Pollution Research (ICOPR) developed a set of criteria that could be used to establish the relative importance of individual research needs in five domains: cost, timeliness, importance, complexity of research question, and current progress. In addition to the five domains, Subject Matter Experts (SMEs) were asked to: (1) select the top five research needs within the Standing Research Areas (SRAs) or subgroups of the SRAs and then rank order the five top needs, (2) provide examples of research needs that may have been missed, and (3) list up to three impediments to fulfilling the top five research needs (excluding cost and time to completion).

Any SME who completed a survey within a subgroup of an SRA was notified they would be contacted again to evaluate the top three needs from each of the subgroups within their SRA. This survey consisted of a list of the top three research needs from each subgroup within the SRA. SMEs were asked to rank order all or up to 10 research needs (depending on total number of needs in the SRA).

The survey instrument was programmed using Qualtrics surveys (city, state) and was extensively tested by the UNHSC staff, as well as by select members from the ICOPR workgroup and CRRC, for accuracy and ease of use.

The University of New Hampshire Institutional Review Board approved the survey and methodology for this study. Respondents were provided assurances of confidentiality and that identifiable information would not be included in any report. The full consent language can be found in Attachment 1 which also includes a final version of the survey.

### **2.0 SME Sample Selection**

The ICOPR Workgroup, CRRC and ICOPR members selected the SMEs for the ICOPR Survey. For each of the SRAs and SRA subgroups, the Workgroup and CRRC identified federal employee SMEs that were knowledgeable about the research areas. In addition, the Workgroup contacted other members of

## Appendix D

ICCOPR and members of their individual agencies to expand the pool of SMEs. In some areas, there was a need to include state agency, academic and industry experts in order to find the right expertise to address the R&D Needs questions. The Workgroup determined, however, that in no SRA category or subgroup should non-federal employees exceed the number of federal SMEs. A total of 38 non-federal employees were used (only 10.4 % of the SME surveyed).

A sample of 289 SMEs was identified to participate in surveys for the SRAs. Any SRA that had more than 15 identified research needs was divided into smaller subareas to reduce respondent burden (“survey fatigue”). This division also added more specificity to the research needs which in turn added more specificity to the SMEs who were selected. A total of 46 ICCOPR SRAs or subgroups were used for evaluative purposes. A list of all 46 SRAs and associated subgroups and the number of selected SMEs for each can be found in Appendix A. If an SME was selected to participate and either requested not to participate or did not consider themselves him/herself knowledgeable in the field, they were replaced by another identified expert (N=6).

### **4.0 Survey Initiation**

The survey was sent electronically to the SMEs on October 31, 2013 with three reminders about participation sent on November 6, November 13, and November 27, 2013. The survey was closed on December 13, 2013. Copies of the invitation and reminders can be found in Attachment 2.

### **5.0 Response Rates**

Surveys were completed by 244 SMEs from a sample of 287 selected SMEs (Table 1). This resulted in an overall response rate of 85%, which is a high response rate for surveys of this type.

**Table 1: Response Rates by SRA series**

SRA Series	Sample Size	Completed	Response Rate
<b>1000 Series</b>	38	30	79%
<b>2000 Series</b>	29	22	76%
<b>3000 Series</b>	135	124	92%
<b>4000 Series</b>	85	68	80%
<b>Total</b>	<b>287</b>	<b>244</b>	<b>85%</b>

## 6.0 Ranking Instructions

A research need was identified as “in the top three” if it received the three highest votes for the top five by the SMEs surveyed. For example, if four people ranked research need #1 in the top five, three people ranked research need #4 in the top five, and two people ranked research need #7 in the top five, and the remaining research needs received one or zero votes for the top five then research needs #1, 4, and 7 were the “top three”.

In the case of a tie, the research need ranked first by at least one SME was selected as having the higher score. If additional tie breaking was required, the research need selected as second by at least one SME was used. For example, if six people ranked research need #4 in the top five and four people each ranked research needs #1, #6, and #7 in the top five, with the remainder of research needs receiving three , or less then there are four needs (#4, 1, 6 and 7) identified for the “top three” list. Of the three research needs receiving four votes, the two with the highest ranks were included in the “top three”.

## 7.0 Calculating a Score

The survey was designed to allow UNHSC to calculate a composite score based on four of the five domains listed above with the exception of current progress. Each domain is scored from 0 to 100. A zero and 100 would place the research need lower and higher, respectively, in significance. In cases where the question was asked in a reverse order<sup>1</sup>, the scores were reversed for all analysis, so that higher scores represented more significant research needs. To reverse code, the following formula was

<sup>1</sup> For example, Question 4 asks how soon the specific research need would improve spill prevention, preparedness, response or impact assessment/restoration, with a zero representing short time frame and 100 representing a long time frame. In this instance, zero and 100 would indicate a higher and lower importance, respectively, for the research need.

## Appendix D

used:  $(\text{respondent's score}) - 100 = |\text{answer}|$ , where the absolute value of the respondent's score minus 100 was calculated. For example, if a respondent scored a research need as 60, the reverse coded score would be  $60 - 100 = |-40| = 40$ .

The fifth domain of current progress was not included in the composite score, but could be included, if additional information was requested by the Workgroup during its deliberations. Additionally, the cost domain was subsequently dropped from the composite score because there was significant missing data for this question. Many SMEs did not choose to estimate the cost of conducting research on a specific need. Ultimately, the composite score consisted of three domains: timeliness, importance and complexity of the research question, with a separate single score based on current progress. The possible range for the composite score was zero to 300 (100 being the maximum score for each of the three domains) and the possible range for the single measure of current progress was zero to 100.

Each respondent's composite score was calculated by adding the three domain scores for a total score within the range of zero to 300. Finally, all respondents' scores for the specified research need were averaged together to get an average arithmetic composite score (with its associated standard deviation) with a range of zero to 300.

### **8.0 Weighting of Data**

The composite score was based on all domains being considered as equally influential on the importance of a research need. Additionally, the Workgroup asked the UNHSC to develop an alternate system to give higher weights to domains that are more influential on the importance of research needs. Domains 1 (importance), 2 (complexity of research) and 3 (timeliness) were weighted to comprise 55%, 30% and 15% of the score, respectively. The weights were selected by the Workgroup. Each domain score was multiplied by the associated proportional weight and then all three were added together. This sum was multiplied by 3 to make the weighted score range consistent with the unweighted score range of zero to 300. Finally, all respondents' weighted scores for the specified research need were averaged together to get an average weighted composite score (and its associated standard deviation) for the research need with a range of zero to 300.

## **9.0 Selecting Decision Making Measures**

The Workgroup met to discuss the final evaluation methodology, and then to evaluate the results of the survey data. Prior to prioritizing the R&D needs, they decided to exclusively use the weighted mean scores of each SRA and SRA subcategory to determine the most important R&T Needs as determined by the survey. The Workgroup unanimously agreed that weighting the results was the best policy. Since Question 5 (current progress) was not included in the scoring, the ICCOPR Workgroup used the results of Question 5 as a way to distinguish between similarly ranked needs. A need that was rated to be a final step might be used to separate it from a similarly ranked need that would take longer to complete. The results of the impediments question (#7) were reviewed to determine if there were any significant issues associated with the selected research priorities that had been missed from the literature search. ICCOPR Workgroup members determined whether these additional R&T Needs were important to the process and if they deserved further consideration. In some cases, these needs were identified by the Workgroup as priorities; in other cases they were combined with other similar R&T Needs in the final prioritization process.

In most cases, they were included as needs on other SRA or SRA subgroup surveys that the SMEs did not see. The final results of the survey were analyzed and summarized for the full ICCOPR Committee for their final review. Comments by the full ICCOPR Committee were evaluated and incorporated into the prioritization process. The results for each SRA Category and Subcategory are presented in Section 7.0

## University of New Hampshire

Research Integrity Services, Service Building  
51 College Road, Durham, NH 03824-3585  
Fax: 603-862-3564

30-Aug-2013

Keirns, Tracy Fowler  
UNH Survey Center, Huddleston Hall  
73 Main Street  
Durham, NH 03824

**IRB #:** 5817

**Study:** ICCOPR Research & Technology Plan

**Approval Date:** 30-Aug-2013

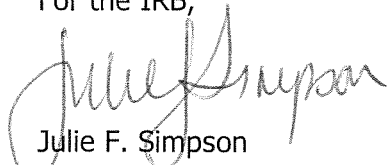
The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved the protocol for your study as Exempt as described in Title 45, Code of Federal Regulations (CFR), Part 46, Subsection 101(b). Approval is granted to conduct your study as described in your protocol.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the attached document, *Responsibilities of Directors of Research Studies Involving Human Subjects*. (This document is also available at <http://unh.edu/research/irb-application-resources>.) Please read this document carefully before commencing your work involving human subjects.

Upon completion of your study, please complete the enclosed Exempt Study Final Report form and return it to this office along with a report of your findings.

If you have questions or concerns about your study or this approval, please feel free to contact me at 603-862-2003 or [Julie.simpson@unh.edu](mailto:Julie.simpson@unh.edu). Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,



Julie F. Simpson  
Director

cc: File



# University of New Hampshire

Research Integrity Services, Service Building  
51 College Road, Durham, NH 03824-3585  
Fax: 603-862-3564

30-Aug-2013

Keirns, Tracy Fowler  
UNH Survey Center, Huddleston Hall  
73 Main Street  
Durham, NH 03824

**IRB #:** 5817

**Study:** ICCOPR Research & Technology Plan

**Anticipated Study End Date:** October 2013

## Exempt Study Final Report

Upon completion of your Exempt study, please provide the information requested below and submit to the Institutional Review Board (IRB) **along with a report of findings for this study**, for audit purposes. Copies of abstracts, articles, and/or publications specific to the project are acceptable. Send to the IRB at the address shown at the top of this form.

1. Please give date of termination date of study. \_\_\_\_\_
2. How many months did you actually perform the proposed investigation or activity? \_\_\_\_\_
3. How many subjects were studied or involved? \_\_\_\_\_
4. Did you conduct the research in accordance with the procedures reviewed and approved by the IRB? \_\_\_\_\_
5. Did any problems emerge or were any serious unexpected adverse subject experiences observed? If YES, please describe on a separate sheet. Yes \_\_\_ No \_\_\_

Principal Investigator or  
Advisor Signature: \_\_\_\_\_ Date: \_\_\_\_\_

cc: File



**INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH**

**RESPONSIBILITIES OF DIRECTORS OF RESEARCH STUDIES INVOLVING HUMAN SUBJECTS**

University of New Hampshire (UNH) tenure-track faculty, lecturers, senior lecturers, visiting faculty with rank, research faculty with rank, clinical faculty with rank, and permanent staff may serve as directors of research studies (researcher) involving human subjects. Adjunct faculty, courtesy faculty (affiliate, affiliate research, and affiliate clinical), and graduate and undergraduate students must be sponsored by an individual who qualifies to serve as a project director.

- A. Researchers are responsible for complying with
  - I. UNH's Policy on the Use of Human Subjects in Research (<http://www.usnh.edu/olpm/UNH/VIII.Res/F.htm>),
  - II. UNH's Federalwide Assurance (FWA) ([http://unh.edu/research/sites/unh.edu.research/files/docs/RIS/FWA\\_1009.pdf](http://unh.edu/research/sites/unh.edu.research/files/docs/RIS/FWA_1009.pdf)), and
  - III. Title 45, Code of Federal Regulations, Part 46: Protection of Human Subjects (45 CFR 46) (<http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html>).
- B. Researchers are responsible for gaining familiarity with, and adhering to, the ethical principles stated in *The Belmont Report* (<http://www.hhs.gov/ohrp/policy/belmont.html>).
- C. Researchers must submit all proposed research activities involving human subjects to the UNH Institutional Review Board (IRB) for review before commencing. Researchers must not involve human subjects in research activities until the researcher has received written, unconditional approval from the IRB for the study.
- D. Researchers are responsible for protecting the rights and welfare of human subjects in their research studies.
- E. Researchers are responsible for keeping co-researchers and all research staff informed about the nature and goals of the study, and the need to adhere to ethical and responsible practices.
- F. Researchers are responsible for adhering to the IRB-approved protocol and consent process, including providing a copy of the IRB-approved and signed informed consent document to each subject at the time of consent, unless the IRB has specifically waived this requirement. The researcher must retain all signed consent documents for at least 3 years after the end of the study.
- G. Researchers must request IRB approval for proposed changes in previously approved human subject research activities before initiating them, except where necessary to eliminate apparent immediate hazards to the subjects.
- H. Researchers are responsible for reporting progress of approved research to the IRB as often as, and in the manner, prescribed by the approving IRB on the basis of risks to subjects. For studies approved at the Expedited and Full Board review levels, this must be no less than once a year (365 days) from the last review date.
- I. Researchers must report to the IRB any injuries or unanticipated problems involving risks to subjects and others within one working day of occurrence.
- J. Researchers will not seek to obtain research credit for, or use data from, patient interventions that constitute the provision of emergency medical care without prior IRB approval. A physician may provide emergency medical care to a patient without prior IRB review and approval, to the extent permitted by law. However, such activities will not be considered research nor may the data be used in support of research.
- K. Researchers who collaborate with colleagues at other institutions/sites have additional responsibilities. Researchers will advise the IRB, Research Integrity Services, and appropriate officials of other institutions of the intent to engage human subjects in research studies for which the UNH FWA or any related Inter-Institutional Amendment or Non-institutional Investigator Agreement applies. Institutions in the collaboration must possess an OHRP-approved Assurance prior to the involvement of human subjects in a research study.

## CRRC Follow-up

Once again we would like to thank you for your participation in this important survey to determine the future research needs in oil spill research. As you know from the first survey there were a large number of research needs in your area of expertise; thus they were broken down into several subcategories with each subcategory being prioritized.

We would now like to ask you to participate in this final survey which asks you only to rank the priorities from all the subcategories (some of which you did not review previously) as this will help advise the ICCOPR in establishing a final prioritization for the whole research area. This survey will take less than 5 minutes of your time. If you have questions regarding the survey please contact Ms. Tracy Keirns of the UNH Survey Center (603-862-1060) or Nancy Kinner UNH Coastal Response Research Center (603-862-1422)

Answer If ICCOPR Is Equal to 1201 Or ICCOPR Is Equal to 1202

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank these 6 research needs in order with a "1" being the most important and a "6" being the least important.

- \_\_\_\_\_ PIPELINE INDUSTRY DATABASE - Consolidated database needed for pipelines installed in the ground. (1)
- \_\_\_\_\_ PIPELINE MATERIALS - Research needed on strain based design and assessment of segments of pipelines with and without fittings. (2)
- \_\_\_\_\_ PIPELINE MATERIALS - Research required on high toughness steels to characterize line pipe toughness for fracture arrest assessment. (3)
- \_\_\_\_\_ PIPELINE LEAK DETECTION TECHNOLOGY - Advanced technology needed for sensing pipeline breaks. (4)
- \_\_\_\_\_ PIPELINE LEAK DETECTION TECHNOLOGY - Develop improvements to mobile based LDS (leak detection systems) that are tested for accuracy on moving platforms (e.g., aerial, mobile vehicles). (5)
- \_\_\_\_\_ PIPELINE LEAK DETECTION TECHNOLOGY - Technology improvements needed to reduce leak detection false alarms. (6)

**Answer If ICCOPR Is Equal to 1501 Or ICCOPR Is Equal to 1502**

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank these 6 research needs in order with a "1" being the most important and a "6" being the least important.

\_\_\_\_\_ DEEPWATER TECHNOLOGY - Develop improved casing and cementing design for ultra-deepwater wells. (1)

\_\_\_\_\_ DEEPWATER TECHNOLOGY - Develop improved subsea ultra-deepwater measurement and monitoring instrumentation, including technologies for "seeing" through the casing via downhole tools to gauge the cement top and in-situ cement characteristics (thickness, channeling, density (gas or liquid pockets), etc.) to better determine potential failure pathways. (2)

\_\_\_\_\_ DEEPWATER TECHNOLOGY - Characterize experimentally the properties and behavior of foam cement samples at in situ conditions to improve the safe use and emplacement of these barriers in deep offshore settings. (3)

\_\_\_\_\_ OFFSHORE DRILLING DATABASE - Develop consistent global dataset for offshore drilling incidents to help prevent future incidents. (4)

\_\_\_\_\_ DEEPWATER CHARACTERIZATION - Conduct research on the conditions (e.g., in-situ stress, sediment rheology, fluid pressure, flow rate and blowout duration) where hydrocarbon pathways to the sea floor established through hydraulic fractures and reactivated natural faults can heal. (5)

\_\_\_\_\_ DEEPWATER CHARACTERIZATION - Expand the research on reservoir characterization to include overburden characterization with emphasis on technology and methods for geological and geomechanical characterization of the subsurface from sea bed to the reservoir. (6)

Answer If ICCOPR Is Equal to 2001 Or ICCOPR Is Equal to 2002 Or ICCOPR Is Equal to 2003

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank these 9 research needs in order with a "1" being the most important and a "9" being the least important.

- \_\_\_\_\_ ARCTIC BASELINE STUDIES - Collect baseline data specifically for ESA's in underrepresented environments including the Arctic (Chukchi Sea, Bristol Bay), particularly in areas that are likely to be developed for oil and gas extraction in the near to mid term. (1)
- \_\_\_\_\_ INTERTIDAL BASELINE STUDIES - Study and synthesize existing information for sand beaches regarding productivity, species diversity, and community structure, and the effects of oil on these parameters, including recovery time with consideration for regional variation. (2)
- \_\_\_\_\_ GOM BASELINE HABITAT STUDIES - Develop benthic mapping of sensitive/important habitats in the GOM. (3)
- \_\_\_\_\_ ARCTIC BASELINE STUDIES - Develop a redundant meteorological sensor system to enhance Arctic coast-wide spill response goals and a series of large-scale studies of oceanographic exchanges, shelf-basin exchanges via wind and eddies, coastal boundary, under-ice river plumes, and sea-ice boundary to better inform pre- and post-spill modeling and response. (4)
- \_\_\_\_\_ BASELINE GEOLOGICAL STUDIES - Collect info on bathymetry and shoreline conditions and natural and human hazards. (5)
- \_\_\_\_\_ GULF OF MEXICO SUSPENDED SEDIMENTS - Conduct research on the baseline sediment loads in the GOM. (6)
- \_\_\_\_\_ ENVIRONMENTAL BASELINE STUDIES - Collect environmental baseline data in ecologically sensitive areas at particular risk to oil discharges where such data are insufficient. (7)
- \_\_\_\_\_ BASELINE PLANNING - Conduct research to improve the understanding of the potential for environmental impacts in frontier ultra-deepwater areas where a well-established infrastructure for spill containment does not exist (e.g., Alaskan Arctic offshore and Eastern GOM). (8)
- \_\_\_\_\_ BASELINE PLANNING - Develop statistics for strategically planning for different risks, their location and therefore who has what stake; develop stats for risk profiles and pre-position equipment. (9)

Answer If ICCOPR Is Equal to 3201 Or ICCOPR Is Equal to 3202 Or ICCOPR Is Equal to 3203 Or ICCOPR Is Equal to 3204

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank the top 10 research needs in order with a "1" being the most important and a "10" being the least important.

- \_\_\_\_\_ ARCTIC OCEANOGRAPHIC MODELS - Develop spill trajectory and weather models based on Arctic conditions. (1)
- \_\_\_\_\_ ARCTIC OCEANOGRAPHIC DATA - Investigate surface circulation using HF radar and satellite track drifters in the Arctic. (2)
- \_\_\_\_\_ ARCTIC OIL BEHAVIOR - Study oil-in-ice weathering, particularly as it relates to the effectiveness of spill response countermeasures and the potential for ecosystem exposure. Oil-water partitioning is recognized as needing further study, especially the potential toxicity of the partitioned phases. (3)
- \_\_\_\_\_ OIL SANDS PRODUCTS CHARACTERISTICS - Conduct research on the chemical and physical characteristics of various blends of dilbit and synbit to better understand how to address spills. (4)
- \_\_\_\_\_ OIL SANDS PRODUCTS DISPERSION - Conduct research on the dispersion of OSP in water (droplet size, coalescence, rise time). (5)
- \_\_\_\_\_ OIL SANDS PRODUCTS WEATHERING - Study the persistence of OSP in the marine and freshwater environments. (6)
- \_\_\_\_\_ IMPROVED OIL TRANSPORT MODELS - Develop understanding of the size, composition, and distribution of particles, both oil and sediment, which are key to developing better models for forecasting, observing, understanding, and hindcasting submerged oil behavior. (7)
- \_\_\_\_\_ SUBSURFACE OIL TRANSPORT MODELS - Develop a decision template or conceptual model of the conditions under which oil might become submerged that includes oil properties and environmental characteristics. (8)
- \_\_\_\_\_ GOM OIL TRANSPORT - Conduct research to improve understanding of vertical movement of hydrocarbon in order to advance ability to predict diffusivity. (9)
- \_\_\_\_\_ IMPROVED OIL TRANSPORT MODELS - Develop improved models predicting dispersability using information on the physiochemical properties of oil. (10)
- \_\_\_\_\_ IMPROVED OIL TRANSPORT MODELS - Develop oil trajectory and fate models used during spill response to predict the behavior of dispersed oil and verify and validate them in an appropriately designed experimental setting or during actual spills. (11)
- \_\_\_\_\_ NEARSHORE MODELING - Develop high resolution nearshore models. (12)
- \_\_\_\_\_ OCEAN CIRCULATION MODELS - Determine the sensitivity of large General Circulation Models to variations in the boundary conditions and forcing. (13)
- \_\_\_\_\_ OCEAN CIRCULATION MODELS - Link models to observation to incorporate real-time data and ocean state. (14)

Answer If ICCOPR Is Equal to 3301 Or ICCOPR Is Equal to 3302 Or ICCOPR Is Equal to 3303

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank these 9 research needs in order with a "1" being the most important and a "9" being the least important.

- \_\_\_\_\_ ICE/OIL DETECTION - Develop AUV mounted sensors for detection of oil under ice. (1)
- \_\_\_\_\_ ALTERNATIVE TECHNOLOGIES - Develop improved methods for detecting thick oil (i.e., large collections of oil) to assist in recovery operations (alternative sensor technologies, improved acoustic survey cost effective laser fluorometers and hyper spectral systems). (2)
- \_\_\_\_\_ ICE/OIL DETECTION - Develop enhanced technology for oil detection under ice and in broken ice and in low visibility. (3)
- \_\_\_\_\_ DISPERSANT MONITORING - Develop technologies to improve oil and dispersant detection in the water column and seafloor. (4)
- \_\_\_\_\_ CHEMICAL MONITORING - Develop advanced field monitoring techniques and rapid chemical analysis. (5)
- \_\_\_\_\_ SMART PROTOCOL - Develop a refined SMART protocol and operational need/value during subsea and surface response based on recent experiences. (6)
- \_\_\_\_\_ SUBMERGED OIL DETECTION - Develop observation systems that can be deployed on scene at spills of submerged oil to help validate or calibrate models and direct sampling and monitoring. (7)
- \_\_\_\_\_ SUBMERGED OIL DETECTION - Develop the capability to confirm and refine the location and quantity of submerged oil detected on a coarse scale. (8)
- \_\_\_\_\_ SUBSURFACE OIL DETECTION - Develop improved methods for sampling and monitoring the transport of subsurface oil. (9)

**Answer If ICCOPR Is Equal to 3401 Or ICCOPR Is Equal to 3402**

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank these 8 research needs in order with a "1" being the most important and a "8" being the least important.

- \_\_\_\_\_ CONTROL AND RECOVERY TECHNOLOGIES - Develop improved mechanical recovery to increase capture rate and capacity. (1)
- \_\_\_\_\_ ARCTIC CONTROL AND RECOVERY TECHNOLOGIES - Develop improved methods of mechanical recovery in arctic conditions (e.g., cold water, ice, broken ice). (2)
- \_\_\_\_\_ ARCTIC CONTROL AND RECOVERY TECHNOLOGIES - Further develop mechanical recovery systems to recover oil accumulated under ice. (3)
- \_\_\_\_\_ ARCTIC CONTROL AND RECOVERY TECHNOLOGIES - Need to develop mechanical recovery equipment and documentation of this capacity in different ice scenarios. (4)
- \_\_\_\_\_ CONTROL AND RECOVERY TECHNOLOGIES - Develop methods to increase the encounter rate of skimming and in situ burning operations, by increasing amount/thickness of oil on the surface (methods could involve use of chemicals, innovative mechanical systems, new operational procedures). (5)
- \_\_\_\_\_ ARCTIC CONTROL AND RECOVERY TECHNOLOGIES - Study the presence or lack of standardized testing approaches (especially wave tanks), the cross-comparability of results, and collaborative development of protocols that would establish the practical recovery limits that are achievable during response operations, and refine our understanding of the appropriate setting and scale at which these devices could be effectively deployed. (6)
- \_\_\_\_\_ ARCTIC CONTROL AND RECOVERY TECHNOLOGIES - Test response equipment in Arctic. (7)
- \_\_\_\_\_ CONTROL AND RECOVERY TECHNOLOGIES - Study response options and determine which were most successful during DWH. (8)



Answer If ICCOPR Is Equal to 3601 Or ICCOPR Is Equal to 3602 Or ICCOPR Is Equal to 3603 Or ICCOPR Is Equal to 3604 Or ICCOPR Is Equal to 3605 Or ICCOPR Is Equal to 3606

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank the top 10 research needs in order with a "1" being the most important and a "10" being the least important.

- \_\_\_\_\_ DISPERSED OIL BEHAVIOR - Study the fate and transport of dispersed oil and dispersants in the surface, subsurface and deep water. (1)
- \_\_\_\_\_ BIODEGRADATION - Study the toxic and sub-lethal effects and ramifications for microbial communities (and the natural biodegradation of oil). (2)
- \_\_\_\_\_ BIODEGRADATION - Develop a detailed investigation on the kinetics of dispersed oil biodegradation at low oil-water ratios to simulate conditions that represent those that follow significant dilution of the dispersed oil plume. (3)
- \_\_\_\_\_ DISPERSED OIL BEHAVIOR - Conduct field trials with dispersants that include tracking and monitoring concentrations. (4)
- \_\_\_\_\_ DISPERSED OIL BEHAVIOR - Study the variables affecting coalescence and resurfacing of dispersed oil droplets to develop models for tracking movement at surface, subsurface and deepwater. (5)
- \_\_\_\_\_ DISPERSED OIL BEHAVIOR - Study the quantification of degradation rates of chemically dispersed, physically dispersed, and undispersed oil. (6)
- \_\_\_\_\_ DISPERSED OIL FATE - Study and evaluate dispersant and dispersed oil chronic and sub-lethal effects on key species for varying, real world exposure scenarios and durations. (7)
- \_\_\_\_\_ DISPERSANT INTERACTIONS - Conduct research on benthic species interactions with oil, oil/dispersants and dispersant contaminated sediments. (8)
- \_\_\_\_\_ DISPERSED OIL TOXICITY - Develop standard methods for toxicity testing of dispersed oil appropriate for coastal regimes. (9)
- \_\_\_\_\_ TOXICITY - Develop protocols for testing efficacy and toxicity of commercially available dispersants and other chemical agents which may become commercially available. (10)
- \_\_\_\_\_ WILDLIFE EFFECTS - Study long-term effects of short-term exposures to dispersed oil on wildlife. (11)
- \_\_\_\_\_ EFFICACY - Study the efficacy of dispersant alternative delivery methods (subsurface application). (12)
- \_\_\_\_\_ EFFICACY AND EFFECTIVENESS - Conduct field testing and evaluation of dispersants (efficacy and effectiveness). (13)
- \_\_\_\_\_ MECHANICAL RESPONSE - Study the effects of dispersant application on subsequent mechanical recovery of undispersed oil. (14)
- \_\_\_\_\_ DISPERSED OIL FATE - Study anticipated fate of spilled oil dispersants and dispersed oil from different operations in geographical locations. (15)

- \_\_\_\_\_ DISPERSED OIL FATE - Study the interactions of chemically dispersed oil droplets with suspended particulate matter and the effect of these processes on the rate of oil biodegradation and fate. (16)
- \_\_\_\_\_ FATE AND EFFECTS - Study the long-term fate and effects of dispersant applications. (17)
- \_\_\_\_\_ SUBSURFACE APPLICATION - Study how subsurface application of dispersants affects characteristics of that oil at the surface. (18)
- \_\_\_\_\_ SUBSURFACE BEHAVIOR - Study the effect of dispersant on deposition, partitioning, toxicity and degradation (deep sea and in presence of high flow rates). (19)
- \_\_\_\_\_ SUBSURFACE EFFECTIVENESS - Develop conditions of operability for dispersant use in the subsea, including characteristics of most effective dispersant, physical parameters of when to apply, considering flow rate. (20)

**Answer If ICCOPR Is Equal to 3701 Or ICCOPR Is Equal to 3702**

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank these 6 research needs in order with a "1" being the most important and a "6" being the least important.

- \_\_\_\_\_ AERIAL PLUME IMPACTS - Study the impact of volatile plumes from in-situ burning on natural resources (e.g., birds). (1)
- \_\_\_\_\_ ISB BIOAVAILABILITY - Study ISB residues, especially toxicity, physical properties, and bioavailability of contaminants contained within the residue matrix; especially with potential benthic community effects. (2)
- \_\_\_\_\_ ISB EFFECTIVENESS - Develop better means of quantifying ISB effectiveness. Unburned oil or other residue from burning operations should be recovered and accounted for when evaluating the effectiveness of in situ burning. (3)
- \_\_\_\_\_ ISB CONTAINMENT TECHNOLOGY - Develop enhanced designs for containment and burning oil. (4)
- \_\_\_\_\_ ISB PLANNING - Develop improved procedures for in-situ burning under various conditions, develop protocols, improve field verification of airborne constituent behaviors. (5)
- \_\_\_\_\_ ISB CONTAINMENT TECHNOLOGY - Conduct research and development programs on ISB to develop more robust booming systems with greater oil encounter rates and expand the weather/sea state of opportunity in which ISB can effectively be used. (6)

Answer If ICCOPR Is Equal to 4101 Or ICCOPR Is Equal to 4102 Or ICCOPR Is Equal to 4103 Or ICCOPR Is Equal to 4104 Or ICCOPR Is Equal to 4105 Or ICCOPR Is Equal to 4106

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank the top 10 research needs in order with a "1" being the most important and a "10" being the least important.

- \_\_\_\_\_ ARCTIC IMPACTS - Develop a Response Gap Analysis framework to assess the impacts of response actions in the Arctic. (1)
- \_\_\_\_\_ ARCTIC IMPACTS - Develop response guide and restoration guide for oil in ice. (2)
- \_\_\_\_\_ ARCTIC WILDLIFE IMPACTS - Study effects of oil on wildlife and effective response intervention in Arctic environment. (3)
- \_\_\_\_\_ EXPOSURE METHODOLOGIES - Develop relevant biological markers of exposure and guidelines for responsible use of biomarkers. (4)
- \_\_\_\_\_ SUBLETHAL IMPACTS - Study relevant endpoints (e.g., growth, behavior, inhibit reproduction, physiological aberrations) and appropriate organisms to use as indicators for different habitats. (5)
- \_\_\_\_\_ TOXICOLOGICAL IMPACTS - Conduct research to identify toxicologically-relevant analytes by habitat and organism. (6)
- \_\_\_\_\_ DISPERSED OIL IMPACTS - Conduct research to evaluate the long-term/chronic impacts of chemically/naturally dispersed oil on invertebrates, anadromous fish, corals, etc. - focus on long exposures to low concentrations, environmentally relevant exposure scenarios. (7)
- \_\_\_\_\_ DISPERSED OIL IMPACTS - Study the impact of dispersed oil on organisms, how it is taken up, end products, effects on benthic primary production. (8)
- \_\_\_\_\_ SUBMERGED OIL IMPACTS - Develop understanding of the chronic toxicity and pathways of exposure leading to toxicity of submerged oil to benthic resources. (9)
- \_\_\_\_\_ ECOSYSTEM IMPACTS - Collect data and evaluate long-term environmental effects of oil discharges larger than 250,000 gallons or if the discharged occurred after Jan 1, 1989. (10)
- \_\_\_\_\_ ECOSYSTEM IMPACTS - Develop methods to assess oil spill injury to wetland communities, submerged vegetation, benthic invertebrates, and waterfowl. (11)
- \_\_\_\_\_ LONG-TERM ECOSYSTEM IMPACTS - Study long-term chronic exposure direct and indirect impacts on the food chain - fish eggs, bottom feeders, birds, mammals. (12)
- \_\_\_\_\_ ECOSYSTEM RECOVERY - Develop conceptual models of service loss and recovery from key habitats, and the information necessary to parameterize recovery models. (13)
- \_\_\_\_\_ ECOSYSTEM RECOVERY - Study data collection efforts for spill impact assessment and evaluation of ecological recovery rates for offshore, near-shore, coastal and estuarine areas impacted by spills. (14)
- \_\_\_\_\_ ECOSYSTEM RECOVERY - Study recovery rates of injured habitats from previous spills. (15)

- \_\_\_\_\_ RISK ASSESSMENT - Develop a risk assessment based on key exposure-response relationships from lab tests where conditions reflect ambient exposures. (16)
- \_\_\_\_\_ IMPACT METRICS - Collect, synthesize and evaluate current data on impacts from a range of exposure scenarios to biota at different life stages. Determine feasibility of using compiled data in determining potential ecological impacts from oil spills. (17)
- \_\_\_\_\_ IMPACT METRICS - Conduct research to determine best metrics for assessing impact/damage. (18)

**Answer If ICCOPR Is Equal to 4301 Or ICCOPR Is Equal to 4302**

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank these 8 research needs in order with a "1" being the most important and a "8" being the least important.

- \_\_\_\_\_ SEAFOOD SAFETY - Conduct research on the short-term and long-term safety of seafood in the GOM following the DWH spill and communicate it to the public. (1)
- \_\_\_\_\_ WORKER SAFETY - Study the health and safety issues associated with spill response, and develop protocols for personnel protection (e.g., training, fitness, stress management.) (2)
- \_\_\_\_\_ PROTECTIVE TECHNOLOGIES - Develop technologies and methods to protect public health and safety from oil discharges, including the population directly exposed to an oil discharge. (3)
- \_\_\_\_\_ HUMAN EXPOSURE RESEARCH PLANNING - Conduct research on the framework needed to deploy a rapid research response for future oil spills. (4)
- \_\_\_\_\_ HUMAN EXPOSURE DURING DWH - Collect long-term monitoring data of health (human) of coastal communities impacted by DWH. (5)
- \_\_\_\_\_ HUMAN DISPERSANT EXPOSURE - Develop models to estimate exposure to dispersant and/or dispersed oil to human populations. (6)
- \_\_\_\_\_ HUMAN EXPOSURE DURING DWH - Conduct clinical evaluations, diagnostics and documentation for individuals affected from the DWH spill. (7)
- \_\_\_\_\_ WORKER HEALTH AFTER DWH - Collect long-term monitoring data on Deepwater Horizon responders' health. (8)

**Answer If ICCOPR Is Equal to 4401 Or ICCOPR Is Equal to 4402**

Each of the following Research Needs was ranked in the top 3 by the Subject Matter Experts assigned to each specific sub-area.

The top 3 from each sub-area are listed here. Please rank these 6 research needs in order with a "1" being the most important and a "6" being the least important.

- \_\_\_\_\_ COMMUNITY PREPAREDNESS - Develop more effective models for community/stakeholder involvement in oil spill planning, response and restoration. (1)
- \_\_\_\_\_ RISK COMMUNICATION - Develop improved methods for communicating risks and tradeoffs to various audiences, including tradeoffs of dispersant use vs. alternative technologies. (2)
- \_\_\_\_\_ COMMUNITY IMPACTS OF SPILLS - Study past support services and aid in communities impacted by past spills. (3)
- \_\_\_\_\_ HUMAN IMPACTS - Study cumulative social impacts of chronic and long lasting spills. (4)
- \_\_\_\_\_ HUMAN IMPACTS - Study the resilience of social-ecological systems to environmental disasters. (5)
- \_\_\_\_\_ HUMAN IMPACTS - Determine the likely degree of impact on human well-being from ecosystem services losses. (6)





# **Appendix E**

## Sample of Research Priority Survey



Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) Research &  
Technology Plan Research Needs Survey

Your input is critical to the success of this project. We know that you are extremely busy, but please take the 10 to 45 minutes required to complete the online survey. We are surveying up to 200 subject matter experts (SMEs) in numerous fields across many federal agencies because we want to capture the unique perspectives of many experts and have them represented in the results.

Note that by completing the survey, you are consenting to participate in this research. Participation in this research is expected to present minimal risk to you. While you may not receive any direct benefits from participating in this study, the anticipated benefits of the knowledge gained via the study include determining future priorities of oil spill research.

Although we hope that you will answer every question, you are certainly free to skip any questions. Your participation is voluntary, and you may withdraw your consent and discontinue participation at any time. The UNH Survey Center and Coastal Response Research Center (CRRC) seek to maintain the confidentiality of all data and records associated with your participation in this research. However, any communication via the Internet poses minimal risk of a breach of confidentiality. Data will be shared with study sponsors, however, your responses will be combined with others in such a way that individual responses cannot be identified when data is reported or published.

Thank you in advance for completing this survey. If you have any questions pertaining to:

- content and/or definition of the research needs, contact Nancy Kinner, CRRC 603-862-1422 or [nancy.kinner@unh.edu](mailto:nancy.kinner@unh.edu)
- the mechanism or “how-to” of completing this survey, contact Tracy Keirns, UNH Survey Center, [tracy.keirns@unh.edu](mailto:tracy.keirns@unh.edu)
- information on ICCOPR (Interagency Coordinating Committee on Oil Pollution Research), contact CDR Eric Miller, U.S. Coast Guard at [eric.j.miller2@uscg.mil](mailto:eric.j.miller2@uscg.mil)
- research integrity and your rights as a research subject, contact Dr. Julie Simpson, UNH Research Integrity services, 603.862.2003 or [julie.simpson@unh.edu](mailto:julie.simpson@unh.edu)

By clicking “Next” you are agreeing to take part in this survey.

You have been selected as a Subject Matter Expert in the area of [SRA or SRA subcategory]

The following questions will focus on evaluation of all identified research needs in your subject matter area.

You will be asked a set of 5 questions for each research need in your subject matter area. These questions will ask you to rate a statement on a scale of 0 to 100. In order to do this, select the slider bar and move the bar to the number between 0 and 100 that comes closest to your opinion. The last set of questions will ask you rank all of the research needs in your subject research area.

If at any time you need to leave the survey, simply close your browser and all of your answers will be saved. To continue the survey just click the original link you were provided and continue the survey. Do not use the browsers back button, but if you would like to navigate through the survey you may use the “Back” and “Next” buttons at the bottom of each page.

While you are not required to answer every question, accurate recommendations can only be made with complete data.

#### IF ANSWERING A SUB AREA

As a Subject Matter Expert (SME) you are being asked to answer questions regarding an important oil spill related Subject Research Area (SRA). Because there were a large number of identified research and technology needs in your SRA we have divided the SRA into subcategories to reduce the number of questions you need to address.

If you would like to see all of the identified R&D needs in the SRA, click [here](#) for a comprehensive list. This may help you at the end of the survey when evaluating whether all the important R&D needs are included in the overall survey.

When all SMEs have completed this survey we intend to send you the list of prioritized R&D needs in all the subcategories within the SRA so you will have an opportunity to provide us with your overall ranking of the top R&D needs in the entire SRA. This will be a simple ranking of the top 1% of the R&D needs and will not require you to evaluate each research need.

Q1

Research Need: \_\_\_\_\_

1. How important is this R&D need to improving any or all of the following: spill prevention, preparedness, response or impact assessment/restoration?

Low Importance  
0

Medium Importance  
50

High Importance  
100

Q2

Research Need: \_\_\_\_\_

2. Some research is designed to answer a *small detail* which refines our understanding of a research problem while other research *answers key questions* that become the building blocks for further advancements. Please estimate where this R&D need fits in this spectrum of oil pollution research (explained above).

Small Detail/Nuance

0

50

Building Block/Key Question

100

Q3

Research Need: \_\_\_\_\_

3. In your opinion, what is the **total** estimated cost of the research to answer this R&D need? (Please provide your best single number estimate - If you still don't know, please enter "0") Please use only numbers with no commas or decimals (ex. 1000000)

\$ \_\_\_\_\_

Q4

Research Need: \_\_\_\_\_

4. How soon would the results of this specific R&D need improve any or all of the following: spill prevention, preparedness, response or impact assessment/restoration?

Short (<2 Years)

0

2 - 5 Years

50

Long (> 5 Years)

100

Q5

Research Need: \_\_\_\_\_

5. Solving larger research problems can require multiple steps. Some research projects take the initial steps while others will be the final step. Please estimate where this R&D need fits in the lifespan of solving a research problem.

Initial Step

0

50

Final Step

100

IF number of research needs is 5 or less only Q6a is asked excluding bracketed text.

Q6

Of the research needs that you reviewed today, which rise to the top (maximum of 5)?

- [Need 1]
- [Need 2]
- [Need 3]
- [Need 4]
- [Need 5]
- [Need 6]
- [Need 7]
- [Need 8]
- [Need 9]
- [Need 10]

Q6a

Of these [top 5] research needs [that you just selected], please prioritize them. (i.e. "1" as your 1st choice, "2" as your 2nd choice, etc)

- [Need 1]
- [Need 2]
- [Need 3]
- [Need 4]
- [Need 5]
- [Need 6]
- [Need 7]
- [Need 8]
- [Need 9]
- [Need 10]

Q7

Are there any research needs related to this subject area that you feel need to be addressed, but were not on this list?

Q8

List (up to 3) impediments (other than cost or time to completion) to the top 5 research needs you indicated. We appreciate succinct bullet responses, complete sentences are not expected.

*[Research Need 1]*

Impediment 1 (1)

Impediment 2 (2)

Impediment 3 (3)

*[Research Need 2]*

Impediment 1 (1)

Impediment 2 (2)

Impediment 3 (3)

*[Research Need 3]*

Impediment 1 (1)

Impediment 2 (2)

Impediment 3 (3)

*[Research Need 4]*

Impediment 1 (1)

Impediment 2 (2)

Impediment 3 (3)

*[Research Need 5]*

Impediment 1 (1)

Impediment 2 (2)

Impediment 3 (3)

Thank you taking for the time to complete this survey. Click "Submit" below to exit.

IF ANSWERING SUBAREA:

Thank you taking for the time to complete this survey. You completed a survey for one subcategory of a larger subject research area.

When all SMEs have completed this survey we intend to send you the list of prioritized R&D needs in all the subcategories within the SRA so you will have an opportunity to provide us with your overall ranking of the top R&D needs in the entire SRA. This will be a simple ranking of the top 1% of the R&D needs and will not require you to evaluate each research need. Click "Submit" below to exit.





# **Appendix F**

## Sample of Survey Data



### Sample of Survey Data Results

R&D Needs	Weighted		# Ranking		Count = 4
	Score Mean	Weighted SD	Rank Order	RN in Top 5	
R&D Need 10	260.44	29.15	1	4	
R&D Need 4	215.74	28.61	4	1	
R&D Need 7	212.70	22.30	2	3	
R&D Need 6	211.99	37.62	6	1	
R&D Need 5	195.41	69.17	4	1	
R&D Need 3	190.76	64.54	8	1	
R&D Need 1	184.28	89.51	-	0	
R&D Need 8	181.91	87.41	7	1	
R&D Need 2	167.74	91.72	-	0	
R&D Need 9	164.96	97.98	3	2	

Sorted by Weighted Mean Score

