Número: 292

UNIVERSIDADE ESTADUAL DE CAMPINAS

INSTITUTO DE GEOCIÊNCIAS

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Pós-Graduação em Geociências
Área de Administração e Política de Recursos Minerais

DONEIVAN FERNANDES FERREIRA

ANTICIPATING IMPACTS OF FINANCIAL ASSURANCE REQUIREMENTS FOR OFFSHORE DECOMMISSIONING: A DECISION MODEL FOR THE OIL INDUSTRY

Tese apresentada ao Instituto de Geociências como parte dos requisitos para obtenção do título de Doutor em Ciências.

Orientador: Prof. Dr. Saul B. Suslick

CAMPINAS - SÃO PAULO

JULHO 2003

Ferreira, Doneivan Fernandes
F413a Anticipating impacts of financial assurance requirements for offshores decommissioning: a decision model for the oil industry / Doneivan Fernandes Ferreira.- Campinas,SP.: [s.n.], 2003.

Orientador: Saul Barisnik Suslick
Tese (doutorado) Universidade Estadual de Campinas, Instituto de Geociências.

1. Indústria petrolífera. 2. Processos decisórios – Modelos Matemáticos. 3. Recursos Naturais. 4. Abandono (Direito Marítimo). I. Suslick, Saul Barisnik II. Universidade Estadual de Campinas, Instituto de Geociências III. Título.

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UNIVERSIDADE ESTADUAL DE CAMPINAS

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PÓS-GRADUAÇÃO EM GEOCIÊNCIAS
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Aprovada em: 04/07/03

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INSTITUTE OF GEOSCIENCES
DEPARTMENT OF GEOLOGY AND NATURAL RESOURCES
AREA OF MINERAL RESOURCES POLICY AND MANAGEMENT

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Dissertation submitted to the Institute of Geosciences of the State University of Campinas in partial fulfillment of the requirements for the degree of Doctor of Sciences
2003

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Campinas, July 04, 2003

DEDICATORY

in memoriam

My mother died when I was just beginning this thesis project. I was able to spend the last month of her life at her bedside along with my family. This work is dedicated to the "living-with-purpose" spirit manifested in the life of my mother, Doriza Fernandes Ferreira.

ACKNOWLEDGMENTS

Firstly and most importantly, thanks to God, because He is Good.

Ju and Viv, my girls, your constant encouragement was the essential factor when the burdens of writing seemed undefeatable. My best friend and precious wife Ju, who has wholeheartedly supported my commitment of time and attention to this project. I could never make it without your love, patience, understanding, and unfaltering encouragement. I thank God for making our love such a great treasure. My little Viv, you cannot begin to imagine how much playing with you every day helped me finish this thesis. I will always cherish these moments. Girls, I love you.

To my parents Dr. Damy Ferreira and Doriza Fernandes Ferreira (*in memoriam*) who taught me the way I should walk. You nourished my life, provided me with some greatly needed correction, motivated my curiosity, challenged my thinking, fired my heart, and blessed my soul. Thanks for leaving such good footprints to be followed. To my brother Dr. Davis Fernandes Ferreira, I am so very grateful for your friendship and unrelenting care. Bro, live long and prosper! To my sisters, Dalel F. Medina and Dorine Ferreira, and respective families, thanks for opening your homes and your hearts for my family during my fellowship in the States.

I am especially grateful to Professor Dr. Saul B. Suslick, my adviser. Thanks for your guidance, patience, and care, but most importantly, thanks for believing in me. I am also thankful to Dr. Aroldo Misi for the encouragement and direction during my pre-UNICAM stage.

Support for this research project was provided by the State University of Campinas (UNICAMP) and the Foundation for the Coordination of Higher Education and Graduate Training (CAPES). Thanks to the Brazilian Petroleum Agency (ANP) and Center for Petroleum Studies (CEPETRO), for project opportunities. Thanks to the Institute for Ecological Economics (IEE) and University of Maryland (UMD), for having me as a fellow for 18 month.

Special thanks to state regulators, and decommissioning and bonding specialists who took the time to provide me with important information and insightful discussions. Thanks to Dr. Robert Costanza, Director of the IEE, for the learning opportunity and to Dr. Roel Baums for the modeling coaching. I am deeply indebted to Dr. Joshua Farley and the Farley family for being our family in Maryland.

Thanks to Paula Moura for the invaluable help with programming and in the Petrobond Project. To my colleagues at the LAGE/UNICAMP, thank you for numerous intelligent discussions. I am also thankful to Valdirene Pinotti and Maria Helena S. Ricardo, for the much-needed help and for being so sweet and caring, and to Marcia A. Schenfel Baena, for the helpful comments in the manuscript.

A special thanks to my in-laws, Joao Benjamim and Iracy Pinheiro, for being near when I needed. Thanks to Dr. Mariano Leonel de Souza, Leila de Souza and the entire Souza Family, for being like family.

EPIGRAPH

Lord, thou hast been our dwelling place in all generations. Before the mountains were brought forth, or ever thou hadst formed the earth and the world, even from everlasting to everlasting, thou art God. Thou turnest man to destruction; and sayest, Return, ye children of men. For a thousand years in thy sight are but as yesterday when it is past, and as a watch in the night. Thou carriest them away as with a flood; they are as a sleep: in the morning they are like grass which groweth up. In the morning it flourisheth, and groweth up; in the evening it is cut down, and withereth. For we are consumed by thine anger, and by thy wrath are we troubled. Thou hast set our iniquities before thee, our secret sins in the light of thy countenance. For all our days are passed away in thy wrath: we spend our years as a tale that is told. The days of our years are threescore years and ten; and if by reason of strength they be fourscore years, yet is their strength labour and sorrow; for it is soon cut off, and we fly away. Who knoweth the power of thine anger? even according to thy fear, so is thy wrath. So teach us to number our days, that we may apply our hearts unto wisdom. Return, O LORD, how long? and let it repent thee concerning thy servants. O satisfy us early with thy mercy; that we may rejoice and be glad all our days. Make us glad according to the days wherein thou hast afflicted us, and the years wherein we have seen evil. Let thy work appear unto thy servants, and thy glory unto their children. And let the beauty of the LORD our God be upon us: and establish thou the work of our hands upon us; yea, the work of our hands establish thou it.

(Moses, Hebrew Lawgiver, 13th cent. B.C.)

"I do not feel obliged to believe that the same God who has endowed us with sense, reason, and intellect has intended us to forgo their use."

(Galileo Galilei, Italian Astronomer and Physicist, 1564-1642)

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ABBREVIATIONS

AMD	ACID MINE DRAINAGE
ANP	BRAZILIAN NATIONAL PETROLEUM AGENCY (AGÊNCIA NACIONAL DO PETRÓLEO)
AP	ANNUITY POLICIES
BIA	BUREAU OF INDIAN AFFAIRS
BLM	BUREAU OF LAND MANAGEMENT
BOE	BARREL OF OIL EQUIVALENTS
BSAB	BUDGET SET-ASIDE BONDS
CB	COLLATERAL BONDS
CCA	CASH COLLATERAL ACCOUNTS
CCCP	CLEANUP COST CAP POLICY
CD	CERTIFICATES OF DEPOSIT
CEPETRO	CENTER FOR PETROLEUM STUDIES (UNICAMP)
CGB	CORPORATE GUARANTEE BOND
CPLAL	CUMULATIVE POTENTIAL LEASE ABANDONMENT LIABILITIES
CSB	CORPORATE SURETY BONDS
CVBS	CONTROLLED VARIABLE BUOYANCY SYSTEM
DOCD	DEVELOPMENT OPERATION COORDINATION DOCUMENT
DOI	U.S. DEPARTMENT OF THE INTERIOR
DPP	DEVELOPMENT AND PRODUCTION PLAN
DTI	U.K. DEPARTMENT OF TRADE AND INDUSTRY
ECA	ESCROW COLLATERAL ACCOUNTS
EIA	ENVIRONMENTAL IMPACT ASSESSMENT REPORT
EIP	ENVIRONMENTAL INSURANCE POLICY
EP	EXPLORATION PLAN
EPA	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ESF	EXTERNAL SINKING FUNDS
FIPB	FINITE INSURANCE POLICY
FPSO	FLOATING PRODUCTION SYSTEM AND OFFLOADING
FRCB	FUTURE REVENUE COMMITMENTS BONDS
FUNCAMP	UNICAMP FOUNDATION (STATE UNIVERSITY OF CAMPINAS)
FWS	U.S. FISH AND WILDLIFE SERVICE
G&G	GEOLOGICAL AND GEOPHYSICAL
GOM	GULF OF MEXICO
HLV	HEAVY LIFT VESSEL
ICMS	INTERNATIONAL COUNCIL ON METALS AND THE ENVIRONMENT
IGP	INSURANCE-GUARANTEE POLICY
IGS	INVESTMENT GRADE SECURITY
IMO	INTERNATIONAL MARITIME ORGANIZATION
IPB	INSURANCE POLICY BONDS
ISO	INTERNATIONAL CONSENSUS STANDARD (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)
JACK-UP	STEEL GRAVITY STRUCTURE
LCCB	LINE OF CREDIT COLLATERAL BOND
LOC	LETTER OF CREDIT
LSAA	LEASING SPECIFIC ABANDONMENT ACCOUNTS
LSCA	LEASING SPECIFIC COLLATERAL ACCOUNTS
MMS	MINERALS MANAGEMENT SERVICE
na	NOT AVAILABLE / NOT APPLICABLE
NGO	NON-GOVERNMENTAL ORGANIZATIONS
NIN	NOTICES OF INCIDENTS OF NONCOMPLIANCE
NIOZ	DUTCH INSTITUTE FOR MARINE RESEARCH
NORMS	NATURAL-OCCURRING RADIOACTIVE MATERIAL
NPD	NORWEGIAN PETROLEUM DIRECTORATE

NPS	NATIONAL PARK SERVICE
NPV	NET PRESENT VALUE
NS	NORTH SEA
NWF	NATIONAL WILDLIFE FUND
OC	OFFSHORE CALIFORNIA
OCS	OUTER CONTINENTAL SHELF
ODCP	OFFSHORE DECOMMISSIONING COMMUNICATIONS PROJECT
OSCOM	OSLO COMMISSION GUIDELINES FOR THE DISPOSAL OF INSTALLATIONS AT SEA
OSM	OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT
OSPAR	CONVENTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT IN THE NORTH EAST ATLANTIC
P-BONDS	POOL BONDS
PPCA	PAID-IN COLLATERAL ACCOUNTS OR PRE-PAID COLLATERAL ACCOUNTS
PPP	POLLUTERS PAY PRINCIPLE
RECB	REAL ESTATE COLLATERAL BOND
RMP	ROYALTY MANAGEMENT PROGRAM
ROW	PIPELINE RIGHT-OF-WAY
RRR	(3R's) REDUCE, REUSE, AND RECYCLE
RRRRR	(5R's) REDUCE, REENGINEER, REUSE, RIGS-TO-REEF, AND RECYCLE.
RTR	RIGS-TO-REEF PROGRAM
SAA	SURETY ASSOCIATION OF AMERICA
S-BONDS	SELF BONDS
S-FUNDS	STATE FUNDS
SMCRA	SURFACE MINING CONTROL AND RECLAMATION ACT
SRCB	SALVAGE REVENUE COLLATERAL BOND
SSP	SEMI-SUBMERSIBLE PLATFORM
T-BOND	TREASURY BONDS
TLP	TENSION LEG PLATFORM
TPB	THIRD-PARTY BONDS
TPWD	TEXAS PARKS AND WILDLIFE DEPARTMENT
UKOOA	UNITED KINGDOM OFFSHORE OPERATORS ASSOCIATION
UN	UNITED NATIONS
UNCLOS	UNITED NATIONS CONVENTION ON THE LAW OF THE SEA
UNEP	UNITED NATIONS ENERGY PROGRAMME
UNICAMP	STATE UNIVERSITY OF CAMPINAS
USGS	U.S. GEOLOGICAL SURVEY

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DOCTORAL DEGREE IN GEOSCIENCES
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ANTICIPATING IMPACTS OF FINANCIAL ASSURANCE REQUIREMENTS FOR OFFSHORE DECOMMISSIONING: A DECISION MODEL FOR THE OIL INDUSTRY

ABSTRACT

DOCTORATE THESIS

Doneivan Fernandes Ferreira

The present thesis describes the financial assurance system (bonding system), an innovative incentive approach being adopted by several countries in different productive areas, with the objective of guaranteeing the availability of funds for the compliance of all ex-post environmental obligations in the offshore petroleum industry. This work provides a general assessment of several decommissioning-related issues that economically impact offshore petroleum projects around the world. There are several forms of bonding instruments currently available providing significant flexibility for companies to meet end-of-leasing requirements. Bonds will provide advantages such as: (1) ensure satisfactory regulatory compliance; (2) safeguard government and taxpayers by attaining reasonable protection from default at a minimum increase in project costs; and (3) protect the environment from potential harm resulting from failure to carryout proper ex-post operations in a timely fashion. Based upon a discount cash flow analysis this study uses an experimental approach, suggesting interactive decision models (simulation models) estimating costs, and identifying the instrument option which offers the least economic impact in the project and, at same time, provides the best financial guarantee for all stakeholders involved in the process. Simulations confirm the current scenario where regulators are likely to require surety bonds, letters of credit, and periodic payment collateral account tools. Sensitivity analysis of Net Present Value and Government Take value indicate ex-post insurance policies, sureties, and letters of credit may cause fewer impacts yielding significantly better payoffs. Simulations confirm that small projects can be severely affected when collateral account instruments are used.

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TESE DE DOUTORADO

TEMA: ANTECIPANDO IMPACTOS DE OBRIGAÇÕES DE GARANTIA FINANCEIRA PARA DESCOMISSIONAMENTO DE INSTALAÇÕES MARÍTIMAS: UM MODELO DECISÓRIO PARA A INDÚSTRIA DO PETRÓLEO

RESUMO ESTENDIDO

Há algum tempo o setor de petróleo foi obrigado a se preocupar com aspectos ambientais e de segurança das áreas onde mantinham atividades. Para garantir que tais áreas fossem devolvidas à sociedade em condições de sustentabilidade, os órgãos reguladores começaram exigir a realização de algumas operações específicas, visando aspectos ambientais e de segurança. Este processo tem sido denominado "fase de abandono".

Desde então, a preocupação passou a ser com o risco de descumprimento de tais obrigações, já que se estas não fossem cumpridas, a responsabilidade seria naturalmente transferida para o órgão regulador. O sistema de garantia financeira começou, então, a ser aplicado no setor como uma forma de gerar incentivos financeiros e garantir recursos para o cumprimento de tais obrigações mesmo em caso de abandono prematuro, insolvência ou negligência.

Nos últimos anos, com a exaustão econômica de inúmeros reservatórios de óleo e gás e com o persistente aumento da demanda mundial por combustíveis fósseis, iniciou-se um processo de disponibilização e oferta de campos marginais no cenário internacional e nacional. Esta oferta deve-se também ao desinteresse das grandes companhias em aplicar recursos em projetos deste tipo, onde o lucro geralmente é marginal ou inexistente. No entanto, concessionárias pequenas e independentes são capazes de produzir com custos operacionais significativamente mais baixos, viabilizando lucros satisfatórios, a depender das condições do mercado.

Com a abertura do setor de petróleo e gás natural no Brasil, aumentou o interesse por oportunidades no país. Apesar da preocupação em fornecer um cenário atrativo para novos investimentos, a Agência Nacional do Petróleo (ANP) e demais órgão ambientais são também responsáveis pela garantia de que as concessões sejam retornadas em condições de auto-sustentabilidade ambiental e sem oferecer riscos de segurança.

Dentro deste cenário, o órgão regulador enfrenta alguns graves problemas: (1) grandes concessionárias iniciam um processo de oferta de campos marginais negligenciando a responsabilidade de verificar a capacitação dos candidatos em cumprir as obrigações de final de contrato; (2) algumas empresas podem ser tentadas a formar companhias espúrias visando a exoneração de suas responsabilidades ambientais futuras; (3) flutuações no mercado afetam significativamente companhias pequenas e independentes que operam campos marginais, aumentando o risco de insolvência; (4) pequenos operadores, além de financeiramente vulneráveis, muitas vezes não possuem a experiência necessária para lidar com problemas ambientais, aumentando o risco de danos catastróficos e/ou irreversíveis; (5) na tentativa de salvaguardar-se das responsabilidades financeiras e ambientais, o órgão regulador pode ser acusado de discriminar contra pequenas e recém formadas concessionárias.

A atual situação dos órgãos reguladores é complexa. Como mostra o histórico de vários países, as responsabilidades negligenciadas ou ignoradas por órgãos reguladores durante esta fase serão eventualmente trazidas ao conhecimento público que, por sua vez, responsabilizará o órgão regulador.

Algumas organizações não governamentais (ONGs) têm utilizado eficientemente diversos mecanismos de marketing como ferramentas de informação, e em alguns casos desinformação, promovendo investidas contra a indústria e órgãos reguladores. Dentro deste cenário, o governo não tem como se exonerar das responsabilidades financeiras deixadas por companhias insolventes ou negligentes, e busca meios de reduzir seus riscos fornecendo incentivos financeiros para o cumprimento das obrigações ambientais, restringindo assim a participação de concessionárias não qualificadas. A tarefa não é simples pois além de diminuir seus riscos, o órgão regulador precisa manter o setor competitivo e atrativo para manutenção e ampliação do fluxo de investimentos.

Os métodos de regulamentação tradicional (Sistema de Comando e Controle), têm algum sucesso no controle do desempenho ambiental durante a vida de um projeto, mas não são capazes de garantir que as obrigações ambientais de final de contrato sejam satisfatoriamente cumpridas.

Já os Mecanismos de Incentivo Financeiro (Sistema de Mercado) vêm sendo utilizados com sucesso para o mesmo propósito.

Dentro dos setores de petróleo e mineração, mecanismos de garantia financeira já são comumente aplicados para garantir o cumprimento de obrigações ambientais (*bond de performance*) durante a fase de abandono e reabilitação (*mine closure*). Atualmente, este conceito vem sendo estendido para abranger todas as fases de um projeto (licitações, exploração, desenvolvimento, produção, abandono e pós-abandono), inclusive para garantir o pagamento de obrigações financeiras e o cumprimento de prazos (*bonds financeiros*).

Os setores de mineração e petróleo têm atraído excessiva controvérsia em decorrência de vários problemas ambientais associados com empresas negligentes, irresponsáveis e não capacitadas. A indústria está preocupada com a imagem negativa que o setor vem ostentando nessas situações. Por esta razão, vários de seus representantes, principalmente grandes empresas, concordam que existe a necessidade de uma regulamentação exigindo garantias financeiras.

O objetivo maior deste trabalho é o de fornecer informação sistematizada para auxiliar agências reguladoras no processo de elaboração de um sistema regulatório de garantia financeira que seja verdadeiramente prático e eficaz, garantindo e/ou custeando as obrigações ambientais *ex-post* (de final de contrato) através: (1) da geração de incentivos reais e eficazes fazendo com que a indústria atue com responsabilidade; (2) do atendimento das atuais demandas de preservação ambiental; (3) do atendimento das necessidades da indústria permitindo a competitividade e a manutenção do fluxo de investimentos no setor de exploração e produção de petróleo e gás natural (E&P); e (4) da identificação de mecanismos de salvaguarda protegendo o órgão regulador, e no fim, o contribuinte, de arcar com o ônus financeiro deixado por concessionárias insolventes ou negligentes.

Dentre as contribuições desta tese, destacam-se a parte conceitual, fornecendo definições que permitam a sistematização da discussão, e a parte empírica, fornecendo uma ferramenta capaz de auxiliar reguladores e indústria no processo decisório gerando fluxos de caixa e análises de sensibilidade. As principais contribuições podem ser sintetizadas em: (1) uma classificação sistemática para danos ambientais que ocorrem ao longo de projetos de petróleo no setor E&P (danos acidentais, contínuos, e *ex-post*); (2) uma discussão sobre custos ambientais dentro do setor; (3) definição de duas categorias distintas de garantias financeiras atualmente utilizadas e que, apesar de sempre referidas pela mesma denominação, "bonds", se comportam de maneira diferente, almejando objetivos diferentes e, conseqüentemente, atingindo resultados diferentes (bonds financeiros e bonds de performance); (4) identificação e descrição de instrumentos financeiros propondo uma classificação inovadora para os vários tipos utilizados como garantia financeiras hoje disponíveis no mercado; (4) uma ferramenta decisória que permite empresas e organismos reguladores antecipar os potenciais impactos financeiros de suas decisões, inclusive decisões sobre o tipo de instrumento a ser utilizado como garantia financeira.

As ferramentas decisórias desenvolvidas auxiliam na redução dos impactos financeiros oriundos da implementação de regulamentações ambientais na rentabilidade de projetos de petróleo. Para tanto, neste trabalho são propostos alguns exercícios de modelagem decisória interativa, permitindo a visualização dos impactos no fluxo de caixa do projeto possibilitando aos tomadores de decisão trabalhar com diversos cenários, alterando variáveis, simulando contingências, antecipando os impactos financeiros de suas decisões, testando o impacto financeiro das várias opções de instrumentos de garantia financeira disponíveis no mercado e, principalmente, visualizando soluções que não seriam tão óbvias de outra forma.

Para que seja viabilizada a elaboração de um modelo decisório como proposto acima, faz-se necessário uma ampla descrição do sistema de garantia financeira e dos instrumentos disponíveis, além de várias questões envolvendo o tema descomissionamento de plataformas marítimas.

As principais motivações para esta tese são: (1) as grandes quantias envolvidas em questões ambientais, principalmente no descomissionamento de instalações marítimas; (2) o evidente nível de ineficiência do atual sistema de regulamentação ambiental "Comando e Controle"; (3) a experiência positiva do sistema de garantia financeira acompanhada em várias partes do mundo; (4) a atual tendência mundial da aplicação de mecanismos de incentivo para fazer valer as exigências ambientais *ex-post*; e (5) a inexistência de uma ferramenta decisória integrada para avaliar os impactos da aplicação de diferentes instrumentos de garantia financeira em diferentes cenários.

Dentre as principais variáveis do modelo proposto estão: (1) as várias opções de descomissionamento possíveis; (2) as opções de instrumentos financeiros disponíveis no mercado e aceitas como garantia financeira para operações de descomissionamento; (3) o tipo de tratamento fiscal dado aos gastos com as operações de descomissionamento e aos gastos com a aquisição de instrumentos de garantia financeira; (4) os parâmetros inerentes dos projetos, como dimensão, duração, etc.; (5) o desempenho operacional do projeto e (6) a variáveis de mercado, como preço do óleo, inflação, taxa de juros, variação cambial, etc.

O sistema de garantia financeira descentraliza o processo decisório, estimulando o comportamento adequado de empresas, definindo seus objetivos de desempenho ambiental e não um protocolo de ação a ser estritamente seguido. Com isso, dá-se uma motivação ao desenvolvimento de tecnologias inovadoras capazes de reduzir a possibilidade de problemas ambientais e, principalmente, reduzir os custos de descomissionamento. Além disso, a exigência de garantia financeira assegura a disponibilidade de recursos e elimina a possibilidade de futuros litígios. Neste contexto, as empresas são obrigadas a internalizar seus custos ambientais (ex-post, contínuo e acidentais), e, voluntariamente, monitorar as conseqüências de suas decisões. Em outras palavras, as companhias assumem a responsabilidade financeira de final de contrato de demonstrar que o suas obrigações ambientais, principalmente obrigações *ex-post* como descomissionamento, ocorrerão de forma satisfatória, fazendo com que o risco financeiro seja transferido das vítimas (governo e contribuintes) para os causadores (produtores e operadores). Desta forma, as autoridades salvaguardam-se de riscos técnicos e financeiros, inclusive de encerramentos prematuros ou não planejados.

Existe uma grande variedade de tipos de instrumentos financeiros disponíveis para garantir operações de descomissionamento, alguns oferecem generosas flexibilidade e outros significativos pesos financeiros. Todos porém, causam algum tipo de impacto, seja impactos diretos, como custos de oportunidade, ou indiretos, como redução da capacidade obtenção de empréstimos. No entanto, uma bem elaborada regulamentação e a aplicação adequada da engenharia financeira, permitem a aplicação eficiente do sistema de garantia financeira, sem desestimular investimentos no setor.

Dois tipos de modelos decisórios serão oferecidos: (1) um algoritmo computacional denominado Petrobond e (2) um modelo produzido com a ferramenta *STELLA*®. Dentro do planejamento estratégico de projetos de petróleo *offshore* tais modelos permitem: simplificar e sistematizar o conhecimento disponível; diagnosticar, interpretar e discernir os dados; interpolar, extrapolar e prever resultados; julgar incertezas; avaliar a sensibilidade dos parâmetros envolvidos; e interpretar e avaliar as diferentes alternativas e cenários. Essas ferramentas possibilitam também soluções ótimas que não seriam óbvias de outra forma, permitindo a criação um de cenário de diagramas dinâmicos.

Simulações confirmam o presente cenário, onde órgãos reguladores tendem a exigir bonds do tipo *surety*, cartas de crédito, e contas do tipo caução com pagamentos periódicos. Análises de sensibilidade de resultados de Valor Presente Líquido e Porção Governamental indicam que apólices de seguro do tipo *ex-post*, bonds do tipo *surety*, e cartas de crédito podem causar impactos menores permitindo melhores resultados. Simulações também confirmam que projetos pequenos são geralmente severamente afetados quando instrumentos do tipo colaterais, como contas cauções, são utilizados.

Quanto à terminologia empregada em português, o autor argumenta o seguinte:

1. A aplicação do termo "abandono", tanto para o projeto como um todo, ou como para o tamponamento de poços ("*well plugging and capping*") ou para o descomissionamento de instalações marítimas (remoção e disposição), não sugere uma atividade confiável. O termo parece ser "politicamente incorreto" já que "abandono" exprime a idéia de "deixar sem cuidado", o que não faz justiça ao verdadeiro objetivo das operações de final de contrato de exploração e produção de petróleo.
2. Os termos "cessação", "desativação" ou "encerramento", são suficientemente amplos para descrever as atividades de retirada, transporte e disposição final de instalações marítimas. Estes termos parecem ser ideais para descrever todo o processo que inclui as várias atividades de final de contrato de concessão visando a reabilitação dos danos *ex-post*, mas, no entanto, não exprime com clareza a específica operação de retirada e disposição de instalações marítimas.
3. O termo "descomissionamento" é utilizado no Brasil para a "descontinuação" da utilização de embarcações marítimas. O autor considera que as instalações marítimas (plataformas, reservatórios, etc.), assim como embarcações marítimas, são "comissionadas" para uma atividade específica e depois, ao se tornarem desnecessárias (seja por motivos técnicos ou econômicos), estas também devem ser "descomissionadas".
4. O termo inglês "*decommissioning*" já vem sendo amplamente adotado pela indústria mundial, e mesmo que não houvesse uma palavra portuguesa correspondente ("descomissionamento"), a aplicação de uma palavra transliterada da original inglesa também seria viável. Além do mais, a palavra "descomissionamento" já vem sendo natural e amplamente adotada pela indústria no Brasil.

A tese está organizada em 6 capítulos: (I) Introdução, (II) Principal Conceitos, (III) Descomissionamento, (IV) Mecanismos de garantia Financeira, (V) Tratamento Fiscal, (VI) Mecanismos Decisórios/Modelagem Econômica, e (VII) Conclusões. Ao final, quatro anexos fornecem subsídios adicionais para a compreensão de alguns capítulos: (A) Questionário para Avaliação de Instrumentos, (B) Descomissionamento de Instalações marítimas, (C) Algoritmo Petrobond, e (D) Ferramenta de Modelagem Stella. No Capítulo II, "Principais Conceitos", o artigo "*A Decision Model for Financial Assurance Instruments in the Upstream Petroleum Sector*", publicado na revista *Energy Policy*, um veículo internacional arbitrado, é reproduzido. No Capítulo VI, "Mecanismos Decisórios/Modelagem Econômica", os artigos "*An Exploratory Analysis of the Environmental Bonding System for Upstream Petroleum Projects*" e "*Identifying Potential Impacts of Bonding Instruments on Offshore Oil Projects*", publicados respectivamente nas revistas internacionais arbitradas *Natural Resources Research* e *Resources Policy*, são igualmente reproduzidos.

CHAPTER I – INTRODUCTION

1.1. OVERVIEW

The world depends on fossil fuels for more than 60% of its total energy needs (ODCP, 1998). Offshore exploration became a very important energy source since it was discovered in 1947 in the Gulf of Mexico (GOM). In 1965, natural gas was discovered in the British portion of the North Sea, followed by the discovery of oil in 1970. Furthermore, of great significance for Brazilian economy, was the discovery of offshore reserves at Campos basin during the 1980's (FORMIGLI and PORCIUNCULA, 1997).

There are over 7,270 offshore installations in place around the world, installed in the continental shelves of more than 53 countries worldwide, of which 40 produce offshore oil and gas in significant amounts (**Figure 1.1**). The present distribution of offshore installations is approximately as follow: 4,500 in Gulf of Mexico, 950 in Asia, 750 in the Middle East, 457 in North Sea, 445 in South America, 649 in Africa, and 53 in Australia (PROGNOS, 1997; ODCP, 1998; POREMSKI, 1998; PANE AND HENDARJO, 1998; GRIFFIN, 1996, 1997, 1998a, 1998b, 1998c, 2000a, 2000b). Retaining the record for deep-water completion, Brazil has approximately 105 producing offshore platforms (ANP, 2003).

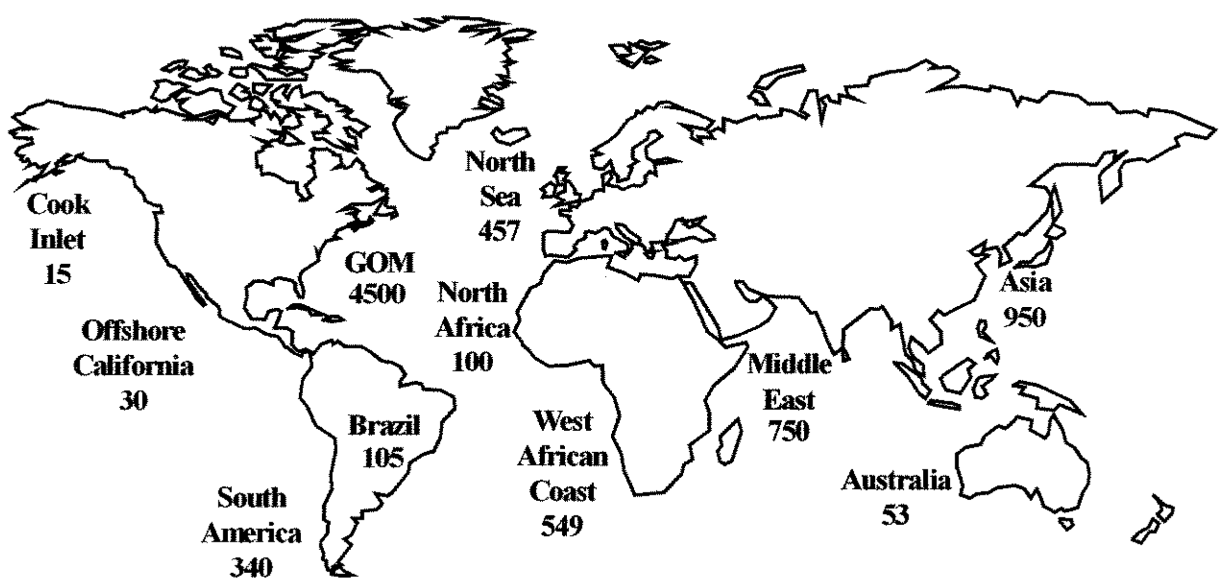

Figure 1.1. World Platform Population. Numbers are compiled from a number of sources including government reports, industry staff, and academic literature.

Although offshore installations must be decommissioned at the end of petroleum projects, most offshore structures were not designed to be removed. In the next 20 years, between now and 2025, it should be expected that over 6,500 installations will be decommissioned, and at an estimated cost of US$ 20-40 billion (COLEMAN, 1998).

Several potential problems related to the abandonment of offshore installations have been officially acknowledged since the *1958 Geneva Convention on the Continental Shelf.* According to CAMERON (1998), this sudden interest had two main motivations: (1) Maturing of several large oil and gas provinces around the world turn decommissioning costs public. (2) The need for offshore decommissioning has coincided with the growing impact of environmental concerns in international affairs. In fact, the first "decommissioning boom" has landed right in the middle of the international sustainable development agenda.

Decommissioning has become a very emotional issue, and, as illustrated during the over-publicized and politicized Brent Spar episode, compliance with all international, regional, and domestic legal requirements may not necessarily be sufficient to satisfy the expectations of public and interest groups. Presently, there is a movement in the United Nations Commission on Sustainable Development to set up a Global Authority for offshore oil and gas operations (MMS, 1999a).

Based on estimated costs, offshore decommissioning may become in the near future one of the major issues facing the global offshore petroleum industry. The impacts of decommissioning expenditures in the profitability of offshore projects and government earnings are significant and must be carefully considered. In this thesis, the author elaborates on the issue of how to anticipate and reduce the impacts of environmental regulations upon the profitability of offshore oil projects. Several approaches can be adopted to guarantee that all decommissioning obligations will be met. This study focuses specifically on the application of the financial assurance system, which is a form of financial security used to safeguard authorities against environmental liabilities. Financial assurance systems and instruments can be found in the literature with different denominations such as: financial surety, financial security, financial guarantee, and bonds.

If financial assurance mechanisms (bonding mechanisms) are to be adopted, the key to avoid investment migration from the sector is the implementation of reasonable policies, making available different forms of bonding instruments that offer reasonable flexibility to companies.

Investment flow in the oil sector is a very important source of capital for economic development. Impacts may also be reduced by the application of adequate financial engineering techniques and comprehensive early decommissioning planning.

Although the author recognizes several other essential economic issues involved in the decommissioning process (i.e. optimum period to initiate decommissioning activities; operation method – single or phased approaches; removal and disposal options; technological innovations), the focus in the present work is on the application of bonding mechanisms to guarantee the satisfactory performance of decommissioning operations and other ex-post environmental obligations. It includes:

- Identification of corporate environmental costs and liabilities related to ex-post obligations;
- Identification and description of forms of bonding instruments currently available;
- Identification and description of existing fiscal regimes in what ex-post environmental costs and bonding-related expenditure are concerned;
- Simulation of offshore oil-producing fields in the Brazilian Outer Continental Shelf (OCS) where different bond options are tested in a series of discounted cash flow scenario analyses based upon the current Brazilian fiscal regime; and
- Suggestion of a decision tool, which will allow the assessment of the potential financial impact caused by different bond options upon the profitability of offshore oil and gas projects.

A hypothetical scenario is proposed based on existing bonding regimes around the world, mainly in the USA and Canada. Some alterations are made in order to adjust proposed bonding policies to new areas open for investment.

1.2. PURPOSE AND JUSTIFICATION

The present work involves two key themes: The decommissioning of offshore installations and the application of financial assurance mechanisms. Academically, both subjects are under explored. Decommissioning-related issues have been increasingly attracting the interest of the industry, government, and interest groups. Since 1995, several technical articles and some academic papers have been written on decommissioning-related issues. The literature record on the application of financial assurance mechanisms in the oil industry is rather scarce.

Most information on bonding mechanisms must be extracted from books on financial incentive tools, official documents (regulatory literature) on financial assurance legal requirements, and from interviews with bonding experts from regulatory agencies and the financial sector.

In Brazil, for instance, very little has been done on both areas. ANP is just beginning to deal with end-of-leasing obligations, including ex-post environmental operations such as decommissioning. Very little is known about the end-points of Petrobras' redundant platforms. In 2002, ANP defined well abandonment rules for the Brazilian industry. Petrobras has recently initiated internal studies and activities aimed at improving company's knowledge on decommissioning and other ex-post related matters (ANP, 2000b). ANP has recently intensified its interest on decommissioning issues what lead to the establishment of a technical consulting project, a research partnership between State University of Campinas (UNICAMP) and the Agency. At the beginning of this project, the present theme was merely an academic essay proposing an eventual application of financial assurance instruments on new oil frontiers in Brazil. Today, as Brazilian authorities in accordance with international conferences and treaties are developing sound decommissioning regulations, the establishment of a Brazilian financial assurance regime involving several ex-post offshore activities is very likely. Progressively being implemented, financial bonds[1] are already required to guarantee contractual obligations in the bidding process (letters of credit).

The main motivations for a comprehensive study on the application of financial assurance mechanisms are:

- Large sums of money involved in meeting decommissioning obligations, which can significantly impact offshore oil projects at the end of their productive lives;
- The noticeable inefficiency of the current command and control regulatory system;
- Encouraging results increasingly obtained from regulatory agencies currently adopting financial assurance mechanisms around the world;
- The perception of a trend in which agencies from different countries begin to adopt economic incentive mechanisms to deal with the uncertainties of environmental regulations; and
- The lack of quantitative studies and publications involving the application of financial assurance mechanisms and their potential impacts on oil projects.

[1] A financial token claiming that the bid will be honored and areas will be explored.

No bonding requirements should be adopted in the oil sector without a comprehensive assessment of their economic impacts. Wrong decisions may drive away important investments. For this reason, **Chapter VI** is devoted to the proposal of a decision model aimed at anticipating the financial impacts upon the profitability of offshore oil projects caused by the different forms of financial assurance instruments. Decision models are essential for managing oil projects, and for simulating potential effects of requirements being proposed by authorities. A well-designed flexible financial assurance system is likely to maintain the flow of investment in the sector and at same time preserving the industry and authorities from the kind of wearing off observed during the Brent Spar episode.

1.3. METHODOLOGY

The main steps for achieving the proposed products of this research project are illustrated on **Figure 1.2**. Information on decommissioning was gathered through literature research, reviews of documents of several countries, periodicals, and interviews conducted with decommissioning managers and government officials via electronic mail, telephone, and specially arranged meetings in the United States, the Netherlands, Norway, and Brazil. Important technical literature on decommissioning has become available in recent years. The majority of government documents has been acquired directly from the competent agencies.

Most specialists were involved in the areas of hardrock and coal mining, and onshore and offshore upstream petroleum recovery; all in the United States and Canada. This process is illustrated in **Figure 1.3**.

In this thesis, the author attempts to answer the following questions:

- **Question 1:** How to guarantee that oil and gas leasing areas will be ultimately returned in environmental conditions at least similar to preexisting ones?
- **Question 2:** How to ensure that all ex-post (end-of-leasing) obligations will be satisfactorily met, safeguarding public environmental and economic interests by maintaining investments in the sector and, simultaneously, providing protection against insolvent and negligent lessees, and eventual unplanned closures?

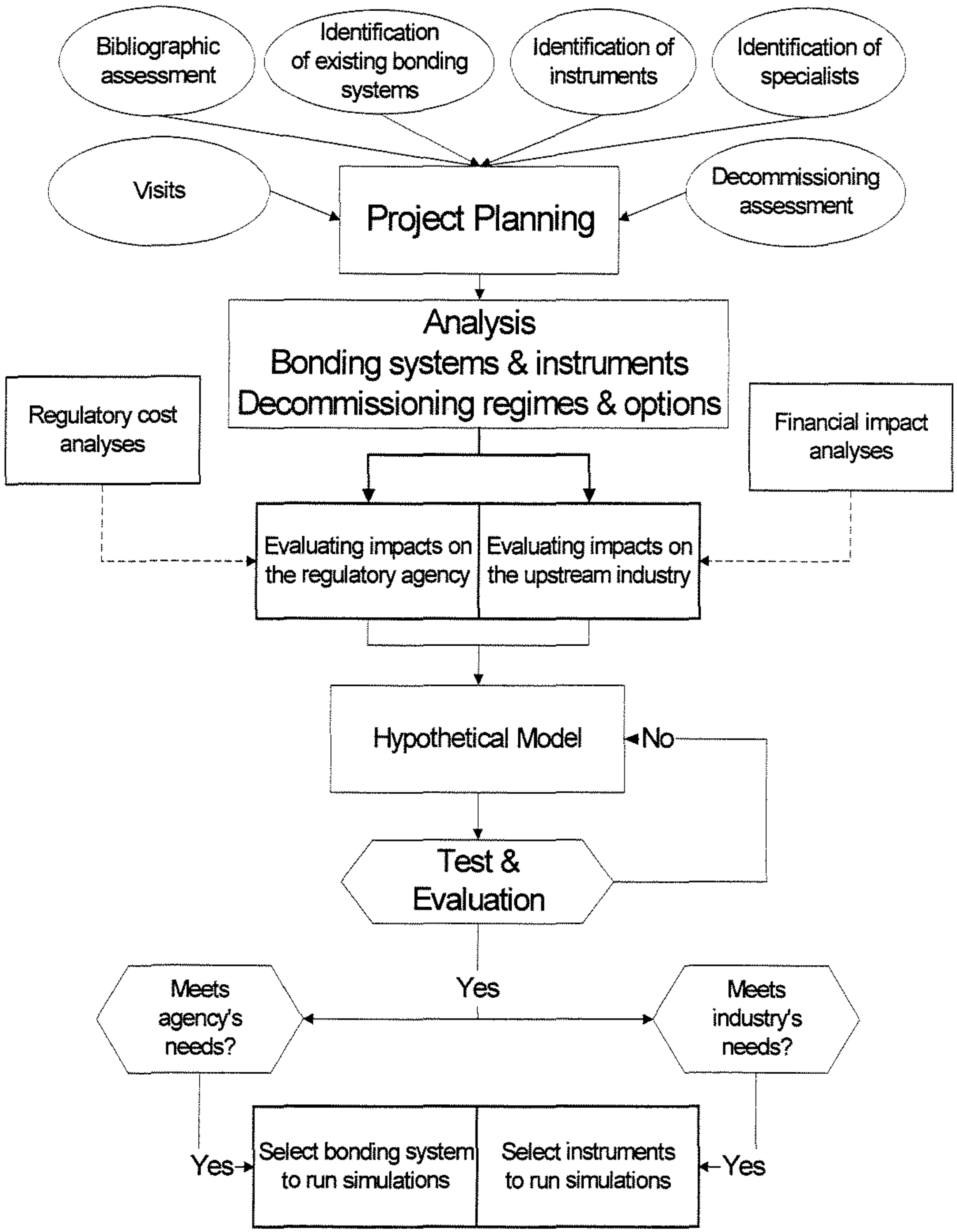

Figure 1.2. Flowchart of main project activities.

- **Question 3:** How to make such a regime viable?
- **Question 4:** How to anticipate and attenuate the financial impacts caused by each of the different forms of performance bonds required as guarantee for the fulfillment of ex-post environmental obligations?

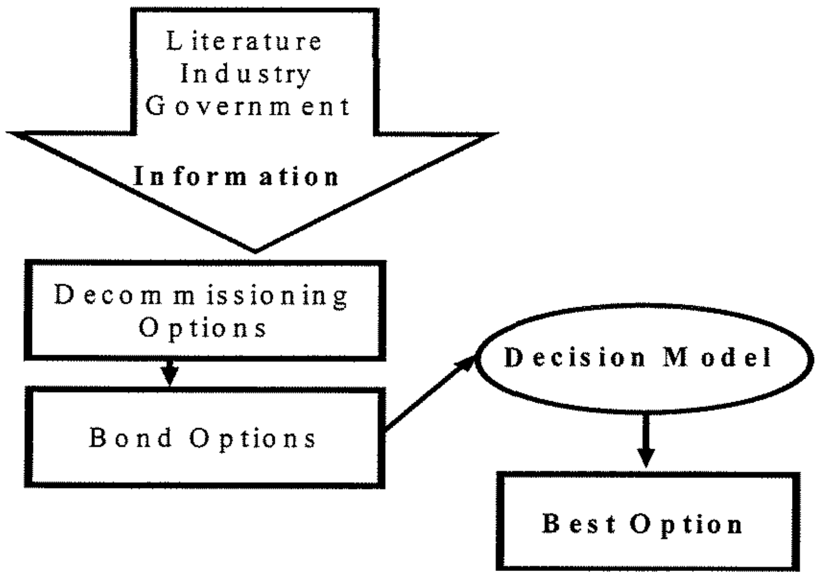

Figure 1.3. Methodology for approaching proposed goals.

Question one through three involves the conceptual part of this thesis. Part four involves the empirical part. In order to approach the forth question, a variety of financial instruments that are available to be applied as financial guarantees in offshore oil projects were identified. How to decide on the best option, the one that will offer the least cash flow impact? How to select the bond instrument that will allow the ultimate maximization of project value?

Main Parameters includes:

- Existing decommissioning legal framework and potential trends.
- Existing financial assurance regimes.
- Existing fiscal regimes.
- Existing historical data
- Existing decision models.
- Identify:
    - Static Parameters
    - Probability Distribution Parameters
    - Dynamic sub-model simulations

The construction of a basic tool to work out the problem: the economic analysis technique is primarily based upon a discounted cash flow. The main economic analysis output will be the Net Present Value (NPV). The reason for using the discounted cash flow method for the economic analysis is to present a systematic and quantitative approach for problem solving, in addition this method can be easily implemented by oil companies[2].

- Economic Analysis: evaluation of the relative merits of situations – profit and cost viewpoints.
- Financial Analysis: behavior of funds – what are the instruments that allow the best yields?
- Intangible Analysis: consideration of factors that affect project but which cannot be easily quantified.

A decision model was designed in order to test all financial assurance mechanisms and compare them against available data using the algorithm Petrobond (**Appendix C**). The strategic planning of offshore oil projects, allows: the simplification and systematization of the available information; sensitivity evaluation of important parameters involved; and the interpretation and evaluation of different alternatives and scenarios. Petrobond also provides a way of finding optimum solutions, which would not be obvious otherwise. For this same purpose, a complementary decision model using the *STELLA*® software is also proposed (**Appendix D**).

Approaches used to incorporate risk and uncertainty into analysis:

- Sensitivity Analysis: used to evaluate the effects of uncertainty on projects by determining the variation of investment.
- Probabilistic sensitivity analysis: used to account for the uncertainty associated with possible variation in project parameters and expected present value to account for risk associated with finite probability of failure.

1.4. LITERATURE REVIEW

Until 1995, articles on decommissioning of offshore installations were scarce. The Brent Spar episode triggered a boom in the specialized literature. One of the first important works on the subject was the PROGNOS (1997), a socio-economic report on impacts of varying

[2] The designation "oil companies" includes other parties that may be responsible for the performance of closure activities (i.e. operators, individuals, lessees).

decommissioning options. This study was done in London in behalf of the Offshore Decommissioning Communications Project (ODCP), and carried out by PROGNOS. Several other studies were conducted by agencies and the industry. The Phillips Petroleum Norway, has been conducting cost assessment studies since 1975, but most of these studies have not been published.

The literature record on the application of financial assurance systems within the upstream petroleum sector is especially limited. Nearly all information is extracted from internal government publications and reports, and a few sprinkled lines in legal publications. The application of financial assurance mechanisms in the US coal industry is particularly well documented and can be used for a better understanding of the different bonding instruments presently available.

COSTANZA and CORNWELL (1990, 1992), and CORNWELL and COSTANZA (1994, 1999) have comprehensively written about environmental assurance bonding. Their work should be used as an important reference on the general application of such mechanisms. Documents from regulatory agencies (MMS, 1998, 1999, 2002; OSM, 1987, 2000a; BLM, 1995, 1996; ANP, 2000a, 2002a; EPA, 1995, 1997; etc.) provide additional decommissioning and bonding information. GRIFFIN (1996, 1997, 1998a, 1998b, 1998c, 2000a, 2000b) has extensively written about offshore decommissioning. Related information and decommissioning data has also been obtained from Bill Griffin's presentations and lectures. MILLER (1998), a study prepared for the International Council on Metals and the Environment (ICME), represents an important and extensive work on the application of bonding instruments on the hardrock mining sector. NWF (2000) describes in detail the current situation of the hardrock mining sector, which is under a very lenient bonding regime. FERREIRA and SUSLICK (2003a) defines several concepts related to bonding mechanisms. It also provides a systematic classification for financial instruments used to fulfill bonding requirements.

CHAPTER II – MAIN CONCEPTS

Which are the main contributions offered by this thesis work? Were there significant contributions to the advancement of knowledge in this area? Answer: The present work systematizes a series of concepts and describes aspects of the financial assurance systems that were not previously defined:

- *Proposes a classification for different forms of environmental damages in the upstream petroleum sector (e.g. accidental, continuous, and ex-post);*
- *Defines the terminologies "financial bonds" and "performance bonds", which have been interchangeably used disregarding the fundamental difference between them;*
- *Presents a comprehensive assessment of currently available financial assurance mechanisms and instruments;*
- *Proposes an innovative, systematic, and ample classification for available financial instruments. The lack of such tool has caused significant misunderstandings in the debate of bonding systems;*
- *Presents a series of modeling exercises with the STELLA® modeling tool, simulating project cash flows for oil projects under different bonding regimes in order to assist in the decision making process;*
- *Presents a complex decision toll for managing offshore oil projects under bonding regimes. This tool, an algorithm denominated Petrobond, is aimed at anticipating the potential financial impacts of several bond alternatives and bonding requirements, providing a practical tool for both industry and regulators (FERREIRA et al., 2003); and*
- *Offers an exhaustive set of references for both themes, decommissioning of offshore installations and financial assurance mechanisms.*

All the above items should ultimately contribute to the development of sound bonding systems that will fund or guarantee ex-post environmental obligations within the upstream sector. They should also identify a portfolio of bonding instruments capable of providing coherent flexibility to companies, maintaining competitiveness within the sector and meeting the needs and aspirations of the regulatory agency

In this chapter, a conceptual article was prepared in order to deepen the current discussion involving financial assurance tools and their effectiveness in providing adequate guarantee for ex-post obligations in the upstream oil sector. In addition, this article presents a multiattribute decision model that attempts to explain the current choice of instruments by both regulators and industry.

I. REFERRED ARTICLE I – Energy Policy, published in 2003

<u>TITLE:</u> A DECISION MODEL FOR FINANCIAL ASSURANCE INSTRUMENTS IN THE UPSTREAM PETROLEUM SECTOR

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ABSTRACT

The main objective of this paper is to deepen the discussion regarding the application of financial assurance instruments, bonds, in the upstream oil sector. This paper will also attempt to explain the current choice of instruments within the sector. The concepts of environmental damages and internalization of environmental and regulatory costs will be briefly explored. Bonding mechanisms are presently being adopted by several governments with the objective of guaranteeing the availability of funds for end-of-leasing operations. Regulators are mainly concerned with the prospect of inheriting liabilities from lessees. Several forms of bonding instruments currently available were identified and a new instrument classification was proposed. Ten commonly used instruments were selected and analyzed under the perspective of both regulators and industry (surety, paid-in and periodic-payment collateral accounts, letters of credit, self-guarantees, investment grade securities, real estate collaterals, insurance policies, pools, and

special funds). A multiattribute value function model was then proposed to examine current instrument preferences. Preliminary simulations confirm the current scenario where regulators are likely to require surety bonds, letters of credit, and periodic payment collateral account tools.

2.1. INTRODUCTION

Due to current world developments and to the ever-increasing demand for nonrenewable fossil fuels, governments are likely to intensify exploration and production efforts, including small and marginal fields. In fact, several traditional and nontraditional producing nations have already established tax incentive policies and royalty relief programs. These policies and programs are based on the perception that oil imports carry profound economic and political costs, which are intensified during times of international instability. Even though governments are interested in maintaining (and improving) investment flow and competitiveness within the sector, safeguarding taxpayers against industry's environmental noncompliance costs is becoming a critical issue.

The scenario described above calls for a number of considerations regarding a desirable balance between the public outcry for environmental accountability and the industry pressure for regulatory flexibility. Regulators are mainly concerned with the noncompliance risk offered by the increasing interest of newly formed and small companies in small and marginal fields (HAYNES, 1994; MMS, 2000a, 2001; ANP, 2000b, 2002a; DTI, 2000; BRYAN, 2000; MARTIN, 2000; WILLIAMS, 2000; MIRABELLA, 2000; BLM, 2001; BAIER, 2001; CORNWELL, 2001; NPD, 2001; MPC, 2001; STOKES, 2001). In addition, without protection mechanisms, large companies could open small spurious companies to evade closure liabilities.

Owing to the evolution of social consciousness and pressure from interest groups, regulators are being compelled to establish stringent environmental policy requirements, including incentive mechanisms aimed at safeguarding society against environmental degradation and related financial liabilities (FERREIRA and SUSLICK, 2001). Financial assurance requirements (bonds) come as a response to environmental compliance concerns in the oil sector, where it is being used to reduce the risk of noncompliance on end-of-leasing contractual obligations[3]. Several countries have adopted bonds in order to cope with these ex-

[3] Recent events tend to significantly affect the political behavior among larger fuel consuming nations. At least initially, a regressive trend may be perceived on environmental policies. This may occur because in order to reduce fuel dependency from

post liabilities in the petroleum sector; among them, Canada, United States, United Kingdom, Australia, and Brazil.

The application of bonding mechanisms is a complex subject involving a great deal of controversy. The scope of this paper is limited and solely directed to the application of bonding instruments within the upstream petroleum sector aimed at ensuring compliance with closure obligations (reclamation, abandonment and decommissioning operations). As will be explained, these activities are specifically associated with the process of mitigating *ex-post* environmental damages, providing and enforcing conditions of negligible health and safety risk to local inhabitants, and ensuring safety for navigation and the environment.

The present work does not focus on the nature or scale of potential environmental impacts; instead, it provides elements in a systematic effort to broaden the current discussion involving the application of bonding instruments in the Exploration and Production sector (E & P). This paper is divided into three sections. The first section describes different forms of environmental damages and presents an overview of environmental costs. It discusses some important concepts, such as assessment of monetary value of environmental damages and internalization of environmental costs. Section 2 briefly describes the main forms of regulatory approaches, explains the application of bonding mechanisms in the upstream petroleum sector, identifies and analyzes a number of bonding instruments currently being used in the sector, and proposes a systematic instrument classification. The last section offers a decision model to explain the current instrument choice among regulators and the industry.

2.2. FORMS OF ENVIRONMENTAL DAMAGES

Upstream petroleum activities have the potential of generating a wide range of environmental impacts (chemical, physical and biological disturbances). Such impacts may be manifested in the surface and subsurface, in the water and water bottoms, and in the atmosphere.

In order to better assess potential environmental impacts, PATIN (1999) suggests a special classification for the development phases, taking into consideration the respective sequence of operations: (1) geological and geophysical survey (seismic surveys, test drilling, etc.); (2) exploration (rig emplacement, exploratory drilling, etc.); (3) development and

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unreliable and hostile foreign sources, governments may be tempted to relax environmental regulations for the upstream sector. However, in due course, domestic and international pressure should force them back on track towards more stringent environmental regulations, including the adoption of bonding requirements.

production (platform emplacement, pipe laying, drilling, extraction, separation, transport, well and pipeline maintenance, etc.); (4) closure and decommissioning (disassembling, structure removal, well plugging, site clearance, land reclamation, etc.).

FERREIRA and SUSLICK (2001) propose three broad categories of environmental damages within the specific context of hydrocarbon recovery: ex-post, accidental and continuous environmental damages (**Figure 2.1**). This classification was previously used by CORNWELL (1997) to explain the role of incentive tools on environmental regulation. This proposed tool helps to systematize the present discussion, assisting in the optimum application of bonding mechanisms.

Accidental Damages

This category includes environmental impacts caused by oil companies in unforeseen events during the course of daily operations. Levels of risk are assigned according to the availability of statistical data on specific events. For instance, an oil company may have control over some contingencies, making it possible to reduce the risk and intensity of accidental damages. In other cases, there is no control over events and no possibility of risk reduction. Examples of accidental damages: blowouts, accidental spillage, accidental discharge of drilling muds or produced waters, sinking of offshore installations, vessels or helicopters, *acts of God* (flood, lightning, earthquake, etc.), war, sabotage, terrorism, etc.

Continuous Damages

This category includes environmental damages resulting from on-going processes during the life of a project. Examples of continuous damages are: discharge of drilling muds and cuttings, emissions and discharge of pollutants, deforestation and other physical disturbances, generation of solid waste, emission of waste in streams, sediment resuspension, interference with humans, fisheries and other users, etc.

Ex-post Damages

This category includes environmental damages that are anticipated as a result of upstream oil activities. In this case, provisions for the remediation or mitigation of such damages are arranged before leases are granted for a specific project. For instance, companies conducting offshore operations are required to reclaim the site by plugging and abandoning all wells, decommissioning all offshore installations and clearing the site of all obstructions. These operations take place at the end of a project, phase, or specific activity. The emphasis lies on achieving proper closure rather than on the closure process. In this case, regulators are not interested in monetary compensations, but rather in the fulfillment of closure obligations. In order to maximize project value, oil companies are motivated to avoid costs of repairing damages, and pursuing less costly closure alternatives.

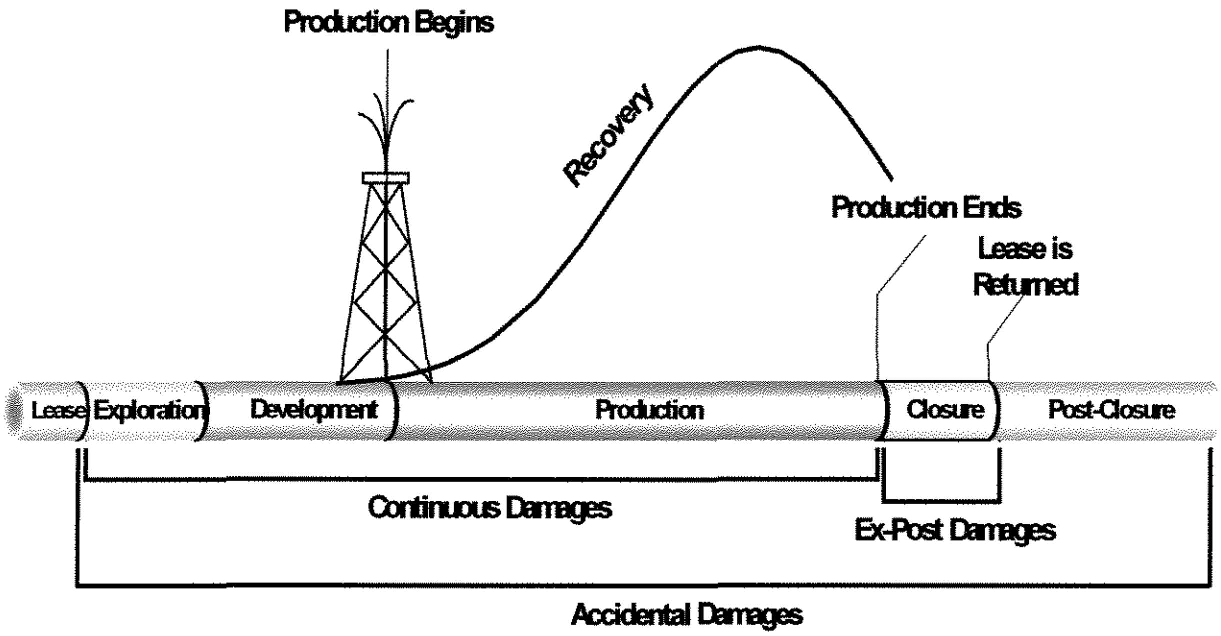


Figure 2.1. Environmental Damage Categories. The life of an oil project, its phases, and potential for environmental damages (FERREIRA and SUSLICK, 2001).

Some examples of ex-post mitigating activities include: plugging and abandonment of wells, removal and disposal of offshore platforms and pipelines, removal and disposal of debris and obstructions on the ocean floor, site reclamation, revegetation, removal of constructions and access roads, etc.

As also concluded by CORNWELL (1997), this is perhaps the best-suited category to be covered by bonds. In the upstream oil sector, some of the corroborating factors are: (1) oil projects have limited time horizons (a defined beginning and a defined end); (3) operations require a lease (or license) before they are undertaken; and (3) in most circumstances, costs for

mitigating ex-post damages caused by upstream activities can be easily estimated (i.e. cost for plugging wells).

Some of the arguments that make the oil sector more convenient for the application of bonding regulations include:

- Petroleum exploration and production operations involve significantly smaller areas than other extractive activities.
- In most circumstances, because of the potential for significant government revenue earnings, oil projects are subjected to more scrutiny and more rigorous licensing processes.
- Currently, due to the costs involved in the licensing, exploration, and development phases, in most cases, oil and gas projects attract fewer risky parties when compared to the mining sector, for instance.
- The potential for ex-post environmental damages in petroleum projects is significantly small when compared to potential ex-post damages in mining projects, for instance[4].

Nevertheless, a number of emerging issues are likely to introduce some complexity in estimating costs of ex-post damages in the oil sector:

- Decommissioning of large fixed offshore installations: the industry does not have real experience in the decommissioning of large fixed platforms. Consequently, due to technological uncertainties, estimating decommissioning costs is a very controversial issue;
- Decommissioning of pipelines: so far, regulators do not require the removal of pipelines. However, this scenario may change bringing significant environmental and financial uncertainties to the closure process;
- Cleanup of offshore sites: currently, there is significant discussion involving requirements for the removal and disposal of drill cuttings generated in offshore operations. As

[4] The internalization of ex-post environmental obligations is a very controversial issue. For instance, if ex-post costs are truly and ultimately internalized and transferred to the final user, as it should, what would be the cost of nuclear energy? Costs related to the decommissioning of nuclear power plant, storage of wastes, perpetual monitoring of radioactive waste is enormous, but such costs are never internalized and someone will eventually have to cover them. The same has been happening in the upstream oil sector where before the problem emerged during the Brent Spar episode, the cost for removing and disposing of offshore structure was largely ignored and never internalized.

regulatory standards for offshore site cleanup toughen, uncertainties will be introduced to the ex-post cost estimation process;

- NORMs: the presence of Natural-Occurring Radioactive Material (NORMs) in waste, fluids and gases brought to the surface from producing subsurface oil and gas formations has become a great concern for the oil industry (MCFADDING, 1996). Long-overdue handling and disposal requirements for NORM-bearing waste and contaminated equipment will significantly impact ex-post costs;
- Residual liability: the discussion on potential residual liability is also expected to add significant uncertainty to this debate: "when can a company walk away" or "when is liability over".

Although the application of bonds is mostly suitable for providing protection against ex-post damages, it may indirectly generate incentives for the reduction of continuous and accidental damages. Bonds may be appropriate to cover accidental damages if the probabilities for contingencies are known and if potential damages are not catastrophic or irreversible. There is a wide spectrum of possible continuous damages, and the applicability of bonding mechanisms depends on the nature and extent of the damage.

2.3. FINANCIAL ASSURANCE SYSTEMS AND INSTRUMENTS

The main approaches to environmental policies are Command and Control (direct regulation) and Economic Incentive Mechanisms (market alternatives). Both Command and Control (CAC) and Economic Incentive Mechanisms (EIM) have been exhaustively discussed in the literature, including their characteristics, applications, and efficiencies (BOHM, 1981; STOLLERY, 1985; WEBBER AND WEBBER, 1985; CONRAD, 1987; BAUMAL and OATES, 1988; PERRINGS, 1989; CORNWELL, 1997).

CORNWELL and COSTANZA (1994) compare CAC and EIM approaches, and some aspects are here adapted to the offshore oil sector: The CAC approach consists of establishing and enforcing laws and regulations, and of setting objectives, standards and technologies with which agents must comply. The EIM provides incentives that encourage the desired behavior while allowing firms the flexibility to act on their unique knowledge of their own production and mitigation costs. This decentralizes the decision-making process to protect lease areas; and it relies on performance objectives rather than on a pre-established course of action. Economic analysis indicates that present methods of environmental protection, mostly based on CAC strategies, are inefficient and often provide disincentives for directing resources toward abatement. The main causes are: (1) great uncertainties in calculating decommissioning and other ex-post costs; (2) costly and lengthy litigious processes involving oil companies and other key stakeholders; (3) unfair homogeneous treatment of oil companies (no record-based assessment); (4) great information burden on the regulatory agency (selecting the best technology, enforcing penalties for noncompliance, monitoring lessees and financial institutions); (5) little incentive for the development of innovations that can result in improvements and cost reduction; (6) encourage regulatory evasion rather than regulatory compliance; and (7) vague regulatory language allowing oil companies to build persuasive cases by showing that ex-post requirements are unachievable.

Environmental Costs

The feasibility of bonding mechanisms will require that regulators and/or third party insurers possess a reasonable estimate of the costs that the mechanisms will need to cover. If costs are underestimated, the assurance is incomplete, and the regulator may be forced to cover the shortfall. If the costs are overestimated, desirable investment may be deterred, or companies may move their operations to countries with lower regulatory standards. What types of costs are relevant, and how they are measured, depends on the type cost under consideration, as mentioned above.

In the case of ex-post closure obligations, oil companies are required to meet a set of standards determined by the regulatory agency. What is far more complicated is the process of deciding on those standards. Once standards are defined, the costs for achieving those standards are fairly simple to calculate, and will determine the amount that must be provided by the bonding mechanism.

Intuitively, it would seem that the standard should be set so that there are no lingering damages (i.e. costs), environmental or otherwise, after closure operations. In the extreme case, this might require returning the site to the condition it was in prior to the start of the extractive activity. However, closure operations entail considerable costs, and the more stringent the standards set by the regulator, the higher these costs. In fact, it is likely that each step taken towards site rehabilitation costs more than the previous one—eliminating the first 10% of the damages may be fairly inexpensive, the second 10% may cost more, and the final 10% required to return the system to its pristine state may be very expensive indeed. A hypothetical marginal cost of closure operation curve is shown in **Figure 2.2**. In contrast, the benefits to restoration may be falling as the site approaches the 'pristine' state. Plugging a well is likely to have enormous benefits in terms of preventing pollution, environmental degradation, and accidents. Removing offshore infrastructures also has important benefits, though less than those of plugging the well. Keeping offshore platforms in place or transporting them to artificial reef locations raise a series of issues, including residual liability. However, the presence of offshore structures does improve ecosystem services. Besides, the decision regarding the complete removal of offshore structures should consider the internalization of all decommissioning costs including emissions, energy consumption, safety risks, etc. (see **Appendix D** – ecological impacts of decommissioning operations) As increasingly on-site contamination is cleaned up, marginal benefits are likely to fall even further. This is shown by the marginal benefits to closure operation curve in **Figure 2.2**.

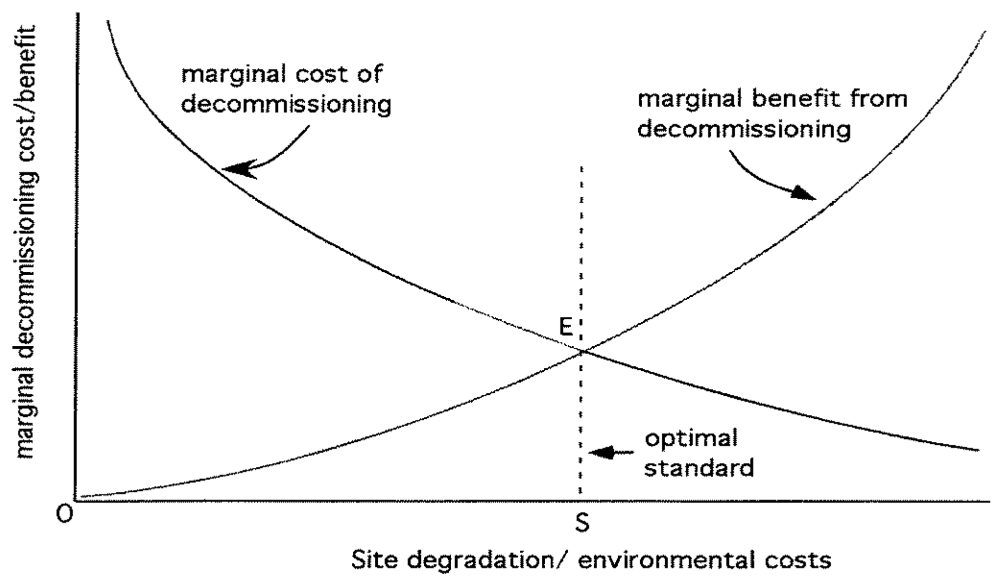


Figure 2.2. Marginal costs and benefits of decommissioning operations. Intersection *E* indicates the point of optimum standard. Area *OES* indicates a low efficiency scenario, where costs outweigh decommissioning benefits.

If the assumption is correct that the costs of restoration increase as we move towards recreating a pristine system, and the benefits decrease, then at some point the costs will outweigh the benefits (all points to the left of *E* in **Figure 2.2**). From the efficiency perspective, this is entirely undesirable. To achieve the most efficient allocation of society's resources, regulators should strive to set the standard at the point of intersection of the marginal cost and marginal benefit curves. This, of course, is much easier said than done, as it shall be explained below.

On the other hand, what right does an oil company have to externalize costs transferring the financial burden to society? Shouldn't polluters have to pay for the pollution they cause? Even from the viewpoint of economics, efficient market outcomes require that producers pay all of the costs associated with their production. Consider tax deductions, which imply cost sharing between companies and government/taxpayers (FERREIRA and SUSLICK, 2001). In **Figure 2.2**, these costs are depicted by area OES, and are substantial. While Polluter Pay Principle (PPP) should apply, closure standards are not the most efficient way to achieve this goal. The resources that a petroleum company would require to completely restore a site are resources that would become unavailable for society to apply towards other desirable activities, such as plugging of orphan wells and sites that were negligently abandoned before bonds were required. To enforce PPP, one option could involve a 'degradation' fee (equal to area OES) added to the costs of meeting the ex-post environmental standard. Such a fee, if adjusted ex-post to reflect actual degradation, could greatly increase the extent to which financial assurance instruments help internalize externalities.

Most types of ex-post bonding instruments are a hybrid of market mechanisms and command and control regulations. The ideal market mechanism would allow a firm flexibility in the extent to which it performs closure operations, but force it to pay for all social costs it imposes. Such a system takes advantage of the firm's internal knowledge of production costs, clean up costs and profits. When closure is more expensive than social costs, the firm pays its social costs. When closure is less expensive, the firm performs closure operations. Most important in the dynamic setting, there is always an incentive to seek new technologies and techniques that minimize environmental costs. In the case of bonds, the regulator must determine the closure standard and is therefore less able to rely on the firm's internal knowledge. However, in a number of ways, financial assurance does help improve market function. Bonds force all firms to pay for at least some of the environmental costs they impose on society, without risk of bankruptcy or non-compliance. Bonds force firms to incorporate environmental liabilities directly into their cash flow accounting, and the costs are made explicit to shareholders. As careful management of all phases of a project can substantially reduce ex-post liabilities, firms have more incentive to minimize damage and avoid accidents throughout the life cycle of the investment. Perhaps most important, firms cannot avoid these liabilities through bankruptcy or refusal to comply. Firms have incentives to develop new technologies for reducing environmental costs as long as the regulator and/or third party insurers take these into account when determining bond requirements (consider that, in practice, regulatory agencies are not very open to unproven technologies, reducing the incentive for the development of technological innovations). Third party insurers are also likely to monitor projects, potentially reducing regulatory costs in this regard (APOGEE/-HAGLER BAILLY with D. R. ANDERSON ASSOCIATES, 1998).

A serious problem with this analysis is that while closure operation costs are fairly simple to estimate, the benefits of such operations are dramatically less so when the impacts include damage to environmental services. There are a number or economic methodologies for estimating the values of environmental services, including contingent valuation, hedonic pricing, travel cost methodology, replacement costs, and others (PEARCE and TURNER, 1990). All of these methodologies are inexact, and rely on a greater knowledge of ecosystem functions, the way those functions benefit humans, and the impacts human activities have on those functions than currently exists. Ecosystems are extremely complex systems, characterized by non-linearity, emergent properties, and non-reversibility beyond often-unknown thresholds (ODUM, 1997). The nascent science of complexity theory offers some insights into ecosystem function, but is still inadequate to explain it (KAUFMANN, 1995). Instead of the fine line depicted in **Figure 2.2**, marginal benefits of closure operations are better illustrated by a thick smear. With so much uncertainty, the industry will pressure regulators to make the standards as vague as possible, while the public may push for stricter standards. In keeping with the precautionary principle, it is safer to err on the side of caution, and standards should be set closer to complete restoration (COSTANZA, *et al.*, 1997).

Bonding may help reduce the difficulty for regulators to estimate closure costs. If standards are set for closure without bonding mechanisms to back them up, firms will have incentives to overestimate closure costs so that regulators will require less complete closure operations. With bonds however, firms have to pay in advance for closure costs, and lose the incentive to overestimate. The question still remains whose costs should form the basis of the estimate. The firm is likely to be able to meet closure costs more cheaply than the regulator, because it will be able to use its own resources and avoid overhead. The government, in contrast, will have to hire outside contractors, possibly at higher cost. However, as it is the regulator that will have to bear the costs in the event of default, the more likely the firm is to default, the more appropriate it becomes to use government costs (usually, estimations are based on project plans provided by operators and confirmed by the regulator's database, and an additional amount is included, usually 15 to 30%, to internalize indirect costs such as overhead and third-party costs).

Bonding Systems

There are five main stakeholders involved in the bonding process: regulators, industry, society, project financing agents, and bonding agents/third party insurers. The focus of this paper is on regulators and the industry. Some key concerns associated with each stakeholder are summarized on **Table 2.1**.

TABLE 2.1. MAIN STAKEHOLDERS

Stakeholders	**Main Concerns**
Regulators (government agencies)	Financial and environmental liabilities Investment flow within the sector
Industry (oil companies)	Profitability Corporate image
Society (public in general and interest groups)	Environmental protection Development
Project Financing Agents (investors, banks, international development institutions)	Investment returns Image
Financial Assurance Agents (insurance and surety companies, banks, etc.)	New business opportunities Risk reduction

Bonds may reduce liability risks by (1) providing financial incentive for contractual compliance; (2) safeguarding government and taxpayers by attaining reasonable protection from default at a minimum increase in project costs; and (3) protecting the environment from potential harm resulting from failure to carry out proper closure operations in a timely fashion. Therefore, oil companies wishing to explore and produce hydrocarbon resources would be required to post a bond in advance equal to the best estimate to cover all closure costs.

As mentioned, setting the appropriate bond requirement may be one of the greatest predicaments within a bonding system. It is not always possible to calculate the total monetary value of complex non-market goods such as ecosystem functions and services, though many methodologies currently exist to calculate partial values (for instance, COSTANZA, *et al.*, 1997).

Another predicament within bonding regimes is tax treatment. For most tax regimes, closure obligations are ordinary and necessary expenses. In general, closure expenditures are tax-deductible only when services have been performed and payments have been made. The same rule applies when progressive closure (the phased approach) is adopted.

Under most bonding regimes, there is no deduction available for companies allocating funds as collateral until the company loses ownership of funds. However, if a company pays fees or premiums to keep surety bonds or environmental insurance policies, expenditures would be amortized over the period covered by the bond. The basic rule is that only an ordinary and necessary business expense is deductible; capital expenditure is not. Being contractually liable for closure operations and emitting bonds (in anticipation) to guarantee such operations, does not entitle companies to deduct cost of services before they are actually performed (FERREIRA and SUSLICK, 2000).

Bonding Instruments

Traditionally, bonding instruments have been used to provide different forms of guarantees as shown below (ROWE, 1987; JOHNSON, 1986; CORNWELL, 1997; MILLER, 2000): fidelity bonds (guarantee honesty); fiduciary bonds (guarantee the proper management of assets); judicial bonds (guarantee the compliance with judicial decisions); and contractual bonds (guarantee the fulfillment of contractual obligations). The category "Contractual Bonds" includes several subcategories including: performance bonds; construction bonds; bid bonds; service and materials bonds; advanced payment bonds; retention bonds; maintenance bonds; transport bonds; government regulatory bonds; customs bonds; financial bonds; and license and authorization bonds.

Within the Exploration and Production sector, two major bond categories can be identified in terms of specific purpose: (1) financial bond, a bond that guarantees the payment of a specific amount determined by the agency in case of noncompliance; and (2) performance bond, a bond that guarantees the performance of a contractual obligation.

Bonds may be used several times within a single contract. Under some regimes, companies acquiring oil or gas leases are required to post a preliminary financial bond (a fixed and relatively small bond) guaranteeing financial aspects of the lease contract (regular payments of rents and royalties, civil penalties, fines, etc.). Usually, companies holding more than one lease may opt for an "Areawide Bond", or "Blanket Bond", in which case, a single bond would cover multiple leases.

In addition to financial bonds, some regulatory agencies require a performance bond, which is usually based on the best-cost estimate for completing ex-post closure operations under the established lease contract. Performance bonds serve individual projects and individual wells. Multiple performance bonds may be found within a lease, but a single performance bond cannot be used to cover multiple projects.

Performance bonds must be maintained until leases are terminated or transferred and until closure obligations are satisfactorily met. If closure activities are being conducted concomitantly during the life of the project, the phased approach, authorities may authorize proportional releases of the bond.

A bond may be subject to forfeiture for different reasons: (1) if a well or installation has been abandoned or temporarily closed without initiating required procedures; (2) if a company fails to meet closure obligations in accordance with the approved plan; or (3) if a company fails to maintain the amount bonded.

Financial instruments used to meet financial or performance bonding requirements may come in several forms with unique attributes and requirements: some are the pledged assets of a company (cash, securities, real estate, escrow accounts, salvage, etc.); others represent a guarantee for a company's performance, fulfillment of obligations (surety bonds), or the transferring of potential financial liabilities to other agents (e.g. insurance policies); others are securities issued by bonding or insurance companies, banks or other financial institutions; and still others are instruments that indicate the deposit of cash (certificates of deposit) or the existence of a line of credit (letters of credit) (BRYAN, 1998).

Definitions and descriptions of currently used bonding instruments can be found in the following publications: BLM (1996), CORNWELL (1997), MILLER (1998), FERREIRA and

SUSLICK (2000), OSM (2000b), NWF (2000), UNICAMP/CEPETRO (2001), FERREIRA and SUSLICK (2003a).

Some complexities are involved in assessing bonding instruments: (1) a specific instrument may be known by a variety of names; (2) a single instrument may comprise a number of significant variations and still carry the same name; and (3) some instruments can be personalized with contractual clauses altering their behavior, but keeping the same name.

Bonding instruments are classified in several ways, but a comprehensive classification that could systematically embrace most instruments was not found. Some authors use a general "soft" and "hard" classification (i.e. MILLER, 1998). "Hard" for instruments that cause significant direct costs[5], and "soft" for instruments that cause less significant direct costs. Despite less significant direct costs, soft instruments may cause some indirect costs, which may include reduction of credit capacity and increase of loan costs. **Table 2.2** shows some financial tools currently being used as bonding instruments to provide guarantee for end-of-leasing and reclamation operations. This classification was designed to facilitate the systematic evaluation and optimum applicability of each instrument.

TABLE 2.2. INSTRUMENT OPTIONS

A_n	Short Name	Bonding Instrument Option
A_1	SURE	Corporate Surety Bond
A_2	PIACC	Paid-in Cash Collateral Account
A_3	PPACC	Periodic Payment Collateral Account
A_4	LOC	Letter of Credit
A_5	SELF	Self Bond
A_6	IGS	Investment Grade Security Bond
A_7	RE	Real Estate Collateral Bond
A_8	INSP	Insurance Policy Bond
A_9	POOL	Pool Guarantee Fund
A_{10}	SFUND	Designated State Fund

2.4. DECISION MODEL

This model is an attempt to explain the current instrument choice by both regulators and industry. It is also intended to systematize the decision-making process to assist in the selection an optimum portfolio of bonding instruments. Such portfolio should offer, at same time, adequate protection for regulators and an acceptable level of cost and flexibility for the industry.

[5] Direct costs usually refer to opportunity costs and liquidity constraints caused by the allocation of large amounts of money at "startup".

Due to public pressure, regulators must impose bonding requirements; however, such requirements generate significant negative impacts on the industry, which in turn, demands flexibility. Regulators must respond in order to keep the market competitive and maintain the investment flow in the sector. Closing the cycle, some of the flexibility allowed may increase the risk for regulators, triggering further pressure from taxpayers and interest groups, as demonstrated in **Figure 2.3**.

For this comparison exercise, this paper simulates the application of ten different financial instruments identified by FERREIRA and SUSLICK (2001) that are commonly used in the oil and mining sectors: Corporate surety bonds, paid-in cash collateral accounts, periodic payment collateral accounts, letters of credit, self bonds, investment grade security bonds, real estate collateral bond, pool guarantee funds, designated state funds. These instruments were chosen based on a study done for ANP where several forms of bonding instruments were being considered to provide ex-post performance guarantee for petroleum projects (UNICAMP/CEPETRO, 2001). Currently, ANP requires financial bonds for the bidding process, where letters of credit and cash are accepted. Studies are on the way aimed at establishing sound performance bond requirements for all phases of Brazilian upstream petroleum projects. Among instruments being studied are collateral cash (paid-in and leasing specific accounts), ex-post insurance policies, and letters of credit.

The methodology used in this process was the identification of the most significant attributes according to the perspective of key stakeholders. In addition, a questionnaire[6] was prepared and sent to a number of bond specialists who were asked to rank several bonding instruments under several categories (attributes), according to their own experience. On **Appendix 1**, on the questionnaire table, the left column indicates some of the instruments used to guarantee or fund ex-post end-of-leasing, closure and reclamation obligations. The top row identifies some of the characteristics of these instruments. Based on the specialist's own

[6] This figure was not included in the original published paper. The information provided in this questionnaire was gathered in meetings with bond specialists from regulatory agencies, industry, financial institutions, and academia, all based on personal experiences with different financial assurance instruments. Regulatory agencies allow different financial instruments based on their own experiences, which oftentimes are not well documented in the academic literature. The information gathered in this questionnaire helped in the development of models that may assist in the decision-making process, anticipating economic impacts of different financial assurance instruments on regulators (regulatory cost, flow of investment, etc.) and on the industry (cost of money, cost of opportunity, tax treatment, etc.).

experience and judgment, he/she was asked score each instrument in the following manner: "5" most favorable through "1" least favorable.

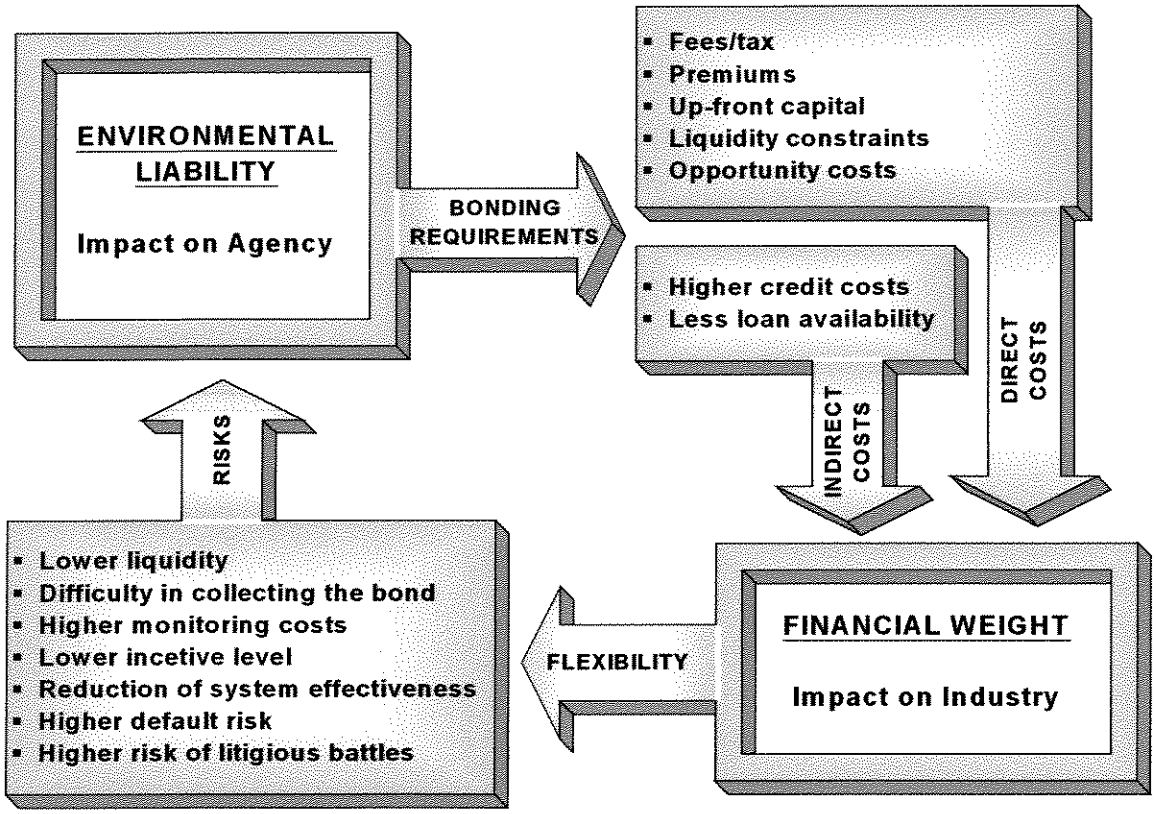


Figure 2.3. The dynamics of the bonding cycle: due to public pressure, bonding requirements are adopted. Bonds cause direct and indirect economic impacts on the industry, which pressures for flexibility. Flexibility may increase liability risk, forcing regulators to review requirements.

Although subjective, personal experiences of bonding professionals have been particularly helpful to explain the current behavior and trends of regulatory systems. This process has also provided data for the decision model explained below.

The Multiple Criteria Decision Analysis (MCDA) was used to balance the conflicting objectives in the decision model. The main steps can be defined as follows according to HWANG and YOON (1981), STAR and ZELENY (1977), and KEENEY (1992): (1) definition of the main problem; (2) definition of the main attributes/criteria; (3) establishment of the relative importance of each criteria; (4) identification of a set of available alternatives; (5) performance assessment of all alternatives according to each criteria; and (6) selection of best alternatives. This model was developed using the *STELLA®* software (**Figure 2.4**). **Appendix D** provides

some conceptual information about economic modeling, decision models, forecasting, and about the Stella modeling tool. **Appendix D** also displays some of the mapping levels for this model[7].

Which of the identified financial instruments (**Table 2.4**) are more likely to be accepted as bonding tools for both regulators and the industry? In order to identify the instrument with the highest performance, a process consisting of three parts must be undertaken: part 1, definition of a preferable instrument alternative for regulators; part 2, definition of a preferable instrument alternative for the industry; and part 3, cross-evaluation of results from parts one and two, and the identification of a consensual best alternative.

TABLE 2.4. INSTRUMENTS AND PROPOSED CLASSIFICATION

PROPOSED CLASSIFICATION		INSTRUMENTS
Credit Guarantees		Corporate Surety Bonds
Collateral	**Negotiable**	Certificates of Deposit, Cash Equivalents, Government-Issued Treasury Securities (T-bonds, Investment Grade Securities, etc.)
	Non-Negotiable	Letters of Credit, Real Estate, Salvage, Cash Accounts, Escrow Accounts, Paid-In Trust Funds, Trust Funds with Periodic Payments, Standby Trust Funds, External Sinking Funds, Lines of Credit Bank, etc.
Self Guarantees		Balance Sheet Tests, Corporate Guarantees, Third-party Guarantees, Set-Aside Revenues and Self-Funding through Financial Reserves
Liability Transfer		Environmental Insurance, Finite Insurance, Life Insurance, Annuities
Risk Spreading Consortiums (for low-rating participants)		Pool Bonds
Risk Spreading Special Funds (for all participants)		State Funds

Regulators and industry view the identified attributes with different degrees of importance (weight) (**Table 2.5**). A choice of a certain instrument may be appealing for regulators, but may be severely opposed by the industry. In addition, the degree of flexibility demanded by the industry may pose unacceptable risks to regulators. Costs to meet technical and bonding requirements for closure obligations will impact companies differently. Usually large and

[7] Information and illustrations provided in **Appendix D** were not included in the original publication of this article.

financially healthy companies are not significantly affected by bonding requirements, though marginal projects operated by any company (large or small) may be severely impacted. Small companies operating small and marginal fields tend to be the most affected parties.

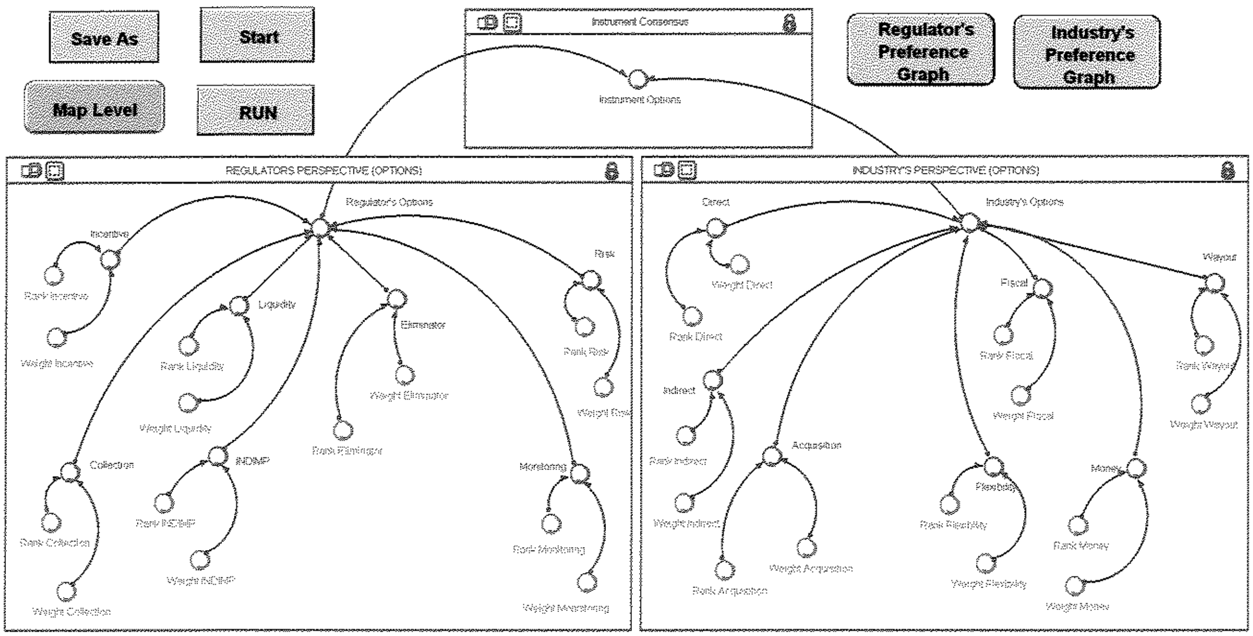


Figure 2.4. Diagram of the Stella Model, including the steps of the decision model: U_{reg}, U_{ind} and U_{cons}.

A comprehensive set of objectives that reflect all concerns relevant to the decision problem are defined at this point (definition of the main attributes). Regulators and the industry do not share the same priorities, but, at same time, do not necessarily have conflicting interests. Regulators are primarily interested in an efficient guarantee (protection), and the industry is primarily interested in reducing economic impacts of bonding regulations (flexibility). The measures for achieving these objectives are expressed in terms of key attributes identified by both regulators and industry. Two sets of attributes were suggested reflecting the needs and preoccupations of key stakeholders. Each set contains seven attributes. As illustrated in **Table 2.5**, the degree to which objectives are met as measured by the attributes is the basis for comparing the sets of bond alternatives: $X_{reg} = \{x_1, x_2, \ldots, x_7\}$; $X_{ind} = \{x_8, x_9, \ldots, x_{14}\}$.

The decision maker's perception with respect to the evaluation criteria must be incorporated into the decision model. Each attribute has a certain degree of importance for a specific decision maker. Therefore, a weight, which reflects the relative degree of importance of

criteria, is assigned to all evaluation attributes, as shown on **Table 2.6**. The derivation of weights is a central step in eliciting the decision maker's preference. Weights reflect the preferences of key stakeholders and hence depend on the choice of individuals. The importance of the attribute x_i could be specified by the weight w_i, where the sum of each set of weights should be equal to 1 (one), as shown below:

$$w_{reg}=\{w_1,w_2,\dots,w_7\},$$

$$\sum_{i=1}^{7} w_i = 1$$

$$w_{ind}=\{w_8,w_9,\dots,w_{14}\},$$

$$\sum_{i=8}^{14} w_i = 1$$

$$w_{cons}=\{w'_1,w'_2,\dots,w'_{14}\},$$

$$\sum_{i=1}^{14} w'_i = 1$$

TABLE 2.5. ATTRIBUTES/CRITERIA

Rank	X_{reg}	Short Name	Regulator Perspective	W_i	W_i'
7	X_1	LIQUIDITY	Level of liquidity offered by the instrument in case of bond forfeit	0.225	0.113
6	X_2	RISK	Overall risk offered by the instrument	0.200	0.100
5	X_3	COLLECTION	Level of difficulty in collecting funds in case of bond forfeit	0.175	0.088
4	X_4	INDIMP	Regulator's concern with impact of instrument on the industry	0.125	0.063
3	X_5	MONITORING	Level of monitoring required in order to ensure instrument integrity	0.100	0.050
2	X_6	INCENTIVE	Level of incentive for contractual compliance offered by the instrument	0.100	0.050
1	X_7	ELIMINATOR	Does the instrument target primarily risky parties?	0.075	0.038
	X_{ind}		**Industry Perspective**	***Total***	**0.500**
7	X_8	DIRECT	Level of liquidity constraints and opportunity costs (Direct Costs)	0.275	0.138
6	X_9	FLEXIBILITY	Overall flexibility offered by the instrument	0.200	0.100
5	X_{10}	FISCAL	Level of fiscal advantages offered by the instrument	0.175	0.088
4	X_{11}	WAYOUT	Level of opportunity for an easy way out (legal, etc.)	0.150	0.075
3	X_{12}	MONEY	Level of money value protection for allocated funds offered	0.100	0.050
2	X_{13}	INDIRECT	Impact on credit and loan capacity (Indirect Impact)	0.050	0.025
1	X_{14}	ACQUISITION	Level of difficulty in instrument acquisition (underwriting process)	0.050	0.025
				Total	**0.500**

In order to assess all alternatives according to each attribute, a finite set of possible bond options $A_j=\{A_1,A_2,\dots,A_{10}\}$ is provided, as indicated in **Table 2.2**. This selection corresponds to the group of most common financial instruments currently being used as bonding instruments in the

United States, Canada, and the UK. The process of evaluating the bond alternatives is based on the value structure and related to the set of evaluation criteria.

TABLE 2.6. MATRIX X_{IJ}: PERFORMANCE OF BONDING ALTERNATIVES ON ATTRIBUTES[a]

Options		Regulators							Industry						
		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
A_1	***SURE***	4	5	4	4	5	5	4	5	4	5	1	1	4	1
A_2	**PIACC**	5	5	5	1	3	5	2	1	1	1	1	3	4	4
A_3	**PPACC**	4	4	4	3	2	4	2	2	3	1	1	3	4	4
A_4	**LOC**	3	2	2	4	2	3	3	3	3	4	3	3	2	2
A_5	**SELF**	1	1	1	5	1	1	3	5	5	1	5	1	1	3
A_6	**IGS**	3	4	4	2	4	5	2	1	1	2	1	4	4	4
A_7	**RE**	1	1	1	5	1	2	1	5	4	2	5	1	2	5
A_8	**INSP**	4	2	2	4	2	2	2	4	4	5	3	1	5	3
A_9	**POOL**	3	1	2	4	1	1	1	3	4	1	3	1	4	5
A_{10}	**SFUND**	3	2	3	3	2	1	1	3	4	1	2	1	4	4

[a] ***Scores: (1) Least Favorable through (5) Most Favorable.***

This process is intended to specify the performance of each alternative for every evaluation criteria, allowing the identification of the best options. The performance of the bond alternative A_j on attribute x_i is indicated by x_{ij}. The values x_{ij} reflect the performance of alternative A_j according to the criteria x_i. Thus, an alternative is completely specified by its performance score profile, as seen on **Table 2.6**. These scores also reflect the personal opinion of key stakeholders from the industry, regulatory agencies, financial institutions and members of the academia involved in the research of bonding mechanisms.

A decision-making rule provides an ordering of all bond alternatives according to their performance with respect to the set of attributes. Choosing the most favorable bonding instruments depends on the selection of the best outcome and the identification of the decision alternative yielding this outcome. The performance of alternative A_j on the set of attributes $(x_1, x_2, ..x_n)$ is associated with vector $(x_{1j}, x_{2j}, ..x_{nj})$ where a component of the vector x_{ij} gives the numerical value of the performance of alternative A_j on criteria x_i.

The multiattribute value function provides an integrated performance score for each bond alternative taking into account all attributes. In the simplest case, value functions can be combined with an additive weighed. Thus the overall value attached to a bond alternative is the weighted sum of its attribute values: $v(a_j) = w_1 x_{1j} + w_2 x_{2j} + ... w_n x_{nj}$. The components w_1, $w_2, ..., w_n$ are the weights which indicate the overall importance of each attribute. Since the current problem involves three sub-problems, three different functions will provide the means for the selection of the best alternatives for regulators, the industry, and for a consensual decision. The three parts of the performance evaluation are shown below (Equations 1, 2 and 3):

a. Performance of bond alternative a_j for regulators:

$$u_{\text{Reg}}(a_j) = \sum_{i=1}^{7} w_i x_{ij} \qquad (1)$$

b. Performance of bond alternative a_j for industry:

$$u_{Ind}(a_j) = \sum_{i=8}^{14} w_i x_{ij} \qquad (2)$$

c. Consensus for decision rule:

$$u_{Cons}(a_j) = [\frac{1}{2} u_{\text{Re}g}(a_j) + \frac{1}{2} u_{Ind}(a_j)] = \sum w'_i x'_{ij} \qquad (3)$$

2.5. RESULTS AND DISCUSSION:

Table 2.7 indicates the results of the decision rule (Equations 1, 2 and 3). Column II and I indicate the final scores for the preferences of regulators and industry, respectively, U_{Reg} and U_{Ind}. Column III results from the sum of columns II and I (U_{cons}). Higher scores indicate instruments with agreeable feedback from both parties. Column IV indicates the positive difference between columns I and II ($|\Delta u|$). High U_{cons} values must be compared against $|\Delta u|$ values, which indicate high degree of antagonism between the two parties. The combination high U_{cons} and low $|\Delta u|$ indicates the preferable scenario, where the instrument encounters less resistance from both regulators and the industry, allowing a smoother implementation of bonding requirements.

TABLE 2.7. TOTAL UTILITY

Instruments		I (Regulators)	II (Industry)	III (Consensus)	IV $\lvert\Delta u\rvert$ [a]
A_1	SURE	2.200	1.775	3.975	0.425
A_2	PIACC	2.038	0.750	2.788	1.288
A_3	PPACC	1.763	1.088	2.850	0.675
A_4	LOC	1.325	1.538	2.863	0.213
A_5	SELF	0.825	1.800	2.625	0.975
A_6	IGS	1.738	0.888	2.625	0.850
A_7	RE	0.800	1.863	2.663	1.063
A_8	INSP	1.350	1.863	3.213	0.513
A_9	POOL	1.000	1.400	2.400	0.400
A_{10}	SFUND	1.175	1.300	2.475	0.125

[a] *Δu is the difference between columns I and II.*

Preliminary simulations suggest that surety bonds allow the highest U_{cons}. These results are in agreement with actual bonding regimes. Insurance policies also reach high scores, however, in actual scenarios; insurance policies are not well accepted by some regulators. It is claimed that insurance policies simply transfer liabilities from producers to third party insurers without generating reasonable incentives for compliance. In fact, agents from the insurance sector agree that insurance policies provide an easier way out for lessees when compared to surety bonds. Letters of credit also reach high U_{cons} values, but are not welcomed by some regulators who claim that the instrument is as good as its issuer.

A set of new parameters should be included in the model in order to account for these discrepancies. In addition, since the preference of regulators overcomes the preference of the industry, a factor should be generated to account for this gain allowing a more realistic scenario.

When stakeholders are analyzed separately, the simulations yield a more realistic set of outputs. According to the proposed model, the industry shows preference for insurance policies, self and surety bonds. The same model indicates that regulators tend towards surety bonds and cash collateral accounts.

2.6. CONCLUSIONS

In the oil sector, bonds indemnify authorities against failure to comply with lease contractual obligations, safeguarding agencies against technical and financial failure, and premature or unplanned closure. Under an ideal bonding regime, the financial risk is shifted from the agency to the lessees. By internalizing ex-post damages and no compliance costs, oil companies are motivated to monitor the consequences of their decisions throughout the project. In case of default, funds necessary to complete all closure obligations would be promptly available avoiding complicated and costly legal processes.

Though a hybrid of market mechanisms and command and control regulations, bonds are also likely to achieve noncompliance protection objectives far more cost efficiently than non-market regulations. Bonds are best suited to cover ex-post environmental damages. The main factors include cost assessment and duration of mitigating operations. Some complications are expected in the near future as emerging issues are further considered. Preliminary results from the simulation model indicate that the surety bond is the most preferable financial instrument among regulators and the industry.

CHAPTER III – DECOMMISSIONING

How to guarantee that oil and gas leasing areas will be returned in similar preexisting environmental conditions? Answer: establishing of sound ex-post requirements, including the decommissioning of offshore installations.

In this chapter, some of the essential issues of offshore decommissioning are addressed. The most prevalent issues cope with potential impacts of decommissioning expenditures. The complexity of the theme increases due to the potential combination of:

- Installation type;
- Removal and disposal options; and
- A wide variety of settings.

In this chapter, the author does not attempt to discuss all these issues, but instead, defines key parameters and offers a systematic approach for addressing decommissioning costs.

3.1. END-OF-LEASING OBLIGATIONS AND PLATFORM DECOMMISSIONING

Ex-post (or end-of-leasing) obligations involve different activities including: engineering analysis and planning; permitting and regulatory compliance; platform preparation; plugging, capping and abandonment of wells; conductor removal; mobilization and demobilization; platform and structural removal; pipeline and power cable decommissioning; transportation and disposal; and site clearance and verification (NPD, 1993; UNEP and E&P FORUM, 1997; GAO, 1999; TOPE, 1999; MMS, 1999a; FERREIRA, 1999). Among the main objectives of ex-post requirements in the upstream offshore sector are: isolate subsurface contaminations sources, guarantee conditions of health and safety, and, if at all possible, return disturbed areas to their pristine conditions.

Although embodying different meanings, the terms *abandonment* and *decommissioning* are often used interchangeably. Both terms are also frequently used to designate the entire chain of ex-post activities. Technically, the ex-post process includes several activities, including *abandonment* and *decommissioning* operations. Decommissioning has been defined by ANON (1999) as the activities related to bringing a platform from an operating condition to a cold, hydrocarbon free condition (but excluding activities related to removal or other methods of disposal). The same author defines *disposal* as the process and/or agreement that brings an installation to its final destination(s) (end-points), where it is reused, recycled, or deposited.

Most commonly, the term *abandonment* is used to denote the plugging and capping of a specific well and the term *decommissioning*, which refers to the facility itself, designates the process consisting of all activities involved in the removal and disposal of an offshore installation (the term also applies to pipelines). The term *abandonment* seems to imply a "politically incorrect" attitude for plugging and capping operations. The general public can easily misinterpret this term as implying a negligent *abandonment*. Both Norway and UK authorities have been using the term *cessation* to account for the entire end-of-leasing process (all ex-post activities). Henceforth, because of references and some citations, the terms *decommissioning*, *abandonment*, *cessation*, *reclamation*, *closure*, and *end-of-leasing process* may be used interchangeably to indicate ex-post obligations.

Ex-post activities are identified and described bellow (from TYAGI, 1998; MMS, 1999b; FERREIRA, 1999; GARLAND, 2000b):

1. ***Residual Value Appraisal:*** The starting point of the decommissioning process is a residual value appraisal.

2. ***Engineering and Planning:*** When decommissioning has been firmly decided, pre-project can start with the analysis of a huge data collection including installations, waste, etc. This phase usually begins two to three years before production ceases. Within this phase, several activities may take place including contractual review, engineering analyses, contracting, and operational planning. Planning decommissioning operations ahead of time may significantly reduce ex-post costs. Since the availability of expertise and appropriate equipment is limited, early planning may be crucial. For example, the Norwegian legislation requires the submission of a decommissioning plan 2 to 5 years before the license expires, or when an installation or pipeline becomes redundant.

3. ***Permitting and Regulatory Compliance:*** This phase includes analysis of legal constraints, contractual obligations, implicit obligations (meeting governmental and stakeholders

expectations), finances, fiscal regime, and safety and environmental issues. In addition, this phase involves activities such as obtaining permits and making installations and all future operations comply with local, State, and Federal rules. Usually during this phase, environmental consultancy firms are hired to assess environmental impacts. Companies may have to provide compensation to commercial fishing companies that are precluded from fishing in areas where decommissioning activities are taking place. Several issues rise regarding commercial fishing (i.e. exclusion areas, sanctuaries, etc.). This theme has attracted a passionate discussion between the oil and fishery industry, environmentalists, and several NGOs (MMS, 1987; MMS 1997a; OSMUNDSEN and TVETERÅS (2000); SANCHIRICO, 2000; DAUTERIVE, 2000b).

4. ***Platform Preparation:*** Platform preparation, also known as *safeout operations*, involves activities aimed at turning the installation safe and ready for dismantling, removal, transport, and disposal. This phase also includes structure and equipment cleaning.

5. ***Well Plugging and Abandonment:*** Plugging all exploration[8] and development wells, isolating subsurface hydrocarbon sources from other subsurface, surface, and freshwater aquifers zones, preventing contamination. This process involves placing a series of concrete and mechanical plugs, and testing their pressure, integrity, and durability (TYAGI, 1998). Following plugging, the well site must be cleared of all obstructions and cuttings. Wells can be *shut-in* or *temporarily abandoned.* Production may be interrupted by technical or economical reasons. If the interruption is only temporary, the well is *shut-in*, but if it is permanent, the well must be *plugged and abandoned.* Shut-ins involve simply closing the valves on the Christmas tree. If the duration of the shut-in exceeds a predetermined allowable period (usually one year), permanent abandonment will be required. Once a well is permanently plugged and abandoned, it becomes mostly unfeasible to reach remaining reserves through that well. The MMS has been using Satellite Radar Imagery to detect leaks at abandoned wells on the US Outer Continental Shelf (MARTIN, 2000). Even though well plugging and abandonment is considered one of the more sensitive ex-post activities within

[8] Despite technological and research efforts, approximately 80% of all pioneer wells do not result in economic prospects. When a well does not indicate the presence of oil, it must be plugged and abandoned.

the decommissioning process, planning in advance may significantly reduce uncertainties (FIELDS and MARTIN, 1997). In the GOM Region, well plugging and abandonment may cost generally less than US$ 60,000/well and rule allow casing to be left in the hole bellow 4.57 meters and tubing can be left in the hole bellow 91.44 meters.

6. ***Conductor Removal:*** This process involves the severing, plugging, and offloading of casings. These activities require the use of a platform crane.

7. ***Mobilization and Demobilization:*** It involves bringing a Heavy Lift Vessel (HLV) to the project site and returning the vessel to its point of origin. When there are no vessels with the capability to remove platforms within the productive area, the vessel has to be brought from other areas (usually from the GOM or NS). Total mobilization and demobilization time may vary greatly from the distances between locations (i.e. 100 to 200 days.).

8. ***Platform and Structural Removal:*** This process includes the removal of the topside (or deck), and the removal of the platform (or structure). Pile severing denotes the method used to separate the platform's components (explosives, mechanical means, abrasive technology, or torches). Severing is currently a very controversial issue due to the potential danger posed to marine animals. Most legal regimes require the complete removal of all offshore installations. CULWELL (1997) and PASTHOFER (1997) discuss technical processes of deck and jacket decommissioning.

9. ***Pipeline and Power Cable Decommissioning:*** Decommissioning of these components is a very complex issue. Knowledge of gradual degradation is limited, since model calculations may not be verified through observations. A rough estimate of total degradation period for steel pipelines is 300-500 years[9]. Removal methods are mainly based on costly reversed installation. Reuse experience for pipelines is limited and, under most regimes, in order to obtain a pipeline license, a company must demonstrate that specifications and quality of the material is adequate. Pipelines must be decommissioned in order to prevent seepage and to minimize potential safety hazards for the environment, marine and human lives, and

[9] Intact concrete caps may significantly delay degradation.

navigation activities. Submarine pipelines and cables are located at a variety of settings. Removal and disposal options are not included in international conventions and national authorities, which may decide on costly solutions, usually define the rules. Regardless of available options, pipelines should be pigged and flushed until they are clean to avoid future leakage. Some agencies (i.e. MMS) require pipelines to be cut at each end, filled with seawater or inhibited water, and caped. Each end should be buried (O'CONNOR, 2000).

10. ***Transportation and Disposal:*** Process steel, marine growth, cement, mud, etc., are materials that must be removed and properly disposed of. There are three main disposal approaches: (1) refurbish for reuse, (2) scrap and recycle, and (3) disposal in designated landfills. Opportunities for refurbishing and reusing facilities depend of several corroborating factors such as structural integrity, additional project developments in the region, matching technical parameters, etc. Transportation and disposal of these materials can be costly. These and other options will be further discussed in this chapter.

11. ***Site Clearance and Verification:*** All obstructions must be cleared from the site. This process may require dragging a trawl, diver search around the well bore, and even seafloor scanning. These activities will ensure that the site is free of obstructions (i.e. sunken helicopters have been found on the seafloor around platforms in the GOM).

3.2. THE DEVELOPMENT OF THE LEGAL FRAMEWORK

For being part of the global commons, oceans must be contemplated beyond domestic interests and expectations. Offshore ex-post requirements (including decommissioning operations) must follow the same rationale. International conventions and guidelines are primarily aimed at establishing legal trends, influencing national legislation, and allowing sound environmental attitudes where a domestic legal framework does not exist. Additionally, international laws impose accountability and constraints on national governments. National governments then legislate in conformity with the international legal framework. Before 1995, both international and domestic decommissioning requirements were flexible to some extent and allowed analysis on a case-by-case basis (UNEP and E&P FORUM, 1997; FERREIRA and SUSLICK, 1999, 2000). However, since the Brent Spar episode in 1995, interest groups have been pressuring for changes in the regulatory framework by requesting the elimination of the case-by-case approach and calling for complete decommissioning (total removal) in all circumstances. **Figure 3.1** summarizes this session.

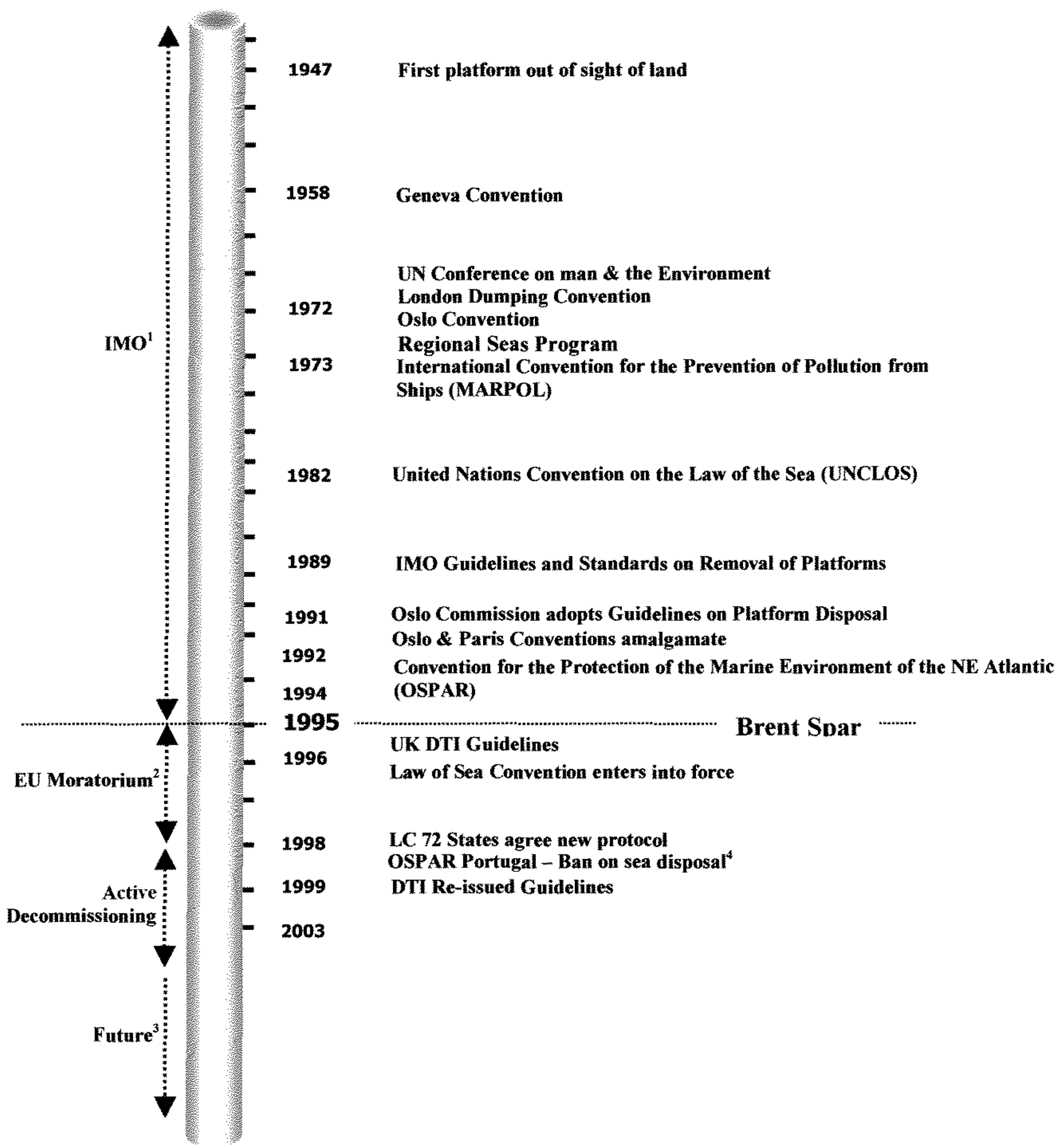


Figure 3.1. Main International and Regional regulations, treats and guidelines. [1]Operations under the Guidelines of the UN International Maritime Organization. [2]UK and Norway did not sign the moratorium and continued decommissioning activities following IMO. [3]New issues may include drill cuttings, pipelines, and NORMs. [4]Except on concrete, damaged and footing of jackets > 10,000 tons.

Probably due to the vague regulatory language employed in international conventions and guidelines, there is still considerable confusion in matters of interpretation. Different stakeholders present convincing arguments for their divergent demands, and it is not difficult to find contradictions and opposing views in different international conventions and guidelines. It is practically impossible to strictly observe all requirements simultaneously.

There are other sources of predicaments. Since international legal provisions cannot specify ex-post procedures for internal waters, territorial seas, etc., guidelines and conventions can only be recommendatory in nature, and the nation is sovereign in regulating and enforcing their offshore oil projects. Usually, national authorities abide by international provisions. Nevertheless, due to high ex-post costs, in situations where a government has sovereignty over an area and public opinion is not a crucial parameter, authorities may disregard international conventions and guidelines.

There are several international conventions and treaties dealing with offshore decommissioning. The most important are:

1. ***The 1958 Geneva Convention on the Continental Shelf:*** The official implementation of the Geneva Convention came only in 1964 when 56 countries signed it. The main provision of this convention, Article 5(5), calls for complete removal of offshore installations but does not mention platform disposal. There is a vast literature record on the interpretation of this article, either favoring or going against the total removal concept. Great part of the industry favors the argument that the 1958 convention is no longer applicable, but the public and other key stakeholders have a different opinion.

2. ***The 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter (the London Convention):*** An international treaty signed by 77 nations presenting provisions for all marine areas, except internal waters. The most important provision of this Convention is found in the Article III (1)(a), which defines "dumping" as "*any deliberate disposal at sea of vessels, aircraft, platforms or other man-made structures*".

3. ***The 1982 United Nations Convention on the Law of the Sea (UNCLOS):*** The UNCLOS was ratified by 127 nations and came into force in 1994. It ensures acceptance of coastal

state control over offshore resources (sovereignty), while preserving freedoms of navigation and overflight. Article 60(3) permits the interpretation in favor of partial removal by stating: *"Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organization. Such removal shall also have due regard to fishing, the protection of the marine environment and the rights and duties of other States. Appropriate publicity shall be given to the depth, position and dimensions of any installations or structures not entirely removed".* As it was with the 1958 Geneva Convention, dispute over the interpretation of this article has erupted. The German interpretation is that the only way to ensure safety and environmental protection is to completely remove offshore installations. The British interpretation is that complete/total removal is contrary to the provisions of Article 60(3). The US interpretation accepts the total removal interpretation but admits an "occasional limited exception" (PICTON-TURBERVILL, 1998).

4. ***The 1989 International Maritime Organization Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf (the IMO Guidelines):*** The IMO Guidelines and Standards, which is basically an interpretation for the 1982 UNCLOS and provides narrow exceptions to the policy of complete removal, sets the following standards for the decommissioning of offshore oil and gas installations (IMO, 1996):
   - Installations weighting less than 4,000 tons, located at places where the water depth is less than 100 m, must be completely removed from the site.
   - Installations located at water depths greater than 100 m must be either totally or partially removed to a depth allowing an unobstructed water column of 55 m above the remaining portions of the installation in order to avoid navigational hazards.
   - Total removal will not be required in the following circumstances: technical unfeasibility, unacceptable human or environmental risk involved in the total removal operations, and extreme costs.
   - All installations (after January 1, 1998) must be designed and built so that their complete removal is feasible (decommissionable structures).

- A structure may be left partially or entirely in place if there is a justifiable and permitted new use or if the structure can be left in place without causing unjustifiable interference with other users of the sea.

5. ***The 1996 Protocol to the London Convention:*** This protocol allows the dumping of offshore installations, consistent with guidelines being developed in the Scientific Group.

6. ***The 1997 Waste Assessment Framework (Scientific Group – May 1997):*** It provides draft guidelines for decommissioning, a framework for governmental decision-making for the issuance of permits to dump using a case-by-case approach, and recommends the consideration of environmental effects.

Currently the London Convention governs the disposal of waste and other material. This convention specifically addresses the disposal of offshore installations. Countries with no national decommissioning regulations generally proceed in accordance with IMO guidelines.

Many producing areas are shared by different neighboring nations, as it is the case of the North Sea oil and gas province. In such cases, regional conventions are of great importance. Until 1998, as part of the UN Regional Seas Program, which began in the early 1970's, there were 15 regional conventions controlling pollution of the marine environment (GRIFFIN, 1998c).

The Baltic Sea regional legal regime requires total removal for all offshore installations. Countries included in Northeastern Atlantic conventions may be going towards a complete ban on sea disposal. Greenpeace pushes for an international ban on partial decommissioning (GREENPEACE, 1998). South Pacific Conventions allows dumping by permit after consideration by other affected parties. Guidelines are being developed for offshore petroleum activities in the Arctic Region. Conventions in the Asia-Pacific Region tend to facilitate private-public cooperation (WALKER, 1998). The following is a brief description of some key regional agreements:

1. ***The 1972 Convention on the Prevention of Marine Pollution by Dumping from Ship and Aircraft (the Oslo Convention):*** This regional agreement comprises the North East Atlantic,

the North Sea and portions of the Arctic Ocean. It prohibits dumping of materials from ships, aircraft, and platforms.

2. ***The 1974 Convention on the Prevention of Marine Pollution from Land Based Sources (the Paris Convention):*** This regional convention controls discharges into the North East Atlantic.

3. ***The 1991 Oslo Commission Guidelines for the Disposal of Installations at Sea (the OSCOM Guidelines):*** The OSCOM Guidelines is aimed at supplementing the 1989 IMO Guidelines by recognizing other alternatives for removal (partial removal). It also establishes a permit system which yields the evaluation of decommissioning project proposals in a case-by-case basis, allowing the consideration of the "leaving-in-place" option, complete or partial removal for reuse, scrapping on land, disposal at sea (*dumping*) or elsewhere.

4. ***The 1992 Convention for the Protection of the Marine Environment in the North East Atlantic (the OSPAR Convention):*** The OSPAR was adopted by the Oslo and Paris Commission in 1992. It establishes that no offshore structure, including pipelines, can be dumped, left wholly or partially in place at sea unless the competent authority, which will analyze it on a case-by-case basis, issues a special permit.

5. ***The 1995 OSCOM Moratorium:*** After the Brent Spar episode, a ban on sea disposal was imposed at the Northeast Atlantic. The UK and Norway governments did not sign this moratorium and proceeded with decommissioning operations.

6. ***The Barcelona Convention:*** This regional convention controls pollution on the Mediterranean Sea and requires removal of offshore installations, but allows the conversion of platforms to new alternative uses (GRIFFIN, 1998b; RAMPOLLI and FASCI, 1997).

7. ***The Kuwait Protocol:*** This protocol controls pollution in the Persian Gulf and requires removal of offshore installations.

8. ***OSPAR Effective February 9, 1999:*** Anything installed after February 9, 1999, must be taken to shore unless it is reused or derogated for safety, environment, technical, or economic reasons. There is no date set for concrete based platforms, but its use is discouraged. This convention also bans sea disposal but provides exceptions (concrete, bottom bay over 10,000 tons, and matters of safety, environment, technology, and economics).

9. ***OSPAR Review in 2003:*** In the 2003-scheduled OSPAR Review, the subjects to be considered are: drill cuttings, hazardous chemicals, produced water, among others.

Despite the effort of international organizations and the availability of regional and international legal models, only few countries have developed their own domestic offshore decommissioning legislation. Most countries provide only superficial or no provisions for decommissioning procedures. Presently, several developing countries have established or are in the process of establishing their own offshore ex-post rules (i.e. Brazil, Indonesia, Belize, Venezuela, Australia, etc.).

Thus far, Australia has minimal decommissioning activity. A FPSO off Western Australia, the Skua, was decommissioned in 1999 and all equipment and pipelines were recovered and reused at Elang/Kakatua. In 1994, the Talisman, also a FPSO, was decommissioned in Western Australia. The Talisman was sent to Singapore, and all other facilities were removed. The Australian legislation has adopted specific and general requirements. Specific requirements address the task of removing or abandoning facilities: Environmental Protection (Sea Dumping) Act, 1981, that implements the 1972 London Convention, the 1972 London Convention guidelines, and the 1988 IMO. General requirements address the abandonment or removal approvals process: the 1967 Petroleum Act (Submerged Lands), and the 1999 Environmental Protection and Biodiversity Conservation Act. The Federal Government is in the process of developing guidelines for decommissioning approvals process (SHINNERS, 2000).

Canada's offshore sector is still in its infancy. Production has been initiated in the early 1990's, and only now few projects are reaching their maturity and exhaustion stages. Decommissioning has been addressed in Canadian legislation and early in project lives, but it is only now becoming a focal issue within government and industry (ABRAHAM, 2001).

Brazil has passed the Law number 9.966 of April 20, 2000 that deals with the prevention, control, and enforcement of pollution caused by oil spills and other polluting and hazardous substances in waters under national jurisdiction (DOU, 2000). This Law is based on the 1973 International Convention for the Prevention of Pollution from Ships as modified by the related Protocol of 1978 known as Marpol 73/78. In addition, Law no. 6,938/81 (National Environmental Policy) has created a national database system, the National Environmental Information System (SINAMA), and the National Environmental Council (CONAMA) (RUIVO and MOROOKA, 2001). The CONAMA is responsible for the environmental licensing process required for all E&P activities. The Brazilian Environmental and Nonrenewable Natural Resources Institute (IBAMA) is responsible for processing E&P environmental licenses for all offshore petroleum projects. In 2000, ANP and IBAMA initiated a review of procedures aimed at harmonizing the licensing process with environmental requirements. Nevertheless, specific decommissioning regulations are yet to be developed.

Most national provisions are derived from international conventions and guidelines. Local legislators work on establishing requirements that may satisfy domestic and international environmental demands, and, at the same time, that are economically feasible. The main concerns are the public demand for environmental preservation and government interest in maintaining the flow of investments in the sector.

Regulators may vary proposed rules according to their capacity to review and approve decommissioning plans, and enforce ex-post requirements. For instance, bonding requirements tend to motivate the development of alternative technologies. If authorities were to oversee directly all decommissioning operations, including evaluate new technologies, the information burden and enforcement expenditure would be excessive. By requiring total corporate liability and transparency (allowing public information access), authorities may be freed of such burden.

Changes in international conventions and domestic legislation have a great impact in the cash flow of oil companies. Solutions must take into consideration technical, environmental, and economic parameters, avoiding unfounded and ineffective restrictive policies that can affect the continuation of long-term investment commitments in the sector.

One of the issues being currently considered by regulators is the concern over the financial capability of buyers; the exit of majors or transference of leases from large operating companies to smaller ones. When leases are marginally funded, the risk of non-compliance increases. One solution would be that both the original assignor of the lease and the new lease owner would be co-responsible for ex-post compliance associated with the original facilities.

Regulatory trends points to some very complex issues including pipeline flushing and decommissioning, shell mounds (drill cuttings, mud, covered by mussel shells), time limit enforcement for decommissioning operations, tightening of bonding requirements to guarantee decommissioning funding, ban on explosives, recycling, re-utilization (recommissioning), and commercialization of redundant facilities.

For internal waters, the closest maritime zone to the land, including waters between shore and Territorial Sea (bays, rivers, lakes, lagoons, channels, archipelagic waters, seabed and subsoil), international treaties and conventions are only recommendatory in nature and the discretion of the coastal nation is considerable. Therefore, costal nations are completely sovereign in regulating the decommissioning of redundant offshore installations within their internal waters.

3.3. HISTORICAL OVERVIEW

The first important international acknowledgement of potential problems related to the abandonment of offshore installations occurred in the *1958 Geneva Convention on the Continental Shelf.* The first offshore decommissioning record encountered in the literature comes from GOM in 1973 (GRIFFIN, 1998a). The Phillips Petroleum (Norway) has conducted studies of potential decommissioning costs in 1975 and 1979 (PHILLIPS, 1999b; NPD, 1999).

Although decommissioning operations have been occurring for almost 30 years (specially in the GOM), arising interest on this issue was only triggered during the development of the Brent Spar decommissioning episode (**Figure 3.2**). This notorious episode started in 1995 with the Royal Dutch Shell's decision to dump a redundant buoy in the North Sea. Thirteen options were reviewed and after four years of studies, Shell decided to sink Brent Spar in deep waters (around 1,830 meters). The onshore disposal of the buoy was considered too risky, and would cost 400% more than dumping it.

At that time, Greenpeace used the media very efficiently. As a result, protesters attacked gas stations in Germany and a very effective boycott was launched (it spoiled 30% of retail in Germany). At the same time, Greenpeace activists occupied Brent Spar. The aftermath of this campaign was that the great majority of European Governments were against dumping Brent

Spar. Brent Spar was sent to Norway where it was dismantled and disposed of on land[10]. The decommissioning of Brent Spar cost Shell approximately US$ 77.4 million, not including the economic impacts of the boycott (FERREIRA, 1999). Greenpeace strategy was indeed successful; a milestone in time was established and its consequences changed the path of the industry (GROVE-WHITE, 1997). It was the first large ex-post operation in the North Sea Province and there were over 70 large facilities to be decommissioned in the following years (**Figure 3.3**). Brent Spar set an unsettling precedent for the oil industry and several lessons can be learned from this event:

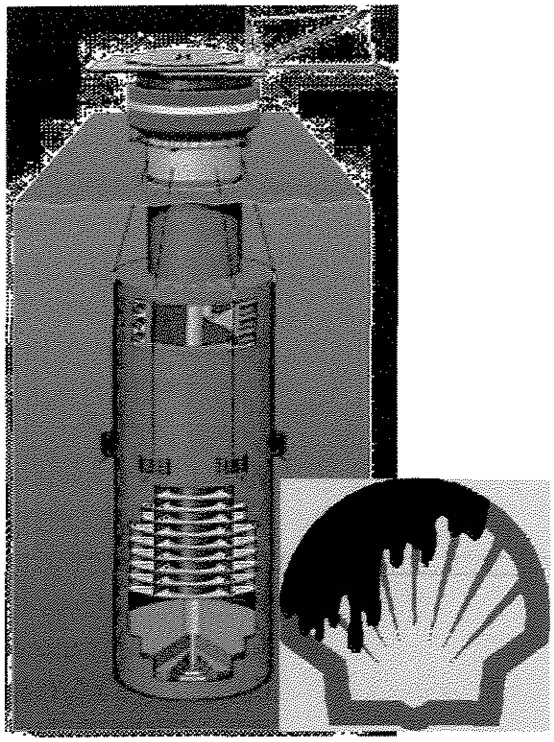


Figure 3.2. Brent Spar and the stained Shell's logo (Shell, 1995; Greenpeace, 1995)

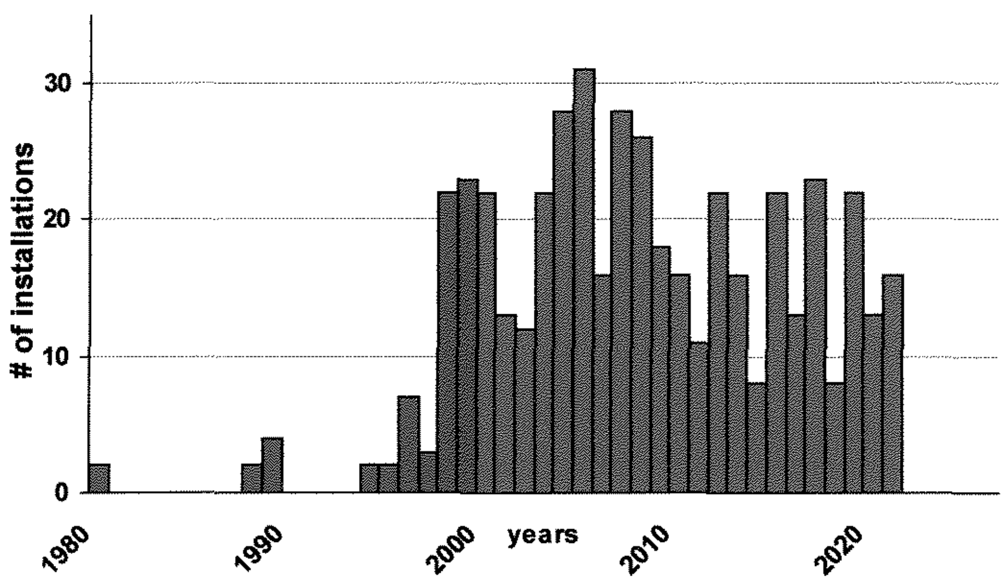


Figure 3.3. North Sea Decommissioning Timetable (GRIFFIN, 2000a).

[10] The Shell Oil Company had to go far beyond regulatory requirements to satisfy public and interest groups demands. The buoy was completely removed, transported to shore, and cut into ring sections. Part of the rings was used in the construction of a pier in the Norwegian coast (SHELL, 1998).

- Shell should have trained a crisis management team to anticipate potential societal problems and promptly act to prevent ex-post damages to its image.
- Shell should have invited to the decision-making process all interested stakeholders, including the general public;
- People's emotional reactions should have been treated as a crucial parameter;
- Shell should have communicated with the public more efficiently and, before crisis erupted, provided education on the subject to all key stakeholders, mainly the media;
- Compliance with all international, regional, and domestic policies might not necessarily satisfy the expectations of public and interest groups. When oil companies are pressured by public opinion, they will be compelled to surpass current regulations and even scientific recommendations, despite significant economic impacts.

Brent Spar cannot be blamed alone for such abrupt public interest on decommissioning activities. The first major round of important decommissioning operations involving large installations was expected for the end of the 1990s and interest groups may have seen the Brent Spar Buoy as an ideal opportunity to state their case. Besides, increasingly public involvement had made government economics more transparent and decommissioning costs, which are usually tax-deductible, became public. In addition, as mentioned, this chain of events coincided with the climax of the international sustainable development agenda (NERC, 1996, 1998).

3.4. DECOMMISSIONING OFFSHORE INSTALLATIONS

According to MARTIN (2000), "all platforms are not created equal". Offshore platforms can be designed for a variety of needs, environments, and purposes (drilling, production, storage, utilities, accommodation, etc.). Parameters such as water depth, distance from shore, environment setting, and climate, prescribe the appropriate type of installation and make them unique and site-specific (GRIFFIN, 2000a). The most common types are: steel jacketed platform for shallow waters; mini-jacket (for marginal-field development); concrete gravity structure; steel gravity structure (jack-up); steel jacketed platform for deep waters; tension leg platform (TLP); compliant tower; semi-submersible platform; spar buoy; and floating production system (FPSO, FSO, etc.) (**Figure 3.4**).

The steel jacketed (frame-shaped) platform is the most common platform type comprising approximately 80% to 95% of all installations in place worldwide. Steel jacket structures weight between 400 and 77,000 tons, including both superstructure and substructure. Steel jackets are usually installed in waters with depths ranging from 10 to 200 meters.

Gravity base platforms are typically used in depths ranging between 70 and 200 meters, but there are exceptions. Their superstructures can weight from 11,000 to 54,000 tons and their substructure between 130,000 and 800,000 tons (POREMSKI, 1998). According to NORSKE SHELL EXPLORATION AND PRODUCTION (1999), the world's tallest gravity base concrete production platform, the Troll A platform, is located at the giant Troll Field, Europe's largest offshore gas field. Troll A's gravity base structure weights 656,000 tons. Its total height is 472 meters (from top to bottom) and its total weight is 1,050,000 tons. Troll A is located 65 km from shore in 303 meters of water column. The construction contract including mechanical outfitting was awarded to Norwegian Contractors in March of 1991. The value of the contract was US$ 475.35 million (NORSKE SHELL EXPLORATION AND PRODUCTION, 1999). The platform is sited 80 km NW of Bergen, Norway OCS (**Figure 3.5**).

The largest semi-submersible platform, the P-36, was operating at Campos Basin in Brazil until it sunk in 2001 killing 11 Petrobrás employees (**Figure 3.6**). It weighted 32,000 tons and was 120 meters high. Two world records were expected to be broken with P-36: production volume (180,000 bbl/day of oil and 7.2 million cubic meters/day of natural gas) and completion in deep waters (1,360 meters). Twenty-one wells were connected to P-36 comprising 15% of the total Brazilian production until 2000 (ANP, 2000b). Unfortunately, P-36 cannot be recovered, recommissioned, or be used as an artificial reef. At the present depth, 1,360 meters, the ecosystem cannot be improved by P-36's presence. Other legal issues have emerged from the episode. A Norwegian insurance company has made an agreement with the family of most victims in a much-criticized deal where each family should receive approximately US$ 29,000 (O GLOBO, 2003). This episode should call the attention for issues related to accidental damages and instruments that are more efficient and fair.

Usually, offshore installations are planned for approximately 20-year projects but most platforms can have a functional life that ranges from 30 to 40 years. At the end of this period, after production ends, unless the platform is reused *in situ* or relocated, it must be decommissioned. The main predicament is that most offshore structures were not designed to be removed.

The number of installations going into decommissioning varies greatly according to the life of the reservoir, time of installation, oil price, and other economic factors, making it difficult to forecast a precise decommissioning schedule. The present scenario is that many aging offshore fields around the world, mainly in GOM and in the North Sea, are near the end of their productive lives. Many of them have already economically depleted their resources (COLEMAN, 1998). In the United States Outer Continental Shelf (OCS), platform decommissioning rate is increasing and, in some instances, going beyond the installation rate. Over 35% of all offshore projects in the US are over 25-year old (MMS, 1999a). According to PERRY III et al. (1998), approximately 620 wells are plugged and abandoned every year in the US. WATSON (1998) indicates that 120 to 150 platforms are removed every year only in the GOM. The Minerals Management Service (MMS) confirms this information and forecasts that 100 to 200 structures will be decommissioned each year (BUFFINGTON, 1996; MARTIN, 2000). Figure 3.7 shows GOM's average platform installations and removals from 1987 to 1999, Figure 3.8 projects future GOM's decommissioning activities up until 2020, and Figure 3.9 indicates the average decommissioning cost per ton.

3.5. DECOMMISSIONING OPTIONS

Establishing a single decommissioning solution for all offshore installations would be unrealistic. The variety of possible combinations of installations and settings, the number of possible combinations of decommissioning options, and, most importantly, large amounts of money involved, make this subject a very complex and politicized matter. **Figure 3.10** indicates the main removal and disposal options for offshore installations.

Most national legal provisions allow oil companies to suggest a decommissioning plan, being the applicable authority responsible for making the final decision, accepting, rejecting, or requiring modifications to the original plan. The decommissioning plan presented by a company usually details all considered options stating the basis for the recommendation. **Figure 3.11** indicates some detailed removal and disposal options for some offshore facilities and components.

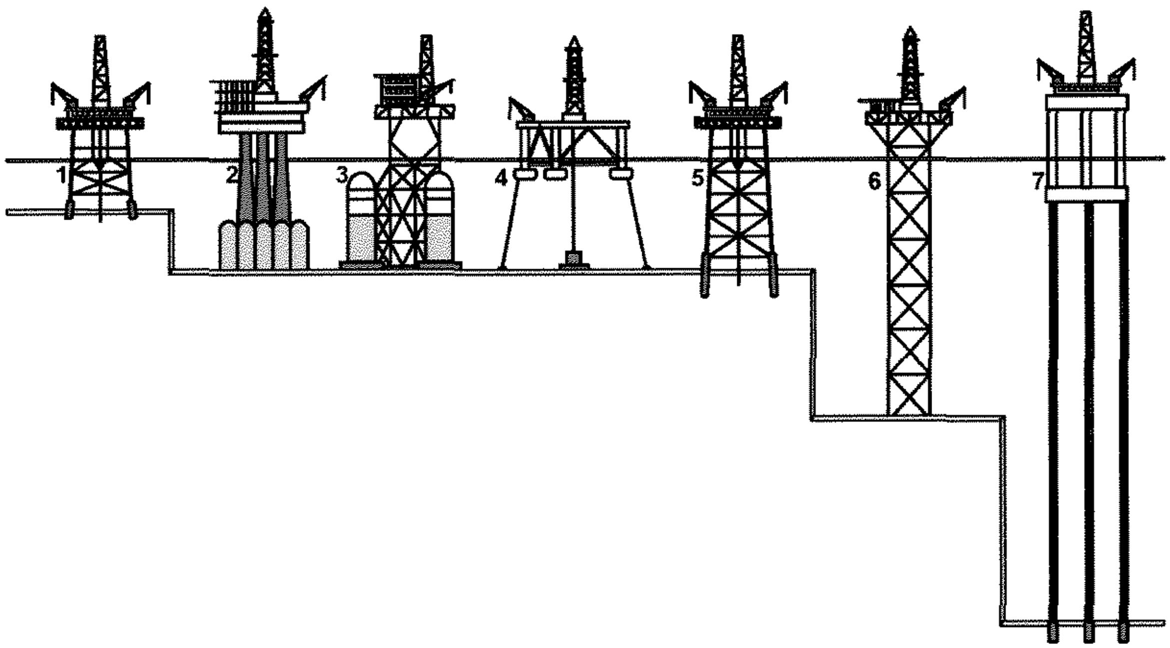


Figure 3.4. Platform types. (1) Steel jacketed platform (shallow water); (2) concrete gravity structure; (3) steel gravity structure; (4) floating production system; (5) steel jacketed platform (deep water); (6) compliant tower; and (7) tension leg platform (GRIFFIN, 2000a).

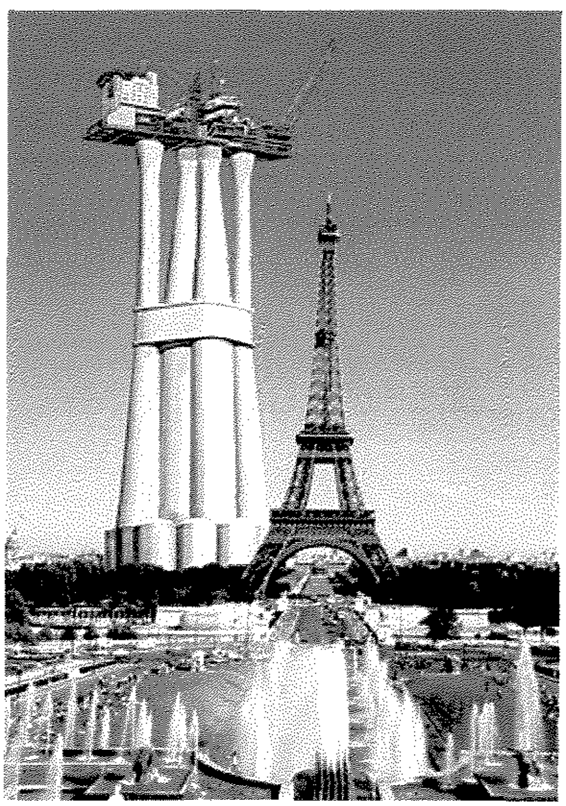


Figure 3.5. Artist's impression of the Troll A platform superimposed on a photograph of Paris (NORSKE SHELL EXPLORATION AND PRODUCTION, 1999).

Figure 3.6. Sinking Petrobras' P-36 (FOLHA ONLINE, 2001).

Under strict decommissioning rules, items located towards the bottom of the illustration tend to be more complex and costly. Ex-post environmental remediation costs for these items are expected to rise in the future due to new rules and more rigorous clean-up standards (JOHNSTONE *et al.*, 1995). Some items, such as concrete gravity, in addition to complex and expensive operations, may pose serious safety risks. As mentioned, new guidelines and rules for pipeline and drill cuttings removal and disposal are currently being discussed (CAMPBELL, 2000).

According to GRIFFIN (1998c), only some 600 large installations, less than 10% of total World platform population, have a greater potential to prompt major controversies. In order to exemplify this controversy, PITTARD (1997) suggests that only around 3% of the word's installations should be candidates for partial removal. The spotlight of the dispute is certainly expected to be on large fixed platforms. **Figure 3.12** depicts a comparative illustration of small and large platforms.

The main argument used by interest groups to call for a ban on partial removal is the potential environmental impact generated by this option. This position has been questioned by the industry, which claims that environmental impacts resulting from different decommissioning options are negligible. Structures are cleaned before they are decommissioned and little environmental impact is expected from substructures. According to the industry, parameters such as cost, safety of personnel involved, and technical practicability, should preponderate in the decision-making process (UKOOA, 1995). As previously mentioned, the adoption of high cost solutions offers only marginal or debatable environmental benefits.

Interest groups challenge industry's reasoning by evoking the Precautionary Principle: "*preventative measures are to be taken when there are reasonable grounds for concern that substances or energy introduced, directly or indirectly, will bring about hazards to human health, harm living resources and ecosystems, or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship between the inputs and the effects*" (GREENPEACE, 1995).

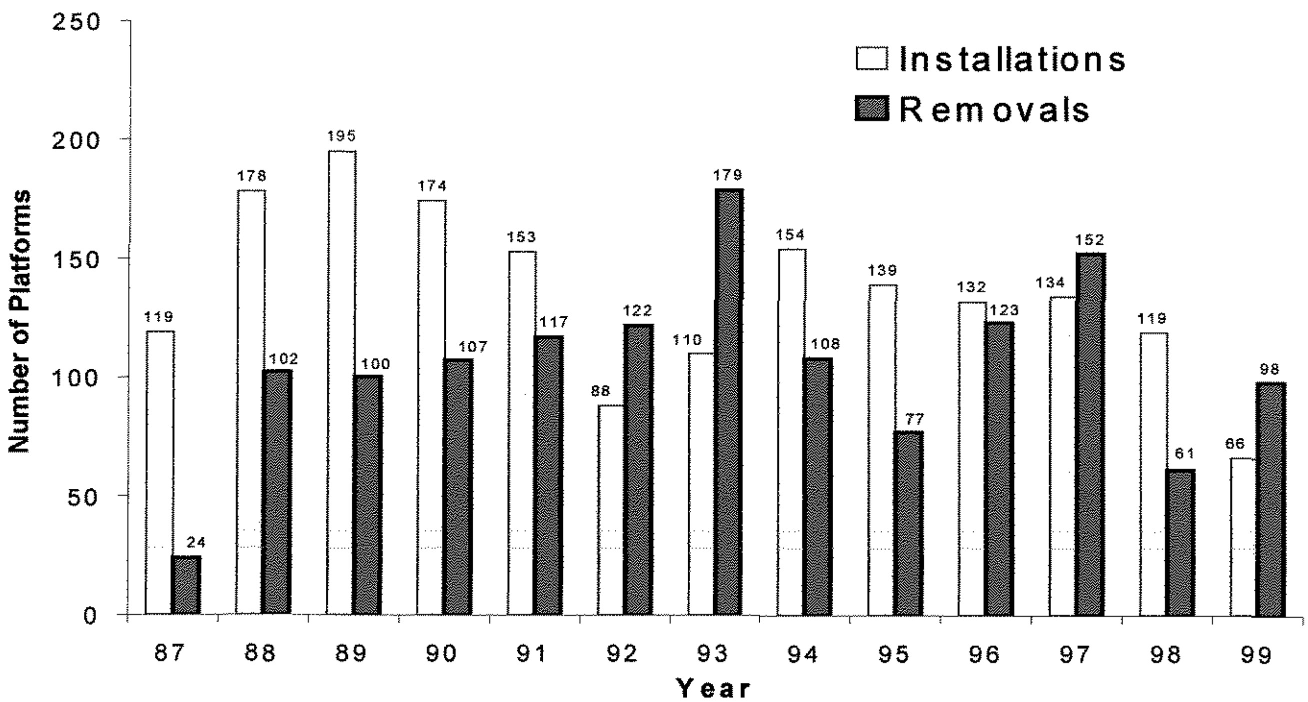


Figure 3.7. GOM average platform installations and removals from 1987 to 1999 (source: MARTIN, 2000)

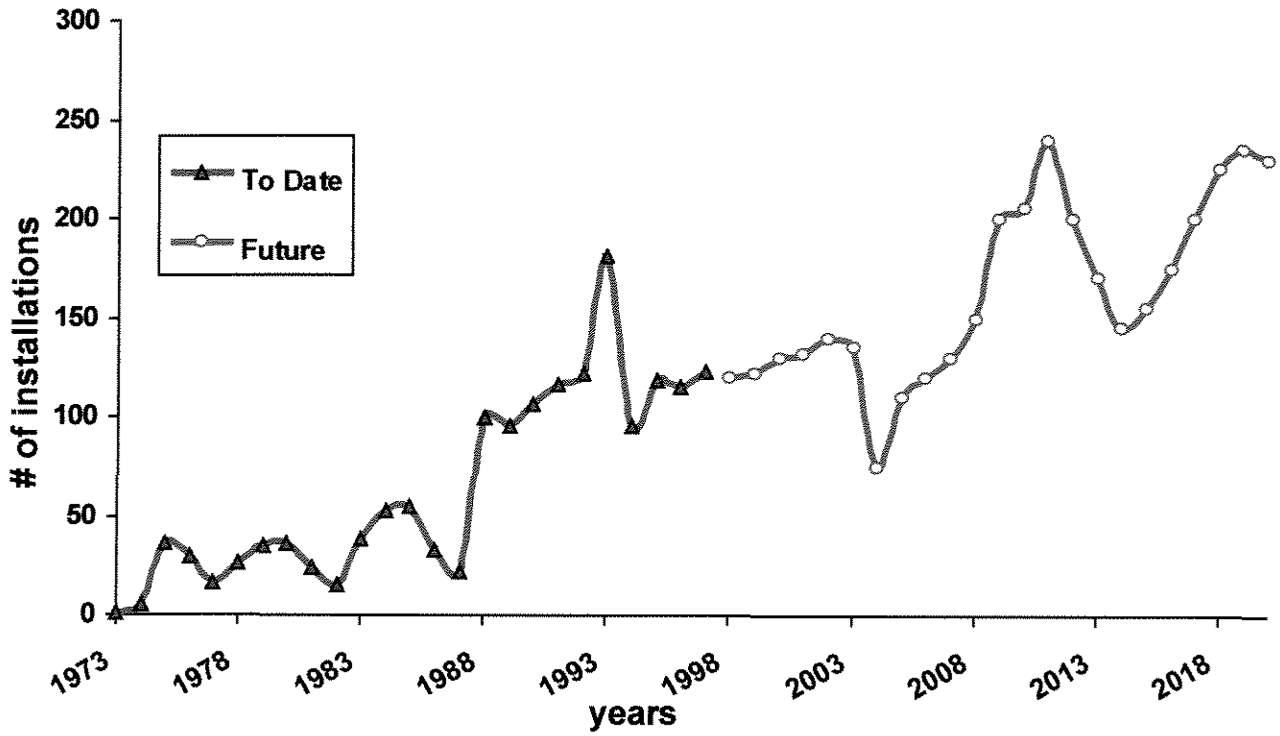
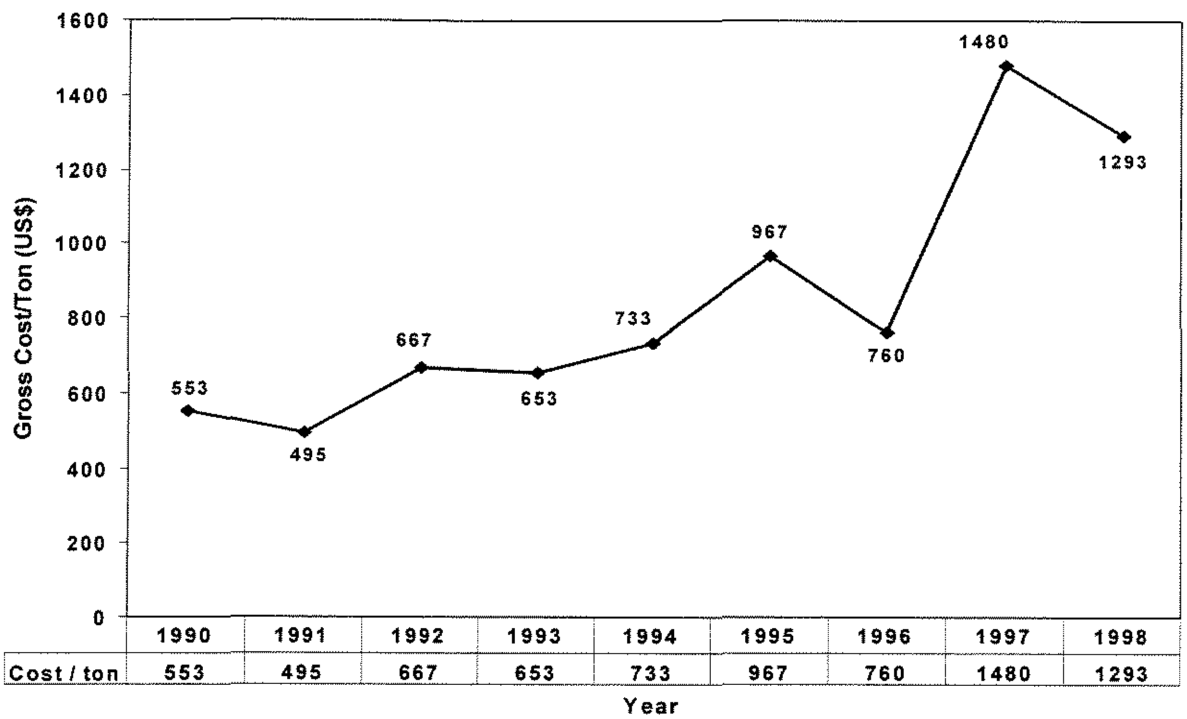


Figure 3.8. GOM's present and future decommissions (source: MARTIN, 2000)



	1990	1991	1992	1993	1994	1995	1996	1997	1998
Cost / ton	553	495	667	653	733	967	760	1480	1293

Figure 3.9. GOM decommissioning cost per ton. Gross Cost Per Ton considers all decommissioning costs except well P&A dived by total facility weight, including jackets, piles, and topsides, based on 54 actual platform removals. Source: TWACHTMAN SNYDER & BYRD, Inc., 1999).

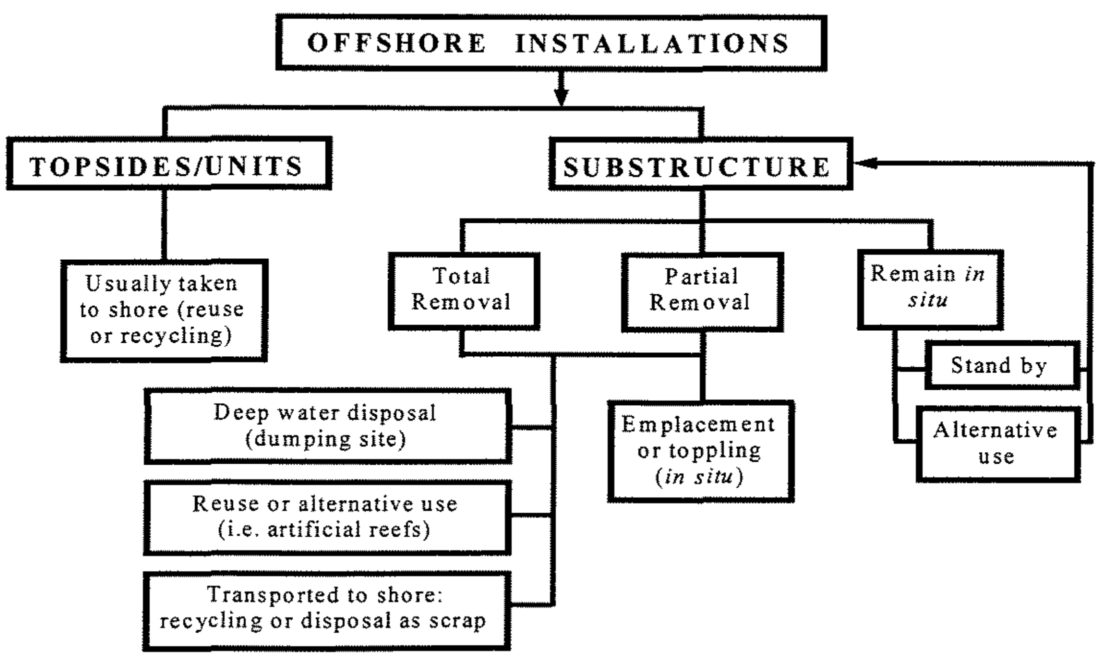


Figure 3.10. Decommissioning options and endpoints for topsides and substructures (sources: PRASTHOFER, 1998; UKOOA, 1995; ATHANASSOPOULOS et al., 1999 and ODCP, 1998).

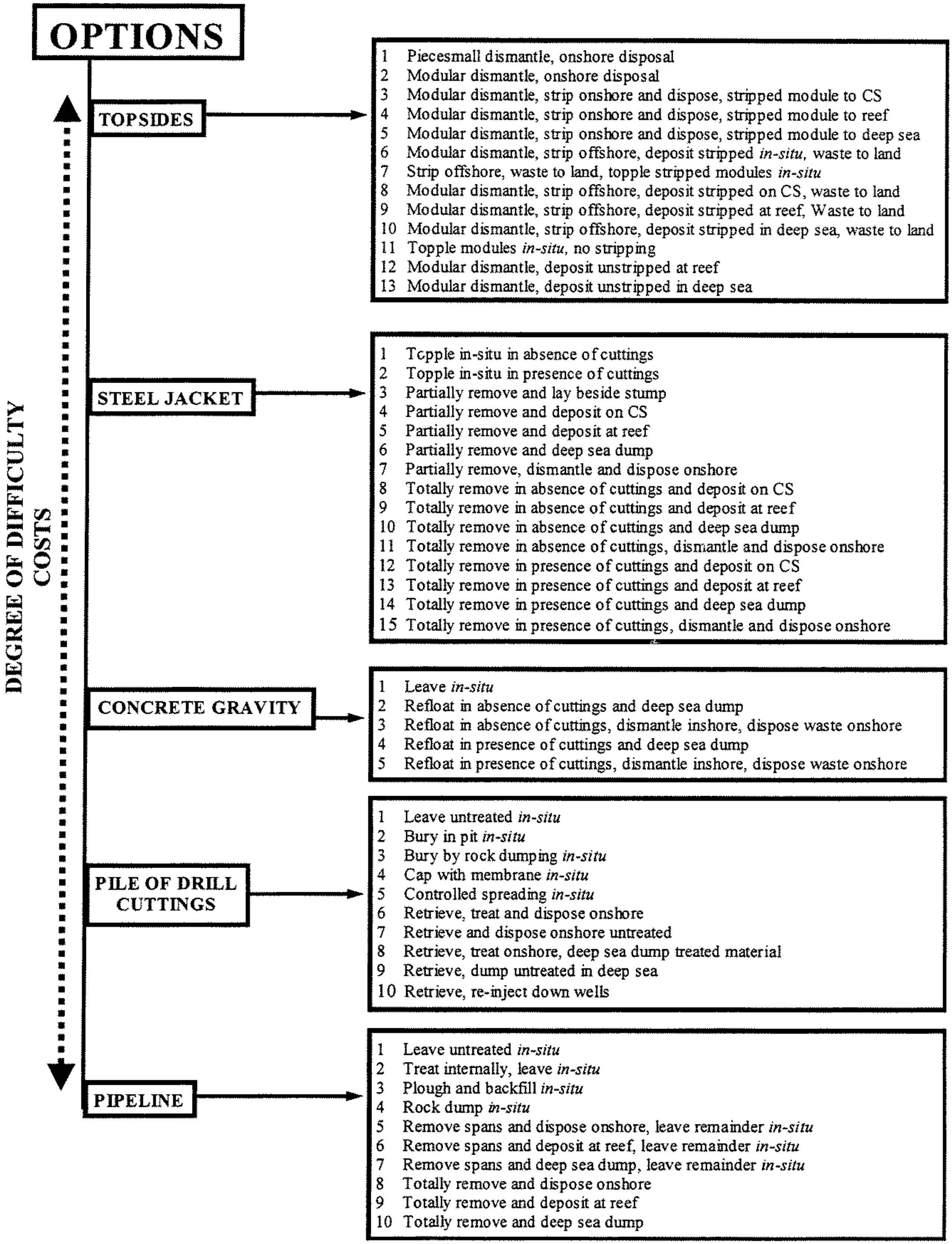


Figure 3.11. Variants for removal and disposal alternatives for different structures and needs (UKOOA, 1995 - modified).

The fact is that once public opinion is engaged in demanding total decommissioning, the matter becomes highly politicized and companies are forced to adopt economically unsound solutions, as it happened in the Brent Spar case. This scenario seems to indicate that two main aspects are fueling the total or partial decommissioning dilemma: the amount of money involved in the decommissioning process, and a feeling of "public mistrust" towards the oil industry. Indeed, the Brent Spar episode has brought the necessary attention to the matter and the public felt that oil companies should not be trusted. As a result, even though it can be argued that environmental benefits of "total removal" against "partial removal" are only marginal, and, in some cases, leaving the structure in place would increase the ecosystem value, public opinion tend to go in the opposite direction. According to ATHANASSOPOULOS et al. (1999), the main public objection in regard to the presence of non-producing installations in California would be the perceived damage to the scenic ocean-views.

An innovative approach used by Phillips/66 Norway to manage upcoming decommissioning operations has received the approval of Greenpeace. Recently, Phillips/66 Norway invited all interested stakeholders to present their opinion during the decision-making process for the decommissioning of oil platforms from the North Sea Ekofisk I field (public involvement plus transparency). As a result, Greenpeace welcomed Phillips/66 Norway's proposal for the decommissioning of all fourteen steel oil platforms from Ekofisk I. According to Greenpeace, since it will be by far the largest upcoming decommissioning project in the North Sea, these operations should boost the development of the onshore decommissioning industry. Over the next few years, fourteen steel platforms and one concrete offshore installation will be decommissioned, dismantled, and taken onshore (PHILLIPS, 1999a, 1999d).

Greenpeace has still criticized Phillips for its intention to leave drilling muds below the platforms on the seabed. According to the environmental organization, "*this will be the next major issue where the oil companies will have to face their industrial responsibility to clean up their acts*" (GREENPEACE, 1999).

The attenuation of impacts caused by decommissioning expenditure depends on planning and proper project administration, allowing significant cost and liability reduction. To some specific segments, decommissioning has become a great market opportunity. Offshore structures and their components are being regarded as assets (scrap, resale or reuse) and economic impacts are being reduced.

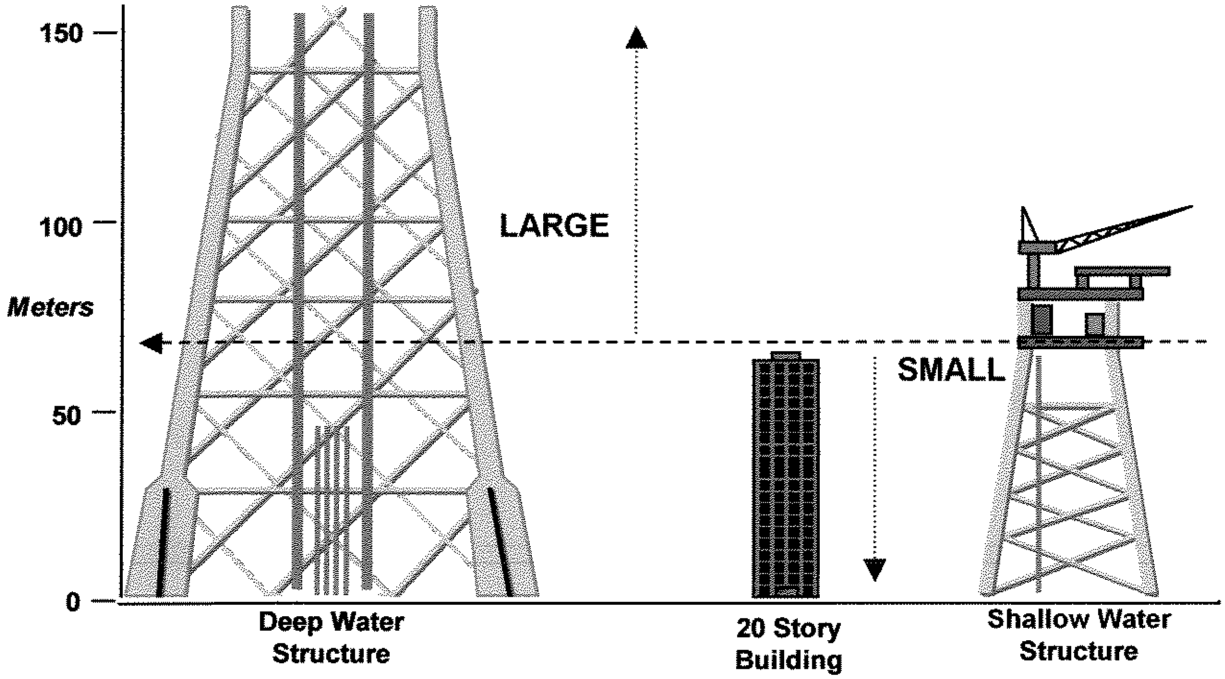


Figure 3.12. Comparative scale indicating the size of small and large structures compared to a 20-story building (Griffin, 2001 – modified).

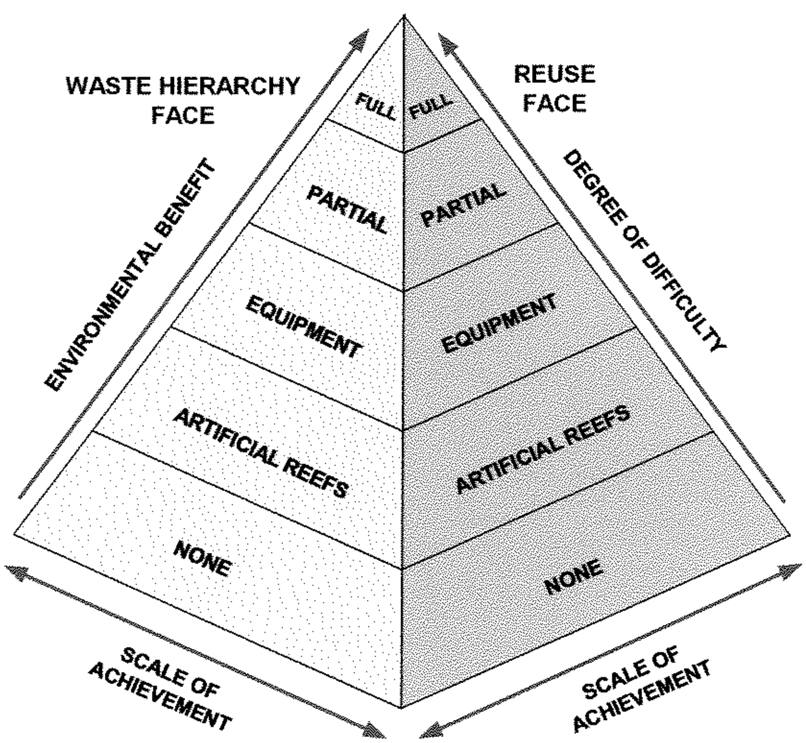


Figure 3.13. Environmental character of the reutilization principle (TILLING, 2001 – modified).

In the GOM Region, scrap credit is approximately US$ 100/ton (O'CONNOR, 2000). Independent contractors are also positioning themselves in the ex-post market including recycling centers, re-adaptation facilities, used platform brokers, etc. (THORTON, 1997). In addition, in the attempt to maximize investments by delaying ex-post costs as much as possible, maintenance and modifications services are increasingly being required. Clearly, this is boosting the sector.

Regarding the reuse of offshore facilities, best practice in GOM suggests that 10% of facilities being reused at the end of field life would be an ambitious goal. In the majority of cases, there will be no alternative to scrapping, salvaging the high value components, and recycling the remaining materials (SILK, 2001).

In most cases, the resale value of old offshore structures, equipment, and parts of it, will not be sufficient to generate enough revenue to cover decommissioning costs. Due to marketability and technical practicability, several companies are not motivated to pursue reuse options, also called recommissioning. The industry is joining forces with authorities searching for strategies to change this "culture", promoting the reutilization of components and recommissioning of facilities.

On the other hand, TWACHTMAN (1997) points out that rising costs for fabrication of new decks, jackets, and pilings, are stimulating the commercialization of decommissioned platform components. Providing that not many modifications are required in the old platform, the use of decommissioned platforms will avoid costly fabrication costs, and even anticipate first-oil. In fact, at least in GOM, the market for used platforms has increased. According to THORTON (2001), each year in GOM, around 100-120 platforms are salvaged (supply), and 120-140 new platforms are installed (demand). Only 35% to 50% are suitable in age and conditions for recommissioning, but no more than 20% of the decks and 10% of the jackets are in fact reused. The first platform reutilization occurrence was recorded in 1967 when Humble Oil moved and reused South Pass 36A (O'CONNOR, 1999).

Most modules contain equipment that are installation-specific and may not be readily reusable in other installations (i.e. equipment from power generator modules, wellhead modules, processing module, accommodation modules, and safety-related facilities). Adaptations of equipments from redundant facilities may incur discouraging costs. New installation requirements may expect features that cannot be accommodated by old installations or can imply unacceptable expenditure (WATSON, 1998). PRASTHOFER (1998) indicates the difficulty in

ensuring the integrity of structures that may be 20 to 30 years old. Additionally, there is the issue of meeting new decommissioning requirements.

WATSON (1998) indicates that parameters that might benefit the reuse market are: (1) high-value; (2) long delivery period for new installations[11]; (3) good match between what is offered and future needs; (4) an age of less than 10 years; and (5) an engineering mindset and reuse culture. Equipment such as power generators, water injection devices, and other items not affected by corrosion, have high potential reuse value; at least when a good match is found. Used equipment should offer competitive prices, cost-effectiveness, and acceptable safety levels. In addition, reused equipment may offer cost, schedule and image benefits. Those in the market are challenged with an extremely conservative industry that requires proven technology, risk evasion, and are extremely sensitive to oil spills. **Table 3.1**, as proposed by WATSON (1998), indicates a comparison between costs associated with getting a new installation and a refurbished one.

TILLING (2001) proposes a nonexclusive criterion for evaluating the possibility of reusing platforms and "who" would be best handling each criterion among stakeholders. **Appendix 2** suggests a similar approach in order to evaluate the possibility of recommissioning. Each criterion has 50-50 chances to succeed. A perfect match is indeed very improbable. **Figure 3.13** illustrates the environmental character of the reutilization principle related to the degree of difficulty.

TABLE 3.1. COST COMPARISON: REFURBISHED vs. NEW

		Refurbished	New
Engineering & Management		200,000	240,000
Jacket & Piles		650,000	1,225,000
Deck		365,000	965,000
Installation		600,000	600,000
Miscellaneous		100,000	700,000
	Total	**1,915,000**	**3,730,000**

WATSON (1998) - modified

If reuse is a real option, timing must also be adjusted (**Figure 3.14**). Other important factors for a successful reutilization project include matching of technical requirements, sufficient time to match market parties, detailed intelligence network, full technical and maintenance records, a set of guidelines[12], and an extremely knowledgeable project team (RIK, 2001; BECK,

[11] The availability of marginal fields requires the reduction of the time between the decision to develop and the first oil flow.
[12] Several large oil corporations have join together to develop guidelines for platform reutilization (BECK, 2001).

2001). In addition, liability conditions must be clearly defined. **Table 3.2** illustrates a successful case history.

TABLE 3.2. CASE HISTORY – EI 300 A - GOM	
Drilling/Production	60.5 meters (water depth)
OD Piles	1.5 - 14.5 meters
Installed	1981
Removed	1996
Deck Sold	1997
	Costs in $MM
Removal preparation cost	0.057
Removal cost	1.121
Site clearance	0.020
PM/Engineering	0.144
Gross Cost	1.342
Deck Sale	0.635
Net Cost	***0.707***
Source: BECK (2001)	

If leaving the platform fully in place is an option, maintenance and surveillance will be required. In certain circumstances, a company may decide to leave an installation in place for a period (*stand by*) or even give it an alternative use (meteorological, geologic, oceanographic and seismologic offshore research facilities, lighthouses, monitoring stations, field laboratories, commercial enterprises such as marine culture and tourism, etc.). In all circumstances, the installation must be completely cleaned, monitored, and, eventually, decommissioned.

As mentioned above, reutilization alternatives may include non-petroleum considerations (*in situ* or relocated). Two very interesting alternative uses given to offshore platforms are: (1) the Sea Launch Co., a partnership between Boeing Commercial Space Co., Kvaerner Maritime A.S. (a vessel builder from Norway), RSC Energia of Moscow, the Russian Government, and the KB Yuzhnoye/PO Yuzhmash of Ukraine (SEA LAUNCH CO., 1999). The Sea Launch Co. provides marine-based commercial satellite launches from a converted Norwegian oil-floating platform in the equatorial Pacific Ocean (**Figure 3.15**); and (2) economic feasibility studies are underway to test the viability of reusing offshore installations as platforms to generate eolic electricity using Wind Energy Converters (OWEC) and other renewable energy systems in the North Sea. The main motivation is to offer an alternative to near term decommissioning.

The comparison between several decommissioning options (toppling, partial removal and total removal) is strongly influenced by the energy cost of replacing material that is lost in the process. This is an externalized cost not borne by companies that if ignored may turn options such as toppling more attractive in this respect (UKOOA, 1995).

The industry needs comprehensive region-specific studies on the socio-economic impacts of available decommissioning options in order to internalize decommissioning costs more accurately into its decision-making process. The internalization is complete when the fees equal the marginal external damages (CARRARO, 1999). Additionally, the elaboration of complex models that can embrace most relevant issues (environmental and societal) would be an alternative approach for obtaining balanced results that could be more efficiently communicated to stakeholders.

In order to identify the preferred decommissioning options, HUGHES and FISH (1999) suggests a technique based on the methodology developed by KEPNER and TREGOE (1981), often used to evaluate bid proposals. This methodology consists in assigning scores to each option based on predetermined selection criteria for objectives in order to arrive at a ranking for the options. When all legal requirements have been met and all legal options have been identified, the oil company would consider the following objectives: Environmental, safety, technical feasibility, cost, and public acceptability. The Kepner-Tregoe analysis method[13] is outlined bellow in steps, as described by HUGHES and FISH (1999):

- Establishment of objectives, which each of the decommissioning options is to be evaluated against.
- Classification of objectives into two categories: "mandatory" and "desirable".
- Attribution of weighting (ranking) to each "desirable" objective, indicating its relative importance, assigning the highest weighting to the most important objective.
- Selection of all options that will be considered.
- Identification of all options that satisfy "mandatory" objectives. The remaining options are discarded.
- For each "desirable" objective, a score to each decommissioning option should be assigned. Judgments can be based on qualitative or quantitative considerations, but are best arrived at as a team, rather than individual effort.

[13] This approach described by KEPNER and TREGOE (1981) dates from the 1970s. This method is widely known and allows it to act as a shared language amongst its users.

- For each decommissioning option, calculate the weighted score for each "desirable" objective. Then calculate the total weighted score for each option.
- The preferred decommissioning option(s) are the ones having the highest weighted score.
- Analyze the sensitivity of the ranking to the weightings.
- For the decommissioning options having the highest scores, consider potential problems including option not feasible at the time of decommissioning and problems occurring during the actual decommissioning. Score the probability of failure for each decommissioning option (high, medium or low). Use **Table 3.3** to evaluate if the possibilities of failure are acceptable.
- Decide on the preferred option.
- **Table 3.4** shows, according to HUGHES and FISH (1999), a summarization of the results of the application of Kepner-Tregoe analysis.

TABLE 3.3. RISK ASSESSMENT BASED ON PROBABILITY OF OCCURRENCE AND CONSEQUENCES

Probability of occurrence	Consequences	Is failure acceptable
High	High	No
High	Moderate	No
High	Low	Yes
Moderate	High	No
Moderate	Moderate	Yes
Moderate	Low	Yes
Low	High	Yes
Low	Moderate	Yes
Low	Low	Yes

HUGHES and FISH (1999) modified.

TABLE 3.4. SELECTED DISPOSAL ROUTE

	Highest Score	Recommended
Jackets	Alternative Use	Recycle Onshore
Topsides	Alternative Use	Recycle Onshore
Subsea Structures	Remove and Reuse	Recycle Onshore
Pipelines	Leave in Place	Leave in Place
Umbilicals & Flexible Pipelines	Leave in Place	Leave in Place

HUGHES and FISH (1999) modified.

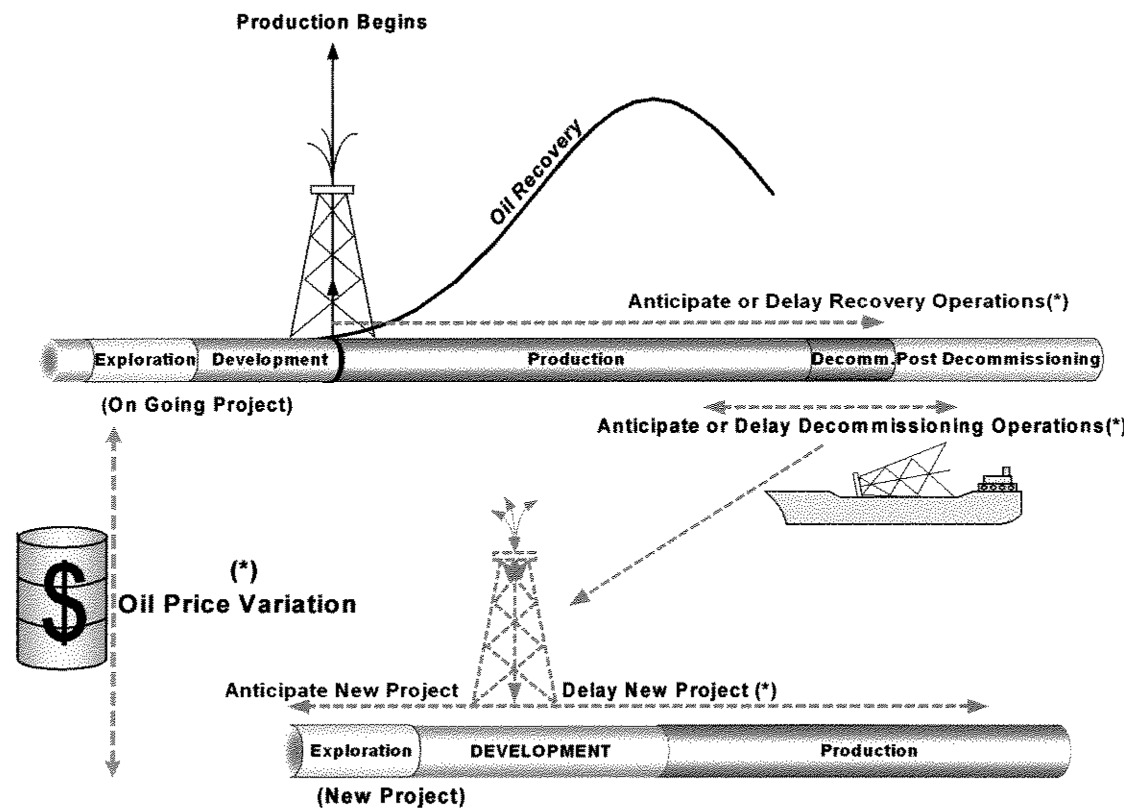


Figure 3.14. Reuse timing adjustment. When a match is achieved for the reuse of a platform, timing also has to be matched. Recovery and decommissioning must be adjusted. Oil price is, most of the times, the main variable.

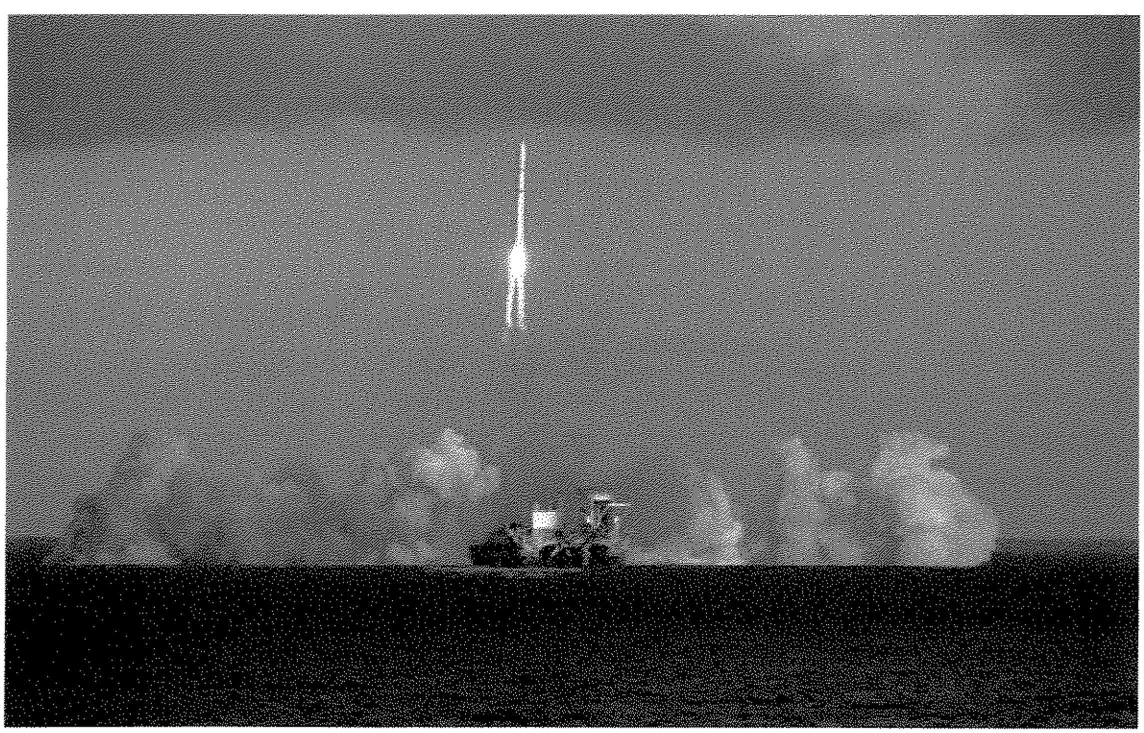


Figure 3.15. Sea Launch Lift (courtesy of SEA LAUNCH CO.).

3.6. THE US RIGS-TO-REEF PROGRAM

Offshore facilities attract a variety of marine creatures to their reef-like structure (DITTY et al., 1997) (**Figure 3.16**). Marine organisms are not the only wildlife attracted to offshore facilities. Every spring and fall, several species of neotropical migrating birds use GOM platforms as resting places during adverse weather conditions. Thousands of Monarch butterflies also use GOM platforms as resting spots during their migration across the gulf (MMS, 2000b, 2000c).

Productive offshore oil and gas structures form one of the world's most extensive defacto artificial reef systems (DAUTERIVE, 2000a). Removal of redundant facilities is not only a financial liability for the petroleum industry but can be a loss of productive marine habitat (KASPRZAK, 2000).

The Louisiana Department of Wildlife and Fisheries, in the United States, manages one of the most active artificial reefs program in the world. One of the reasons for this is that through December 1999 over 1835 rigs were removed from the GOM. This program was designed to take advantage of fishing habitat opportunities offered by these obsolete platforms (KASPRZAK, 2000). Other materials have been tested as substrate for artificial reefs including aircrafts, war tanks, subway cars, etc.

In 1977, Mobil Oil requested permission of the US government to modify and abandon *in situ* the accidental wreckage of the drilling rig Topper III as an artificial reef at 143 Km from the coast of Texas (REGGIO, 1989). After a number of success histories, US authorities established programs allowing the use of abandoned offshore structures in the construction of artificial reefs. Offshore structures are the ideal substrate form marine life because of their weight and durability.

US legislation enabled oil companies to donate offshore structures to entities such as the Texas Parks and Wildlife Department (TPWD). Along with structure donation, companies are required to pay a fee equivalent to half of the total decommissioning cost saved (removal and cleanup), or negotiate an alternative "contribution" with the applicable authority (MMS, 1987, 1997a, 2000b, 2000c; DAUTERIVE, 2000a, 2000b). These fees provide the means to the implementation and maintenance of a controversial artificial reef program called *Rigs to Reefs*.

Sometimes contingencies may anticipate decommissioning, as it is the case of several platforms destroyed by hurricanes in GOM. When such accidents occur, platforms are left *in*

situ. In 1992, Hurricane Andrew destroyed or damaged over 181 active platforms and caissons, five of which subsequently entered the Louisiana Artificial Reef Program (KASPRZAK, 1998).

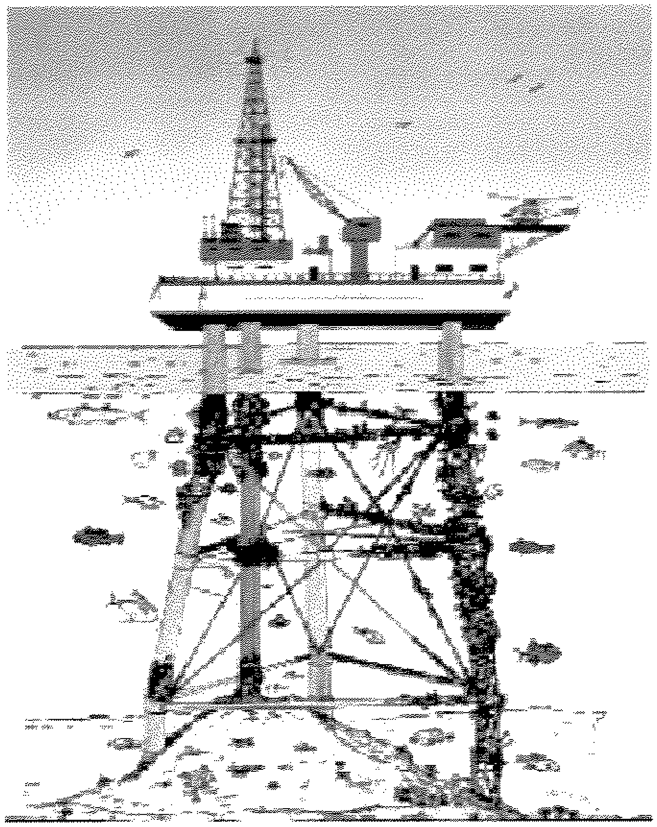


Figure 3.16. Islands of Life. Marine organisms attach themselves onto the hard substrate of offshore structures initializing the food chain which leads to the creation of a unique ecosystem that ends when platforms are removed. This areas work as a fish recharge area helping our overfished oceans (Photo: MMS, 2000c).

By the end of 1998, approximately 125 offshore structures (around 10% of all decommissioned structures) had been placed on the seabed at disposal sites as permanent artificial reefs. The states of Louisiana and Texas have received over US$ 15 million from projects they have sponsored (REGGIO, 1998). **Table 3.5** shows an estimate of potential opportunities to reduce decommissioning costs by implementing the Rigs-to-Reefs program. In California, the Rigs-to-Reefs Bill has been resubmitted to the State Senate and Assembly in 2001. Since this bill has been withdrawn before, the industry is teaming up with non-industry supporters (non-profit public benefit organizations, sport fisherman, divers, environmentalists and conservationists) in order to establish an active advocacy through communications and presentations (STEINBACH, 2000). All the uncertainty involving potential ecological benefits of California artificial reefs and residual liabilities that would be ultimately transferred to government entities seems to be a unsurpassable roadblock in the negotiating process (ATHANASSOPOULOS et al., 1999). Other issues concerning the ecology of decommissioning options can be found in MCGINNIS (2001).

TABLE 3.5. RIGS-TO-REEF OPPORTUNITY TO REDUCE COSTS IN CALIFORNIA

	(US$ million)
Full Removal Cost Estimate	1,253
Rigs-to-Reefs Cost Estimate	595
Savings (Before Donations)	658

Source: STEINBACH (2000)

The MMS maintains a partnership with state agencies for the establishment of these artificial reefs. Before being sent to a designated location, structures are cleaned. Then, the company donates the structure to the State, transports, and places them in a designated area. The State assumes all residual liabilities.

Artificial reefs not only improve certain ecosystems but also create new business opportunities. The artificial reef program has:

- Established a market for sport fishing;
- Created recharge cells for the overfished GOM, improving conditions for the commercial fishing industry;
- Provided research material for universities; and
- Generated valuable resources.

Technical requirements include:

- Maintenance of at least 25 meters of water column clearance; and
- Reef areas are designated in zones having depth between 60 and 90 meters, where the ecosystem can be improved by the presence of structures.

The artificial reef concept for offshore structure disposal has not been accepted unanimously. For instance, North Sea producing nations and the State of California are still debating the issue. Authorities and the industry agree that there is very little to gain in establishing artificial reefs in the North Sea environment (deep, cold and cloudy waters), and artificial reefs programs would be just a convenient way of "dumping" offshore facilities. O'LEARY *et al.* (2001) has comprehensively discussed the feasibility of artificial reefs in the North Sea, and TAKAGI (1998) has conducted similar studies for Japan. Despite all ecological and societal aspects, probably the most unsurpassable predicament lies on "residual liabilities". Most governments are not willing to accept the uncertainties of artificial reef programs.

Existing artificial reef programs in Louisiana, Texas, and Italy are, undeniably, very successful. However, success stories are associated to a combination of ideal environmental conditions (where ecosystem services can be improved), available redundant offshore structures, and a favorable legal scenario.

3.7. ENVIRONMENTAL, HEALTH, SAFETY, AND SOCIETAL CONSIDERATIONS

Usually, before an installation is decommissioned, authorities require a detailed safety analysis. Operations involved in the decommissioning process comprise several potentially hazardous operations that offer safety concerns towards workers involved in the process (divers, mechanics, welders, etc.). Even recycling has its own safety and pollution risks.

The ODCP[14] Research and Technology Assessment Program Report shows that safety risks are approximately 50% higher for the total-removal alternative compared to partial-removal alternatives. Consequently, reducing offshore decommissioning activities is a determinant factor in reducing risks (PRASTHOFER, 1998).

In analyzing the environmental impacts generated by the several decommissioning options available today, some considerations should be made:

- Thus far, a great number of ships, railway wagons, war tanks, etc., have been sunk around the world offering a much greater potential for environmental damage.
- Natural occurring heavy metals are present in mid-oceanic ridges and thermal vents.
- Organic matters, heavy metals, and halogen organic compounds are present in large amounts in effluent discharges by rivers, ducts and occur in natural seepage under the seabed.

Those occurrences, both natural and previously man induced, should be used to provide scientific data for further decommissioning studies, but not as an excuse for irresponsible disposal of offshore installations.

The geographical extent of impacts from the deep-sea disposal will depend on a number of factors such as topography, sediment characteristics, dispersion and transport patterns, etc. Considering that structures are prepared in such way that only a limited amount of harmful substances remains, no severe environmental damage is anticipated during decommissioning operations. Besides, environmental impact resulted from several decommissioning options seems to be not significant (PROGNOS, 1997).

[14] The Offshore Decommissioning and Communications Project (ODCP) was disbanded in September 1998. The ODCP operated for two years under the sponsorship of the OGP (then the E&P Forum), UKOOA (UK Offshore Operators Association), and OLF (the Norwegian Oil Industry Association). The OGP Decommissioning Committee was established in October 1998 to take over the work of the ODCP.

A recent study conducted by LINDEBOOM (2000) of the Dutch Institute for Marine Research (NIOZ), on Texel, compares environmental effects of trawler fishing, sand extraction, and oil and gas drilling in the Dutch part of the Continental Shelf, in the North Sea. The study concludes that fishing has the most disturbing effects on biodiversity. Plowing the top layer of the soil with heavy nets is very harmful to crabs, shrimps and starfish, favoring only certain worms on which flatfish feed. Offshore platforms, according to this study, even have a beneficiary effect on the ecosystem. Part of it is because fishing within 500 meters of a platform is prohibited. This interdiction is questioned by NGOs connected to the fishery industry. Commercial fishing is also not allowed on the proximities of artificial reefs. This issue tends to get very emotional since it provides an "easy way out" for oil companies, and, at same time, a way to restrain the abuses of commercial fishing in overfished areas. FERREIRA and BOUMANS (2001) (**Figure D.5**) presents a carbon model where ecological impacts of offshore platform removal are accessed. Several other issues concerning the fishery industry are raised by OSMUNDSEN and TVETERÅS (2000).

There are topics that are not comprehensively addressed by international legal provisions. Sea-floor sediment pollution by discarded drilling muds such as barite ($BaSo_4$) used for specific gravity control may contain significant quantities of heavy metals sulphides (e.g. PbS, ZnS, FeS_2), among other compounds and additives (UAFSE, 1999; PEREZ, 1997). Health risks may also be involved during onshore dismantling and waste disposing activities. During the 1990's the presence of Natural-Occurring Radioactive Material (NORMs)[15] in waste, fluids and gases brought to the surface from producing subsurface oil and gas formations, has become a great concern for the oil industry (MCFADDIN, 1996; RYGH and BONIFAY, 2000). Decommissioning planning must consider specific handling of NORM-bearing waste, which are usually deposited onto the seabed, and NORM-contaminated material, such as drilling equipment, well tubing, pumps, etc. These procedures have not been adopted in the majority of producing nations.

Dealing with the recovery and disposal of drill cuttings may be very complex. As in other issues, there are several technological, safeties, and economic challenges involved in these activities. Leaving drilling muds *in situ* would probably be the best available alternative. It

[15] Radioactive materials have spontaneous decays over time emitting ionizing radiation. Such radiation can cause biological damage to individuals who are exposed to it, increasing the risk of cancer and birth defects (MCFADDIN, 1996).

should be noted though, that environmental impact might also occur as a result of long-term presence of endpoints[16] on the seabed.

This scenario does not seem any better when dealing with pipeline decommissioning. Potential environmental impacts from several disposal options may include emissions of heavy metals, emissions of oil/tars and softeners, emissions to air, water and land, impacts on habitats, and littering of the seabed (MUSAEUS, 2000). In this case, the best environmental solution, safest, and most cost effective option, may be leaving pipelines in place, but this issue will probably attract scores of emotional disputes.

HUGHES and FISH (1999) indicate that all disposal options involve secondary CO_2 emissions and other gases to the atmosphere. The author also points out that if installations were disposed of offshore (i.e. deep-sea dump), there would be a cost in replacing lost material. Marginal energy savings will result if total removal options are adopted. However, if the necessary precautions were taken, environmental impact would be at acceptable levels, regardless of the disposal option.

An Environmental Impact Assessment Report (EIA) can preclude many problems by suggesting mitigating measures to reduce negative impacts and enhance positive ones (NESSE, 2000). An EIA can also provide basis for balanced decisions, better awareness of risks and knowledge of legal requirements.

Lately, regulators have been motivated to consider social impacts produced by offshore activities, and, principally, impacts emerged after the end of activities in nearby communities. For instance, a small costal village begins to change rapidly after the discovery of offshore oil in the region; establishment of field offices and support facilities, helicopter transport companies, hotels, supermarkets, etc. The great challenge is to avoid that at the end of activities, when the resources are depleted, communities that have become dependent on the benefits brought by nearby operations are disrupted. Oil companies are motivated to work with these communities establishing infrastructure and stimulating alternative productive activities that may substitute, or at least attenuate, the void expected after operations are concluded. Undoubtedly, social issues are significantly more complex than environmental issues.

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[16] Endpoints: remains, such as structures, concrete bases, drill cuttings, etc. an example of endpoint effects is the deterioration of steel left on the seabed.

3.8. TECHNOLOGIC AND TECHNICAL CONSIDERATIONS

Frequent periods of high oil and gas prices have been encouraging governments to offer fiscal incentives and royalty relief in order to turn small and marginal fields viable. Such projects attract the attention of independent and small operators. With the aim of optimizing profit, new approaches are being directed to technology and concepts that allow more attractiveness in the development of some shallow water fields. Economic incentives and the emergence of new concepts by minimal platform designers are yielding a renaissance in the technology and use of minimal facilities, as pointed out by ALBAUGH et al. (2001).

Old platform designs can add significant challenge to decommissioning operations. According to the MMS (1997b), current technology available for platform removal includes bulk explosives, shaped explosive charges, mechanical cutters, and underwater arc cutters. For the industry, explosives are the most commonly used, safest, most cost-efficient, and most reliable method for severing piles and conductors of platforms. Removal methods for GOM Region from 1986 to 1997 were explosives (67%), mechanical (28%), abrasive (4%), and other (1%) (O'CONNOR, 2000). However, because of the threat to marine animals, including turtles and dolphins, it remains a very sensitive topic among environmentalists and the general public. Probably, for this reason, related research sponsored by the MMS has intensified: (1) Overpressures developed by shaped explosive charges used to remove wellheads; (2) Environmental effects of wellhead removal by explosives; (3) Blast effects upon the environment from the removal of platform legs by explosives; (4) Development, testing and evaluation of an explosive shock wave focusing tool with minimum explosive weight; and (5) Effectiveness of 50 pound bulk charges in cutting platform members (MARTIN, 2000).

The industry has accumulated considerable decommissioning experience along the years, however removing large and heavy installations (steel and concrete) in deep waters and rough seas can still be particularly complex. Some of the challenges found in these operations involve underwater cutting of thick concrete and steel, lifting sections in excess of 4000 tons, diving in deep, cold, harsh waters, loading large and heavy structures onto barges in open sea, scarce equipment, and removing concrete structures where reflotation could be unpredictable.

The most common risks involved in decommissioning operations in deep waters are potential equipment damage or loss. Some other potential contingencies are: sinking of installations; dropped loads during marine operations; dropped loads during outcome/end-use phase of the work; loss of a towline during severe adverse weather conditions; and diving (DNV, 1995). Such risks are considered tolerable since the likelihood of that scenario and their consequences are considered low.

Aiming at reducing decommissioning costs and minimizing capital and operational expenditures on marginal fields, the industry tends to avoid producing large structures. Since many structures were constructed with a fatigue life of 100 years, capable of withstanding winds in excess of 160 kilometers per hour and waves as high as 30 meters, companies are looking at ways of reusing offshore installations.

New breeds of offshore structures are designed with economic and environmental advantages, weighting less, being more easily lifted and transported, and offering the opportunity for reuse on new development projects. The new trend goes in the direction of the "Minimum Facility Concept", involving usually unmanned platforms, ranging from self-installing gravity platforms and twisted-base jacket structures to 3-legged tension leg platforms, offering environmental features and partial or total reusability (ALBAUGH, et al., 2001; O'CONNOR and ROBINSON, 2001). Other concepts are also being pursued, such as the platformless[17] development in deep waters (**Figure 3.17**). In the near future, technology leaps may offer profound impact on developments. Common use of mechanisms such as seabed separation and extended wellstream transfer to onshore plants may become a standard approach to development projects. Platformless development may become tomorrow's main option, since it may provide ways of reducing both cost and implementation, and, additionally, reducing decommissioning costs.

Other examples are the mini-jacket platforms used in the coast of West Africa and the Maureen platform, used at the North Sea. The Maureen platform is a large gravity base platform that has been used for oil production, processing, and storage in the North Sea since 1983. The platform is 235 meters tall and weights 110,000 tons. Three large ballast tanks form the base of the platform, which is held on the seabed by gravity (virtue of its weight). The Maureen can be completely refloated and reused in a different location (**Figure 3.18**).

The number of innovative offshore technology becoming available since the Brent Spar episode has increased significantly. Most available technologies have only been tested in the GOM Region. Some of these technologies are mentioned by TWACHTMAN (1997), and

[17] Platformless deepwater production systems.

HUGHES and FISH (1999): the Versatruss system, the master Marine Catamaran System, the RAMBIZ catamaran dual crane vessel used for bridge installations, the Norwegian Offshore Shuttle System, and the Controlled Variable Buoyancy System (CVBS) for refloating substructures. Most of these technologies are not yet available but in developing stages. Once again, the motivational fuel is cost reduction.

3.9. ECONOMIC CONSIDERATIONS

The two main decisions affecting ex-post costs are timing and decommissioning options. Decommissioning timing is based on production flows, economic criteria, and establishment of financial models. Decommissioning options depends on regulations, environmental, safety and economic criteria, and, frequently, public reaction.

Regarding timing options for decommissioning operations, there are basically three possible scenarios: (1) remove installations progressively as each becomes redundant; (2) remove in contractual groups; and (3) remove all installations at the end of field life. According to HUGHES and FISH (1999), removing all installations at the end of field life often allows the lowest decommissioning cost[18]. This happens because of high costs involved in relocating the limited number of heavy derrick barges and rigs to offshore production areas. If a company can coordinate more than three decommissioning operations in the same region, limited and valuable ex-post capital will be saved. For this same reason, cooperation among different operators may allow significant savings, as demonstrated on **Table 3.6**.

TABLE 3.6. JOINT INDUSTRY APPROACH TO REDUCE COSTS IN CALIFORNIA

Components		Savings (US$ million)
Wells		11
Pipelines		16
Platforms		92
Onshore Disposal		31
	Total	***150***

Source: STEINBACH (2000)

[18] Some regimes enforce a 1-year period for decommissioning of installations once recovery activities cease. In such cases, production can be extended marginally in order to adequate end-of-production with neighboring platform schedules.

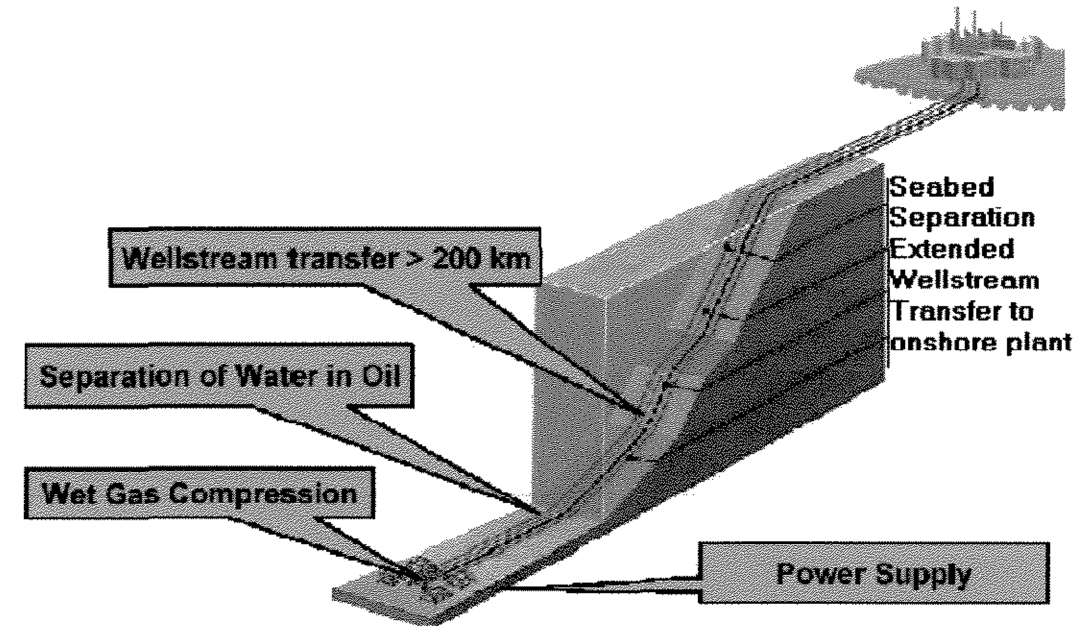

Figure 3.17. Platformless Field Development. Subsea to beach technological breakthrough. Field development costs are reduced in up to 30%. *Source:* Norske Shell (LEONARD, 2002 - modified).

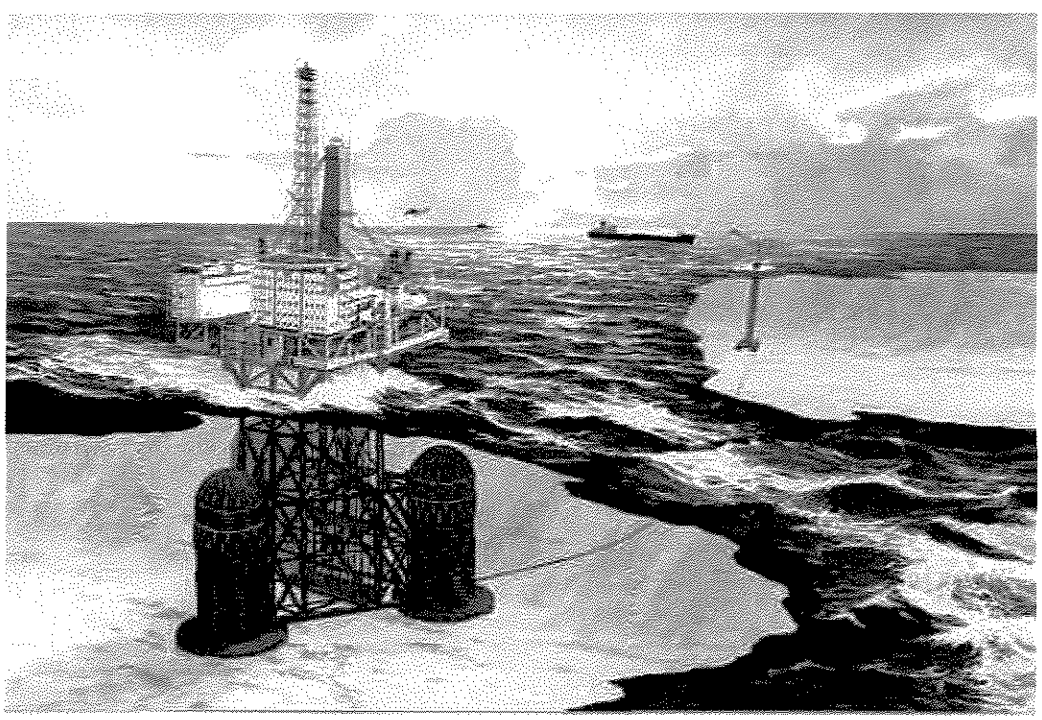

Figure 3.18. Schematics of the Phillips Maureen (PHILLIPS, 1999c).

As indicated by HUGHES and FISH (1999), the most efficient way to determine optimum timing for ex-post activities is to examine the field production tail-down and cash flow forecast. This careful modeling process should produce charts indicating periods of uneconomical operations when OPEX exceeds revenues. This assessment would involve several studies including forecast analysis of future oil prices and corporate taxes. Sensitivity analyses would show different tail-downs for each scenario and decision-makers would decide on the optimum timing for ceasing production.

Because of inherent uncertainties, estimating future decommissioning costs can be a very complex task. Currently, a wide range of decommissioning cost estimates for large heavy platforms were made available in the literature[19]. Inconsistent numbers can be blamed on the limited experience available. Regarding cost, the decommissioning process seems to be analogous to the development process: costs for decommissioning large installations in sensitive areas usually have the same order of magnitude as costs for developing the project. Platform removal and disposal costs are not the only disturbing aspect of offshore decommissioning projects. As indicated by GARLAND (2000b), in some areas of the world, well plugging and abandonment operations may represent up to 50% of the total decommissioning cost. These operations involve great technological challenges and substantial uncertainties, such as complying with well plugging and abandonment requirements at great depths (i.e. over 2,000 meters). Cost estimates will greatly depend on available technologies. This factor can certainly be used as a catalyst for technological research.

Other signs for higher decommissioning costs are noticeable. For instance, TWACHMAN (1997) calls attention to: (1) the limited number of derrick barges and rigs; (2) expanded exploration; (3) tough production requirements; (4) growing number of installations; (5) larger number of decommissioning projects; and (6) greater number of complex projects involving larger platforms in progressively more difficult places. Additional reasons includes: (1) the advent of new production zones in developing countries (i.e. Brazil, Asian Pacific countries and West African countries), which tend to increase the demand for the already limited number of equipment and vessels; (2) stringent regulations; and (3) rigorous_clean-up standards.

[19] There are several studies providing cost evaluation for different decommissioning options; however, due to the dynamic character of technological development, such assessments must be frequently revised.

also provide substantial savings (DELLA, 1997). Unplanned delays may result in additional expenditure such as cost with maintenance, insurance, bond premiums, and fees that still have to be paid until the installation is removed. Although it may increase operation costs, maintenances will avoid contingency expenditures. Contractors specializing in different sorts of installation work (adaptations, maintenance, etc.), have an expanding market ahead.

3.10. DECOMMISSIONING COSTS

Table 3.7 indicates some recent estimate and actual decommissioning costs in different regions. According to HUGHES and FISH (1999), when a new field development is in the planning phase, decommissioning costs may look insignificant if examined by discounted cash flow methods.

Indeed, towards the end of recovery, decommissioning expenditure becomes a considerable burden to projects. Welcoming signs of culture change are evident, but unfortunately, decommissioning expenditure is still viewed by some segments of the oil industry as a lost investment where "funds are allocated and no revenues are generated".

According to COLEMAN (1998), between now and 2025, it should be expected that over 6,500 installations would be decommissioned at an estimated cost of US$ 20-40 billion. Until recently, over 50% of the word industry expenditure with decommissioning was expected to come from only three countries where almost 70% of all offshore installations were concentrated: the United States, the United Kingdom, and Norway. Depending on regulatory developments in some producing developing countries, this scenario may change. In some developing countries, offshore exploration and filed development are increasing significantly (i.e. South America, West Africa and Asian Pacific nations).

The North Sea oil field is viewed as a mature province. The estimated cost for the total removal of all North Sea installations ranges from US$ 12 billion to 15 billion (GRIFFIN, 1998b; PROGNOS, 1997). According UKOOA's estimates (1995), the total decommissioning cost for offshore installations located at the UK section of the North Sea is approximately US$ 8.02 billion. Over the next ten years, some 50 UK installations are expected to be decommissioned at an estimated cost of US$ 2.4 billion.

TABLE 3. 7. DECOMMISSIONING COSTS BY REGION, CATEGORY AND INSTALLATION TYPE

Region			Estimated Costs	Option	Reference
Australia			1.0	Total	SHINNERS, 2000
NS (UK + Norway)			12.0-15.0	Total	GRIFFIN, 1998b; PROGNOS, 1997
NS UK			8.0	Total	UKOOA, 1995
CA			1.3[6]	Total	STEINBACH, 2000
GOM			5.0[1]	Total	GRIFFIN, 1998b
Southeast Asia			1.5-2.0	Total	GRIFFIN, 1998b
Total World			20-40	Total	COLEMAN, 1998
North Sea Numbers			**Estimated Costs**	**Option**	**Reference**
Total Decomm. Cost			12.7	Total	PROGNOS, 1997
Total Decomm. Cost			7.7-11.7	Partial	PROGNOS, 1997
Annual Cost			0.9-1.4	Total	PROGNOS, 1997
Annual Cost			0.3-0.5	Partial	PROGNOS, 1997
Gov. Expenditure			4.9	Total	PROGNOS, 1997
Gov. Expenditure			2.7-4.6	Partial	PROGNOS, 1997
Revenue from decomm.			6.0	Total	PROGNOS, 1997
Revenue from decomm.			4.9-5.4	Partial	PROGNOS, 1997
Possible Recycling Earnings			0.5	Total	PROGNOS, 1997
Possible Recycling Earnings			0.4-0.5	Partial	PROGNOS, 1997
Site / Installation	**Type**	**Depth (m)**	**Final Cost**	**Option**	**Reference**
NS Brent Spar – shell	Buoy	na	+/- 77.4	Total	DNV, 1995
NS Mime – Norsk	na	na	4.6[2]	Total	NPD, 1998
NS Nordøst Frigg – Elf	na	na	9.0[3]	Total	NPD, 1998
NS Odin – Esso (1995)	na	na	11.2[4]	Total	NPD, 1998
NS Øst Frigg – Elf (1993)	na	na	12.6[4]	Total	NPD, 1998
NS Ekofisk[5] I (1999)	na	na	1.0	Total	PHILLIPS, 1999a, 2000
NS Frigg (2000/01)	na	na	na	Total	NESSE (2000)
CA Exxon Belmont Island	na	13.7	20.0	Total	STEINBACH, 2000
CA Mobil Seacliff Pier	na	9	15.0	Total	STEINBACH, 2000; BROOKS et al., 2000
CA Chevron, Arco, Phillips, Texaco, Unocal, Aera. Abn Rig Sharing SWARS	na	20 – 83.5	72.0	Total	STEINBACH, 2000
CA Chevron Platforms	na	29 – 41.7	42.0	Total	STEINBACH, 2000
GOM West Delta 76 A	4-pile	55	0.4	RRR	O'CONNOR, 1999
GOM Eugene Island 300 A	4-pile	60	0.7	Reuse	O'CONNOR, 1999
GOM West Cameron 563 A	8-pile	58	1.4	RRR	O'CONNOR, 1999
GOM	Jacket	0-6	0.05-0.5	na	KASPRZAK, 1998
GOM	Jacket	6.1-30.5	0.5-1.5	na	KASPRZAK, 1998
GOM	Jacket	30.6-61.0	1.0-2.5	na	KASPRZAK, 1998
GOM	Jacket	61.1-122.0	5.0-15.0	na	KASPRZAK, 1998
GOM	Jacket	122.1-610.0	15.0-100.0	na	KASPRZAK, 1998
GOM	Jacket	< 15	+/- 3.2	Total	MMS, 1999b
GOM	Jacket	15-61	+/- 3.9	Total	MMS, 1999b
GOM	Jacket	61-122	+/- 9.8	Total	MMS, 1999b
GOM	Jacket	> 122	Up to 94.0	Total	MMS, 1999b
OC (4 Chevron platforms)	na	30.5-42.5	+/- 56.0	Total	MMS, 1999b
Indonesia	na	38.1	7.2	Total	DJALAL, 1998
Indonesia (Java Sea)	na	na	1.0-4.0	N/A	IDGOG, 1998

[1]The US Rigs-to-Reef Program allows lower decommissioning costs; [2]Estimated disposal cost; [3]Disposal cost; [4]Accrued disposal cost; [5]Includes decommissioning operations in 14 installations (different installation types and decommissioning procedures); NS = North Sea; GOM = Gulf of Mexico; OC = Offshore California; na = not available; RRR = Reuse and Rigs-to-Reef; [6] Assumes platforms are removed in groups of 4 to 5. All values in $ billion.

Noteworthy is the fact that the number of platforms in the North Sea province comprises only about 7% of the total world platform population; but, as shown, it accounts for approximately 35% of the total worldwide decommissioning expenditure[20]. The main reasons for this discrepancy are the weight and structural complexity of the installations and the severe weather conditions common to that region (PRASTHOFER, 1998). In addition, Norway possesses a network of 7,500 kilometers of export pipelines (1/3 buried), and 2,000 kilometers of interfiled pipelines (80% buried) (MUSAEUS, 2000). Up until 1997, over 1,500 platforms were removed in the Gulf of Mexico and approximately 27 in the North Sea. **Table 3.8** shows the approximate number of installations in the North Atlantic Region, which includes the North Sea Province, **Table 3.9** indicates the estimated number of installations in the Mediterranean Sea Region, and **Table 3.10** indicates the estimated number of offshore installations in West African Countries.

TABLE 3.8. NORTH ATLANTIC PLATFORMS

Settings	UK	NORWAY	NETHERLANDS	OTHERS
Less than 10,000 Tons Jacket (Steel)	210	72	106	12
Greater than 10,000 Tons Jackets (Steel)	27	6	0	0
Concrete Installations	8	14	2	0

Source: *TILLING. (2001).*

TABLE 3.9. PLATFORMS IN THE MEDITERRANEAN SEA REGION

Countries	Platforms	%
Croatia	4	2
Egypt	18	9
Greece	4	2
Libya	2	1
Italy	142	71
Spain	6	3
Tunisia	24	12

Source: *ONARGHI (2000).*

[20] The Norwegian State carries the majority of disposal costs.

TABLE 3.10. WEST AFRICA OFFSHORE INSTALLATIONS				
Country	Shallow waters	Deep waters	Floating installations	Total
Nigeria	134	-	7	134
Cameroon	54	-	-	54
Gabon	71	-	3	71
Congo	67	3	2	70
Angola	220	-	2	220
			Total*:	**549**

**Numbers do not include floating facilities. Source: GARLAND (2000a).*

There are approximately 53 offshore production facilities in Australia (18 SPJ platforms, 16 Monotowers, 9 Subsea completions, 4 FPSO's, 3 CGS's, 3 minitowers, and associated pipeline network). Significant decommissioning activity is not anticipated before 2010, with most existing facilities removed by 2030. Current estimations indicate decommissioning costs in the order of US$ 1 billion (SHINNERS, 2000). Decommissioning of all platforms in Southeast Asia is estimated to cost between US$ 1.5 and US$ 2.0 billion (GRIFFIN, 2000b).

Figure 3.19 illustrates the dynamics of installation and removal costs in GOM. Cost estimates for decommissioning of Gulf structures are lower than one would expect. This is due to the success of the US Rigs-to-Reef Program, which brings down ex-post expenditure.

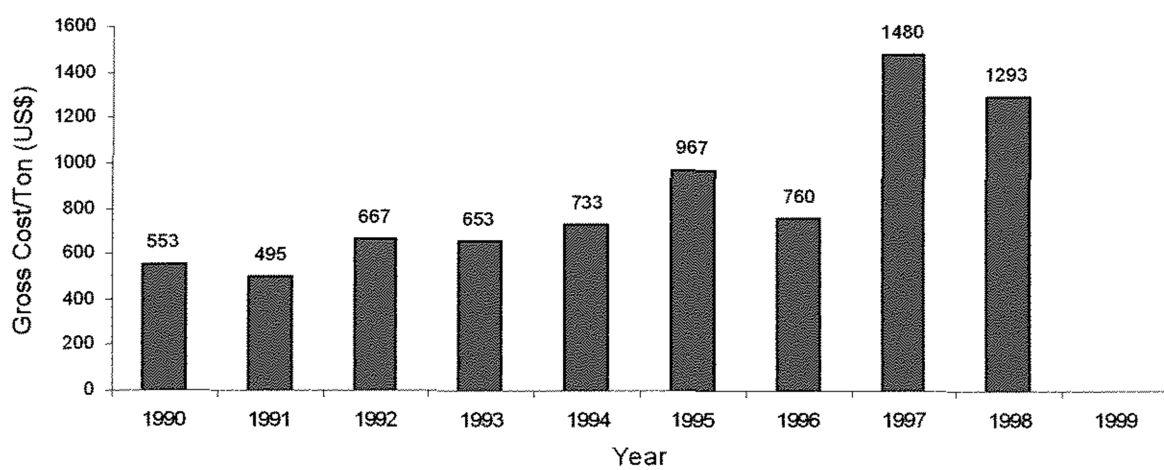

Figure 3.19. GOM Historical of Decommissioning Costs: Gross Cost Per Ton, Excluding Well P&A. **Note:** Gross Cost Per Ton considers all decommissioning costs except well P&A divided by total facility weight, including jackets, piles, and topsides, based on 54 actual platform removals (TWACHTMAN SNYDER & BYRD, INC., 1999).

In the United States outer continental shelf, platform decommissioning rate is increasing and, in some instances, going beyond the installation rate. As remarkable as it seems, approximately 620 wells are plugged and abandoned every year in GOM (PERRY III et al., 1998). The number of platform decommissioned yearly in this same region is between 120 and 150 (WATSON, 1998). The MMS forecasts that 100 to 200 of structures will be decommissioned each year (BUFFINGTON, 1996). The estimated cost for completely decommissioning all Gulf structures is US$ 5 billion (GRIFFIN, 1998c).

Currently there are 105 offshore installations in Brazil (**Table 3.11**) (ANP, 2003). In 1998, around 50% of all Brazilian offshore platforms in the OCS were installed in depths greater then 400 meters (ANP, 2002a). Since not many fixed platforms of this size have been removed around the world, expertise is limited and cost estimates vary greatly. Removing floating installations in the Brazilian OCS is significantly less costly than removing fixed ones. However, the cost of plugging and abandoning wells in Brazilian deep and ultra-deep waters (over 1,000 m) tends to pose additional complexities and costs. Complexities are also expected in site-clearance activities.

TABLE 3.11. BRAZILIAN OFFSHORE PRODUCTION INSTALLATIONS

Type of Installation	March/2003
Floating Production Systems (FPS)	2
Floating, Production, Storage and Offloading (FPSO)	8
Fixed Production Systems	77
Fixed Production Systems (concrete)	3
Semi-Submersible	15
Total	***105***

Source: ANP (2003)

Brazil has only initiated its open market policy towards oil and gas exploration. Therefore, no estimates for future decommissioning expenditure were found in the literature. First decommissioning activities are expected to take place in 2004 (RODRIGUEZ, 2000). Some of the issues being currently considered in the Brazilian scenario are: regulatory framework for decommissioning, removal options, reutilization of structures and equipment, and establishment of an artificial reef program. No one seems to know for certain how many platforms have been removed (or toppled *in situ*) in Brazil, if any (ANP, 2000). Most new offshore projects in Brazil are in ultra-deepwater sections of the OCS and involve floating installations. Currently (2003),

Brazil has 706 offshore producing wells (ANP, 2003). The estimated cost for plugging and abandoning deep-sea wells could not be found in the current literature.

TABLE 3.12. ASSESSMENT OF PROPOSED OPTIONS FOR BRENT SPAR

AMEC Civel Engineering:

- Preparation: This proposal covers only the end use phase. A different contractor must assume the preceding phases.
- Destination: Barge transportation of rings sections from dismantling site to the North Norfolk Coast.
- Process: Artificial Reef construction (placing ring sections, sand filling and rock dumping).
- End use: Coastal Protection

Estimate: US $52,9 million

Brown & Root Energy Services (BRES)

- Preparation: Repair damage tanks and pressure reduction (divers). Removal of helideck and turntable.
- Operations: Reverse upending (horizontal) in Erfjord by deballasting with winchline assistance.
- Destination: Towing to Nigg, Cromarty Firth.
- Process: Mechanical dismantling in dry-dock.
- End use: Scrap and recycle.

Estimate: US $77,4 million.

Kvaerner Seaway Spar Alliance (KSSA)

- Preparation: Repair of damaged tanks and installation of hoses.
- Destination: Tow vertically to Haneytangen yard.
- Operations: Vertical out of water by deballasting only.
- Process: Cut into ring sections and lift by crane vessel.
- End use: Training Center, Fish Farm or scrape and recycle.
- Alternative: Reverse upending to horizontal, with dismantling in dry-dock.

Estimate: US $18,4 million and US $28,4 million

McAlpine Doris Able (MCDA)

- Preparation: Remove helideck and turntable. Pressurize with inert gas via vent lines.
- Operations: Reversed upending to horizontal in Erfjord by deballasting only.
- Destination: Repair tanks. Tow to TERRC. Teeside..
- Process: Mechanical dismantling in dry-dock.
- End use: Quay extension in dry-dock.

Estimate: US $31,6 million.

Thyssen Aker Maritime (THAM)

- Preparation: Pressurizing via vent lines for ballasting to 90m draft in Erfjord.
- Destination: Tow vertically to Hinna, Stavanger.
- Operations: Vertical out of water by deballasting and jacking with tension bars to a cradle under the installation.
- Process: Cut into ring sections and lift onshore.
- End use: Scrap and recycle.

Estimate: US $34,4 million.

Wood GMC (WOGM)

- Preparation: All work in Erfjord. Assembly of catamaran with cross barge.
- Operations: Deballasting and jacking with strand jacks to a cradle under the installation.
- Process: Cut into ring sections and skid to a barge.
- Destination: Transport of sections by barge to Mekjarvik, Stavanger.
- End use: Quay extension using the ring sections. Scrap topside.

Estimate: US $34,7 million.

Deep Sea Disposal (DSD)

- Preparation: Removal of all accessible hydrocarbons. Installation of explosive charges.
- Destination: Tow vertically to deep-disposal site.
- Operations: Rupture Spar ballast tanks with explosives to get it to sink as one unit in a controlled manner.
- Process: Cut into ring sections and skid to a barge.
- End use: None.

Estimate: US $7,6 million.

Source: DNV (1995) – Modified

Partial removals cover a great range of different alternatives and combinations, and, if it were a viable option in the North Sea Province, it would represent cumulative savings ranging between US$ 1 billion and US$ 5 billion up until 2020. (PROGNOS, 1997). Costs savings would range between 8% and 39%, depending on the variant (PROGNOS, 1997). During the Brent Spar episode, several decommissioning options were evaluated by Shell. **Table 3.12** shows an assessment of proposed options and respective costs for the disposal of the Brent Spar Buoy.

Legal requirements and decisions from authorities will also play a decisive role in determining decommissioning costs. For instance, if the length of a pipeline were required to be removed rather than left in place, costs would increase substantially.

3.11. COST DRIVERS IN DECOMMISSIONING OPERATIONS

The method used to access decommissioning costs was the compilation of detailed information obtained from the available literature. Necessary information to develop a comprehensive list of decommissioning related activities for the Brazilian scenario was not available. The main reason is that information relative to decommissioning costs for specific projects are considered proprietary by the industry.

One of the objectives of this chapter was to provide general guidelines for regulators so estimates for a range future decommissioning projects in the Brazilian OCS could be performed. This study does not cover compliance with specific ANP requirements. In addition, costs for specific projects will depend on several parameters, including planning and company's capability, which allow cost internalization.

Firstly, several steps of the decommissioning process were identified in the literature and related costs are briefly described bellow. Figures used are derived from assessments from projects in offshore California, GOM, the North Sea, and according to MMS (1999b) estimates:

1. **Engineering and Planning** – costs will depend greatly of the size of the project, type of structures and on the degree to which expenditures may be internalized. Basically, it will depend on the availability of in-house expertise.
2. **Permitting and Regulatory Compliance** – it includes costs involved in obtaining the necessary permits to carry out decommissioning operations, including fees to comply with

ex-post environmental requirements. This will greatly vary according to the regulatory regime. Estimating such costs for Brazilian projects is considerably complex. The requirements are not yet clear and uncertainties are high.

3. **Platform Preparation** – costs are impacted mostly by size and complexity of installations. Removal procedures, transportation and disposal, and degree of required structural reinforcement, may offer a variety of price ranges. Internalization of expenditure is also an important parameter. Cutting methods may significantly impact final costs.

4. **Well Plugging and Abandonment** – Costs for this phase will depend greatly from applicable regulatory requirements, number of wells, and mainly on the difficulty and eventual complications encountered. Well depth is a less significant factor compared to plugging difficulty. Plugging and abandonment involve one of the most costly activities within the decommissioning process.

5. **Conductor Removal** – costs for the removal of conductors will also depend on regulatory requirements. The primary cost determining factor is water depth. Cutting methods may also significantly affect final costs. If platforms have derricks and cranes capable of performing the removal of conductor casing, the company may not need to contract a derrick barge, significantly reducing costs.

6. **Mobilization and Demobilization** – It involves costs incurred to bring a HLV to the project site and return the vessel to its point of origin. When there are no vessels with the capability to remove platforms within the productive area, the vessel has to be brought from other areas (usually from the GOM or North Sea). Total mobilization and demobilization time may vary greatly according to distances between locations (i.e. 100 to 200 days.). Daily rates for HLV rages from US$ 25,000 to US$ 310,000 per day, depending of the lift capability of the HLV. It is important to notice that since there is a great demand for HLV's in the GOM for deep-water development, firms owning HLV's would not commit them to distant areas unless there were at least five platforms scheduled to be removed.

7. **Platform and Structural Removal** – Removal costs will also depend greatly on the regulatory requirements. The main variables in estimating removal costs include: size and weight of the structures, the number of modules, the number of lifts, etc. Estimates for removal in depths greater than 366 meters are very speculative and require technological development. MMS estimations assume that it would take 8 hours to remove each platform skirt pile, 8 to 24 hours for the removal of the main piles (depending on the water depth), 2 days per module, 2 to 5 days for sectional cuts and moves of the jacks. Contingency costs should be expected (delays, weather conditions, etc.).

8. **Pipeline and Power Cable Decommissioning** – Cost estimates for the decommissioning of pipeline and power cable decommissioning will depend on regulatory requirements which will determine decommissioning procedures and disposal options. The main variables affecting price include: length, size, pipe coatings, etc. **Table 3.13** shows cost estimates for different pipeline decommissioning options in Norway.

TABLE 3.13. COST ESTIMATES FOR DISPOSAL OF PIPELINES IN NORWAY

	(US$ million)
Total Burial	200-500
Rock Dumping	2,500
Removal	4,400

Source: MASAEUS (2000)

9. **Transportation and Disposal** – Transportation and disposal of material (process steel, marine growth, cement, mud, etc.) may be very costly. Costs will depend on several factors such as distance between operation and disposal sites, etc. The MMS assumes costs of US$ 350 per ton of steel, US$ 300,000 per small platform for marine growth, cement and mud, and US$ 700,000 per ultra-large platforms.

10. **Site Clearance and Verification** – Costs associated with site clearance and verification will depend on regulatory requirements. The main variables involved are water depth; size of area to be cleared and verified; quantity, size and type of debris; and the weather conditions. Contingency costs should also be expected.

Due to the great range and combination of alternatives, estimating decommissioning costs should consider each case separately, on a case-by-case basis. **Table 3.14** shows MMS estimations for most activities involved within the decommissioning process in offshore California. This table provides estimations for different platform sizes. **Table 3.15** summarizes high and low decommissioning cost estimates for **Table 3.14** and indicates the comparative breaking-down of decommissioning costs as indicated by HUGHES and FISH (1999).

According to HUGHES and FISH (1999), the main "critical success factors" for any decommissioning plan are (**Figure 3.20**):

- Maximize reservoir performance while minimizing decommissioning costs;
- Evaluate alternative field management strategies (this review would normally include new prospects);
- Comply with relevant government legislation and guidelines;
- Develop contracting strategy to optimize overall field revenue and profitability;
- Develop a plan to ensure that decommissioning activities are correctly phased with offshore removal operations so as to minimize unnecessary loss of production;
- Establish safe and economical removal methods for the platforms that are not solely dependent on the use of any single methodology;
- Adopt safe engineering procedures;
- Minimize environmental impact;
- Recommend reuse of facilities where shown to be technically and economically viable; and
- Promote acceptable disposal methods where reuse or recycling is not the preferred option.

3.12. SUGGESTION FOR DECOMMISSIONING COST ASSESSMENT

Cost assessment of decommissioning operations still involves considerable uncertainties. A variety of issues require further investigation and data collection. A comprehensive assessment project is recommended for the development of a complex decision model that would assist in the identification and quantification of potential impacts of management decisions involved in the decommissioning process. Such model should consider the possibility of carrying out decommissioning activities at the end of project, or concomitantly with production. **Table**

3.16 illustrates a hypothetical project schedule sheet where decommissioning activities are carried out parallel to recovery activities. It should also aid in the identification of an optimum time for beginning decommissioning operations. In this case, parameters such as field economics, technological innovations, logistics and market parameters, among others, should be included as variables.

Appendix B.2. suggests an activity sheet to assist in the calculation of decommissioning costs in areas where decommissioning activities are non-existent or just beginning.

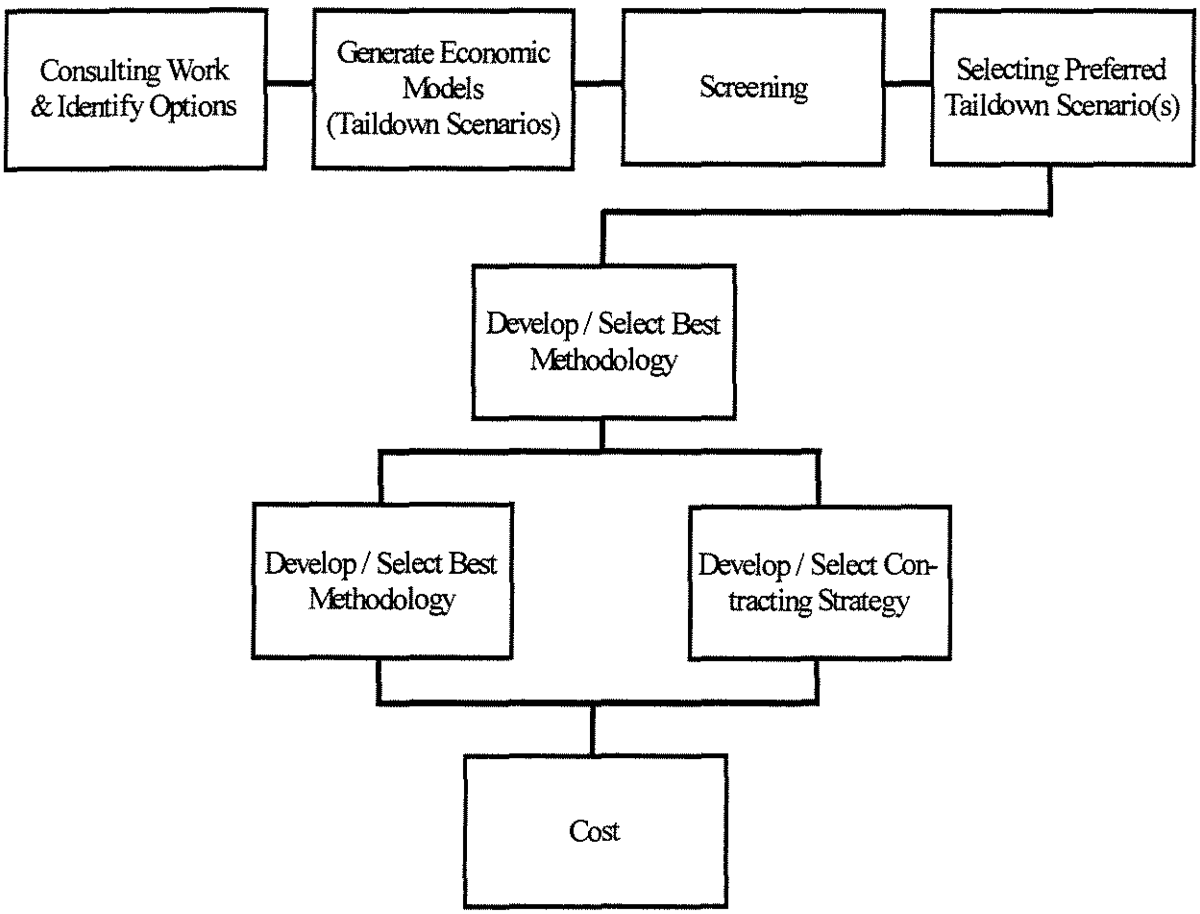

Figure 3.20. Decommissioning Study Execution Flowchart (HUGHES and FISH, 1999) - modified.

TABLE 3.14. US MMS DECOMMISSIONING ESTIMATES FOR OFFSHORE CALIFORNIA

Engineering and Planning	
Platform Size	Cost Estimation ($)
Small	200,000
Medium	400,000
Large	600,000
Ultra-Large	1,400,000
Permitting and Regulatory Compliance	
Location	Cost Estimation ($)
Offshore California	175,000 to 300,000
Platform Preparation	
Platform Size	Cost Estimation ($)
Small	300,000
Médium	480,000
Large	900,000
Ultra-Large	1,200,000
Well Plugging and Abandonment	
Difficulty	Cost Estimation ($)
No complications	63,300
Minor Complications	95,500
Major Complications	192,400
Conductor Removal	
Water Depth (meters)	Cost Estimation ($)
< 121	21,900
122 – 244	34,400
245 – 366	59,400
Mobilization and Demobilization	
HLV Lift Capability (ton)	Cost Estimation ($)
500 (100 days)	450,000
2,000 (200 days)	5,400,000
4,000 (200 days)	8,280,000
4,000 – 5,000 (200 days)	11,160,000
Platform and Structural Removal	
Water Depth (meters)	Cost Estimation ($)
61	3,960,000
122	15,263,000
213	21,450,000
366	48,675,000
Transportation and Disposal	
Platform Size	Cost Estimation ($)
Small	2,050,000
Medium	3,850,000
Large	11,000,000
Ultra-Large	25,200,000
Site Clearance and Verification	
Water Depth (meters)	Cost Estimation ($)
< 91 (+ 10% contingency)	244,200 – 521,400
> 91 (+ 15% contingency)	590,700 – 1,060,400

Source: *MMS (1999b)*

TABLE 3.15. COMPARATIVE COST ANALYSIS: OFFSHORE CALIFORNIA & SOUTHERN NORTH SEA

Decommissioning Cost estimates for offshore California
Percentage breakdown[1]

Decommissioning Activity	Low Estimate		High Estimate	
	Cost	%	Cost	%
Engineering and Planning	$200,000	8%	$1,400,000	4%
Permitting	$175,000		$300,000	
Platform Preparation	$300,000		$1,200,000	
Site Clearance	$244,000		$1,060,000	
Well Plugging and Abandonment	$955,000	9%	$6,016,000	6%
Conductor Removal	$219,000	6%	$3,802,000	9%
Pipelines and Power Cables	$404,000		$5,482,000	
Mobilization and Demobilization	$2,700,000	24%	$11,160,000	11%
Decks and Jackets	$3,960,000	35%	$48,675,000	46%
Transportation and Disposal	$2,050,000	18%	$25,200,000	24%
Total	$11,207,000	100%	104,295,000	100%

Decommissioning Cost in the Southern North Sea Oil and Gas Province
Percentage break down according to Foster Wheeler and Tecnomare[2]

Description	% of Total Cost
Mobilization and Demobilization of Marine Vessels	4.5%
Plugging and Abandonment of Platform Wells	6.0%
Plugging and Abandonment of Subsea Wells	3.2%
Topsides Decommissioning and Preparation for Removal	14.1%
Topsides and Jacket Removal	34.0%
Pipeline abandonment in situ & other subsea work	12.3%
Overall field decommissioning support	4.3%
Onshore Dismantling & salvage	0.7%
Main Contractor Engineering & design	4.0%
Owner costs	7.9%
Contingency 10%	9.0%
Total	100%

[1] ***Source:*** MMS (1999b).
[2] ***Source:*** HUGHES and FISH (1999). This breakdown is specific to a particular gas field in the NS but proportions are considered reasonably typical for other Southern NS fields

TABLE 3.16. GENERAL CHRONOGRAM FOR ONSHORE CLOSURE – THE PHASED APPROACH

Activity	Year												
	1995	-	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production		-											
Dismantling		-											
Well Abandonment		-											
Decontamination		-											
Rehabilitation		-											
Monitoring		-											

3.13. DECOMMISSIONING DISCUSSION

Since oil companies have a fair amount of time before decommissioning operations begin, considerable attention should be given to strategic planning in order to minimize liabilities and costs. Decommissioning should not be viewed as an isolated phase at the end of the project, but instead, planning should take place as oil recovery progresses. Decisions made during all phases of the project will, in some way, impact the decommissioning process. For this reason, planning must always be reviewed and updated. Although uncertainties are considerable, this approach should allow cost reduction, improved safety, and sound environmental decisions.

Incentives should be provided to ensure ever-improving technologies, addressing needs and aspirations of all stakeholders, and, mainly, ensuring that the industry is able to comply with all ex-post obligations. As illustrated on **Figure 3.21**, aiming at reducing environmental costs, energy expenditure, and risk of contingencies, a 5 R's approach is proposed for the oil industry. This approach is analogous to the traditional 3 R's approach (reduce, reuse, and recycle). Accordingly, bonding mechanisms should be used to generate incentives for:

- **Reduction** – lessen the number of needed installations through rethinking concepts and approaches (i.e. platformless field developments);
- **Reengineering** – during project planning, set as a priority, the design of decommissionable facilities, the application of new concepts and approaches, testing new materials and technologies (i.e. minimal facility approach, Maureen Platform);
- **Reuse** – consider the use of redundant installations and equipment, and stimulating the expansion and improvement of a reutilization economy (i.e. adaptations yards, brokers, etc.);

- **Rigs-to-Reef** – opening dialog with key stakeholders and academic institutions for the consideration of an artificial reefs program, allowing the reduction of decommissioning costs and creating artificial habitats to improve fish recharge in overfished areas;
- **Recycling** – establishing academic partnerships and creating incentives for the expansion and improvement of the recycling industry, and the research of recycling technology and application of recycled materials.

Decommissioning has become an all-inclusive, politicized, and costly issue. Experience shows that, mainly in stringent regimes, transparency and communication are crucial in dealing with the general public and interest groups, addressing the needs and aspirations of all key stakeholders (**Figure 3.22**).

An ideal decommissioning assessment report must include effect of all possible decommissioning options including energy use, biological and ecological impact of discharges, secondary emissions to air, physical and habitat matters, fisheries, waste management, littering, drill cuttings deposits, free passage, safety of personnel, national services, employment, cost feasibility, and impact on local communities, including visual interference, noise, odor, and traffic. The "public relation environment" may be looked at before the "physical and legal environment". A company may strictly follow all regulations and scientific reports, and still be far from satisfying public aspirations.

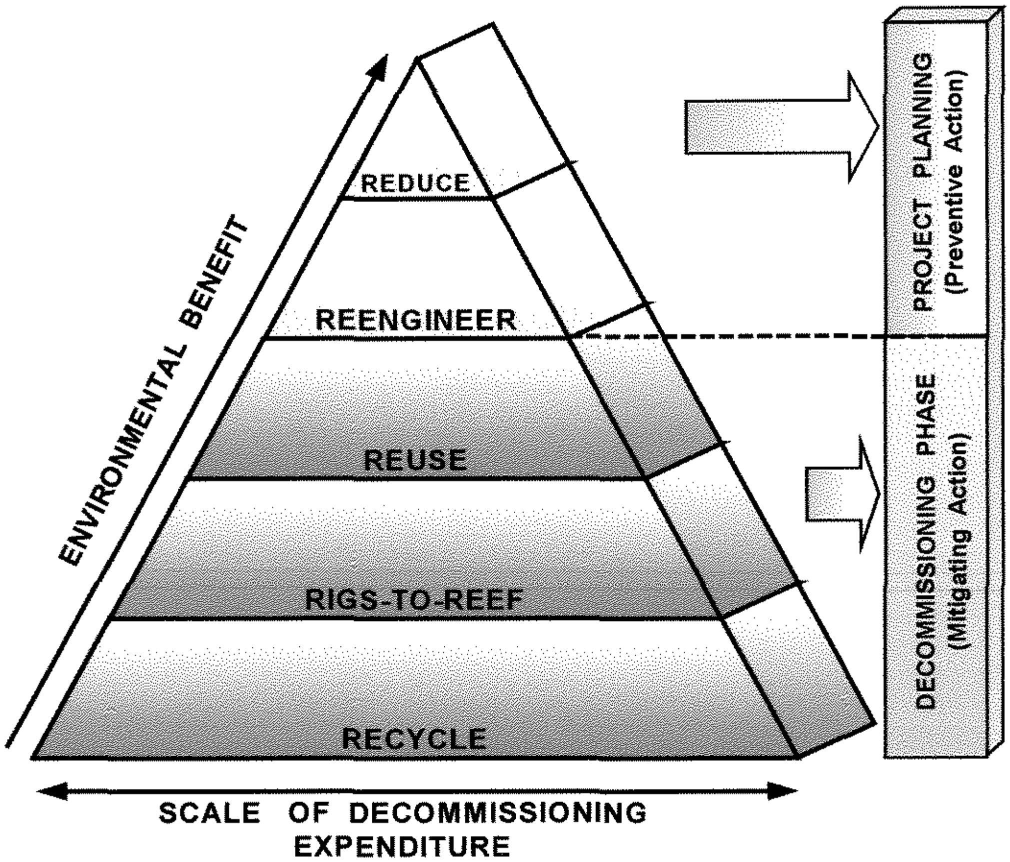

Figure 3.21. Environmental character of the proposed 5 R's Approach.

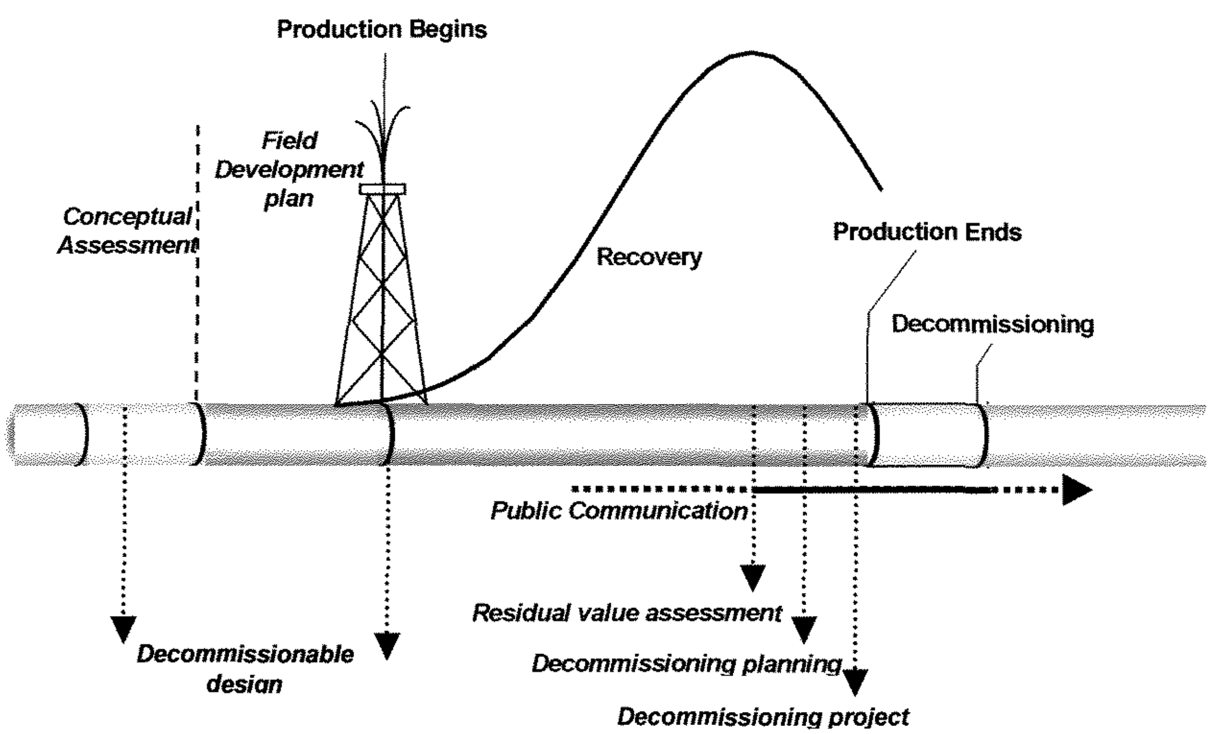

Figure 3.22. Pre-project decommissioning planning for stringent regimes.

CHAPTER IV - FINANCIAL ASSURANCE SYSTEMS: BONDING MECHANISMS

How to ensure that all ex-post obligations will be satisfactorily met, safeguarding public economic interests by maintaining investments in the sector and, at the same time, providing guarantees against negligent lessees and eventual economic and natural contingencies? Answer: Establishing a financial assurance regime (a performance bond regime).

4.1. ENVIRONMENTAL COSTS

Environmental cost is one of the many different forms of costs petroleum projects face as they provide oil and gas to supply society's needs. Today, environmental performance is essential for the success of a project and for the survival of oil companies. As indicated by EPA (1995b), Environmental costs and performance deserves management attention for the following reasons:

- Business decisions may significantly reduce or eliminate environmental costs;
- Environmental costs may be hidden in the overhead accounts or otherwise unnoticed;
- For instance, oil companies have discovered that environmental costs can be offset by generating revenues through sale of equipment, waste by-products, recycling, and even redundant structures;
- Improved management of environmental costs may result in enhanced environmental performance and significant benefits to human health, safety, and business success;
- Understanding environmental costs and performance of processes and products may allow more accurate costing and pricing of products and can help companies in the design of more environmentally preferable operation alternatives, processes, products, and services;
- Because of the new public environmental consciousness, competitive advantage with costumers can be obtained by oil companies that can demonstrate to be environmental referable;
- Accounting for environmental costs and performance can support a company's development and operation of an overall environmental management system. Such a system is today a necessity for companies engaged in international trade due to the

establishment of the international consensus standard ISOs, developed by the International Organization for Standardization.

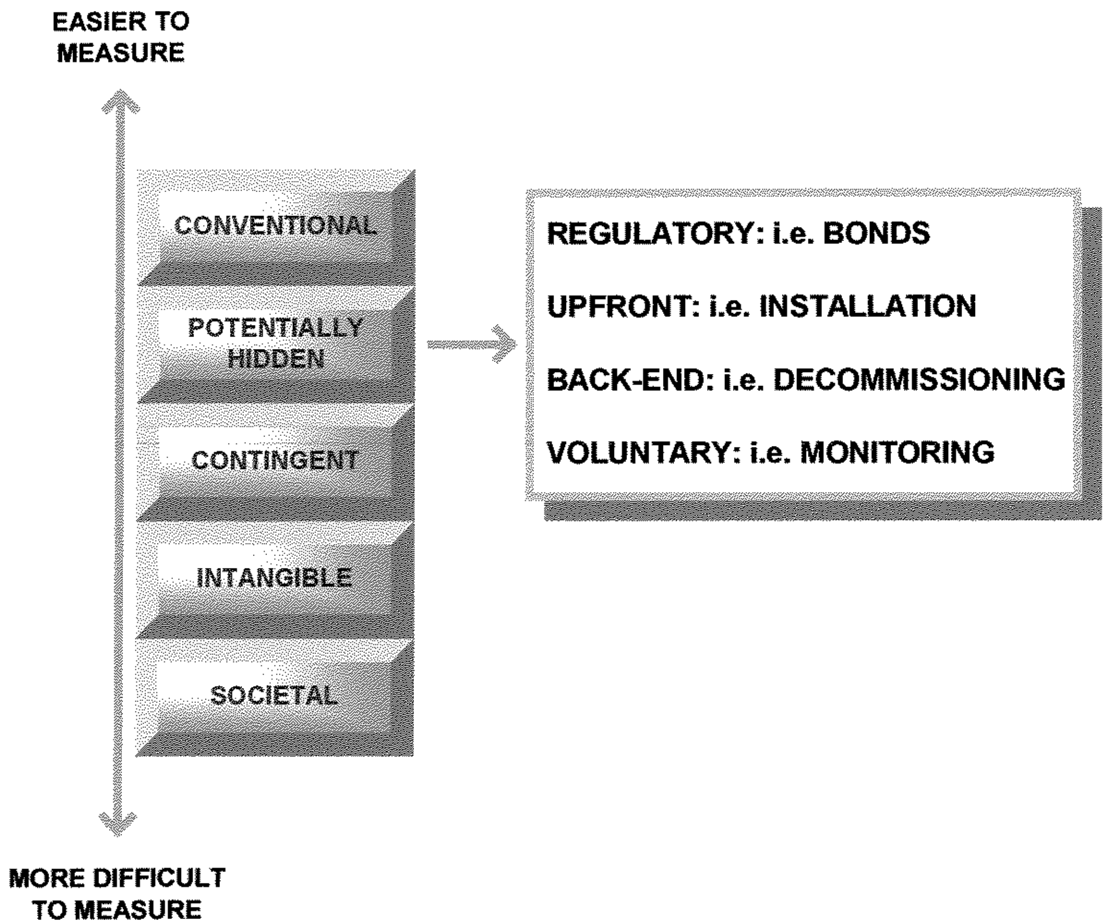

Figure 4.1. Cost Categories, deggree of difficulty, and examples of potentially hidden environmental costs.

The definition of environmental cost will depend of how a company intends to use the available information (i.e. cost allocation, capital budgeting, process/product design, other management decisions) and the scale and scope of the exercise. **Figure 4.1** indicates several examples of environmental costs incurred by companies including the relative degree of difficulty in approaching each category. **Figure 4.2** shows an additional classification criterion with respective examples of costs involved in projects.

The main environmental cost categories, according to EPA (1995a), are described as follows:

- ***Conventional costs:*** costs of using raw materials, utilities, capital goods, and supplies. Although not usually considered as environmental costs, they may sometimes be overlooked in business decision-making.

- ***Potentially Hidden Costs:*** costs that may be potentially hidden from managers (i.e. upfront environmental, regulatory, voluntary, and back-end costs).
- ***Contingent Costs:*** costs that may or mat not be incurred in the future. Such costs may be illustrated in probabilistic terms (expected values, ranges, probability of exceeding some amount, etc.).
- ***Intangible costs:*** costs incurred voluntarily for environmental activities and operations. The costs themselves are not "intangible", but the direct benefits often are.

A discussion on environmental costs and damages is presented on **Chapter II** and three broad categories of environmental damages are proposed (accidental, continuous and ex-post).

4.2. REGULATORY APPROACHES: COMMAND AND CONTROL VS. ECONOMIC INCENTIVE

The sustainability concept asserts that oil and gas exploration and production activities should not compromise future environmental quality. There are two main approaches in regulating environmental issues: (1) command and control mechanism (command system), and (2) market-based economic incentives (incentive system or market mechanism).

The present environmental scenario, a result of the continuous application of the command and control approach, shows the inefficiency of this approach in protecting the environment. The main causes are pointed out by CORNWELL and COSTANZA (1994) and adapted below to the oil sector:

- The great uncertainties involved in calculating end-of-leasing costs (i.e. contingencies, liabilities, and future operation costs).
- The costly and lengthy processes involved in trying to collect funds from liable companies through litigation.
- It treats projects homogeneously not taking into consideration type of platforms, installation settings, company's records on environmental performance, financial history, regulatory compliance record, etc.
- It places a great information burden on the regulatory agency (i.e. determining the best available technology for platform decommissioning and well abandonment, monitoring and enforcing penalties in cases of noncompliance, etc.).

- It defines the use of a particular technology for the removal and disposal of offshore installations, and for capping, plugging and abandonment of idle wells. If a specific technology is enforced, there is no incentive for the development of innovations that could result into improvements and cost reduction.
- It motivates regulatory evasion rather than regulatory compliance.
- It usually presents vague regulatory language, which offers companies the opportunity to build persuasive cases by showing, for instance, that certain decommissioning or abandonment requirements are unachievable.

Governments, which are responsible for producing and implementing regulations, were forced to come up with mechanisms that would guarantee the availability of financial resources in case of contingencies and/or insolvencies; otherwise, government would cope with environmental ex-post costs. For this reason, authorities have been promoting alternative tools to control environmental damages (SHOGREN *et. al.*, 1993; TIETENBERG, 1996; DIETZ and VOLLEBERGH, 1999).

YOUNG *et al.* (1996) has indicated several benefits produced by market-based mechanisms for the general productive sector. Nevertheless, to the upstream petroleum sector, in theory, the merits of market-based mechanisms are their ability to:

- Influence behavior through price signals without the need for direct intervention in the affairs of oil companies;
- Encourage oil companies and operators to seek the most cost effective (and often innovative) solutions to environmental problems;
- Decentralize decision making to companies and operators who often have better information on how to solve such problems than government or agency authorities;
- Reduce agency's enforcement costs as well as the industry compliance costs;
- Provide the upstream petroleum industry ongoing incentive to develop better environmental approaches.

According to CORNWELL and COSTANZA (1994), the incentive approach encourages the distribution of responsibilities among all stakeholders, decentralizing the decision-making process on their own interest, in order to protect and rehabilitate the environment, while the applicable authority would be responsible for providing economic incentives to encourage a determined behavior, defining performance objectives rather than a course of action. **Figure 4.3** indicates key stakeholders and their main interest in bonding mechanisms.

MILLER (2000) indicates that, presently, many governments routinely require the use of environmental financial assurance instruments to guarantee environmental performance during different stages of the mining cycle (exploration, development, operations, closure and reclamation).

Indeed, incentive mechanisms allow better economic efficiency than traditional command approaches leading to better results, as demonstrated in the US coal mining sector, US government construction works, collection systems for beverage containers, lubricating oil, automobile batteries, and tires (CORNWELL and COSTANZA, 1994; ANDERSON and LOHOF, 1997). In the upstream offshore petroleum sector, the application of incentive mechanisms is relatively recent.

The most common incentive approach used in the oil sector is the financial assurance system (bonding system), which is designed to ensure compliance with all ex-post environmental obligations (abandonment, clearance and decommissioning requirements), providing and enforcing conditions of negligible health and safety risk to local inhabitants, and safety for navigation and the environment. Worldwide, several countries are adopting, or in the process of adopting, financial assurance requirements. A number of natural resources agencies, petroleum and mining, have already established some form of bonding system aimed at ensuring the performance of ex-post environmental obligations (FERREIRA *et al*, 2003a). These systems can be found in operation in the United States, Canada, the United Kingdom, Australia, Brazil, the Philippines, Fiji Islands, New Zealand, and Sri Lanka, among others (OSM, 1987, 2001; GAO, 1994; YOUNG, *et al.* 1996; AEP, 1996, 1997, 1998a, 1998b; CANADA, 1996; JAMES, 1997; ADB, 1997; RANASINGHE, 1998; NIUMATAIWALU, 1998; HORESH, 1998; FERREIRA and ALVES, 1998; AEP, 1998a, 1998b; RYAN, 1998; HESS, 1998; BRYAN, 1998; CORNWELL and COSTANZA, 1999; WEBSTER, 1999; MMS, 2000d; DTI, 2000a, 2000b; GERARD, 2000; FERREIRA and SUSLICK, 2000; MIRABELLA, 2000; BAIER, 2000; STOKES, 2000; UNICAMP/CEPETRO, 2001; ANP, 2002a). Some countries such as the United States tend to move forward with new rules aimed at strengthening bonding requirements (BOYD, 2001).

Potentially Hidden Costs		
Regulatory	**Upfront**	**Voluntary**
Notification	Site studies	Community relations/ outreach
Reporting	Site preparation	Monitoring/testing
Monitoring/testing	Permitting	Training
Studies/modeling	Research & Development	Audits
Remediation	Engineering & procurement	Qualifying suppliers
Record keeping	Installation	Reports
	Conventional Costs	Insurance
Training	Capital equipment	Planning
Inspections	Materials	Feasibility studies
Manifesting	Labor	Research & Development
Labeling	Suppliers	Habitat protection
Preparedness	Utilities	Landscaping
Protective equipment	Structures	Other Environmental projects
Medical surveillance	Salvage value	Financial support to environmental groups and/ or researchers
Environmental insurance	**Back-End**	Philanthropy
Spill response	Closure/Decommissioning/ abandonment	
Stormwater management	Disposal of inventory	
Waste management	Post-closure care	
Taxes/fees	Site survey	
Contingent Costs		
Future compliance costs	Remediation	Legal expenses
Penalties/fines	Property damage	Natural resource damage
Response to future releases	Personal injury damage	Economic loss damages
Intangible Costs		
Corporate image	Relationship w/ workers	Relationship w/ regulators
Relationship w/ customers	Relationship w/ suppliers	Relationship w/ researchers
Relationship w/ investors	Relationship w/ lenders	Relationship w/ academic institutions
Relationship w/ insurers	Relationship w/ host communities	
Relationship w/ professional staff		

Figure 4.2. Examples of environmental costs (EPA, 1995 – modified).

4.3. THE BONDING SYSTEM IN THE OIL INDUSTRY

The bonding system can be used to operationalize the sustainable development concept. Companies wishing to explore and produce hydrocarbon resources would be required to post a bond in advance equal to the best-cost estimate for ex-post operations. Therefore, before a company is granted licenses or permits to drill, deepen, or alter a well, and before a platform is installed at sea, a bond must be posted to cover all plugging, abandonment, and decommissioning obligations.

In practice, the merits of bonding systems in the upstream petroleum sector are difficult to be demonstrated, mainly due to lack of empirical evidence. According to WAELDE (1995), the difference between instruments of public policy is not always easy or clear and may often merely indicate the choice of a specific format rather than a difference in substantive policy. Most bonding systems used in the oil sector are not self-enforcing and may involve considerable control costs YOUNG *et al.* (1996). Bonding instruments used for guaranteeing the performance of ex-post obligations in the oil sector are a hybrid of market mechanisms and command and control regulations. As mentioned before, the ideal market mechanism would allow a firm flexibility in the extent to which it performs closure operations, but force it to pay for all social costs it imposes (including environmental costs). Such a system takes advantage of the firm's internal knowledge of production costs, clean up costs, and profits. When closure is more expensive than social costs, the firm pays its social costs. When closure is less expensive, the firm performs closure operations. Most important in the dynamic setting, there is always an incentive to seek new technologies and techniques that minimize environmental costs. In the case of bonds, the regulator must determine the closure standard and is therefore less able to rely on the firm's internal knowledge. However, in a number of ways, financial assurance does help improve market function (FERREIRA *et al*, 2003a).

Even though obligations such as decommissioning operations may represent up to 10% of a project's total investment, quantitative studies on the potential impacts of such policies are rare. The academic interest in such approach is relatively recent and available references in the literature are scarce. This is a rather interesting scenario, since the application of bonding mechanisms has a great potential to severely impact the profitability of offshore projects. Some instruments require the anticipation (upfront security requirements) of 100% of ex-post environmental costs, even before projects produce revenue.

An evident change of attitude is corroborating to the worldwide implementation of incentive approaches. In a not so distant past, the industry in general, would view any obligation to provide financial securities to guarantee ex-post environmental obligations as "lost investment". Companies used to look primarily for immediate low cost solutions. Presently, the industry acknowledges that public image has a great value in today's economy.

With increasing public awareness, pressure from interest groups and the politicization of ex-post environmental issues, it is becoming rare for an oil project to obtain leasing concession or

operating license without the provision of some means of financial security to indemnify governments against ex-post environmental costs. Authorities are increasingly looking for ways of eliminating liabilities before licenses and permits are issued. It seems only reasonable to suggest that such trend may soon arrive in new developing frontiers. For instance, ANP is in the process of preparing a set of end-of-leasing regulations, which in the near future could include performance bond mechanisms. Currently, ANP requires a form of financial bond, an irrevocable stand-by letter of credit, in the bidding process (ANP, 2002a).

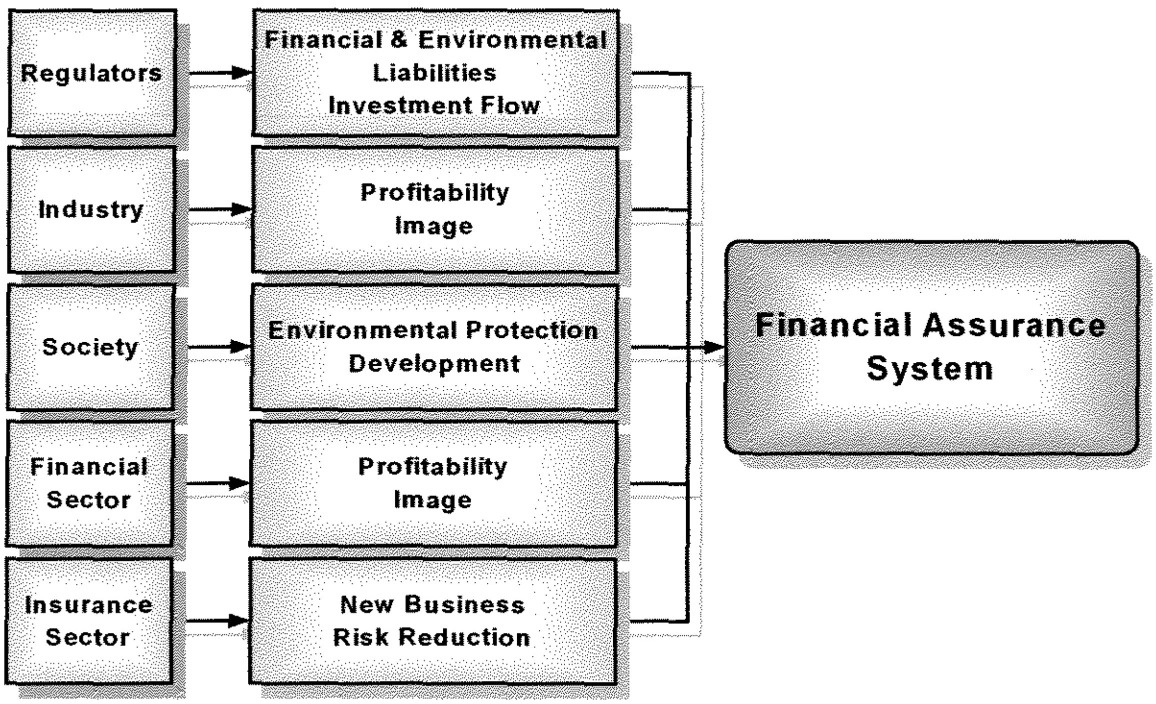

Figure 4.3. Key Stakeholders involved in the bonding process.

Bonds are financial instruments that can come in several forms with unique attributes and requirements, as described in **Chapter II.** All forms of bonding instruments must be (1) pledged to the regulatory agency and (2) kept in good standing during the entire life of the project.

A comprehensive description of financial instruments used as bonds in the upstream oil sector can be found in BLM (1995, 1996), MMS (2000d), and UNICAMP/CEPETRO (2001). Other key references are not directly aimed at the upstream petroleum sector, but do provide substantial information on instruments used as financial guarantee (YOUNG *et al.*, 1996; CORNWELL, 1997; EPA, 1997; BRYAN, 1998; MILLER, 1998; APOGEE/HAGLER BAILLY WITH D. R. ANDERSON ASSOCIATES, 1998; NWF, 2000; OSM, 2000b; NWF, 2000).

4.4. BONDING COSTS

It is acknowledged that the cost to meet technical and bonding requirements for ex-post environmental obligations will impact companies differently. Such impacts can be direct (premiums, fees paid to surety companies, fees associated with third-party securities and requirements, interest earned in cash deposit in escrow accounts, etc.) and/or indirect (increase or reduction of government earnings trough corporate taxes and other participations, improvement of accumulated funds on savings-undersupplied economies, reduction of the company's borrowing capacity, increase in the cost of credit, etc.). MILLER (2000) indicates that the amount of capital tied up in security is enormous.

Successful application of bonds will depend upon form of bonds, type of projects and companies, and scenarios. Usually large and financially healthy companies are not significantly affected by bonding requirements though marginal projects operated by large companies may be severely impacted. On the other hand, small companies operating small and marginal fields tend to be severely affected.

Authorities must pursue flexible and optimum solutions; on the contrary, smaller companies will be driven out restricting the sector. It may be the intension of some regulatory environments to drive out companies that cannot provide adequate guarantee. Other regimes may be interested in improving the competition within the sector by offering flexible mechanisms and being more sensitive to financial impacts of bonding policies on small companies. Some agencies, with a longer bonding implementation history, have developed more complex bonding regimes allowing incentives for companies with good history of environmental compliance, credit record, decommissioning experience, etc.

In **Chapter II**, two major bond categories were identified in terms of specific purpose: (1) financial bond, a bond that guarantees the payment of a specific amount determined by the agency in case of noncompliance; and (2) performance bond, a bond that guarantees the performance of a contractual obligation. Performance bonds indemnify authorities against operation costs, safeguarding agencies against both technical and financial failure, and premature or unplanned decommissioning (**Figure 4.4**). A financial bond does not guarantee the performance of an obligation. Instead, it can be compared to a token pledging, under the penalty of loosing no more than the amount bonded, the candidate's intention of keeping all financial commitments (e.g. timely payment of royalties and rents, honoring bids, etc.).

4.5. SETTING THE BOND AMOUNT AND DURATION

Determining the amount to be bonded is probably one of the greatest predicaments involving the bonding system. Due to inadequate bonding estimation, many problems were caused in the past when mining companies became insolvent and the bond in place was not sufficient to cover abandonment/rehabilitation costs; for instance, the well known Uranium Mines Episode in Western USA (COLLINS, 1991).

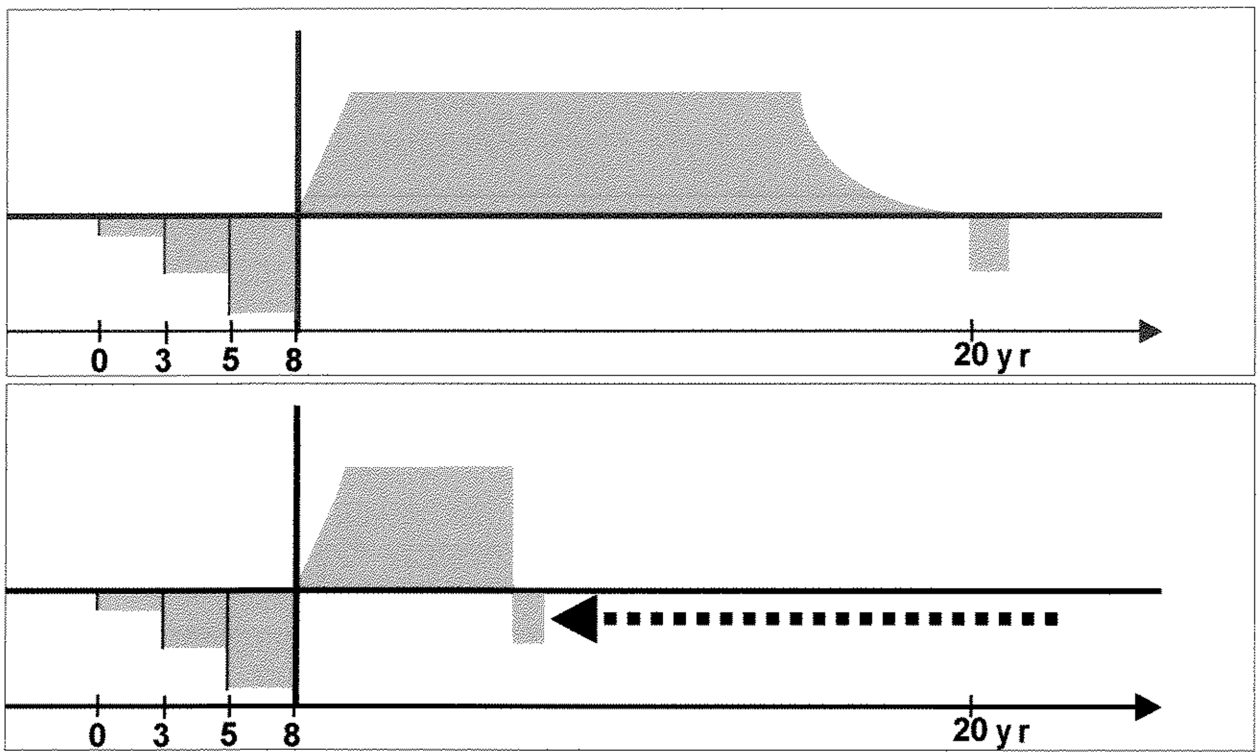

Figure 4.4. Typical cash flow for oil projects. Provisions for premature and unplunned decommissioning operations. Ex-post provisions brought up as upfront costs making funds available even in case of technical, financial failure, or premature and unplanned decommissioning.

The determination of the amount and duration of performance bonds is based on: (1) the nature, extent, and duration of the proposed project; and (2) the magnitude, type, and estimated closure cost. Bonds must be maintained in good standing for the duration of the project, remaining in effect until all ex-post obligations have been successfully completed. Authorities will then release the bond.

Usually, authorities set the bond based upon the company's closure cost estimate plus profit and overhead, which represents the third party cost to complete operations in the event of forfeiture. Ideally, cost estimation should consider a worst-case damage scenario, or the highest

estimated operation cost to complete ex-post closure operations. In this case, if a company were able to demonstrate that the damages to the environment or costs to complete ex-post closure operations are less than previously estimated, the difference would be refunded to the company.

In case of under-performance of ex-post operations or forfeiture (due to insolvency, negligence, etc.), the bond would include sufficient financial resources to repair, cover all damages, or complete operations. In any of these cases, there would be possibility for refunds.

The practical result is that the motivation for properly completing ex-post obligations and investing in new technologies comes now from oil companies and not from authorities, public, or interest groups (FERREIRA, 1999).

For US offshore projects, the required bond amount varies significantly from state to state. Public interest plays an important role in the definition of such amounts. Some states are more interested in safeguarding future investments than guaranteeing the proper abandonment of future wells. Other states will set very high bonds in other to lower the risk of environmental damage, and keep risky parties away, as it is the case in the State of Alaska (**Table 4.1.**).

TABLE 4.1. US BOND REQUIREMENTS FOR ONSHORE PROJECTS

State	Bond starts at (US$)	Blanket bond starts at (US$)
Alaska	100,000	200,000
Arizona	10,000	25,000
California	10,000	100,000
Inactive well	5,000	100,000
New Mexico	7,000	50,000
Ohio	5,000	15,000
Pennsylvania	5,000	25,000
Tennessee	2,000	10,000

Source: MCFADDING (1996)

In reality, it is very unlikely that a disturbed area will be able to be truly restored. Most extractive activities produce and trigger irreversible damages, and users can only reduce impacts, mitigate problems, and rehabilitate the area for future uses or conservation. Rehabilitation objectives must be rigorous but, at same time, realistic. Two good reasons why regulators should not compromise are:

- Future impacted communities will not spare the agency and litigious actions will be inevitable.

- Stringiness of regulations provides excellent incentive for technological innovations, allowing better environmental results and lower ex-post environmental costs.

Regarding setting the appropriate bond amount, experience shows that lax requirements do not encourage compliance and strict requirements encourage evasion; lenient requirements are ignored and stringent are disobeyed. An optimum ground must be pursued.

Ex-post standards and requirements should not be definite. The petroleum sector is extremely dynamic (new equipment, new technologies, new frontiers, etc.). Regulators must recognize the value of changes and be alert to identify over-regulations.

Ideally, bond requirement should be based on the cost for the rehabilitation of the entire lease area, applying the present value of all ex-post operation costs. There are three main methodologies for defining performance bond amounts for offshore projects:

- 100% of ex-post costs + (plus) indirect costs:
- 100% of ex-post costs * (times) risk rate:
- 100% of ex-post costs + (plus) worst-case scenario:

During the preparation of this present work, several approaches for calculating bonding requirements were identified. The following briefly describes some of the most common methodologies currently applied:

1. **By the lessee -** the company defines all ex-post operation costs and the bond amount is based on this estimate. Accepting this approach provides low regulatory costs for the agency. However, regulators become susceptible to inaccuracies and deceitfulness. Most certainly, lessees will tend to underestimate ex-post costs and ignore indirect costs. Historically, it is possible to verify that the liability (financial, environmental and legal) of successive misestimated projects is disastrous. To avoid this situation, contracting the services of independent specialists could be a short-term solution for the agency. In the long run, the agency should work at constructing a comprehensive database system. Some agencies try to minimize direct involvement and maximize public scrutiny. However, this approach is mostly suitable to societies that historically coexist with the extractive sector, knowing all

related socioeconomic benefits and burdens, and where a mature and transparent population/industry relation has been historically achieved.

2. **By the lessee and agency** - the lessee submits a closure plan that is either approved or modified by the agency, which will establish a bond amount. In this case, the agency must rely on a group of ex-post operations experts in order to evaluate, and, if necessary, revise the proposed plan and define the bond requirement.

3. **By the agency** - the agency owns a control system, usually a comprehensive database, and establishes bond requirements based upon its own knowledge of ex-post costs.

4. **By independent certified experts** - in this case, independent and certified specialists would evaluate the ex-post plan along with cost estimation proposed by the lessee, and produce a technical report recommending a bond amount. Authorities must not presume that independent experts will share the experience being acquired. There is a strong financial motivation for not happening so.

Some critics say that regulators have a possible tendency to overprotect themselves from all possible liabilities, even the more remote ones, leading to unreasonable high-cost bond requirements. Probably, the conciliatory attitude should be testing the sector, balancing the need for demonstrating financial capacity with the necessity for keeping a competitive and attractive sector. Excessive direct costs upon the industry may represent the redirection of important investments to regions that offer better profit margins. In this case, the agency walks on a very thin line between public pressure for stringentness and industry pressure for flexibility (**Figure 2.3**).

4.6. FORFEITURE AND BOND RELEASE

A bond may be subject to forfeiture for different reasons: (1) if a well or installation has been abandoned or temporarily closed without initiating required procedures; (2) if a company fails to meet ex-post obligations in accordance with the approved plan; or (3) if a company fails to maintain the amount bonded (MCELFISH *et al,* 1996; FERREIRA *et al*, 2003).

After the successful completion of all closure requirements, authorities must provide release from all bonds. If *ex-post*-related activities are being conducted concomitantly during the life of the project and if activities are satisfactory completed, authorities may also authorize the proportional release of bonds.

4.7. THE BONDING SYSTEM STEP-BY-STEP:

1. Bonding system dynamics:

- Submission of a detailed exploration plan to the regulatory agency.
- Definition of the bond amount by the regulatory agency.
- Fulfillment of bond requirements (providing the bond).
- Exploration.
- Submission of a detailed development, production, and decommissioning plan to the regulatory agency.
- Reevaluation of the bond amount by the regulatory agency.
- Fulfillment of new bond requirements (providing the bond).
- Operation and ex-post obligations (i.e. decommissioning).
- The bond is released and, if this is the case, refunded to the oil company.

2. Main positive bond effects (Figure 4.5)

- Decentralization of the decision process.
- Performance objectives are defined rather than establishing a protocol of action to be strictly followed.
- Incentive to the development of technological innovations with the objective of improving decommissioning results and reducing costs.
- It guarantees the availability of funds to cover the costs of all ex-post obligations
- It eliminates long and costly litigious battles.
- It motivates the internalization of contingency costs, stimulating the monitoring of the consequences of each decision made.

- Companies begin to assume the ex-post burden in order to demonstrate that end-of-leasing obligations will be met as contractually required, transferring the financial risk from the potential victims (government and taxpayers) to oil companies.
- It safeguards authorities from technical and financial risks, providing funds for eventual premature or unplanned closures.

3. ***Some bond definitions:***
   - Performance bonds: mechanism used to guarantee performance requirements.
   - Financial bonds: mechanism used to guarantee financial obligations.
   - Blanket bond (areawide): mechanism used to cover an area with several wells and installations.
   - Bond Pool: a consortium of small producers established to reduce and spread inherent risk in offshore oil projects.
   - General Bond: bonding general requirement for all companies, usually less significant bond amounts (financial bonds).
   - Supplemental Bond: additional bonding requirements based on a company's risk assessment model (environmental, technical, financial and compliance risks). Supplemental bonds can comprise both financial and performance bonds. **Figure 4.6** indicates the risk evaluation of a candidate lessee. **Figure 4.7** shows the calculation matrix for the risk evaluation data obtained in **Figure 4.6.**

4. ***Bond-calculation Parameters:***
   - Estimated ex-post costs.
   - Estimated contingency costs (only related to ex-post operations).
   - Planning and engineering costs.
   - Third-party profit and overhead costs.
   - Management, inspection, and supervision costs.

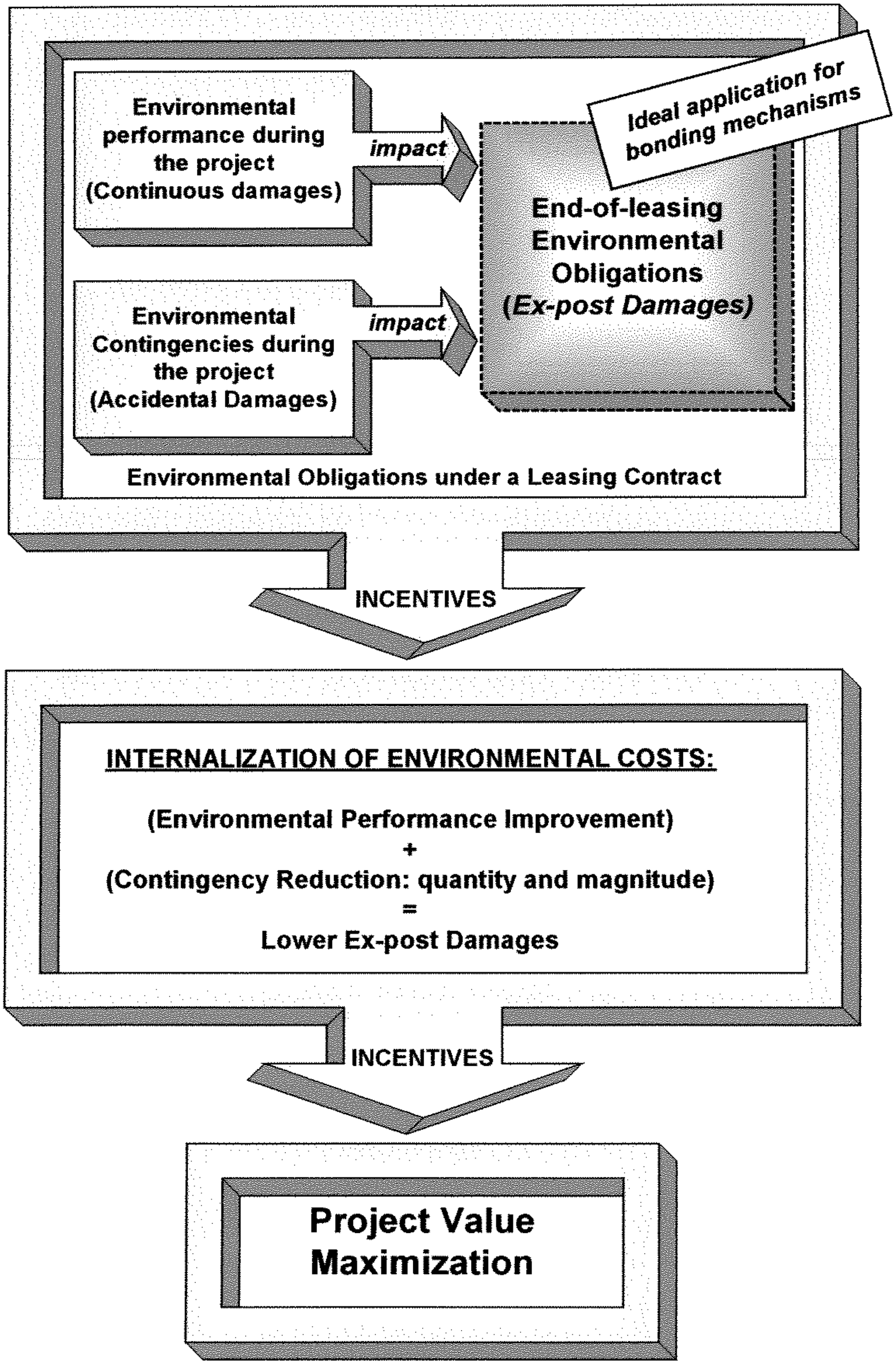

Figure 4.5. The bond effect. Bonding requirements acting over the internalization process, assisting in the reduction of accidental and continuous environmental damages, and maximasing project value.

5. ***Reasons for Recalculating Bond Values (increment or reduction):***
   - Changes in the parameters used to calculate the bond amount.
   - Changes in the economic scenario.
   - Signs suggesting problems in the operating company.
   - Changes in the technical and financial credibility of the oil company.
   - Changes in the financial capability of the oil company; its capacity to fulfill existing financial obligations is being questioned in the market.
   - Changes in the estimates of proven reserves within areas leased to the company.
   - Changes in the credit record of the company.
   - Changes in the compliance record of the company (moral risk).

6. ***Main Bond Obligations:***
   - All Bonds must be previously approved by the regulatory agency.
   - All bonds must be payable to the regulatory agency.
   - All bonds must be sufficient to guarantee all ex-post obligations.
   - All leased areas must be bonded.

7. ***The Regulatory Agency is Responsible for:***
   - Monitoring all bonding instruments.
   - Monitoring eventual market value variations of issued bonds (market value).
   - Monitoring institutions that issue notes, securities, collaterals, and other assurance instruments.

8. ***A bond may be Forfeited due to:***
   - Legal reasons.
   - Technical reasons.
   - Financial reasons.

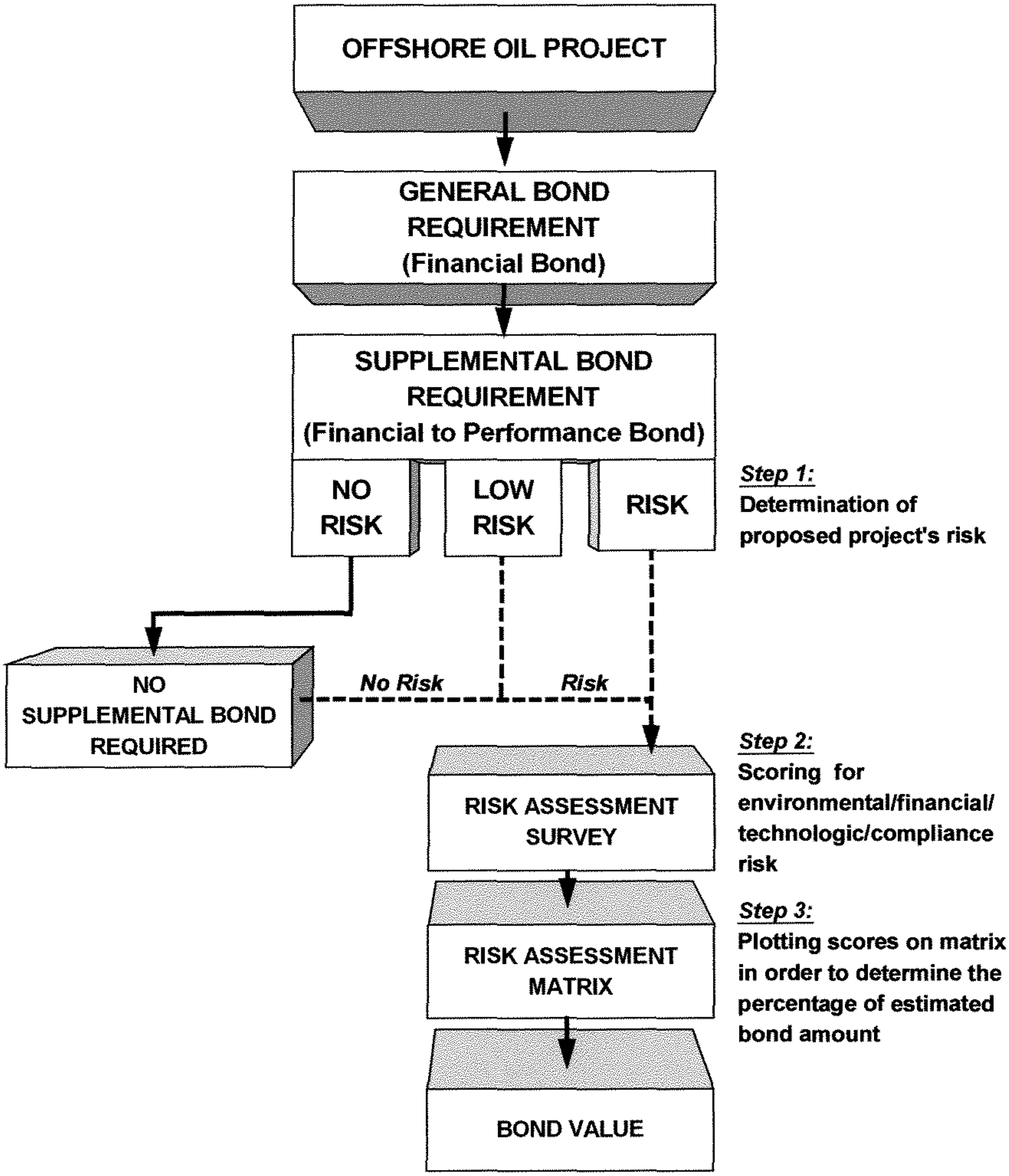

Figure 4.6. Risk Assessment Model. Based on AEP (1998a) proposal for mining reclamation bonds, here adapted to the oil industry. In this case, the performance bond requirement is set based on risk offered by the candidate.

9. *If a bond is forfeited, the agency will:*
   - Collect the value of the forfeited bond.
   - Use the bond to fund a third-party, a contractor, to update and/or correct the project in accordance to the proposed closure plan.
   - Return funds in excess to the company.

4.8. DIFFERENT FORMS OF BONDING INSTRUMENTS

Traditionally, bonding instruments have been used to provide different forms of guarantees as shown below: fidelity bonds (guarantee of honesty); fiduciary bonds (guarantee the proper management of assets); judicial bonds (guarantee the compliance with judicial decisions); and contractual bonds (guarantee the fulfillment of contractual obligations) (ROWE, 1987; JOHNSON, 1986; YOUNG *et al.*, 1996; CORNWELL, 1997; CORNWELL and COSTANZA, 1999; MILLER, 2000, UNICAMP/CEPETRO, 2001). The category "Contractual Bonds" includes several subcategories including: performance bonds; construction bonds; bid bonds; service and materials bonds; advanced payment bonds; retention bonds; maintenance bonds; transport bonds; government regulatory bonds; customs bonds; financial bonds; and license and authorization bonds.

As mentioned before, within the Exploration and Production sector, two major bond categories can be identified in terms of specific purpose: financial and performance bonds. Both financial and performance bonds may be used several times within a single contract. Under some regimes, companies acquiring oil or gas leases are required to post a preliminary financial bond (a fixed and relatively small bond) guaranteeing financial aspects of the lease contract (regular payments of rents and royalties, civil penalties, fines, etc.). Usually, companies holding more than one lease may opt for a mechanism called "Areawide Bond", or "Blanket Bond", in which case, a single bond would cover multiple leases.

In addition to financial bonds, some regulatory agencies require a performance bond, which is usually based on the best-cost estimate for completing ex-post operations under the established lease contract. Performance bonds serve individual projects and individual wells. Multiple performance bonds may be found within a lease, but a single performance bond cannot be used to cover multiple projects.

Bonds must be maintained until leases are terminated or transferred and until ex-post obligations are satisfactorily met. If closure activities are being conducted concomitantly during the life of the project, the phased approach, authorities may authorize proportional releases of the bond.

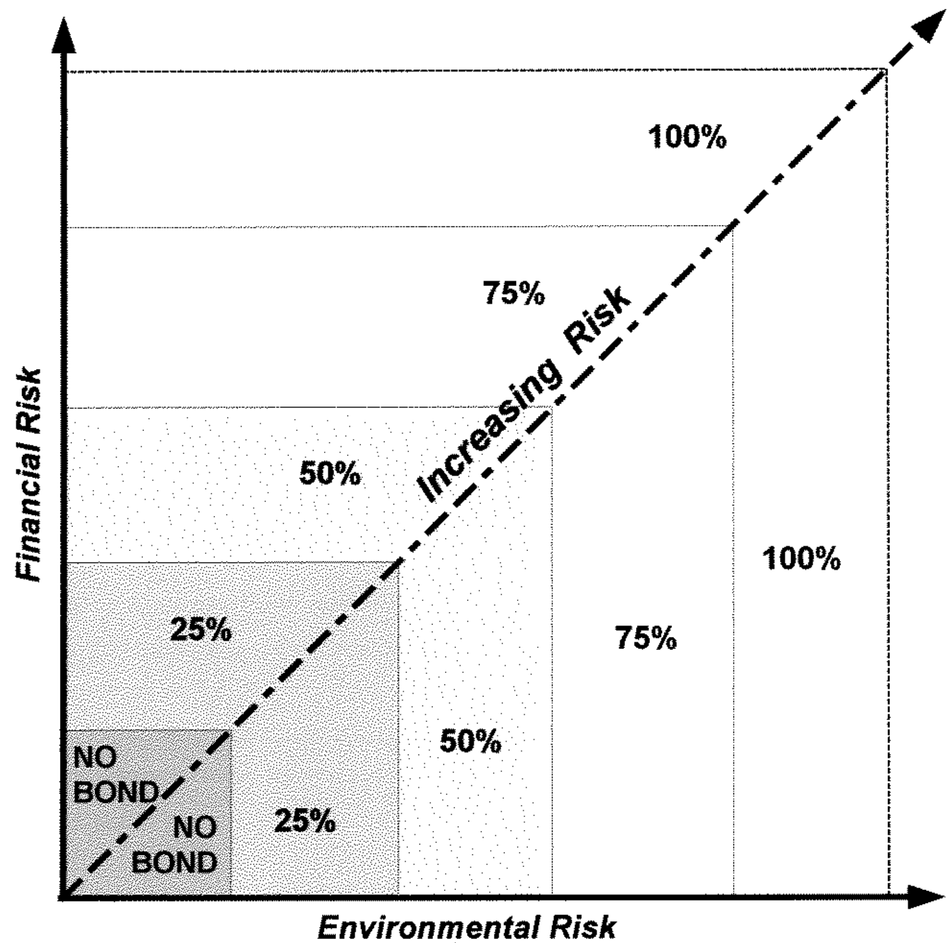

Figure 4.7. Risk Assessment Matrix

Definitions and descriptions of currently used bonding instruments can be found in the following publications including CORNWELL (1997), FERREIRA and SUSLICK (2001), OSM (2000b), NWF (2000), ANP (2001), UNICAMP/CEPETRO (2001), and FERREIRA *et al.* (2003a). As explained on **Chapter II** and illustrated on **Table 2.4**, a classification was proposed in to facilitate the systematic evaluation and optimum applicability of each financial instrument. The present study was able to identify the following financial instruments, which are briefly described below. Descriptions are based on information obtained on the following publications and interviews with specialists (MCELFISH, *et al*, 1996; MCFADDING, 1996; ISO, 1997;

BOLENDER, 1998; HORESH, 1998; AIG, 1998; BRYAN, 1999; BAIER, 2000; BRYAN, 2000; DIE, 2000; NWF, 2000; MILLER, 2000; STOKES, 2000; WILLIAMS, 2000; OSM, 2000b, 2000c; MMS, 2000e; BLM, 2000; MIRABELLA, 2000; RADIGAN, 2000; CORNWELL, 2000; MPC, 2000; UNICAMP/CEPETRO, 2001):

Corporate Surety Bonds (CSBs):

A surety bond is a contract involving three parties, the surety company, the oil company or lessee, and the regulatory agency. Sureties are issued (written) by certified financial institutions. The surety contract guarantees the payment of funds (not to exceed the penal sum) or the performance of ex-post activities in case oil companies fail to fulfill them. Sureties guarantee the credit of an oil company and both parties equally share contractual obligations. Surety companies do not expect a default scenario. However, if it occurs, the surety company pursues reimbursement from the principal. In case of default, authorities hire an independent contractor to perform ex-post operations. Sureties may provide extended guarantee for residual liabilities even after ex-post obligations are finished (evergreen clauses). In order to obtain sureties, candidates must go through a rigorous underwriting process, which will access their financial, technical and moral capacity. The underwriting process makes it difficult for small or newly formed companies to obtain surety bonds. In the United States, the US Treasury defines a maximum coverage amount (a form of government reinsurance) and monitors surety companies.

Surety bonds are analogous to insurance policies in that companies pay annual premiums and fees to keep the bond in place. The main difference between sureties and insurance policies (and annuities) is that a surety guarantees the credit of an oil company, and an insurance policy transfers the liabilities to the insurer.

Each surety company follows its own financial criteria to judge a company and determine premium rates (i.e. net worth level, credit rating, decommissioning experience, etc.). More commonly, premiums are defined according to the financial risk and project characteristics. Currently within the oil sector, surety premiums are usually paid annually; for instance, $12.50 per $1,000 per year, or 1.25%, but it may get up to 3.00%. Under most regimes, as it will be seen in **Chapter V**, premiums and fees are allowable against tax (deduction rates vary significantly). Because of such high stakes, some bonding companies will not write this class of instrument for

the oil industry, only larger broker houses or larger surety companies (BOLENDER, 1998; FERREIRA and SUSLICK, 2000; DIE, 2000).

Sureties are non-cancelable, even if the contracting company fails to pay premiums and/or in the event of bankruptcy or insolvency. One of the main advantages of this instrument is that no upfront funds are required. If companies remain solvent and conclude required operations, bonds are released and premium payments cease. The contracting company still has to disburse out-of-packet funds to cover ex-post operations. In case of forfeiture, the surety company will have to pay for all contractual obligations. In addition, under most legal regimes, further complications may incur, including civil and criminal penalties, loss of operating license, credit, and reputation damage, etc. (FERREIRA and SUSLICK, 2000).

Some surety companies offer a combination of sureties with a trust fund, but most of the times, sureties are sufficient to demonstrate financial guaranty. Since it may be difficult for some small and newly formed companies to obtain a surety bond, regulators some times offer different forms of escrow accounts so these companies are allowed to establish their credibility within the sector, acquire experience and build up their assets. Then, companies can substitute their escrow accounts for sureties.

Another benefit provided by sureties is that they are irrevocable, and issuers are monitored by the Central Bank (US Treasury), reducing regulatory costs. In addition, surety companies have a great interest in monitoring the principals, the lessees. If there is margin for any litigious inquiry, it will be between the surety company and the principal; and regardless, the agency will promptly receive the penal sum. Some regulators, mostly in the mining and onshore oil sector, complain of having some difficulty in collecting money from surety companies.

A number of specialists defend that government should provide some form assistance so small and newly formed companies could obtain surety bonds more easily. The problem is that such mechanism would completely annul incentives for compliance, which is the whole point of requiring bonds. In addition, in case of default, since surety bonds are a guarantee of credit, the government would be accountable for the absence of credit, and taxpayers would, once more, cope with liabilities.

Collateral Bond (CBs):

Collateral offered by companies to provide guarantee for the completion of ex-post obligations include: company's assets, such as cash, real estate, treasuries, instruments indicating the presence of a line of credit or a funded account. Some collateral instruments offer interest earnings (cash, Investment Grade Securities, Treasury securities, etc.). Other instruments require payment of fees and premiums (Letters of Credit, etc.).

Within this category, instruments have similar attributes and characteristics and, many times, their names are used invariably with the same meaning. Such accounts must be under the control, for administration purposes, of a trustee other than the agency and the lessee. In some circumstances, the agency may function as a trustee.

Paid-In Collateral Accounts or Pre-Paid Collateral Accounts (PPCAs)

There are several variations of PPCAs, but they usually work as a three-party irrevocable agreement, where an oil company transfers funds to a financial institution (trustee) to be managed in the name of a third party (the regulatory agency). The account must be supplied with the full bond amount, the required guarantee, before the project begins. Funds can only be released with the approval of the regulatory agency and the agreement cannot be altered or cancelled unilaterally. Interest revenues may be either added to the account and paid at the end of the project, or paid as they are earned. Allocation of cash in this manner causes significant direct costs.

Companies cannot use the deposited collateral to fund ex-post activities. After the successful conclusion of all ex-post operations and the release of the bond, the deposited amount is reimbursed to the oil company. In case of forfeiture, the bond amount is used by the agency to contract an independent operator to perform the necessary ex-post obligations. In this case, other sanctions may be imposed.

PPCAs pay interest, guaranteeing the value of money and this instrument category is promptly available in the market. The trustee has the power to manage the investments. An annual fee is charged and interest earnings can also be added to the account to reduce or eliminate future adjustments required by the agency. Currently, these accounts are rarely used due to the availability of a variety of other less costly options.

Allocating capital in large quantities in such way (upfront) cause considerable financial impacts on the lessee, allowing significant opportunity costs. In order to offer some attractiveness, both the industry and the financial sector waits for some form of fiscal incentives for this form of instrument. Currently, PPCAs are not tax deductible and interests earned are taxable.

As far as regulators are concerned, PPCAs are very efficient in guaranteeing ex-post performances, offer premium liquidity, and an excellent incentive for compliance. Unfortunately, PPCAs require complex contracts and close monitoring of financial institutions. This may cause some additional regulatory costs, mainly in long-term projects. In order to reduce risks, the agency must be the only beneficiary, making it possible to regulators to withdraw funds upon pre-established conditions.

Escrow Collateral Accounts (Escrow Agreements) (ECAs)

The difference between escrow accounts and other accounts is very tenuous, and, most of the times, these names are used interchangeably with the same meaning. ECAs must have the guarantee of central banks. For this reason, they must not surpass the maximum guaranteed value established by the Central Bank. The trustee would be responsible for buying Treasury Bonds every time the limit is reached. This mechanism may bring some form of fiscal incentives during certain periods. Usually CDs may substitute escrow accounts.

Cash Collateral Accounts (CCAs)

This instrument falls in the same category as escrow accounts. Some agencies allow small and independent lessees to use cash and cash equivalent (certified checks, savings accounts, etc.) to demonstrate financial guarantee. In such cases, the accounts must be certified by the Central Bank. In more competitive regimes, this is the only form of instrument that small and independent operators have available to demonstrate financial guarantee. Terms of account contract must state that funds cannot be withdrawn without the written permission of the agency.

External Sinking Funds (ESFs)

ESFs work as any collateral account but allowing periodic payments. In addition, this form of instrument requires a combination of instrument guarantees. For this reason, ESFs may take the form of different instruments available in the market. Whatever the instrument used, it is intended to set aside resources and assets. The combination of guarantees must produce the total amount of the bond required. As the account is being funded and the real guarantee increased, the lessee may reduce, in the same proportion, the use of other instruments. When the account is completely funded and requirements are completely satisfied, the ESF may be transformed in other instruments. Advantages and disadvantages will depend on the form of instrument assumed by the ESF. This instrument integrates the financial benefits and attributes of interest earnings, the flexibility of periodic payments (the same as a LSCA), and the approval of the agency (the same as a PPCA). In some occasions, a well-prepared portfolio of instruments may offer a better scenario than a PPCA. Regulatory costs for ESFs are considerable and managing a variety of instruments at the same time can be very complex.

Certificate of Deposit (CDs)

CDs certify that a specific deposit has been made. Certificate of Deposits are known as debt-instruments that pay fixed interest and have a predetermined maturity (term). They can be used as collateral for loans and demand penalties for early withdrawn. CDs can also be attached to binding contracts between interested parties. Maturing periods vary significantly but can be renewed automatically. CDs may be negotiable and nonnegotiable. Nonnegotiable are usually of small face value. Negotiable CDs are usually of large denominations and can be traded in the financial market by corporations, governments, and central banks from other countries. This mechanism was developed throughout the history as a result of innovations within the financial market.

CDs with variable rates, CDs rollover, and CDs that can extend the term of other CDs. CDs can also be *time-deposit* and *demand-deposit*. Time-deposit CDs are paid only in specific dates set by the instrument and penalizes if redeemed prematurely. Demand-deposit CDs allow withdraws at any time after a period defined by the instrument (30 to 90 days). All CDs must be payable or directed to the regulatory agency, and placed under the protection of the same agency or an independent financial agency. In case of default, the agency is authorized to liquidate the instrument and use the funds to fulfill ex-post obligations.

This category of instruments remunerates with interests, guaranteeing the value of money. After maturity, CDs may be redeemed by the principal value plus accumulated interests. This instrument is promptly available to the agency, as needed. Issuing and maintaining CDs generate direct and indirect costs to the lessee (legal fees, depreciation value, market, fluctuations, etc.).

If the CD face value is at least the same value of the costs to complete ex-post obligations, the instrument offers an efficient form of guarantee to the agency. CDs are also efficient to guarantee long-term closure projects. In order to reduce inherent costs, the agency should contractually require that CDs are made payable to the agency. In such circumstances, the issuing party must renounce all rights to pledge the CD in other contracts. CDs must not be issued with face values higher than the amount guaranteed by the applicable Central Bank (in the US: US$ 100,000). CDs must be issued with a limited maturity, so they can be periodically adjusted for inflation and submitted to revisions regarding ex-post obligation costs. CDs must be sufficient to cover ex-post obligations even if they have to be traded before the maturity period. If sold before maturity, CDs are traded bellow their face value. As an additional guarantee, the agency may require a "standby" or escrow account combined with the CD, especially for long-term projects.

Salvage Revenue Collateral Bonds (SRCBs)

This category is similar to Self Guarantees. It is difficult to separate these two categories from each other. Under this scenario, the lessee would demonstrate that the estimated value of its salvage (platform, equipment, units, etc.) is sufficient or partially sufficient to cover ex-post obligations.

SRCBs do not require allocation of capital, eliminating opportunity costs and direct costs. In addition, there are not premiums or fees involved. On the other hand, SRCBs do not offer adequate liquidity to the agency. Mostly for this reason, it is an inefficient and risky way of demonstrating financial guarantee for ex-post obligations. For instance, in case of contingencies such as sinking of the platform, the guarantee instrument is included in the physical losses.

Real Estate Collateral Bond (RECBs)

This mechanism consists of placing a real estate property (of equal or higher value) as a collateral guarantee for the completion of contractual obligations. Real Estate guarantees can be secured for long periods. The market value must be payable to the regulatory agency under a Deed of Trust and must be sufficient to cover all ex-post obligations under the contract.

In order to eliminate some of the risks involved in the acceptance of this instrument, a contract is drawn establishing the regulatory agency as the only beneficiary of the property in case of default or insolvency. In addition, the property must not be part of the area involved in the project and must be free of liens or loans. During the entire life of the project, an independent agent must monitor the market value of the property. If the property value falls bellow the value required by the bond, the regulatory agency must be notified and a new form of guarantee must be promptly provided. Real estate properties carry very low liquidity and create additional regulatory costs. Besides, in case of default, the selling process is complex and may be long. Often, the agency is forced to sell the property for a value significantly inferior, allowing additional costs to tax payers. Direct costs caused by this instrument are very low, however some other costs such as taxes, legal fees, depreciation, and market fluctuations, may incur.

The acquisition of a real state property as a form of investment is not a good way to allocate capital, since there is no guarantee for the value of money. If the property already belongs to the lessee, it would reduce the total capital allocated as a collateral guarantee, reducing opportunity costs for the lessee. If pledged as a financial guarantee, the lessee is unable to use the same piece of real estate as collateral for other ventures, including obtaining loans.

Treasury Bonds and Investment Grade Securities (T-Bonds and IGSs):

Investment Grade Securities are instruments that offer annual interests and may come in several forms. They are generally bought with long maturing terms in order to avoid frequent substitutions and keep higher earnings. The most common IGS instrument used as collateral to demonstrate financial guarantee for ex-post obligations are bonds issued by various levels of government (debt instruments with fixed terms). Government-issued notes are usually kept until their maturity (term), but they can be negotiated in the market without penalties. When used in this context, government bonds are usually negotiable and transferable, so some additional care must be taken protecting the document. IGSs are as good as the institutions issuing them. IGS bonds pay interest, guaranteeing the value of the money allocated. In order to avoid the volatility of the market, regulators tend to recommend US Treasury Notes. The regulatory agency has the right to sell the securities if the company does no meet ex-post obligations. Funds acquired will be used to complete all ex-post operations. After maturity, bonds are redeemed by the face value plus accumulated interest. This instrument category offers good efficiency even for long terms projects.

Leasing-Specific Collateral Accounts, Leasing-Specific Abandonment Accounts, or Periodic-payment Collateral Accounts (LSCCs, LSAAs, or PPCAs)

This category works similarly to PPCAs; however, some flexibility is added in the way payments are made. There are several variations of this instrument. Payments must be completed within a pre-determined period according to a formula provided by the regulatory agency. The format adopted by the MMS requires a company to commit itself to fully fund the LSAA within four years or, by the beginning of the year in which the agency projects that the company will have cumulatively produced 80% of the originally recoverable reserves, whichever is first.

The first payment is generally equal to or greater than 50% of the estimate of the cumulative potential lease abandonment and clearance liabilities (ex-post costs). The company will base the amount of the initial payment on the agency's analysis of rates of production from other leases, cash flow for similar projects, characteristics of the producing reservoir(s), plugging and abandonment information available in the agency's databases, and/or other information provided to the agency.

The objective of the MMS is to establish a time schedule for incremental payments that will ensure that the deposited amount in the LSAA will increase at a faster rate than the rate at which the originally recoverable hydrocarbons are being produced from the lease. In actual projects, the agency may require the submission of a risk insurance policy in order to cover residual liabilities[21] in the event that a catastrophic failure or other contingencies may prevent the completion of the remaining payments.

Table 6.8, on **Chapter VI**, is a demonstration of the time schedule for incremental payments of a LSAA bond. It indicates the time schedule adopted and the amount of each

[21] Some agencies require post closure financial assurance for a 30 years period after closure (GAO, 1994).

incremental payment to fund the account over a four-year period. The following example describes the situation on a hypothetical oil-producing field. A LSAA must be funded with $17.25 million, which is the value of the bond. The amount of the initial payment is 50% of the field's cumulative potential decommissioning costs, which is equal to $8,63 million. By the end of year 4, even if the company were not able to produce 80% of the recoverable reserves originally in place, the account would need to be funded with the full $17.25 million. Notice that, yearly payments of $2.16 million during the 4-year period increased the fund from $8.63 million to $17.25 million by the end of year 4. Interests earned are transferred to the oil company. Even complying with all LSAA bonding requirements, companies still have to pay with out-of-packet funds to cover ex-post operations at the end of projects. Other examples are illustrated in **Chapter VI**.

Instruments under this category discreetly eliminate opportunity costs from large upfront disbursements. However, these benefits are only possible with the transference of some risk to the agency. With periodic payments, there is no real guarantee that the total value of the bond will be available if the lessee defaults before the account is fully funded. This risk is being reduced by the requirement of the following mechanisms: (1) requirement of an insurance policy in the value of the owned amount; (2) requiring a short period for funding the account (usually four years); (3) establishing the agency as the only beneficiary of the account; and (4) making the contract irrevocable. The attractiveness of these instruments also depends significantly from fiscal incentives. The account management also generates some taxes and fees. In addition, these measures demand additional monitoring and regulatory costs.

Letters of Credit (LOCs)

Letters of Credit are documents issued by financial institutions authorizing the holder to receive a specific value. More specifically, a line of credit in the name of an oil company is issued to guarantee that the amount required to complete all ex-post obligations will be available in case of default. LOCs are negotiable instruments that specify the maximum amount of available credit. The financial institution will deduct annual premiums, taxes, interests, and other fees in order to maintain LOCs. LOCs can be negotiable or non-negotiable instruments (most commonly non-negotiable) and are usually issued for one-year terms with *evergreen clauses*[22].

[22] Evergreen clauses allow automatic renewals or "rollovers".

However, renewals depend upon the approval of the financial institution, which may decide not to extend the instrument based on new developing factors that indicate increasing risk of default. In this case, what happens is the equivalent to a situation of noncompliance, and the beneficiary, the agency, may redeem the face value of the LOC. All three parts have great interest in avoiding this situation.

Premiums and fees are often based on a credit evaluation of the candidate company. Under ideal conditions, only soft collaterals are required. In order to reduce the risk of non-payment, regulators may require a letter of credit contract involving three parties (the issuing institution, the oil company, and the regulatory agency). Letters of credit preferably should be irrevocable and have the regulatory agency as the only beneficiary. The oil company will not be able to use the established credit or the involved collateral to fund ex-post obligations.

LOCs, indeed, behave as nonnegotiable instruments. No institution would pay the face value of an LOC to a party other than the specified beneficiary. Any contract changes must be approved by all three parties (agency, principal and beneficiary).

Contract terms for a LOC will have the same provisions involved in the end-of-leasing contract between the lessee and the agency. Some specific terms are included to govern over circumstances that will permit the redeeming of the instrument by the beneficiary, including missed deadlines, negligence of specific operations, and unacceptable standards and levels of quality.

Usually, premiums and fees for the maintenance of LOCs are very reasonable and negotiable, but costs will depend on the credit evaluation of the principal (usually a percent of the financial guarantee being required). Under most regimes, expenditures originated on the establishment of an LOC may be deducted from corporate taxes. Once the LOC is established, maintenance costs are low, but the principal is obligated to refund the LOC issuer all interest related to funds withdrawn by the beneficiary. Small, newly formed, and independent lessees may encounter some difficulty in obtaining a LOC, and probably would have to provide the issuer with the deposit of the entire instrument face value as collateral.

LOCs will reflect the credibility of issuing institution. They are as good as the institution issuing them. If the financial institution is currently in trouble, the instrument offers great risk. If the financial institution becomes insolvent, the instrument is no longer a guarantee. In order to reduce risks, the agency must carefully monitor issuing institutions, what may significantly increase regulatory costs. The agency may also require the establishment of a combination of LOC with a standby collateral account.

Line of Credit Collateral Bonds (LCCB)

A LCCB is not a negotiable instrument but behaves like a LOC. This instrument is essentially an agreement made between a financial agent, who lends the necessary funds, and the lessee. The financial agent becomes responsible to fund all ex-post operations in case of default. The maximum credit value must correspond to the costs of contractual ex-post obligations. LCCBs must not depend of possible fluctuations in the financial health of the lessee. On the contrary, the financial agent must disburse of the amount pledged without defiance. In case of default, funds are withdrawn as needed by the agency, until a maximum amount contractually approved.

Financial agents usually require collaterals for the establishment of LCCBs. Direct and indirect costs may be significant. For regulators, high regulatory costs are also expected. A Standby trust fund may also be required in combination with a LCCB.

Third-Party Bonds (TPBs)

TPBs are common in the mining sector and some oil agencies may accept them under some circumstances. Requirements are significantly more severe and complex. Each agency has its own complex list of requirements involving formulas and specific questionnaires for both lessee and parent company.

Self Bonds (S-BONDS)

A self-bond is a form of waiver provided by the regulatory agency to companies that can provide some specific financial requirements (unencumbered net assets and net worth tests). There is a wide range of self-bond variations, also called financial tests. Some agencies are considerably rigorous in granting these instruments and others are not so rigorous. Self-bonds differ significantly from third-party guaranties and from other flexible collateral instruments such as set-aside revenues, salvage, and real estate. In general terms, self-bonds are based on the assessment of the assets and responsibilities of the lessee and its capacity of paying for and performing ex-post obligations. Flexible self-bonding mechanisms can offer significant risks to regulators.

Third parties do not back self-Bonds. In addition, the lessee is not under the obligation of providing collaterals or other guarantees. Usually, in order to benefit from this instrument, the lessee has to observe certain criteria determined by the agency. Self-bond criteria vary significantly; involving simple and complex formulas, net working capital and tangible net worth calculations, credit rating, ex-post operation experience, etc. Ideally, only major, experienced and historically competent companies should qualify.

S-bonds may benefit companies that have been established in the oil business for a long time, maintain a good financial health, sound environmental record, etc. S-bonds do not require premiums or fees, nor cause opportunity costs, eliminating all direct costs. Indirect costs do apply and reduce the company's capacity in obtaining loans and increase credit cost.

This instrument category is very criticized by different groups that tend to expect more liquidity from bonding instruments. The mining sector has shown that large and historical companies can also default, become insolvent and bankrupt. The risk for large companies plunging into a crisis may be small, but catastrophic since most large companies are associated with several large projects with the potential of generating large and catastrophic ex-post environmental damage. In addition, if a lessee is a subsidiary from a large parent company, both should be financially responsible for all ex-post obligations.

These past years have shown that a company's financial situation can be easily manipulated, stockholders can be deceived, and gigantic companies can pretend to be extremely lucrative on day, and go bankrupt next morning. Political manipulation of markets demonstrated in the Enron incident involving allegations of excessive political influence and manipulation among United States Representatives, involving even the current Bush administration, should be an opportunity to consider a more secure form of guarantee for large companies and projects.

Future Revenue Commitments, Budget Set-Asides, Corporate Guarantees (FRCB, BSAB, CGB)

These instruments are somewhat similar to self-bonds and, most of the times, it is difficult to differentiate them apart. Companies using this category of instruments have to fulfill annual criteria. Set-Asides, for instance, allow a company to use as guarantee the resources it intends to gain. This can become very complex and controversial. For instance, what is the risk scenario involved in a marginal field being operated by a small company that uses one of these instruments as a performance bond?

Direct impacts are nonexistent under this category. However, depending on the instrument, indirect costs may become very undesirable. For instance, the set-aside instrument will reduce drastically the capacity for acquiring loans and increase the cost of credit. This category offers great flexibilities to the industry; however, it comes with a considerable cost to the agency, including monitoring costs and high default risk.

Pool Bonds (P-BONDS)

A poll bond is a form of consortium of operators (usually small or newly formed companies) designed to provide flexibility by spreading the risk of non-compliance and minimizing bonding costs for associated parties. Associated companies become responsible for making payments towards a common fund, which will be available in case of default of one of the parties. Payments are usually based on a percent of the production, and are nonrefundable and nondeductible. Associated lessees have no control over the fund, which is managed by an independent trustee. Some regulators argue that pool bonds only attract the interest of risky parties. Indeed, pool bonds spread risk among associated companies, and only lessees under extreme high-risk conditions would be interested in type of deal. In addition, monitoring and regulatory costs are significantly high for regulators.

Insurance Policy Bonds (IPB)

An insurance policy is a two-party contract transferring existing ex-post liabilities on an existing lease contract (up to the policy value) to an insurer. Insurance companies offer a wide variety of environmental insurance products; however, in order to be accepted by most regulators, a financial guarantee, policies must be irrevocable, free of liens and loans, have a pre-paid single premium, and have the regulatory agency as the only beneficiary of the policy.

Annuities Policies (APs)

An annuity works like a series of payments (or a single large payment), made by an insurance company (or another financial institution) in behalf of the principal, the lessee, in exchange by an upfront premium paid by the principal. When the instrument is bought, the insurer becomes contractually obligated to cover payments in favor of the principal, whenever required. These payments, or single payment, are equivalent to continuous and/or ex-post environmental obligations. Payment program must be defined at the time the policy is signed. In some special circumstances, irregular payment fluxes are permitted.

Since payments can be made periodically or at a single installment, the lessee may benefit from interest earnings, guaranteeing, at least, the value of money. In addition, lessees may also benefit from acquiring annuities at values significantly inferior to the required bond amount. Longer periods allow greater benefits, greater interest earnings, significantly reducing opportunity costs. Annuities do require the payment of premiums and some fees; however, this instrument offers one of the lowest direct costs among all instruments considered.

The contract defining the payment schedule must coincide with environmental obligations being covered by the policy. Annuities offer an adequate guarantee for long-term projects, and as other insurance products, annuities may backfire on regulatory agencies. Since annuities behave like insurance policies, in case of default insurers may provide legal reasons to exonerate themselves from paying the bond. Collecting annuities may require long litigious battles. For this reason, some agencies will only accept annuities upon the presentation of collaterals (i.e. a standby trust), which, most of the times, eliminates all benefits provided by the policy. In order to reduce risks, the agency must be irrevocably established as the only beneficiary of the policy.

Environmental Insurance Policies (EIPs)

EIPs are contracts where the insurer promises to pay for all ex-post environmental obligations in behalf of the lessee to the beneficiary, the agency. The face value of the policy must be 100% ex-post obligation costs. The policy must also guarantee that resources, up to the face value, will be promptly available when necessary. Policies must be kept active for the entire length of the project. EIPs must be irrevocable, except by default of premium payments. Until recently, insurance products for ex-post environmental obligations in the oil and mining sector were rare. The insurance sector now offers innovative and flexible products, which may be adjusted to fulfill specific regulatory needs. Some products may be directed to cover liabilities from personal damage or damage to third-party properties.

Premiums are set based on the cost of potential loss and the probability of default. The insurer assumes the total liability. In order to provide optimum guarantee, agencies should require single pre-paid premiums, and irrevocable contracts (single premium whole-life policies). Unfortunately, in case of noncompliance, the insurer may, and they typically do, question judicially the payment of the policy, delaying the availability of funds to the agency.

Finite Insurance Policies (FIPs)

FIPs cover known ex-post environmental obligations and losses associated with the discovery of new environmental obligations. This is a new and very interesting product offered by AIG (1998). FIPs have a total aggregated value and multi-annual terms for log-term projects. Perhaps, the greatest innovation offered by FIPs is the possibility of a personalized policy, which attends to all lessees needs, regulators desires, and to specific ex-post environmental demands of the sector.

FIPs are structured to allow the sharing out of costs and profit between the insurer and the lessee. Premiums are paid fully at the beginning of the policy and corresponds to the NPV of the estimate balance to complete the full payment of all ex-post environmental obligations. The premium will cover the required value and even a possible pre-established additional amount for ex-post eventualities. Great part of the premium is allocated into an account that will be rewarded with the same annual interests paid by US Treasury Notes (around 5.5%), and paying the losses during the length of the project, if any. The insurer will manage the account as it wishes. However, only revenues equivalent to interests paid by the US Treasury Notes will be deposited at the "Notional Commutation Account" (NCA). If investments allow better earnings, the balance will go to the insurer. If there are losses in the process, the insurer remains responsible for paying agreed interests into the NCA. If the total expenditure is less than previously estimated, the insurer must return the balance to the NCA to the lessee (**Tables 4.2 and 4.3**).

FIPs require significant upfront capital allocation, causing direct costs including opportunity costs. However, the NCA is rewarded with interests and profits, and shared between the insurer and the lessee (**Figure 4.8**). There are no annual premiums or fees.

TABLE 4.2. COMMUTATION ACCOUNT BALANCE – FINITE INSURANCE
Optimistic scenario

Year	Comm. Account @ Beginning	Investment Income	Loss Payment	Comm. Account @ End Year
1	9,918,463	545,515	200,000	10,263,979
2	10,263,979	564,519	200,000	10,628,498
3	10,628,498	584,567	200,000	11,013,065
4	11,013,065	605,719	200,000	11,418,784
5	11,418,784	628,033	200,000	11,846,817
6	11,846,817	651,575	2,500,000	9,998,392
7	9,998,392	549,912	2,500,000	8,048,303
8	8,048,303	442,657	500,000	7,990,960
9	7,990,960	439,503	500,000	7,930,463
10	7,930,463	436,175	500,000	7,866,638
11	7,866,638	432,665	500,000	7,799,303
12	7,799,303	428,962	500,000	7,728,265
13	7,728,265	425,055	500,000	7,653,320
14	7,653,320	420,933	500,000	7,574,252
15	7,574,252	416,584	500,000	***7,490,836***
Total			***10,000,000***	

Under this optimistic scenario, the insurer would pay out $10 million in losses and the insured would receive a profit of $7,490,836 at the end of the term. 84.8% of the premium paid went originally to the notional commutation account, which will be used to pay losses. 15.4 % of premium payment is used to pay expenses, taxes, and risk assumption charges. ***Source: RADIGAN (1996)***

TABLE 4.3. COMMUTATION ACCOUNT BALANCE – FINITE INSURANCE
Pessimistic scenario

Year	Comm. Account @ Beginning	Investment Income	Loss Payment	Comm. Account @ End Year
1	9,918,463	545,515	6,000,000	10,063,979
2	4,463,979	553,519	6,000,000	10,217,498
3	(1,290,502)		1,000,000	(2,290,502)
4	(2,290,502)		1,000,000	(3,290,502)
5	(3,290,502)		1,000,000	(4,290,502)
6	(4,290,502)		1,000,000	(5,290,502)
7	(5,290,502)		1,000,000	(6,290,502)
8	(6,290,502)		1,000,000	(7,290,502)
9	(7,290,502)		1,000,000	(8,290,502)
10	(8,290,502)		1,000,000	(9,290,502)
11	(9,290,502)		1,000,000	(10,290,502)
12	(10,290,502)		1,000,000	(11,290,502)
13	(11,290,502)		1,000,000	(12,290,502)
14	(12,290,502)		1,000,000	(13,290,502)
15	(13,290,502)		1,000,000	***(14,290,502)***
Total			***25,000,000***	

Under this pessimistic scenario, the insurer would pay out $25 million in losses and the notional commutation account would be negative, but since the term sheet did not indicate any additional premiums, the insurer would not be obligated to pay this back. The insurer assumes this risk (underwriting and timing risks). ***Source: RADIGAN (1996)***

FIPs have different applications. They could be used to protect ex-post processes and even post-closure processes of waste facilities, mine closures, end-of-leasing operations in the petroleum sector, including decommissioning of offshore facilities, decommissioning of nuclear power plants, etc. This product offers a great incentive, which is the opportunity to anticipate deduction from corporate taxes.

The allocation of upfront capital used to demonstrate financial guarantee (anticipating costs of ex-post operations as it occurs with collateral bonds, LSCAs, and other) cannot be deducted from corporate taxes until expenditure actually occurs. Most of the times, when this condition is fulfilled, there are no more revenues to be deducted from. Discount rates offered by insurance companies may be better than after tax investment rate of the insured. Usually, insurance companies that offer FIPs have great operational experience, and can provide auxiliary expertise to ensured companies, reducing risks and allowing better ex-post performances.

FIPs offer an efficient guarantee for ex-post liabilities including some possible "overruns" on long-term projects. Policies cannot be used as collateral for other ventures or loans. FIPs offer a single pre-paid premium, a policy that is irrevocable and free of liens, collaterals, and, mainly, a policy that establishes the regulatory agency as the only beneficiary of the policy.

The ensured transfers all liabilities to the insurer. For this reason, there is the need for monitoring the insurer, creating some additional regulatory costs. Most regimes have a sector to oversees insurance companies, avoiding monitoring costs to the agency.

Insurance-Guarantee Policies (IGPs)

This insurance product is being proposed to satisfy financial assurance requirements in Brazil. IGPs, as other insurance policy products, transfer liabilities from the lessee to the insurer. The face value of the policy may not surpass 100% of contractually defined ex-post obligations. The policy is active throughout the length of the project and is only released after the fulfillment of all ex-post obligations. Theoretically, when the ensured party defaults, the beneficiary has the right to request the face value of the policy to fulfill ex-post obligations after the refusal of the ensured to comply with an extra-judicial warning. After paying the policy, the insurer has the right to pursue reimbursement from the ensured.

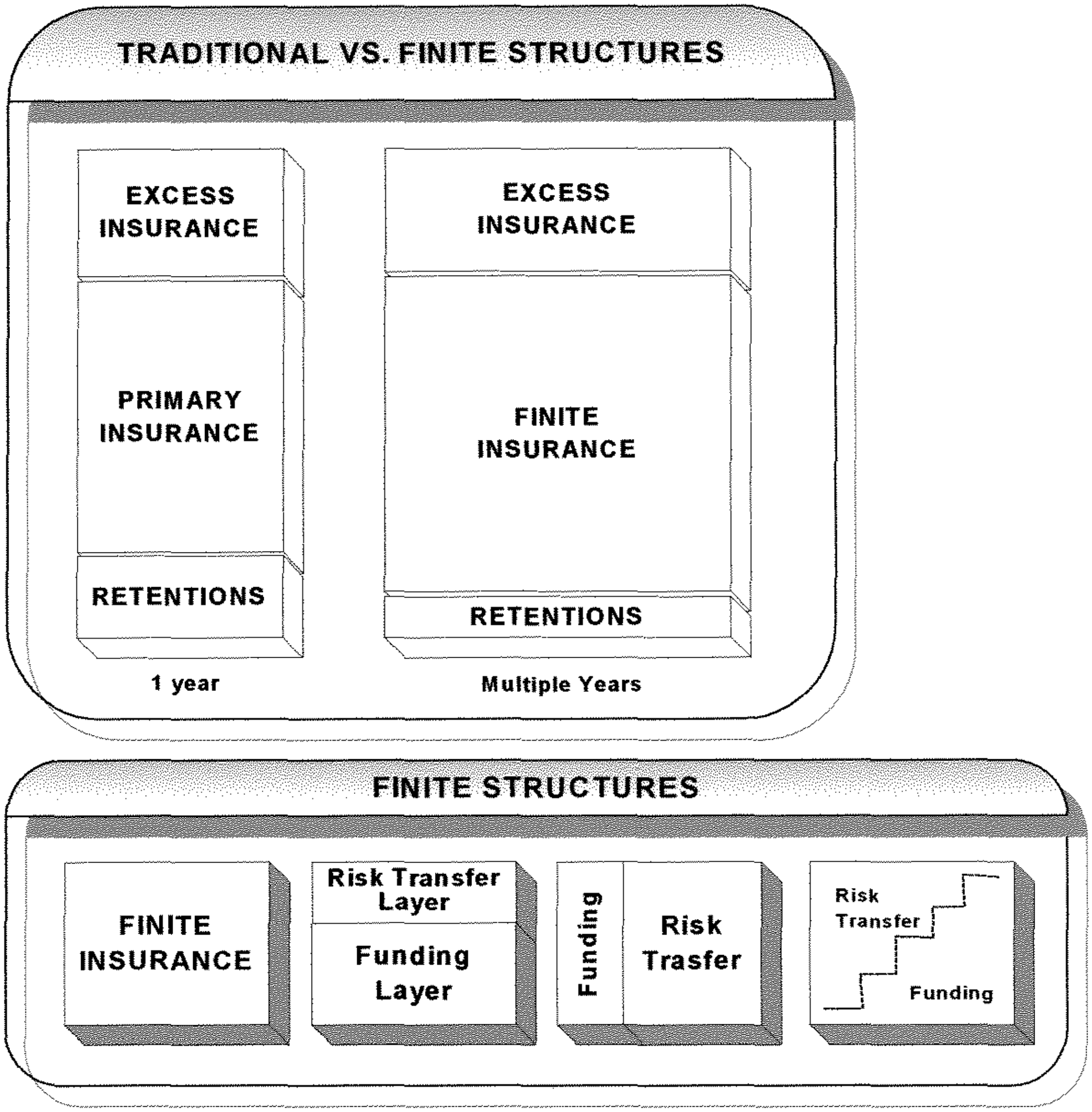

Figure 4.8. Finite Insurance structure compared to traditional environmental insurance policies, and different methods of funding finite insurance.

Insurance companies have a criterion to define premium rates and the maximum policy value. Depending of the ensured classification, collaterals and other guarantees may be required. When required, guarantees will correspond to a minimum of 130% of the policy. In many aspects, an IGP is similar to a surety bond. However, the basic principle of an insurance policy is the transference of liability from the ensured to the insurer, and the principle of a surety bond is the guarantee of credit (CORNWELL, 2001; UNICAMP/CEPETRO, 2001).

This is a relatively new product and further studies are required in other to identify impacts on the industry and on regulators. Insurance companies usually offer 8% of the

As it is the case of CCCPs, PLLPs have a specific application, but cannot be used alone to demonstrate financial assurance. These instruments are highly recommended as auxiliary instruments.

State Funds (S-Funds)

A State fund consists of a special account established to receive funds from all companies involved in the exploration or production of hydrocarbon resources in a specific region. Payments may be based on production, accumulated revenue, or in a percent of estimated ex-post costs. Most commonly, this mechanism is used as a state-managed account, providing funds for emergency actions (accidental environmental damages) in high-density exploration and production areas where it may be difficult to identify the responsible party for damages that require prompt mitigating response. Funds are nonrefundable. If the fund is withdrawn, the company found responsible for the damage must promptly refund the account.

Several instruments may be used to provide guarantee for ex-post environmental obligations. Unfortunately, all instruments have limitations, which can, in certain circumstances, expose regulatory agencies to excessive financial liabilities. Even with the best of intentions, some lessees may not fulfill or may only partially fulfill their ex-post obligations. In addition, even well designed bonding systems eventually fail, leaving the financial liability to taxpayers. An advantageous strategy would be establishing a safety net to cover eventual financial assurance breaches or loopholes. Contingency funds fall into this category. They are auxiliary mechanisms to go along with financial assurance systems. S-Funds may also be used for emergency actions, including remediation of spills and other emergencies in offshore provinces. S-Funds have been used in the United States with several levels of success.

4.9. FINANCIAL ASSURANCE SYSTEMS

Several versions of financial assurance systems were identified and examined during this study. What follows is a brief description and analyzes of four U.S. bonding regimes. The reason for choosing them is that these regimes are the oldest bonding system in operation identified and, for this reason, possess the longest uninterrupted experience. The systems are:

- *Office of Surface Mining* (OSM) – Coal Mining
- *Bureau of Land Management* (BLM) – Hardrock Mining
- *Bureau of Land Management* (BLM) – Onshore Petroleum
- *Minerals Management Services* (MMS) – Offshore Petroleum

4.10. THE FINANCIAL ASSURANCE SYSTEM IN THE US COAL MINING INDUSTRY (US OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT)

Within the coal-mining sector, performance bonds used to guarantee closure operations are know as reclamation bonds, closure bonds, and rehabilitation bonds. The following bonding regime description was obtained through interviews with OSM personnel (OSM, 2000c; STOKES, 2000; BRYAN, 2000). The OSM of the US Department of the Interior was created with the objective of protecting the environment during coal mining and guaranteeing that the land is reclaimed when operations cease. The agency was created by former President Jimmy Carter with the signature of the Surface Mining Control and Reclamation Act of 1977 (SMCRA).

The OSM has approximately 650 employees nationwide and works in partnership with producing states. The primary responsibility for regulating surface coalmine reclamation belongs to the states themselves. Twenty-four coal-producing states[23] exercise this responsibility. For the remaining states (Tennessee and Washington), federal lands and Indian Reservations the OSM issues coal-mining permits, conducts the inspections, and manages enforcement responsibilities.

The OSM's current annual budget is approximately US$ 273 million. With that sum, the agency assists states surface mining programs and pays 100% of the costs for restoring abandoned mine lands that were left unreclaimed before the present regulation. Financial

[23] The following states have adopted their own coal regulatory system: Alabama, Alaska, Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, Montana, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Texas, Utah, Virginia, West Virginia, and Wyoming.

resources for reclaiming abandoned mines come from tonnage-based reclamation fees (royalties) paid by active coal mines.

As a practical result of the current legislation, past abuses in coal mining operations ceased. Coalmine lands are reclaimed as operations advance and mined lands are no longer abandoned without proper reclamation. Current numbers show:

- Over 76,9 million m^2 of pre-1977 dangerous abandoned mine waste piles have been restored to productive use 76,9 million m^2 (19,000 acres);
- Over 823,000 linear meters of dangerous cliff-like highwalls have been eliminated; and
- Over 20,000 dangerous abandoned portals and hazardous vertical openings have been sealed.

Since it began (1977), the Abandoned Mine Land Trust Fund collected over US$ 5 billion. Since 1979, when states began receiving abandoned mine land reclamation grants, over $2 billion has been distributed from the fund.

General description

Most mining regulatory regimes around the world now require mining closure procedures. The ex-post process usually comprehends mine rehabilitation, site reclamation, and restoration (establishment of vegetation). Activities comprehend underground and surface structures and infrastructure, site reclamation, water management, re-vegetation (restoration), topographic restoration (when possible), etc. Mining closure processes are divided into two distinctive phases: (1) an active phase, and a (2) passive phase. The active phase comprehends the reclamation of the site, and the passive phase, the monitoring and the waiting period for the establishment of vegetation.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) states that, before a company obtains a coal mining permit, it must furnish a financial assurance in the form of a Reclamation Performance Bond[24], to ensure that funds to reclaim the site will be available in case

[24] Reclamation bonding is a long term commitment and is a normal cost of doing business for today's coal mining industry

the company fails to complete its reclamation obligations in accordance with the approved reclamation plan.

The major goal of Federal and State coal regulatory programs is to ensure that the environment and citizens are protected during mining and that the mined land is reclaimed and restored to beneficial use following mining.

Regulatory agencies have different requirements (Federal, State, and County). The instruments used are similar; but there are different reclamation and closure requirements in each State. The Federal government does not regulate the reclamation of hardrock mines. Each State has its own requirements for hardrock and oil extraction (see BLM and MMS Bonding System descriptions).

Permit

Before posting a bond and getting an operation permit, a mining company must have a closure plan approved by the OSM. The closure process involves not only reclamation activities, but it must also meet Revegetation Success Standards (RSS) that are either in the permit or in the regulatory program.

Mining companies must provide bonding for 100% of what would be required to reclaim the mine at the point of maximum disturbance[25] during a given 5-year term of the permit. Permits are renewed every 5 years. As mining progresses, bonds are adjusted to cover new projected disturbances. The only way to obtain the required bond amount reduced is to apply for full or partial bond release as reclamation progresses.

After all the ex-post requirements and environmental performance standards have been met, the reclamation bond may be released. Nonetheless, even after all ex-post obligations are satisfactorily met, the agency requires a 5 to 10-year waiting period (based upon average precipitation) that represents the long-term liability period for the reestablishment of vegetation (all standards have to be met including diversity, cover and production).

[25] Such situations could be referred as the worst-case scenario, as suggested by COSTANZA (1992) and CORNWELL (1994).

Forms of Bonds

The OSM acknowledges three major categories of reclamation bonds: Corporate surety bonds; Collateral bonds (cash; certificates of deposit; first-lien interests in real estate; letters of credit; federal, state, or municipal bonds; and investment-grade securities); and Self-bonds (legally binding corporate promises without separate surety or collateral, available only to companies which meet OSM financial tests). State regulatory programs will vary somewhat, but in general, they will accept the above categories. Some States will not incorporate the self-bond option.

All forms of bond must be made payable to, or pledged to, the regulatory authority (OSM and/or the applicable State regulatory authority). The OSM may allow the company to post a combination of acceptable bond forms. The total sum of the bonds furnished must equal to the required bond amount.

Bond Amount

The amount of the bond is based on estimated third-party costs to complete the reclamation plan in the event of forfeiture (including profit and overhead). The regulatory authority sets the bond amount based on the operator's cost estimate for reclamation.

There are strict requirements for each form of bond. Bond providers or issuers (surety companies and other financial institutions) are subject to the laws of their regulators: State insurance commissioners, State banking examiners, and the Comptroller of the Currency.

Reclamation bonds cover all operations during the term of the permit. Before a permit is issued, a bond must be posted to cover: (1) the entire permit area; (2) the initial area of land to be affected under a cumulative bond schedule; or (3) the initial area of land to be affected under an incremental bond schedule. Under either cumulative or incremental bond schedules, the company must post additional bond before affecting lands in succeeding increments or additional lands in accordance with the approved cumulative schedule.

Self-bonds could be explained as OSM's acceptance of a company's assets, current and forecasted financial health, and compliance record as the sufficient guarantee that the company will perform all its ex-post environmental obligations. In order to obtain and maintain qualification for self-bonds, companies must sustain a tangible net worth of at least $10 million, maintain fixed assets in the U.S. of at least $20 million, and either meet certain financial ratios or have an "A" or higher bond rating.

All collateral posted as bond must be owned solely by the applying company, free of all liens, and valued at current market value not face value. The regulatory authority reduces the market value of collateral by a margin sufficient to cover the regulatory authority's cost to liquidate the collateral in the event funds are needed for reclamation. Certificates of deposit are negotiable collateral instruments and need to be secured from loss and theft.

There are bond forms that will generate interest earning. As interest is earned, it may be deposited into a separate account, or paid to the mining company by check periodically. Essentially, interest is available to the mining company as it is earned.

Surety bonds and letters of credit require payment of annual premiums or fees. Annual premiums are based on a percentage of the sum of the bond (or the amount of the letter of credit). Premiums are not based on the risk of a claim being filed. When a surety company[26] writes a surety bond it guarantees that the mining company will reclaim the property. In case of default, the surety company will pay the bond sum to the regulatory authority so it can perform the reclamation. If a surety company is qualified, it may perform the reclamation in lieu of paying the bond amount. However, the surety is held to the same level of compliance including the long-term liability period. Corporate surety and letters of credit used to bond reclamation operations in the coal mining industry must be noncancelable and irrevocable, even for the failure to pay premiums and/or in the event of bankruptcy of the mining operator.

Surety companies charge according to the financial standing of the mining company (net worth level), credit rating, and experience in the mining industry, etc. There is no Government control over premium rates. The Surety Association of America (SAA) recommends premium rates and every surety company has its own financial criteria to judge mining company customers. Generally, the more net worth a mining company has, the smaller the premium will be.

Mining companies that have used certificates of deposit as bonding collateral over the years have seen the interest rate drop from double-digit numbers in the 1970's to the current 5.0. The principal amount of a certificate of deposit provides the reclamation guarantee (bond) and the interest is retained by the mining company.

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[26] A Surety company must be licensed in the State where the operation is located.

In some instances, fraudulent individuals posing as representatives of legitimate surety companies have issued surety bonds. In order to avoid fraud, the operator may check the Surety Association of America's (SAA) Obligee's Guide[27] and the US Department of Treasury's Circular 570[28]. Each form of bond has its own set of legal documents required by the regulatory authority. Providers of the bonds (surety companies and banks) are subject to the laws of the financial industry's regulators: State Insurance Commissioners, State Banking Examiners, and Comptroller of the Currency.

Besides surety, collateral, and self-bond instruments, some States have OSM-approved *alternative* bonding systems in the form of *Bond Pools* where mining companies pay a regular fee based on tons of coal produced and/or acres permitted. The funds accumulate and are used to reclaim any site where a member of the consortium fails to reclaim (bond forfeiture). Bond pool systems are a combination of the conventional bonds (which guarantee the most costly part of reclamation), and bond pool funds (which cover only the final stages of reclamation).

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) also provides a variety of financial instruments for a variety of area and staged systems for posting bonds. Mining companies may post bonds to cover the entire permit area for the term of permit up front, or post bond to cover the initial increment of land to be affected during the term of permit, or post bond to cover a discreet area of land within the permit area (incremental bonding). The OSM must pre-approve an incremental bonding scheme. Prior to affecting subsequent increments of disturbance, additional bond must be posted by the mining company.

Up until 2000, approximately 75% of the bonds covering coal-mining operations were corporate surety bonds. Small operations with bond amounts in the tens of thousands of dollars tend to use certificates of deposit and other assets. Some individual bond amounts in excess of US$ 100 million are typically in the form of corporate surety bonds, letters of credit or self-bonds. Presently, there are approximately US$ 5 billion coal reclamation bonds in place in the United States. Each State has its own database of bonding information. These tend to be updated to show the current amounts but rarely keep historical records.

One of the major public concerns when the bonding concept is first introduced involves the maintenance of bond and its provider's integrity during long periods (e.g. 30-year projects).

[27] Surety Association of America's Bond Authenticity Program Obligee's Guide: http://www.surety.org/obliguid.htm

[28] U.S. Department of the Treasury's Approved Sureties Listing Treasury Circular 570: http://www.fms.treas.gov/c570/index.html

The Federal Government relies on the insurance/surety industry regulators (State Insurance Departments) to regulate the financial requirements so that surety companies are solvent, financially secure, for the duration of the bond. If an Insurance Department finds that a company no longer meets financial tests, the company may be closed/liquidated. In addition, only sureties that are listed in the U.S. Treasury as being financially qualified can issue surety bonds on Federal properties. The Treasury evaluates all listed sureties annually and announces to the public if a surety company no longer qualifies to be listed. Mining companies must replace bonds written by surety companies that are liquidated or taken off this list.

One of the worst foes of the coal mining industry is the formation Acid Mine Drainage (AMD) (STOKES, 2000). The necessary attention to this important issue is not yet on the official environmental agenda in Brazil, but it does not diminish the severity of such condition. Once generated, AMD triggers more AMD and it may continue for centuries. Mitigation operations may cost millions. The US and Canadian Governments and companies have directed significant resources on innovative technologies and treatment techniques. Canada has established a program named Mine Environment Neutral Drainage (MEND), in which a number of stakeholders gathered together to develop technologies to control acidity drainage from mines, allowing significant environmental and economic benefits (CANADA, 1996).

What would be the OSM response upon the anticipation of AMD for a specific project? Would surety companies risk the possibility of assuming perpetual treatment for AMD? The OSM will not issue a permit for a coal mine site where AMD is anticipated. If unanticipated AMD occurs, the mining company must set up a trust fund, obtain insurance, or find a surety willing to issue a surety bond for long-term coverage. The OSM has a specific policy statement regarding AMD.

Understandably, cash is rarely given to the OSM to hold as financial assurance. Cash is not an efficient way to finance long-term operations with high reclamation costs. One or more surety bonds would likely cover a long-term commitment, a trust fund where money is deposited annually in escrow, letters of credit, or perhaps some kind of environmental insurance. In situations where cash is used, it would either be placed in an earmarked State/Federal treasury account assigned to the applicable government agency or it could be placed in a bank in a federally insured account under an Escrow Agreement between the mining company, the bank, and the agency. Depending on where it is located, it would either be managed by the State's fiscal staff if the money is in the State treasury (no interest would be earned), or the escrow agent at the bank would manage it. The escrow agreement would specify that the State or Federal agency have full control over the account until it is released after reclamation.

Sometimes it is difficult for people having their first glance at bonding systems to understand that the resources set aside as performance bonds cannot be used to cover reclamation costs when reclamation operations begin. A mining company cannot use the deposited cash to fund the reclamation. The company has to pay for reclamation out of operating costs. After successful reclamation and release of the bond, the money is returned to the mining company.

Bonds such as certificates of deposit, letters of credit, investment grade securities, and real estate collateral can all be held for long periods. Certificates of deposit are set up to be self-renewing so that when they mature, they roll over for the next term(s). Letters of credit are typically issued with a one-year term but may contain an *evergreen* clause that allows the letter of credit to roll over into the next term unless the bank gives the agency prior 90-days notice. If the bank does not roll it over, the mining company must replace it with something else before it expires, or stop mining and start reclaiming.

Real Estate could also be held for the long term but the mining company would have to own the property in fee, free and clear of any liens. The mining company would have to provide the agency with annual market value appraisals and updated title certificates to assure the property is holding its value. The market value of pledged real estate (under a Deed of Trust) must always be enough to cover the reclamation amount and liquidation costs if there were a forfeiture of the bond.

Investment-grade securities such as U.S. Treasury Bills/Notes would be purchased with a long maturity period to avoid the need for frequent substitution in order to keep earning the interest.

Self-bonds are like the Financial Test arrangements under the EPA regulations. If a mining company can meet certain net worth, fixed asset level, certain financial ratios (like assets to liabilities), it may apply with the agency to self-guarantee its reclamation without a separate commercial surety. Self-bonding is discretionary with the regulatory agency. Accordingly, a company that meets all financial tests may be denied if it does not have a good compliance record, or if it has a threatening pending lawsuit, for instance. Self-bonding requires the signing of a contract known as an Indemnity Agreement, which is a promise to either perform the reclamation or pay the amount to the regulatory authority.

The OSM offers several options for companies allowing flexibility, meeting all applicant companies needs. According to the OSM, flexibility does not imply that anyone can get into the coal mining business: "*if a company cannot provide the expected guarantee, it will not be welcome into the business*". It is one way of eliminating environmental risk. Usually large and financially healthy companies will end-up paying smaller bond amounts, since they are able to meet financial tests required by self-bonds, but such companies have strong financial motives not to forfeit their bond.

Analysis of the OSM bonding system

The OSM is the branch of the U.S. Department of Interior that regulates coal exploration and production, and oversees the environmental protection during these activities, ensuring that affected areas are rehabilitated after closure according to standards adopted in 1977, when the agency was created.

The OSM bonding system is clearly aimed at safeguarding the agency against costs related to the proliferation of abandoned areas (literary; with undefined ownership). A great portion of these areas presents AMD problems requiring onerous and costly rehabilitation operations, or perpetual treatment (indefinite control of produced acidity).

In addition to AMD problems, the agency fights a permanent battle with a excessive number of litigious actions against the agency in which affected communities blame the OSM for problems inherited by insolvent and/or irresponsible operators.

The OSM bonding system does not require financial bonds, only a performance bond in the value of 100% of rehabilitation costs plus indirect costs such as third-party profit and overhead costs.

Among the four systems emphasized in this study, at the Federal level, OSM's offers the widest level of instrument flexibility to participating companies, offering a generous portfolio of instruments, allowing a large spectrum of participants, from independent operators (small scale) to large corporations. Notwithstanding offering considerable flexibility, the level of success of the OSM bonding system is commendable. The main reason for this success is the methodology used to define the bond amount, which corresponds to the real costs of mine reclamation, offering an adequate incentive for compliance. It has been observed throughout the preparation of the present work that, most of the times, the value of the bond is more important than the type of bonding instrument used.

Bonds are required as prerequisites for licensing and will only be released by the agency upon the fulfillment of all ex-post obligations in accordance with the approved reclamation plan, and after the observance of a waiting period in which the agency determines if the risk of residual liabilities is acceptable and if the vegetation has been successfully reestablished.

One of the advantageous characteristics of the sector is that reclamation operations can be performed concomitantly with mining activities (phased reclamation). Consequently, operators can plan for phased-production, reducing the values of bonds and the period capital is allocated.

The accommodating portfolio of financial instruments acceptable as bonds by the OSM includes: corporate surety bonds, escrow accounts, cash, Certificates of Deposit, Letters of Credit, Treasury bonds, real estate, collateral of different assets, pool bonds, self bonds, among others. Though the efficiency of the OSM bonding system is evident, the pile of lawsuits remains bulky. A preliminary analysis indicates the following causes for the current scenario:

- Coal production is an activity accessible to small and independent operators, attracting all sorts of participants, including high-risk ones.
- Producing areas are usually easily accessible, allowing the uncomplicated extraction and transportation. However, these areas are in great part within inhabited areas, exposing communities to risks and allowing easy public scrutiny.
- Coal is commonly associated with other mineral bodies with high tendency to produce AMD.
- The US economy depends significantly on energy produced with coal. Consequently, there is a noticeable political pressure to keep the attractiveness and competitiveness of this sector, especially during times of high energy prices and international instability.
- The OSM asserts that if, during the exploration and planning phase, the possibility of AMD formation is identified, the project license is rejected. However, OSM criteria seem considerably subjective and AMD problems are still common. Indeed, this is one of the main problems related to lawsuits, in which the agency is blamed by the public of negligence in allowing the licensing of high-risk projects.

- Another factor may be the excessive flexibility offered to small and independent operators. If a mechanism to reduce the participation of high-risk operators were in use, probably future lawsuits would be significantly reduced.

4.11. BONDING SYSTEM FOR THE US OFFSHORE OIL AND GAS DECOMMISSIONING PROGRAM (US MINERALS MANAGEMENT SERVICES)

This item summarizes, describes and explains the MMS bonding system applied in the U.S. OCS oil and gas, and sulphur leases (MMS, 2000; MIRABELLA, 2000; MARTIN, 2000, WILLIAMS, 2000). **Figure 4.9** shows the schematics of the MMS bonding system.

The MMS is a bureau of the U.S. Department of the Interior that manages the country's natural gas, oil, and mineral resources of the OCS, and collects, accounts for, and disburses about US$ 6 billion in revenues each year from offshore mineral leases and from onshore mineral leases on Federal and Indian Lands (MMS, 1999). The MMS regulates the offshore oil sector by overseeing drilling and production matters, pipeline operations, emergency shutdown systems, inspection and testing of production and drilling equipment, decommissioning platforms, and investigating oil pollution (OCS Lands Act).

Throughout the regulatory-making process, the MMS accepted the participation of the industry and other stakeholders. Contributions that did not jeopardize public's best interest were accepted by the MMS. In addition, worthy of mentioning is that, the MMS effort to make rules accurate and comprehensible by providing online easy-to-read revisions that maintain technical accuracy, and do not alter the substance of the law. The result is an efficient regulation that provides adequate flexibility for companies to meet bond requirements and ensures that companies adequately fund their ex-post environmental obligations.

Among the main objectives of the MMS are:

- Ensuring that companies are financially capable of completing all ex-post obligations, safeguarding government and taxpayers by achieving a reasonable degree of protection from default by a company at a minimum increase in regulatory costs including, costs for lease, permit, or pipeline operations, and eventually, final cost to the public;
- Protecting the environment from potential harm resulting from a company's failure to carryout proper ex-post environmental obligations in a timely fashion, including: well abandonment and site clearance operations;

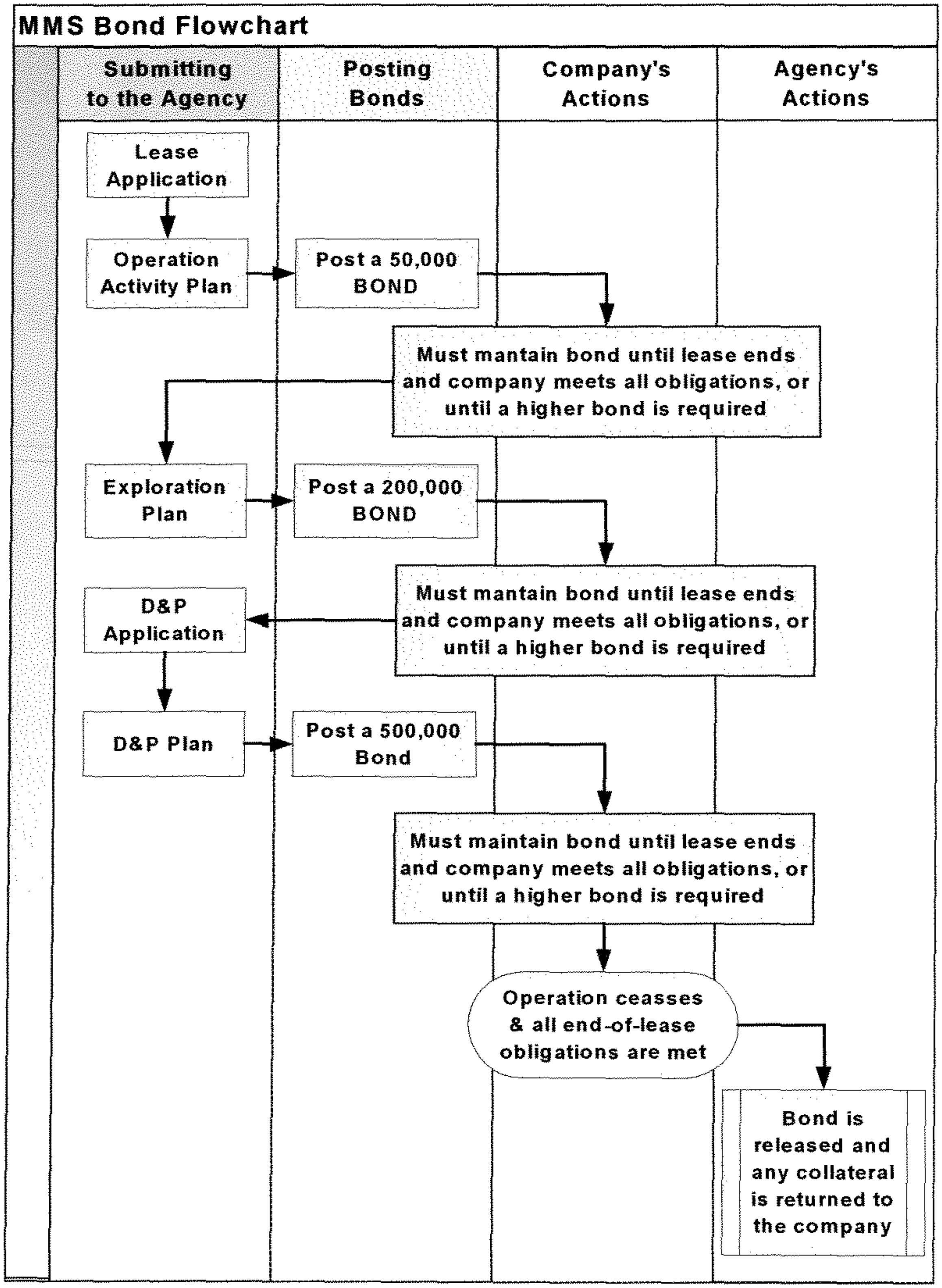

Figure 4.9. MMS Bonding System Schematics.

- Requiring bond coverage for holders of Geological and Geophysical (G&G) permits (deep stratigraphic test well drilling) and authorizing a demand for supplemental bonds for holders of G&G permits or pipeline right-of-ways; and
- Selecting a method for attaining such goals with fairness to all stakeholders guaranteeing that all ex-post operations are completed in a satisfactory manner.

In the present MMS regulation, all co-lessees and operating rights owners are liable for compliance with all terms and conditions of their OCS leases. When large producing companies transfer OCS leases to smaller companies (some marginally financed), the risk of default and non-satisfactory completion of ex-post obligations usually increases. To avoid such risk, all parties involved in the negotiation (the assignor of the OCS lease and the new lessee) will be held responsible for the compliance of all ex-post obligations related to the facilities the original assignor installed.

General Bonds

The following falls under the main financial bond category, but are treated by the MMS as general bond requirements. General bond requirements are the same for all applicants:

- ***Lease Bond:*** A US$ 50,000 single lease or US$ 300,000 areawide bond along with the submittal of an operational activity plan. A lessee does not need to provide this bond if an applicable lease or areawide bond is in place in accordance with one of the following, higher requirements.
- ***Exploration Bond:*** A US$ 200,000 lease or US$ 1,000,000 areawide bond along with the submittal of a proposed Exploration Plan (EP). A lessee does not need to provide this bond if an applicable lease or areawide bond is in place in accordance with one of the following, higher requirements.
- ***Development and Production Bond:*** A US$ 500,000 lease or US$ 3,000,000 areawide bond along with a proposed Development and Production Plan (DPP), or a Development Operation Coordination Document (DOCD).

Supplemental Bonds

Evidently, ex-post costs will be higher than the US$ 500,000 financial bond amount posted by the company. For this reason, the MMS may require additional security (a supplemental bond or bonds) whenever the cost to meet all potential present and future lease obligations surpass the amount of the general bond (US$ 500,000), except when the company, or one of the current lessees, demonstrate to the satisfaction of the MMS financial capability to meet the obligations.

Some of this supplemental bond will not fall precisely under the category of performance bonds, for corresponding to an insufficient amount to guarantee the performance of all ex-post obligations. However, this waiver granted by the MMS to companies that are able to demonstrate financial capability, can be understood as a form of Self-bond. Companies required to post a supplemental bond correspondent to 0% to 100% of estimate ex-post operation costs may be understood as a partial self-bond "supplemented" by the amount it was not able to demonstrate being capable of paying if ex-post operations were to be performed at that moment.

In order to provide a more flexible and, at same time, efficient regulatory framework, the MMS has established rules for the acceptance of Lease-Specific Abandonment Accounts (LSAA) and third-party guarantees. In recent years, the MMS has set a higher and more realistic level of bond coverage to the holder of a Geological and Geophysical (G&G) exploration permit to drill deep stratigraphic test wells and also authorizes a demand for a supplemental bond from the holder of a G&G permit or pipeline right-of-way. All situations are analyzed on a case-by-case basis by the MMS.

If a company decides to use third-party guarantees, the guarantor will not be required to qualify as a surety with the Department of the Treasury (Treasury) but it must agree to fully perform all lease obligations without the dollar limitation permitted to sureties, as stated by the MMS rule.

When a company is able to satisfactorily furnish evidence of its financial strength and that all ex-post obligations will be met, the MMS will not require additional bonds. If the financial strength of the company is considered not satisfactory to guarantee completion of all ex-post obligations, then the MMS will require the posting of additional bonds to cover all potential liabilities. All projects are susceptible to reviews. The supplemental bond amount may be increased if the company takes on new activities. Likewise, it may be decreased if the company completes any part of its abandonment and/or decommissioning plan that reduces its potential ex-post liability. There is a great incentive for the research of innovative technology in this area. If a company can provide evidence, for instance, that the cost for removal of a platform installation is much less than MMS previous stipulation, the requested supplemental bond amount may be reduced. Note that the general bond amount (US$ 500,000) must be maintained until the lease ends and all ex-post obligations have been successfully met, regardless of supplemental bond issues.

The MMS will consider several parameters in order to estimate the total cost of ex-post obligations, including:

- Financial (e.g. financial strength and credit rating);
- Cost estimates (e.g. well plugging and abandonment, and platform removal and disposal);
- Compliance parameters (e.g. decommissioning compliance record);
- No abandonment/decommissioning reasons: possibility that the company may get behind in paying its due royalties.

Supplemental Bond Procedures

According to the MMS boding rule, a company will be required to provide additional securities, supplemental bonds, when the estimate expenditure to achieve all potential present and future lease obligations surpasses the general bond amount.

If one of the current lessees can demonstrate financial capability to meet all financial obligations, including: rents, royalties, plugging and abandonment costs, and other necessary operations to ensure performance of regulatory requirements; the supplemental bond will not be required (waiver or self-bonding mechanism).

Assessment of Financial Strength

What follows is a summary of MMS procedures (applied to all OCS Regions) used in assessing the financial strength of OCS lessees in other to implement supplemental bond requirements.

Additional security will be for an amount not more than the full amount of ex-post costs in cases when none of the lessees can demonstrate the financial capability and strength to carry out present and future obligations.

Reviews

Reviews of Cumulative Potential Lease Abandonment Liabilities (CPLAL) are performed when requested or when necessary (at any time). The MMS will review all lessee's general and supplemental bonds, cumulative liabilities, and financial strength.

a. Subsequent reviews may be conducted when a company requests approval for:

- Assignment of the lease record title interest (lessee of record), or a portion of the record title interest in a lease;
- Significant revision to an approved EP;
- DPP or a significant revision to an approved DPP;
- DOCD or a significant revision to an approved DOCD;
- Application for a pipeline Right-Of-Way (ROW) or modification to an existing pipeline ROW;
- Assignment of record title interest of an existing or approved pipeline ROW permit with platform amenities; and
- Significant revision to an approved pipeline installation plan for a pipeline having platform amenities.

b. At MMS's discretion, it may conduct reviews:

- Periodically;
- When it becomes aware of information that indicates a change in the financial strength of the company or potential cumulative liability;
- When it issues Notices of Incidents of Noncompliance (NIN) for incidents related to safety, environmental, non-payment of royalty, or other violations of MMS regulations; and/or
- A lessee takes an action that causes the MMS to initiate a review and then the company withdraws the action. At MMS's discretion, it may carry the review of the need for additional bonds to completion.

Evidence of Financial Strength and Reliability

If a company meets all the following conditions, the MMS will not require supplemental bonds, unless it determines that the financial or operational history of the company justifies that a bond is needed to ensure that the company will meet all ex-post obligations:

a. If the estimated cumulative potential ex-post liability is less than or equal to 25% of the most recently available and independently audited calculation of the company's net worth, the MMS will not require a supplemental bond if the company meets the additional criteria bellow (b or c) and shows adequate reliability as evidenced by the following:

- Experience: number of years of successful operations and production of oil and gas (or sulphur) in the OCS or in the onshore oil and gas industry;
- Financial: credit ratings, trade references, and verified published sources;
- Moral/Compliance: record of compliance with the current and previous governing laws, regulations, and lease terms; and
- Other: items that indicate financial strength or reliability.

b. If a company produces fluid hydrocarbons in excess of an average of 20,000-barrel oil equivalents (BOE[29]) per day from its OCS leases, based on MMS's calculation of company's production for the most recent 12 months for which data and information are available.

c. If a company can demonstrate financial strength to carry out present and future financial obligations. The company may exhibit financial capacity by providing audited financial statements, including an independent auditor's report, balance sheet, and profit and loss sheet. This audit must demonstrate that the lessee falls within one of the criteria identified below:

- Stockholders equity or net worth has a minimum value of US$ 50 million but does not exceed US$ 100 million, the current ratio (current assets/current liabilities) is equal to or greater than 1.0, and the debt to equity ratio (total liabilities/net worth) is less than or equal to 2.5.
- Stockholders equity or net worth has a minimum value of US$ 100 million but does not exceed US$ 150 million, the current ratio (current assets/current liabilities) is equal

[29] BOE for natural gas: 5.62 thousand cubic feet of natural gas = 1 barrel of oil equivalent (BOE), as measured fully saturated at 14.73 psi and 15.6° Celsius (30 CFR 250.1203-b).

to or greater than 0.75, and the debt to equity ratio (total liabilities/net worth) is less than or equal to 3.0.

- Stockholders equity or net worth has a minimum value of US$ 150 million, the current ratio (current assets/current liabilities) is greater than 0.50, and the debt to equity ratio (total liabilities/net worth) is less than or equal to 3.0.

d. The determination of financial strength is valid for one year, but it can be extended for one year at a time if:

- An independent accountant submits verification of the company's current financial capacity at least 60 days prior to the expiration of the current determination; and
- The company continues to meet the previous criteria.

Determination of the Cumulative Ex-Post Liabilities

The required supplemental bond will be equal to the cost of meeting all potential present and future lease obligations including rents, royalties, and amount of plugging and abandonment costs necessary to ensure performance of regulatory requirements, as mentioned before.

a. The MMS will estimate the amount of cumulative abandonment liability including the lessee's obligations to plug and abandon wells, remove platforms and other facilities, and restore the lease to its original condition by clearing the obstructions from wells, platform sites, and ROWs. The estimate is based on the assumption that all facilities will be removed and abandoned onshore (total decommissioning).

b. Estimates are based on available historical costs (MMS database). The company may provide additional information in order to assist estimate ex-post costs. When providing additional data, the company should explain the basis for the data. The MMS will estimate costs as follows:

- Plugging and abandoning a borehole will cost US$ 100,000[30] per borehole for all water depths.
- Costs for dismantling and abandoning a platform will vary with water depth according to **Table 4.4**.
- Costs for clearing a lease will vary with water depth according to **Table 4.4**.

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[30] Estimate provided by both the MMS and Byrd and Twatchem (1999)

TABLE 4.4. MMS ESTIMATED EX-POST COSTS ACCORDING TO WATER DEPTH

Estimated decommissioning			
Water depth of 46 meters or less	Water depth between 46 and 70 meters	Water depth between 70 and 90 meters	Water depth of 90 meters or more
US$ 400,000	US$ 600,000	US$ 1,250,000	US$ 2,000,000 +

Estimated cost of site clearance		
Water depths of 46 meters or less	Water depths between 46 and 76 meters	Water depths of 76 meters or more
$300,000	$400,000	$500,000 +

Since developments in the continental shelf of many petroleum provinces have reached the 2,000 meters mark, the concept of deep waters has been somewhat altered and the terminology *ultra-deep waters* has been frequently used. ***Source of data: MMS (2000d)***

c. The MMS will use the following procedure to estimate the need for and amount of supplemental bonds:

- Identify all leases being held by the company.
- Apply lease specific bonds (i.e., lease specific general bonds, lease specific supplemental bonds, and lease specific guarantees) to identified leases.
- Exclude from the company's lease abandonment and clearance liability calculation, for the purpose of supplemental bond determination, up to the full amount of the clearance liability for any leases for which the MMS has determined that one or more co-lessees have such financial strength that it is not necessary to require submission of a supplemental bond. The MMS will exclude less than the full amount in cases where it is determined that additional security is needed as a result of previous financial or operational record.
- Deduct a reserve account for the Royalty Management Program (RMP) from the general bonds on file. The MMS will credit this account $50,000 per lease or $300,000 per area-wide bond on file.
- Apply the remaining general area-wide bonds, or blanket bonds, to leases in chronological order beginning with the lowest lease numbers on file.
- After calculating the remaining potential liability, the MMS will evaluate the financial strength and reliability of the company and the need for supplemental bonds and the amounts will be determined.
- Request lease-specific supplemental bonds from the company.

d. The company may provide detailed information on existing leasehold facilities in order to assist the agency's evaluation. The company may also provide evidence to support an adjustment in MMS's estimate of company's cumulative potential abandonment and clearance costs. That evidence may include:

- The itemized data and information by lease used as a basis for company's estimate of the cumulative potential abandonment and clearance costs represented by wells and facilities on company's leases.
- The itemized data and information by lease on which a third-party bases its estimate of company's cumulative potential lease abandonment and clearance costs.

e. When conducting a subsequent review of the need for a supplemental bond, the MMS analysis will consider the number of wells drilled or plugged and abandoned in the time that has elapsed since the last review of company's cumulative potential liabilities, the number of platform installations or removals since the last review, changes in the amount and value of hydrocarbons being produced, the projected rates of oil and gas production, inflation, and other changes in the market conditions. The objective of the MMS review and analysis is to ensure that supplemental bond coverage or alternate form of security provided is adequate to cover potential lease abandonment and clearance liabilities.

Compliance with Requirements to Provide a Supplemental Bond

A company may submit and maintain supplemental bonds in the following ways:

a. Submitting LSAA supplemental bonds, U.S. Treasury Securities, or an alternate form of supplemental security approved by the MMS (MMS, 2000). If the value of the company's security falls below the level of the supplemental bond required, or if the U. S. Treasury no longer certifies the issuer, the company must notify the MMS within 15 days.

b. Submitting, with MMS's prior approval, a LSAA funding plan according to 30 CFR 256.56. The plan must include the following:

- An initial payment into the LSAA that is generally equal to or greater than 50% of MMS's estimate of the cumulative potential lease abandonment and clearance liabilities.

- A prescribed time schedule for making specified incremental payments (e.g., monthly payments) in amounts that will ensure that the amount in the LSAA will increase at a faster rate than the rate at which the originally recoverable reserves are being produced.
- Commitment by the financial institution in which the lessee established the LSAA to notify the agency of the date and amount of the initial deposit and of each subsequent incremental payment.
- Submitting a risk insurance policy to the agency covering residual liabilities in the event of any catastrophic failure that prevented the completion of remaining payments.

c. The company must immediately submit, and maintain, a supplemental bond in an amount equal to the remaining portion of MMS's estimate of the amount of company's cumulative potential lease ex-post liabilities in the event the company fails to:

- Make the initial payment into the LSAA; or
- Timely deposit into the LSAA the amount agreed.

LSAA Steps (example)

- Total Supplemental Bond Payment = US$ 5,000,000.
- Initial payment = 50% of required bond. Since 50% is greater than the percentage of the recoverable hydrocarbons originally in place that MMS projects will be produced by the end of Year 1.
- By the end of year 3, the company will have produced 60% of the original recoverable reserves. The fund will need to have not less than 60% of the total supplemental bond (US$ 3,000,000 = 60% x US$ 5,000,000) by the start of year 3.
- By the end of year 4, the company will have produced over 80% of the recoverable reserves originally in place. The LSAA will need to have the full US$ 5,000,000 by the end of year 4. Quarterly payments of US$ 156,250 during the 4-year period will increase the fund to US$ 5,000,000 by the end of year 4.

Using Third-Party Guarantees Instead of Supplemental Bonds

The company may submit a third party guarantee in lieu of a supplemental bond. The guarantee must be provided by a third party (guarantor) who will guarantee compliance with all lease obligations. There are severe regulations involving the acceptance of third-party guarantees. The Agency will accept third-party guarantees if the guarantor and the indemnity agreement are considered satisfactory.

Termination of Bond, Guarantee, or Determination that a Supplemental Bond is Not Necessary

The Agency has the right to deny a company's request for finding that submission and maintenance of a supplemental bond is not necessary, the agency has knowledge that recent or anticipated future events may adversely affect the lessee's/lessees' ability to comply with current and/or future lease obligations. The MMS may also require supplemental bonds on any leases, regardless of any prior determination, if it is determined that the operator has not fully and consistently complied with regulations.

a. When any of the following occur, the company needs to immediately take necessary action to meet these requirements. If the company does not, the MMS may issue a civil penalty, stop operations on the lease, or take any other action authorized by the Outer Continental Shelf Lands Act (OCSLA) or the implementing regulations.

- Supplemental bonds are required when the MMS had previously determined that company's financial strength was sufficient that the MMS did not require a bond. In such cases, the MMS will give the company a minimum of 20 days notice before requiring a supplemental bond.
- The third party guarantor ends the period of the guarantee.
- The bonding company ends the period of bond protection.
- The value of company's security falls below the level of the required bond.
- The U. S. Treasury no longer certifies that the issuing company.

b. If the company chooses to provide a LSAA instead of providing a bond, the MMS may allow the company with 70 additional days to prepare and allow the MMS to review a plan for incremental payments and to add funds to the account, according to the plan.

Analysis of the MMS bonding system

The MMS is a Branch of the U.S. Department of Interior and regulates exploration, development, and production of oil and gas in the U.S. Outer Continental Shelf (where the costal State jurisdiction ends, approximately three miles from state coastlines). Just in the GOM OCS, the MMS is responsible for over 6,000 concessions. The current MMS bonding system was established between 1989 and 1991, after an administrative separation of the BLM. This bonding system has its roots in the very same BLM system. During 1989 and 1991, a comprehensive alteration of the former BLM system was made aimed at adjusting the old rules to the current offshore sector. The establishment of the supplemental bonding rules (performance bonds) was prepared in 1993.

The MMS bonding system consists of bond requirements in all project phases. An estimation of ex-post costs in the concession area determines the value of the bond required. Instruments accepted by the MMS are corporate surety bonds, U.S. Treasury Bonds that may be negotiable at any time with a cash value that corresponds to the value of the guarantee.

The MMS asserts that will analyze any proposal for the acceptance of alternative financial instruments, but assumes that, so far, no exceptions to the small list of acceptable instruments were made. The MMS also reserves the right to require additional coverage in the form of supplemental bonds at its own criteria.

4.12. THE FINANCIAL ASSURANCE SYSTEM IN THE US HARDROCK MINING INDUSTRY (US BUREAU OF LAND MANAGEMENT)

The BLM (Hardrock Mining) is a Branch of the U.S. Department of Interior and regulates mining exploration and production. Bonding regulations vary greatly from state to state, but generally, bonds are required per area used. At the National level, bonds have been used since 1994, but with poor results, according to observations made during the present study. The BLM is under intense criticism from society and NGOs (NWF, 2000; MPC, 2000). The environmental liability is significantly high. Rehabilitation costs estimates at national level are many times superior to the amount currently secured in the form of bonds.

Undeniably, the most problematic situation concerning the application of bonding mechanisms among the four bonding systems studied is the BLM - Hardrock Mining. The current regulatory system is complex and allows excessive confusion among jurisdictions and state and federal regulations.

Hardrock mining operations have the potential of causing extensive environmental and social impacts. The BLM bonding system suffers throughout the sector, from small-scale operations, which cause elevated damage but are not included in the bonding regulation, to large operations which generate a great deal of rock burden, AMD, suspended particles, deforestation, visual impacts, among other impacts.

In most cases, bond requirements are insufficient to cover all ex-post environmental obligations, and, for this reason, do not generate any incentive for compliance. As a result, the environmental liability in the sector is high and companies that profit from the activity can easily exonerate themselves from their responsibilities, imposing costs on the agency. Closure costs in mining areas vary significantly from state to state ($ 1,000 to $20,000 per each 4,046.9[31] m^2 affected). However, if the agency is obligated to perform closure operations, or subcontract a private operator, costs may be 50% to 500% higher. This happens mainly because state agencies, without any kind of verification mechanism, accept the estimates offered by operating companies. In addition, state authorities accept virtually any form of bonding instrument, and, in some cases, even projected revenue from the project being bonded.

The BLM bonding system is under severe criticism and faces several litigious actions. Other problems faced by the agency include political pressure against proposals for higher bonds, excessive flexibility offered to operators, high monitoring costs (areas of difficult access), and a historical legacy of abandoned mines.

4.13. THE FINANCIAL ASSURANCE SYSTEM IN THE US ONSHORE PETROLEUM INDUSTRY (US BUREAU OF LAND MANAGEMENT)

The BLM (Onshore Petroleum), is a Branch of the U.S. Department of Interior and regulates exploration, development, and production of oil and gas in Federal and indigenous land. The agency is responsible for the inspection of over 112,000 oil and gas wells (BLM, 1992). This branch of the BLM is a very old agency. Preliminary studies indicate that the term "aged" is probably a suitable definition for the agency. Financial assurance has been required since early 1920's and very few alterations have been made since then. The system is based on requiring

[31] 1 US Acre.

only symbolic financial bonds, although higher bonds can be legally required. The historic BLM policy has been of requiring bonds only to safeguard the agency against companies getting behind in paying, or exonerating themselves of paying, their due royalties.

Currently the most complex problem faced by this branch of the BLM involves *orphan* wells[32]. These wells were not capped, plugged, nor adequately abandoned. Other issues involve the great number of *shut-ins*[33], in which production may resume depending on market conditions.

The BLM bonding system is a textbook example of a financial assurance system based solely on financial bonds, in which the only objective of the mechanism is to ensure proper and timely payment of royalties, or, in other words, a token or symbolic value, indicating the intention of the candidate company in complying with royalty obligations. Incentives for ex-post environmental compliance are not provided by BLM requirements.

Bonds have been required by the BLM since 1920 (US$ 5,000 per well), when the regulation was inaugurated. A revision of the bond amount was made in 1960 (to US$ 10,000 per well), and it remains since then. A movement for increasing this value to $20,000 was launched around 1999. During interviews and conversations with BLM staff, it was apparent that there is an interest of the agency in reevaluating this bond amount. However, it was also evident that fierce opposition was encountered. Although higher bonds can be required under the current rule, adequate performance bonds are nonexistent. It is important to emphasize that the agency assumes an interest in higher financial bonds, but not in requiring performance bonds, which would represent the full value of ex-post costs.

Regulators recognize that small operators often choose to default the bond instead of assuming ex-post costs; and, with no incentives, the irregular interruption of projects is frequent. For this reason, the BLM also faces substantial litigious actions. Interesting enough is the fact that the agency is aware of potential environmental complications from various forms of contaminations caused by improper abandonment or noncompliance with ex-post obligations, including mercury contamination from old manometers used to measure gas pressure, which in the past have been largely abandoned *in situ*.

The BLM does not offer much flexibility in what financial instruments are concerned. Instruments accepted are: corporate surety bonds, Certificates of Deposit, Letters of Credit, Cash,

[32] Orphan wells: wells where a responsible party cannot be identified.
[33] Shut-in wells: temporarily abandoned wells.

and Bonds issued by the Government (Treasury Notes). As mentioned, according to the current review conducted during this study, the major BLM problem is not excess of flexibility given by the number and forms of instruments, but lax bonding requirements (no incentive for compliance). The number of contractual default also confirms this.

4.14. COMPARATIVE ANALYSIS OF THE FOUR U.S. BONDING SYSTEM

Although based in the very same 1920-regulation, the MMS regulation has been more realistic and objective than the rule applied by the onshore branch of the BLM. For instance, under the MMS bonding system:

- The lessee that cannot demonstrate capacity to fulfill all ex-post obligations, will not obtain an operating license;
- Bonding instruments accepted are few, offering a limited flexibility for small and independent operators. As a practical result, the participation of high-risk companies was drastically reduced; and
- The bonding requirement, bond amount, may be reduced or increased, depending on the risk offered by the candidate.

During the relatively short time the MMS bonding rule has been in place (since 1989-1993), the very first case of ex-post noncompliance case occurred in 2001. In addition, due to the dynamic character of the offshore sector, the agency promotes some form of adjustments in the regulation every two or three years, reflecting corrections of any forms of evasion opportunity (loopholes) identified in the system throughout that period. With this approach, the MMS has very little problems and regulatory costs are low. At the beginning, lessees resisted, but the agency persevered firmly and companies adapted themselves to the stringentness of the new requirements. During all this time, there has been only one litigious action against the MMS (2000e).

The onshore branch of the BLM, in contrast to the MMS, bears significant liabilities that were inherited from very old operations; in addition, the BLM has to deal with very complex issues of leases in Federal and Indigenous lands. A great part of the BLM concessions are marginal fields and in the hands of small and independent operators. There are some very unique situations involving onshore projects. For instance, there are cases where a project owner (a single project owner) contracts three or four workers and starts producing onshore petroleum (BLM, 2000). With a very generous regulation, which motivates evasion and a strong lobbying of producers, the BLM problems are significant, such as:

- A large number of orphan wells[34] in which no responsible parties can be identified, and idle wells[35], which are inactive but not properly plugged and abandoned.
- When oil prices are low, companies refuse to abandon wells (plugging) arguing that there is no capital left to do so. When prices are high, lessees argue that they cannot plug the wells because there are possibilities of returning to old reservoirs. Consequently, there are plentiful idle wells.
- The BLM suffers with a number of litigious actions impetrated by lessees, municipalities, and the public. Preliminaries analysis indicates that the BLM is in a lose-lose situation: In order to avoid additional litigating actions and further evasions, the agency must yield for bargaining proposals.
- Backed by a strong lobbying, any attempt to improve the current BLM legislation is frustrated.
- Evasion of royalty payments, lack of funds for monitoring ex-post operations, and currently, the opposition of the executive administration[36] to any requirement that might suggest "environmental costs" to oil producers.

For practical purposes, studies were concentrated on more mature bonding systems, which could provide hands on the job information. Four American agencies were able to fulfill this criterion and **Table 4.5** identifies their main characteristics allowing an item-by-item comparison.

Observations during this preliminary assessment indicates that among the bonding systems studied, the MMS's is the most efficient one. It is important to emphasize that the offshore oil sector presents different and more favorable characteristics than the remaining agencies and the areas under their jurisdictions.

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[34] 1992 BLM estimations indicated around 16,384 orphan wells under the jurisdiction of the agency. A general estimation for all state jurisdiction indicated 51,043 (Source: BLM, 1995).

[35] 1992 BLM estimations indicated around 114,896 idle wells under the jurisdiction of the agency. A general estimation for all state jurisdiction indicated 214,894 (Source: BLM, 1995).

[36] The current President of the United States, Mr. George W. Bush, is a former independent oil producer with a lax environmental record.

TABLE 4.5. SUBJECTIVE COMPARATIVE ANALYSIS OF STUDIED BONDING SYSTEMS				
	Analyzed Agencies			
	OSM **Coal**	**BLM** **Onshore Oil and Gas**	**BLM** **Hardrock Mining**	**MMS** **Offshore Oil and Gas**
System Established in:	1970	1920 (1960*)	1994 (1970*)	1989 - 1993
Form of required guarantee?	1. Performance bond 2. Contingency Fund 3. Residual Liability	1. Financial Bond	1. Performance Bond (depends on jurisdiction)	1. Financial Bond 2. Performance Bond 3. Contingency Fund 4. Residual Liability
Value of required guarantee?	100% of ex-post costs + Indirect Costs	Minimum amount US$ 10.000 / well US$ 25.000 / *blanket bond (State)* US$ 150.000 / *blanket bond (National)*	< US$ 1.000 to US$ 20.000 per affected 4,046.9 m^2	US$ 50.000 to US$ 500.000 – Financial Bond 100 % of ex-post costs – Performance Bond US$ 35 million to US$ 150 million – Special Fund
Who defines bond amount?	Agency & Operator	Agency	1. Operator (usually) 2. Agency & Operator 3. Agency (rarely)	Agency & Lessee
Guarantee Level (*according to observations*)	Adequate	Insufficient	Insufficient	Adequate
Accepted Instruments	Sureties, Cash, Escrow Accounts, CDs, Letters of Credit, Treasury Notes, Real Estate, Pool Bonds, and Self Guarantees	Sureties, CDs, Cash, Treasury Notes, and Letters of Credit	Varies from State to State, but practically all available instruments including Budget Set-Asides	Sureties, LSAA, Third-Party Bond, and Self-Bonds
Main Problems	AMD, abandoned mines, and litigious actions for negligence (AMD-related)	Inadequate ex-post cost estimates, large number of orphan and idle wells, political pressure, antiquated and inefficient legislation, Industry's bargain power	Bias from regulatory agency, totally inadequate bond amounts, excessive flexibility, excessive number of acceptable instruments, high monitoring costs, high environmental liabilities, abandoned mines, etc.	Large interest of small, independent, newly-formed, or marginal companies on the large number of small and marginal fields available.
Ranking based on Level of Problem Complexity (1 worst → 4 Best)	2	3	1	4
System contemplates Residual Liability?	Yes	No	No*	Yes
Level of Litigious Actions related to the bonding system	High	Moderate	High	Insignificant
Level of Environmental Noncompliance	Low	High	Very High	Insignificant
Level of Environmental Liability left to the Agency	High	High	Very High	Insignificant
Most used instrument (*excluding self bonds*)	Surety	Surety	Not Known	Surety
Least used instrument	Not Known	Not Known	Not Known	Not Known
Instrument which allows the highest level of default	Not Known	Not Known	Not Known	Not Known
Total amount allocated in form of bonds	Not Known	Not Known	Not Known	Not Known
Highest potential liability	Not Known	Not Known	Not Known	Not Known
Level of participation of small or independent operators	High	High	Very High	Very Low
Level of use of self-bonds	Moderate	None	High	High
Level of Regulatory Costs	Very High	High	Not Known	Low

The MMS deals with a scenario where monetary values are usually greater than in other sectors such as hardrock mining, onshore petroleum, and coal mining. Even dealing with greater financial responsibilities, non-compliance risks are significantly lower. These circumstances do not take away merits from the MMS, since the agency has established and maintained an efficient and viable bonding regulation. For instance, during the last 9 months of 2001, the MMS branch office in the GOM region, handled 123 decommissioning applications. During 2002, 196 new structures were approved and placed in production areas. The same branch oversees over 6,000 concessions and around 5,000 installations. Any modification (engineering, logistic, etc.) must be approved by the agency, and usually this process takes only two or three working days. The most interesting aspect is that a single MMS employee is responsible for the entire decommissioning sector (new structure approvals, shallow areas, and decommissioning) for the entire GOM Region. A small group handles pipelines (plugging and decommissioning) and a third group handles well plugging and abandonment. This allows very lean regulatory costs.

4.15. REGULATORY ISSUES

Do bonding requirements discriminate against small, newly-formed, and independent lessees? In order to obtain permission (or license), to explore, develop, and produce within public areas, a lessee (or operator) must sign a comprehensive contract acknowledging all ex-post environmental obligations. If a candidate company, a potential lessee, cannot demonstrate its capacity to fulfill such clauses, the regulatory agency as the designated keeper of this public good, is responsible for stopping this company from obtaining the lease. Allowing high-risk lessees would be negligence and, in countries where this criterion is not being applied, governments have been inheriting huge financial liabilities. Otherwise, oil companies would be risking precious natural resources in exchange for a profit opportunity. Bonds are aimed at guaranteeing the performance of operations that the lessee has already agreed on completing, as a basic condition for operating in this sector. If an oil company cannot demonstrate its financial capability to cover pre-established contractual obligations, it would not be financially equipped prevent, mitigate, remediate or financially compensate damages that may occur during the length of the project, consequently, it would be demonstrating that it would not be able to comply with contractual obligations.

The efficiency of a bonding system also depends on the costs required to maintain the regulatory role. In order to obtain some forms of bond, financial institutions will submit candidate companies to stringent underwriting processes. These instruments allow significant regulatory cost savings. Bond-issuing financial institutions have a direct interest in monitoring the financial health of their clients, operating companies; and, in case lessees default, financial institutions will have to assume all their client's ex-post obligations.

Instruments offering superior flexibility and low direct costs, most of the times, will cause high indirect costs or higher risk to the regulatory agency. Regarding regulatory costs, gathering information may be one of the most costly activities for regulators (the "information burden"):

- Establishment of a database system to assist in the estimation and comparison of operations costs;
- Assessment of new technologies and practices within the sector;
- Hiring or forming experts in the areas of interest (i.e. bonds, decommissioning, insurance policies, etc.);
- Assessing and monitoring the financial health of lessees and bond-issuing institutions during the length of the project.

The applicability of bonding system must consider ongoing projects and projects near the end of their lives. For instance, how to enforce bonding requirements from a lessee operating a marginal project? What would be this lessee's capacity to fulfill recently established ex-post obligations? What to do if funds necessary to fulfill ex-post obligations are higher than potential revenue? Should a different approach or a case-by-case evaluation be applied under these scenarios?

Some argue that an oil company that has been acquiring financial resources throughout its life must have available capital to fund even newly enforced ex-post obligations, whatever they may be.

Idle wells can be a source of great problems within the sector. Usually, agencies establish a period in which a well can be temporary inactive before permanent plugging and abandonment is required. A possible solution for this scenario would be offering incentives such as tax reduction and royalty relief for marginal producing projects, allowing them to be active even under unfavorable market conditions. This approach would extend the life of fields, reduce impacts of ex-post operations, increase total oil output, and leverage investments within the sector.

In the specific case of Brazil, some public construction projects require bidding participants to contract insurance policies to guarantee the performance of projects. It is probably possible to use the same legal basis to promote the requirement of environmental insurance to be used as performance bond, although, as stated previously, there are instruments more efficient than insurance policies. Instruments under the escrow accounts category may pose a problem, since the legislation forbids governmental institutions of owning joint accounts with individuals. This same principle would limit the application of other instruments such as some pool bonds categories. Other forms of financial guarantee instruments currently in use in Brazil are LOCs and CDs.

This study has identified a view in which some sectors of the industry believe that performance bonds are aimed at super compensate the regulatory agency in the event of default. Experience shows that regulatory agencies require bond liquidations as a very last alternative. The liquidation of a bond brings excessive complexity to regulators, who will have to assume a problematic project and find a subcontractor willing to undertake an unfinished and uncertain project.

Another legal argument against the application of bonding instruments is that it deprives the lessee of a basic universal legal principle, which is: *innocence is presumed and guilt requires proof.* However, in the case of economic activities such as upstream petroleum projects, the probability of ex-post damage, or guilt, is 100%. Ex-post damages are indeed expected as a natural outcome of the activity, and then, before such activities are permitted and licenses are granted, a guarantee for the availability of funds to cover ex-post damages must also be of 100%.

Any environmental problems erupting after ex-post obligations are met should be denominated "residual responsibilities". Lessees surely will require from regulators some form of guarantee that once ex-post obligations are met, there will be an endpoint, a ticket out, to liabilities, and, mainly, there will be no post-closure liabilities.

For society, oil companies will always be responsible for environmental problems, direct or indirect, and during or post-production. The legal debate involving residual liabilities is very complex and divisive. Large and historical transnational companies have intangible cost incentives to prompt and voluntarily deal with residual liabilities. Currently, a negative public perception may cause considerable cash flow impacts for these large corporations. On the other hand, small and marginal companies would not have the same incentive, and the agency would probably have to fund post-closure mitigating operations.

The oil industry has been seriously affected by environmental problems. Legislators have heard the public outcry and transferred their stress to regulations. Contacts made with representatives from large oil companies, do not feel they need bonding requirements to be motivated to fulfill ex-post environmental obligations, although agree that bonds are necessary to protect government and taxpayers from future liabilities left by other class of operators.

Under stringent regimes, the industry complains that lessees with proven financial capacity should be authorized to use *soft bonds*, and only more vulnerable lessees would be obligated to provide hard bonds. The financial sector in the United States indicates that in well-elaborated regulations, such requirements would not offer great problems to large historical companies. However, agencies that offer excessive flexibility accumulate a great number of litigious processes in which the public requires to know why sufficient resources were not available to guarantee the performance of ex-post operations.

Some smaller companies prefer to allocate a certain amount of capital in collateral accounts receiving interest revenues rather than buying a product that requires the payment of nonrefundable premiums and fees. A large company undertaking a large project would prefer to acquire an insurance policy or a surety bond in order to receive fiscal advantages and face less significant opportunity costs.

There is a common feeling among most experts, and also some regulators, that an accurate method of estimating ex-post operation costs and establishing bonding requirements, is of greater importance than defining the ultimate bonding instrument. Amongst large oil companies, there is also a general belief that term and conditions of licenses are more important than bonding requirements. Nevertheless, regulators must demonstrate to society that an adequate financial protection is available to safeguard taxpayers from future liabilities.

CHAPTER V – FISCAL TREATMENT – DECOMMISSIONING & BONDS

Are ex-post expenditures tax-deductible? What kind of fiscal incentives are available to improve investments on innovative technologies and processes aimed at improving environmental performance of end-of-leasing activities and reducing ex-post expenditure?

Are there fiscal incentives for bonding instruments? Should further incentives be provided to instruments in order to reduce financial impacts on project cash flows? Is fiscal planning an important issue for decision makers considering bonding options?

5.1. DECOMMISSIONING FISCAL TREATMENT - DISCUSSION

Fiscal planning becomes more important as economic incentive mechanisms are increasingly being adopted by regulatory agencies around the world. As competition increases, environmental regulations toughen, and projects get marginal, companies are increasingly expected to reduce, as much as legally possible, government earnings in projects. According to YOUNG and MCMICHAEL (1998), the most significant negotiable factor that affects the performance of the project is income tax.

Future liabilities, such as costs to meet decommissioning obligations, must be carefully considered in company's financial statements. Companies must consider how to anticipate such expenditures and how, whenever possible, to apply them in each year's accounts. Lower estimations of cost to meet ex-post obligations may provide better NPVs (cash flow results). Lower tangible ex-post costs may provide better profits. The problem is that higher NPVs lead to higher corporate taxes. In addition, higher decommissioning estimates, may lead to higher financial assurance requirements.

Companies are not the only parties impacted by high ex-post costs. Such costs involve direct and indirect impacts on governments, taxpayers, and society as a whole. Current tax structures determine that governments, and consequently taxpayers, bear part of the cost for decommissioning, providing tax relief for oil companies. In some countries where the debate on decommissioning related issues is more advanced, the matter of charging the taxpayer for decommissioning operations of private oil companies is being severely questioned. However, most regimes do provide legal basis for dividing the costs of meeting ex-post obligations between the state and the private sector. In some countries, the government bears the majority of the financial responsibility, as it is the case of Norway.

Deduction rates may vary significantly from country to country. In the UK, for example, oil companies are taxed on their earnings from oil and gas production but since decommissioning expenditures are allowable against taxable earnings, the UK government loses revenues equivalent to 50% to 70% of ex-post costs (PROGNOS, 1997).

In Norway, government covers the greatest part of platform removal costs and companies cannot deduct removal expenses in their corporate income tax (NPD 1999; PHILLIPS, 1999b). Decommissioning obligations are not subjected to ordinary tax handling. They are kept outside the tax system. In any case, other costs involved in the decommissioning of installations are fully deductible.

In 1975, Phillips Petroleum Norway claimed deduction for future removal costs. That was when NPD established its first special tax rule for decommissioning costs: "based on the principle of taxation, all costs are deductible but due to the uncertainties involving anticipating costs, no tax deduction for future costs are allowed" (PHILLIPS, 1999a; PHILLIPS, 1999b; NPD, 1999).

The Norwegian Removal Grant Act (25/04/1986) states that when installations are to be removed, the State will bear a share of removal and disposal costs. Other ex-post obligations are not included in this cost sharing treatment. This Act is only applicable for expenses directly related to the removal and disposal of installations. Other ex-post costs such as preparation, assessments, well plugging, etc., are considered legitimate operation costs and are deductible (NPD, 1993).

A better way of understanding this system is: "State's percent share is equal to the average tax rate for each licensee over the lifetime of an installation" (PHILLIPS, 1999b). Payment of tax before 1975 is not included. The State share for removal costs are based on the estimates of each licensee. The State contribution cannot exceed accumulated paid taxes. The final decision is not taken by NPD, but rather by the Ministry of Finance, which defines removal costs. This calculation will include all years from the development of the platform up to its removal and disposal. The calculation does not include taxes paid when the platform was not installed. For instance, if the average corporate tax paid during the 20 years of operations of a platform was 75%, the Norwegian government will pay for 75% of the disposal costs. One problem that can be anticipated is, for instance, if at the time of the decommissioning of a specific platform the tax rate is around 80% and the average was calculated at 75%, the company will loose 5% on possible deductions.

Even losing considerable funds by allowing tax relief for ex-post expenditures, governments will earn tax revenues from income tax of workers and other several levies imposed on companies involved in ex-post environmental activities. In addition, by allowing fiscal incentives governments may significantly reduce the risk of noncompliance and undesirable environmental liabilities.

Within this context, parameters such as decommissioning options (total or partial platform removal) may cause significant fiscal effects. For instance, North Sea government's expenditure, or the amount by which tax receipts are reduced as a result of decommissioning, amount to about US$ 6.3 billion in the case of total removal and between US$ 3.8 billion and US$ 5.8 billion for partial removal. Consequently, possible "savings" offered by partial removal options are somewhere between US$ 1 billion and US$ 2.5 billion up to the year 2020, just for North Sea projects. The income tax revenue generated by new jobs and related decommissioning activities, total about US$ 1.4 billion for total removal, which is US$ 0.1 billion and US$ 0.3 billion higher than in the case of partial removal (PROGNOS, 1997).

According to these numbers, considering total and partial removal options, taxpayers from North Sea producing countries would save between 8% to 44% (US$ 15 million to US$ 95 million) per year, if partial removal options were to be adopted for all installations. If total removal is adopted, taxpayer from North Sea producing countries will be paying for decommissioning up to the year 2020 between US$ 400 million to US$ 2.2 billion.

The fiscal environment may also contribute to the adoption of even more improved practices. KAPOEN (2001) suggests that in order to encourage the reutilization of redundant offshore installations and components, depreciation should not only apply to new business assets. In addition, authorities should accept that remaining partners could rollover their tax bookvalues. Fiscal incentives may help improve the market for used structures, mainly to be used in small and/or marginal projects.

Therefore, for most tax regimes, ex-post environmental obligations, including decommissioning costs, are ordinary and necessary expenses. In general, such expenditures are tax-deductible only when services have been performed and payments have been made. When progressive abandonment is adopted, the same rule applies. Deductions are usually not allowed for decommissioning activities carried on during non-income years (when production has ceased). In such situations, companies are usually allowed to carry a "credit" towards a future project, as it is the case in the current Brazilian fiscal regime. Some regimes offer provisions allowing some type of "anticipated tax-deduction provisioning" spread over a period during revenue-producing years. The approximate government participation in Brazil is around 65%, not including bond related expenditures (BARBOSA, 2001). **Figure 5.1** shows the profit-split between the government and the producing companies.

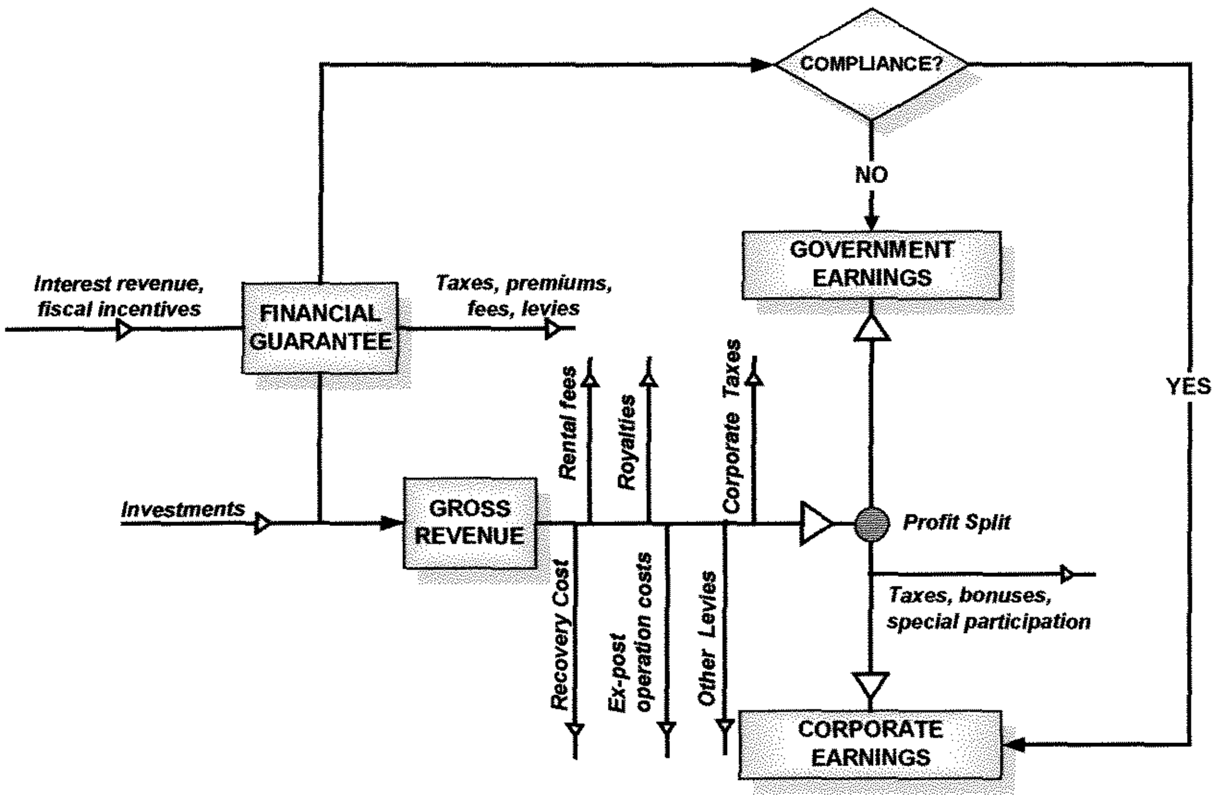

Figure 5.1. A simplified fiscal system including bonding system.

5.2. BOND FISCAL TREATMENT - DISCUSSION

Within financial assurance regimes, companies depositing funds into escrow accounts pledged to the government (bonds), no deduction is available until the company loses ownership of the funds. However, within most financial assurance regimes, if a company pays fees or premiums to keep surety bonds or environmental insurance policies, such expenditures would be amortized over the time period covered by the bond.

In general, the rule for deductibility is that the expense has to be an ordinary and necessary business expense and not a capital expenditure (IRS, 1999). The fact that a company is contractually liable for ex-post expenditures or provides anticipated funds to guarantee such obligations (bonds), does not entitle it to deduct the cost of such services before they have in fact been performed.

In Canada, Japan e South Africa, collateral bonding instruments such as escrow accounts that allocate upfront capital are also conferred with deductions. However, any revenue awarded from financial application of allocated funds (i.e. interest from escrow accounts) is subjected to ordinary taxation. Under more mature bonding regimes such as in Canada, there is a common notion among specialists and regulators that offering a net fiscal incentive is better than risking inheriting ex-post environmental liabilities from the mining and oil sector. Indeed, a very interesting study proposal would be the assessment of potential fiscal incentives for financial assurance instruments.

On the other hand, some other aspects must be considered. Would further fiscal incentives reduce or eliminate the main motivation for compliance with ex-post obligations? If deductions are extended to cash collateral accounts, for instance, the main motivation for compliance, which is "doing it right in order to get the bonded money refunded", may be annulled. As a result, if a company can get its allocated capital back through tax deductions before the end of the project, what kind of incentive is left for compliance? Three variables can act as catalytic factors within bonding regimes: flexibilities demanded by the industry, requirements established by regulators, and risks offered by flexibilities. Providing fiscal incentives could be considered a form of flexibility. **Figure 2.3** illustrates the dynamics of the bonding system where, due to public pressure, regulators establish stringent performance bond requirements generating direct and indirect economical impacts on the profitability of petroleum projects. The industry demands flexibilities that may come in the form of softer instruments, fiscal incentives, or lower bonding estimations. These flexibilities increase the risk of noncompliance triggering public concern and involvement, closing a very common cycle.

CHAPTER VI – DECISION TOOLS: ECONOMIC MODELS

How to anticipate and reduce the impacts of environmental regulations, more specifically, financial assurance requirements, upon the profitability of offshore petroleum projects? Answer: developing decision tolls and economic models for managing oil project decisions involving ex-post and financial assurance mechanisms, providing a way to anticipate economic impacts of several bond alternatives.

In this chapter, two articles are presented. The first article offers an algorithm in order to assist decision makers, both regulators and industry, evaluate potential NPV impacts of financial instruments used to satisfy bonding requirements. The second article deals with potential financial impacts of bonding instruments on offshore oil projects.

I. REFERRED ARTICLE II – Natural Resources Research, submitted in 2003

TITLE: AN EXPLORATORY ANALYSIS OF THE ENVIRONMENTAL BONDING SYSTEM FOR UPSTREAM PETROLEUM PROJECTS

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ABSTRACT

This paper deals with potential financial impacts of different bonding instruments on oil projects. An algorithm was prepared in order to assist decision makers, both regulators and industry, evaluate potential NPV impacts of financial instruments used to satisfy bonding requirements. Instrument option is the main variable for the proposed model. The user will be able to chose between four commonly used instruments (letters of credit, prepaid collateral closure accounts, leasing specific closure accounts, and ex-post insurance policies). This study includes simulations for three producing fields of different reserves (9 MMbbl, 53 MMbbl and 148 MMbbl), where four financial instruments, in addition to a "no instrument" scenario, are tested under a proposed bonding regime. Sensitivity analysis of Net Present Value and Government Take value indicate ex-post insurance policies and letters of credit cause fewer impacts yielding significantly better payoffs. Preliminary simulations also confirm that small projects can be severely affected when collateral account instruments are used.

KEY WORDS: Financial Assurance; Economic Model; Bonds

6.1. INTRODUCTION

Worldwide, several countries have adopted or are in the process of adopting financial assurance requirements (bonds). A number of natural resources agencies, petroleum and mining, have already established some form of bonding system aimed at ensuring the performance of ex-post environmental obligations (end-of-leasing or closure requirements). Such systems can be seen in operation in countries such as the United States, Canada, the United Kingdom, Australia, and Brazil, among others (OSM, 1987; YOUNG, 1996; JAMES, 1997; MMS, 2000; OSM, 2000b; FERREIRA and SUSLICK, 2000; DTI, 2000a; ANP, 2000b; UNICAMP/CEPETRO, 2001).

The present study includes cash flow simulations and sensitivity analyses of four commonly used financial instruments: Letters of Credit, Prepaid Collateral Closure Accounts, Leasing Specific Closure Accounts, and Ex-post Insurance Policies. Denominations for bonding instruments can vary significantly.

The first section of this paper provides an overview of bonding systems. Section two describes the methods, algorithms, and variables for the model. It also includes a brief explanation of the fiscal parameters used. Section three offers an analysis of the data resulting from these preliminary Petrobond simulations.

6.2. BONDING SYSTEMS

Current attempts of extending the lives of mature fields and turning small and marginal fields into profitable projects has attracted the interest of a number of risky small and recently established, and, possibly, marginal and spurious companies. Bonds come as a response to environmental liability concerns, aimed at reducing the risk of noncompliance with ex-post environmental obligations (e.g. plugging, abandonment, decommissioning, reclamation).

Bonds are hybrids of market mechanisms and command and control regulations. Despite not being pure market instruments, bonds force companies to internalize ex-post environmental liabilities directly into their cash flow accounting, making costs explicit to shareholders.

Bonding systems currently in use include one or two of the following bond categories: Financial and Performance bonds. A financial bond does not guarantee the performance of an obligation. Instead, it can be compared to a token pledging, under the penalty of loosing no more than the amount bonded, the candidate's intention of keeping all financial commitments (e.g. timely payment of royalties and rents, honoring bids, etc.). A performance bond, in contrast, guarantees the performance of all closure obligations. In case of insolvency or default, the amount bonded will be available to the agency to perform all closure operations, as contractually required.

Bonding instruments can come in several forms with unique attributes and requirements. Some forms of bonds are pledged assets of oil companies (cash, securities, real estate, escrow accounts, etc.); performance guarantee of a project (surety bonds); securities issued by insurance companies, banks or other financial institutions; some are instruments that indicate the deposit of cash (certificates of deposit) or the existence of a line of credit (letters of credit) (BRYAN, 1998; FERREIRA and SUSLICK, 1999). Other common forms of bonds are: self bonds (a type of financial test or balance sheet test), trust accounts; other forms of bank guarantees, cash bonds or cash deposit certificates, cash trust funds, corporate guarantees, parent company guarantees, other forms of third-party guarantees, deposit of securities, financial reserve, and security agreements.

Four commonly used instruments were selected and tested by the proposed model. The choice of these instruments was primarily based on their applicability under the current Brazilian legal framework, although it can be applied to any other form of concession contract. These instruments are briefly described below:

- *Prepaid Collateral Closure Account* (PCCA): instrument option PCCA is a three-party irrevocable agreement. The lessee transfers assets to a financial institution (trustee) to be managed in behalf of a third party (the regulatory agency). The full amount of the bond must be deposit at once when the account is established. This collateral account cannot be released without the prior approval of the agency.

- *Leasing Specific Closure Accounts* (LSCA): option LSCA works like option PCCA, but instead of requiring upfront bond disbursement, it allows the spreading of payments during a pre-determined period (usually four years), or until production reaches 80% of the recoverable reserves; whatever comes first. Since the application of option LSCA depends on data from recovered reserves, it is only applicable to oil producing phases (development/production).
- *Letter of Credit* (LOC): option LOC is an instrument of collateral guarantee. A financial institution establishes a line of credit in behalf of the lessee guaranteeing the payment of the bond amount to the agency in case of default.
- *Ex-post Insurance Policy* (EIP): option EIP transfers liabilities to an insurer, which becomes the principal payer. The insurance policy will be maintained over the entire life of the project. The bond will be released only upon the fulfillment of all closure obligations.

6.3. METHODS

In order to perform cash flow calculations simulating a variety of oil projects scenarios under different bonding regimes, an algorithm (named PETROBOND) was prepared in Visual Basics (version 6.0) enabling decision makers evaluate potential impacts of financial instruments used to satisfy bonding requirements. This algorithm was developed for the Brazilian National Petroleum Agency (ANP) allowing the handling of operational variables, permitting realistic simulations taking into consideration oil and gas production profiles, costs, investments, closure costs, estimated life of projects, estimated oil and gas reserves, and market variations. For further calculations, results are displayed in Microsoft Excel spreadsheets. **Figure 6.1** shows the general algorithm layout.

Three categories of input variables are used in the proposed algorithm: (1) operational, (2) financial, and (3) bond-related. Under the "operational" category, the user is required to provide operation parameters such as production, operational costs and capital expenditures, project life, and field characteristics. **Appendix C Tables C.1, C.2,** and **C.3** provide a thorough description of all algorithm variables. Under the "financial" category, the user is asked to provide information on the applicable market scenario, fiscal regime, and other government contributions.

Under the "bond-related" category, the user is asked to define the desired bonding rule (an existing or theoretical system).

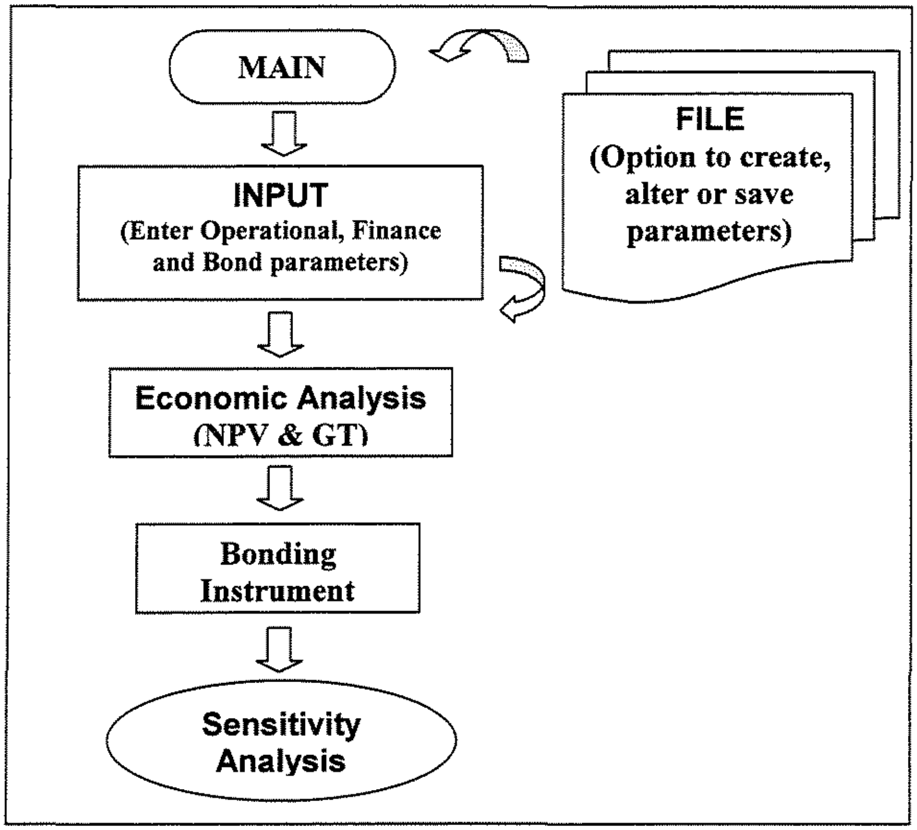

Figure 6.1. Macro-structure for the Petrobond Algorithm.

The proposed model incorporates the main variables of an ordinary upstream petroleum project (oil price, operational costs, investments, oil type, and production schedule) determining the ideal rate of royalty relief for an array of input combinations. Sensitivity analyses are also incorporated into the model in order to test all instrument options, and potential impacts caused by other input variables.

A general description of bonding mechanisms within some phases of ordinary upstream oil projects is explained bellow.

Since there is no environmental risk involved in the bidding phase, the user may opt to require (1) no bonds, or (2) a single financial bond. Choices are made by keying in values inside the input variable window (zero to switch bonding requirements off, and the desired bond amount to switch requirements on). In the case of compliance, bonds are reimbursed to the lessee or redirect towards the next project phase (exploration phase).

In the exploration phase, as illustrated in **Figure 6.2**, the user may opt to require (1) no bonds, (2) a single financial bond, (3) a single performance bond, or (4) a combination of a financial bond and a performance bond. If the lessee decides not to develop the project, all exploration sites must be properly "abandoned", in accordance with closure contracts. In the case of compliance, the bond is released and/or reimbursed to the lessee. Otherwise, if the lessee decides to develop the project, the bond may be reimbursed or redirected to the next phase of the project (development/production phase).

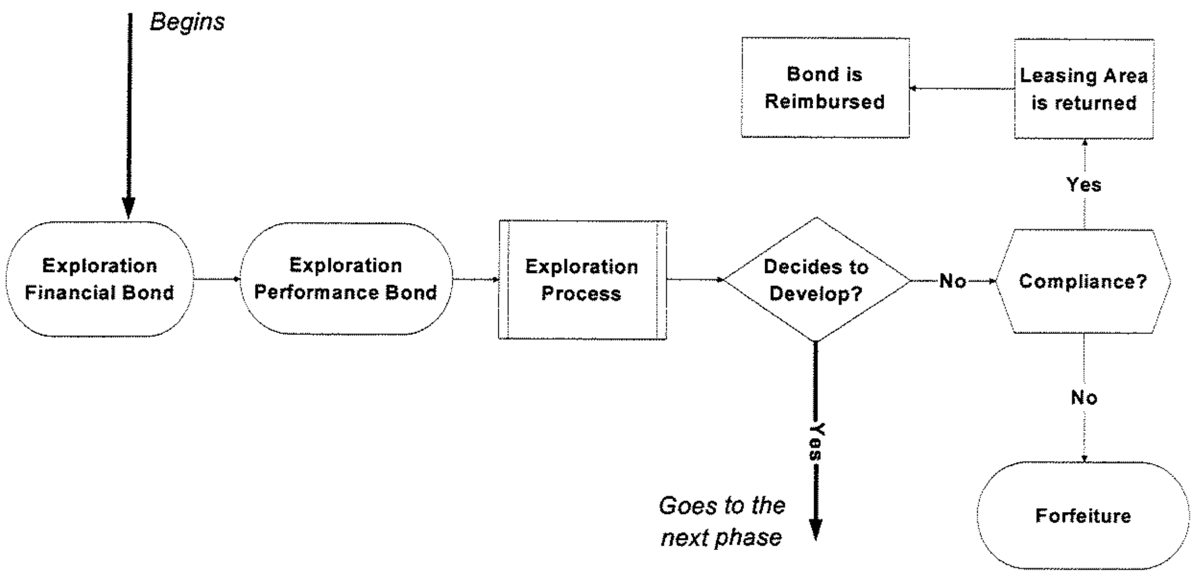

Figure 6.2. Diagram for the exploration phase.

Similarly to the exploration phase, for the development/production phase the user may choose to require (1) no bonds, (2) a single financial bond, (3) a single performance bond, or (4) a combination of a financial bond and a performance bond. All ex-post closure obligations must be satisfactorily met before development/production bonds are released or reimbursed.

Figure 6.3 illustrates the closure and post-closure phases. In the case of compliance, bonds are released or reimbursed. In the case of noncompliance, bonds are forfeited and the agency takes all required steps to ensure compliance with all end-of-leasing obligations. The user may decide on requiring a post-closure extended guarantee. In this case, the development/production performance bond is withheld for a post-closure period of monitoring (e.g. 6 years). After this period, if there are no incidents, the bond is finally released and reimbursed. Some bonding instruments may come with an additional guarantee for residual liability (e.g. some surety bonds).

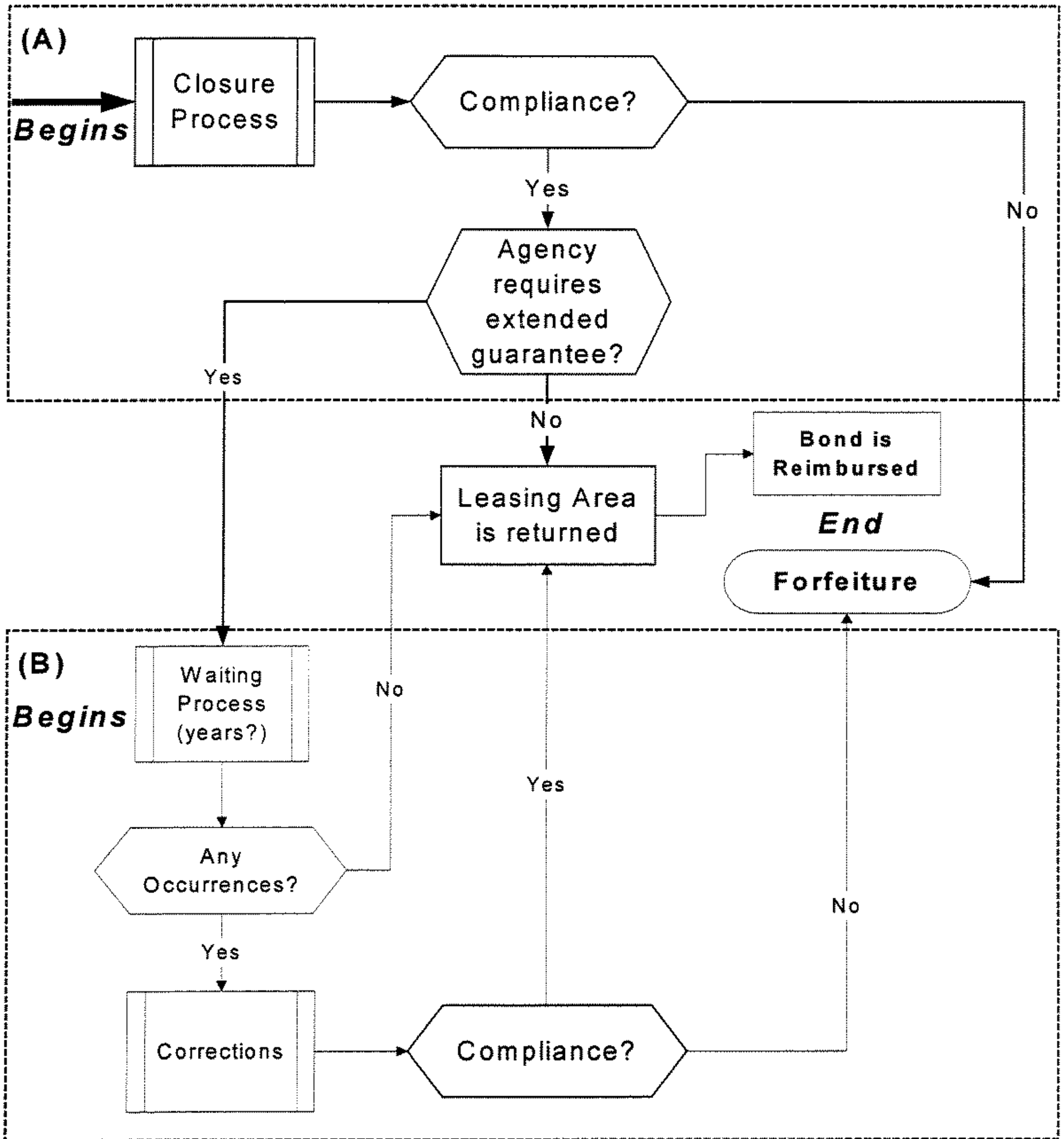

Figure 6.3. Diagram for the Closure and Post-Closure phases.

Simulations

The performance of the Petrobond algorithm was tested on three producing fields with reserves of 9 MMbbl, 53 MMbbl, and 148 MMbbl. In order to assist decision makers in selecting the most appropriate bonding instrument, Petrobond offers:

- Applicability, allowing the control of variables and manipulation of parameters;
- Flexibility, allowing the application of all options independently or combinations of options;
- Versatility, allowing the reproduction of a particular regulatory framework;
- User-friendly, providing help menus for user not acquainted with all aspects of bonding systems;
- Expediency, allowing the evaluation of best instrument performance under the perspective of regulators or the industry.

Table 6.1 indicates project parameters for all simulations. The following describes the hypothetical[38] bonding regime proposed to rule algorithm simulations performed under this present study:

Financial bonds are required in every phase, for all projects. Performance bonds are only required in the exploration and development/production phases. Bond amounts are indicated on **Table 6.2**. Post-closure operations will not be required; consequently, extended guarantees to cover eventual residual liabilities will not be necessary. For all simulations, it is assumed that lessees fully comply with all end-of-leasing and bonding requirements (no project default; no bond forfeit). Regarding bond amount calculation, the agency requires a 15% bond increment to cover indirect costs, such as third-party profit and management fees, in case of default.

All project cash flow simulations are carried out under an identical hypothetical bonding regime. Base-case costs for closure operations are indicated on **Table 6.2**.

For all simulations, production starts at "Year One" (since some tax categories depend on production, this assumption does affect government earnings). In addition, "end-of-project" coincides with "end-of-production".

Even after complying with all bonding requirements, oil companies must disburse out-of-pocket funds to pay for closure operations at the end of each phase. Bonds are released when bonded activities have been satisfactorily completed (in the case of collateral accounts, options PCCA and LSCA, bonds are released and refunded).

[38] The proposed scenario is based on proposed rules for the Brazilian bonding system, but can be applied to any concession model.

TABLE 6.1. PROJECT PARAMETERS

Items	Inputs Field A	Field B	Field C
Field Characteristics			
Oil Reserves (MMbbl)	9.00	53.00	148.00
Gas Reserves (MMBoe)	0.00	0.00	0.00
Oil Type (°API)			
General Characteristics			
Exploration Period (years)	1.0	1.0	1.0
Development Period (years)	1.0	1.0	1.0
Production Period (years)	12.0	16.0	21.0
Water Depth (meters)	1000.0	1000.0	1000.0
Costs			
OpEx (US$/boe)	2.25	2.25	2.25
Investments			
CapEx (US$/boe)	2.50	2.50	2.50
Depreciable Value (%)	65.00	65.00	65.00
Government Take			
Royalties (%)	10.00	10.00	10.00
COFINS (%)	3.00	3.00	3.00
PIS (%)	0.65	0.65	0.65
CIT (%)	25.00	25.00	25.00
BID (MMUS$)	0.50	0.50	0.50
CSLL (%)	12.00	12.00	12.00
PE (%)	*	*	*
Rent Area (Km^2) (for all phases)	400.00	400.00	400.00
Rent - Exploration Phase			
▪ Rent (US$/$Km^2$)	125.95	125.95	125.95
Rent - Development Phase			
▪ Rent (US$/$Km^2$)	251.91	251.91	251.91
Rent - Production Phase			
▪ Rent (US$/$Km^2$)	1259.54	1259.54	1259.54
Market Parameters			
Oil Price (US$/BBL)	21.00	21.00	21.00
Gas Price (R$/$m^3$)	0.13	0.13	0.13

(*) Special Participation based on recovery volume, reservoir location (onshore/offshore), and depth (when offshore) according to a differentiated rate table.

Based on an exploration project, the lessee submits a closure plan to the agency. The agency then establishes a performance bond requirement that should be sufficient to cover closure costs relative to potential ex-post damage generated by exploration activities. If the lessee decides to proceed and develop the project, a development/production plan is submitted along with a closure plan. The agency then establishes a performance bond requirement that should be sufficient to cover closure costs relative to potential ex-post damage generated by development and production activities. Under the present study, for comparison purposes, all projects will be developed; therefore, all phases of a successful petroleum project will be present.

TABLE 6.2. BOND PARAMETERS			
Items	**Inputs**		
	Field A	**Field B**	**Field C**
Bid Phase			
Instrument Type	LOC	LOC	LOC
Financial Bond Amount (MMUS$)	0.02	0.05	0.05
LOC Rate (%)	3.50	3.50	3.50
Exploration Phase			
Closure Costs (base case)	1.00	2.00	2.00
Financial Bond Amount (MMUS$)	0.05	0.10	0.10
▪ Instrument Type	LOC	LOC	LOC
Performance Bond Amount (MMUS$)	1.15	2.30	2.30
▪ Instrument Type	LOC	LOC	LOC
LOC Rate (%)	3.50	3.50	3.50
Development/Production Phase			
Closure Costs (base case)	2.00	15.00	15.00
Financial Bond Amount (MMUS$)	0.50	0.50	0.50
Performance Bond Amount (MMUS$)	2.30	17.25	17.25
▪ LOC Rate (%)	3.50	3.50	3.50
▪ PCCA Rate (%)	5.50	5.50	5.50
▪ LSCA Rate (%)	5.50	5.50	5.50
▪ EIP Rate (%)	3.00	3.00	3.00
Discount rate based risk evaluation (%)	0.00	0.00	0.00
Credit Rating	Top	Top	Top

It is assumed that all lessees have top credit and performance rating. Therefore, instrument options LOC and EIP will be offered reasonable premium rates, low fees, and, in addition, supplementary collateral guarantees will not be required[39].

The terminology "Government Take" (GT) herein applied comprises several taxes and levies including, Signature Bonus (BID), Royalties (ROY), Special Participation Compensation (PE), Rental Area Fees (Rent), social contribution for funding Social Security (COFINS) and Workers Social Integration Programs (PIS), Corporate Income Tax (CIT), and Social Contribution over Net Profit (CSLL) (**Table 6.3**).

[39] Letters of credit are very complex tools and financial institutions tend to be very conservative in the underwriting process. Collaterals are often required.

TABLE 6.3. FISCAL CALCULATIONS

Gross Income = total income from oil and natural gas sale

Less
- Royalties
- Operation Costs
- Closure Costs (if allowable against tax)
- Depreciation

Taxable Basis = Gross Income – Amortization

Plus
+ Bond Interests (for PCCAs or LSCAs)

Less
- Investment Credits
- Financing Interests
- Fiscal Loss Compensation
- BID
- Fees (for LOCs)
- Premiums (for EIPs)

Note: the following taxes are calculated: PE, P&D (1% of the gross income, according to production limits obeying PE criteria). CIT, and CSLL (these calculations take into consideration loss compensation of up to 30% and deduction of 1/3 of COFINS annual values.

In most countries closure costs are treated as operational costs (ordinary and necessary expenses), and, for this reason, can be fully deducted. This issue of charging taxpayers for closure operations of private oil companies is being questioned in some countries (PROGNOS, 1997). However, most regimes do provide legal basis for sharing the costs of meeting end-of-leasing obligations between the public and the industry. In general, closure expenditures are tax-deductible only when services have been performed and payments have been made. The same rule applies when progressive closure approach is adopted. Under some regimes, deductions are not allowed for closure activities carried out during non-income years (when production has ceased). In this case, companies are allowed to carry a "credit" towards future projects, as it is the case in the current Brazilian fiscal regime (ANP, 2000b).

Under most fiscal regimes where bonding systems are currently in use, deductions are not available for companies allocating funds as collateral guarantee (e.g. PCCA and LSCA). Deductions are only available when the lessee loses ownership of funds, closure services have been performed and payments have been made. However, if a company pays fees or premiums to keep bonding instruments in place (e.g. LOC, LOC and surety bonds), expenditures may be amortized over the period covered by the bond. The basic rule is that, only ordinary and necessary business expenses are deductible; capital expenditure is not. Being contractually liable for closure operations and issuing bonds (in anticipation) to guarantee such operations, does not entitle companies to deduct cost of services before they are actually performed (FERREIRA and SUSLICK, 2001; BARBOSA, 2000).

Simulations performed under this proposed model were ruled by the current Brazilian fiscal regulation. **Figure 6.4** provides a visual analysis of the proportion of the main cash flow components.

Special Participation Compensation (PE) is an additional financial compensation paid by lessees in fields of high productivity or high profitability. Its calculation is based on the gross revenue from production minus royalties, exploration investments, operational costs, closure costs, depreciation, and other tributes required under the current regulation (IR, COFINS/PIS) (BARBOSA and BASTOS, 2001; BARBOSA, 2001). Rental fees are based on the area leased (in Km^2). Cash flow calculations for government participations are illustrated on **Table 6.3**.

For the specific case of instrument options EIP and LOC, premiums are deducted for CSLL and CIT calculations according to the allowable deduction rate supplied by the user. Interest earnings from instrument options PCCA and LSCA are subjected to CIT. For all simulations, interest earnings are paid as earned.

6.4. ANALYSIS

The traditional discounted cash flow method (DCF) was used to measure the profitability of projects. The standard indicator NPV (Net Present Value) was used to measure the returns obtained by the firms. The ratio NPV by recoverable volume (the weighted NPV per barrel discounted at 15%) was applied for assessing the relationship between volume and value for future stand-alone comparisons. Government Earnings (GT) was also used as basis for comparison. The total net production was estimated excluding the volume of re-injected oil and natural gas or petroleum consumed during production operations.

The following approaches were used on the algorithm Petrobond for evaluating the results obtained in the simulations: (1) company's perspective: the preferable choice should have the highest payoff (NPV); and (2) government's perspective: the preferable choice should comprise a combination of reasonable government earnings to maintain the regulatory role, an adequate guarantee to ensure performance, and a cost considered tolerable by the industry.

Financial instruments are used here to determine the sensitivity of the variable "Bond Option". This study includes five simulations for each of the three oil-producing projects: one simulation for each bond scenario (NoBond, PCCA, LSCA, LOC, and EIP) with recoverable reserves ranging from 9 MMboe to 148 MMboe (million of barrels of oil equivalent).

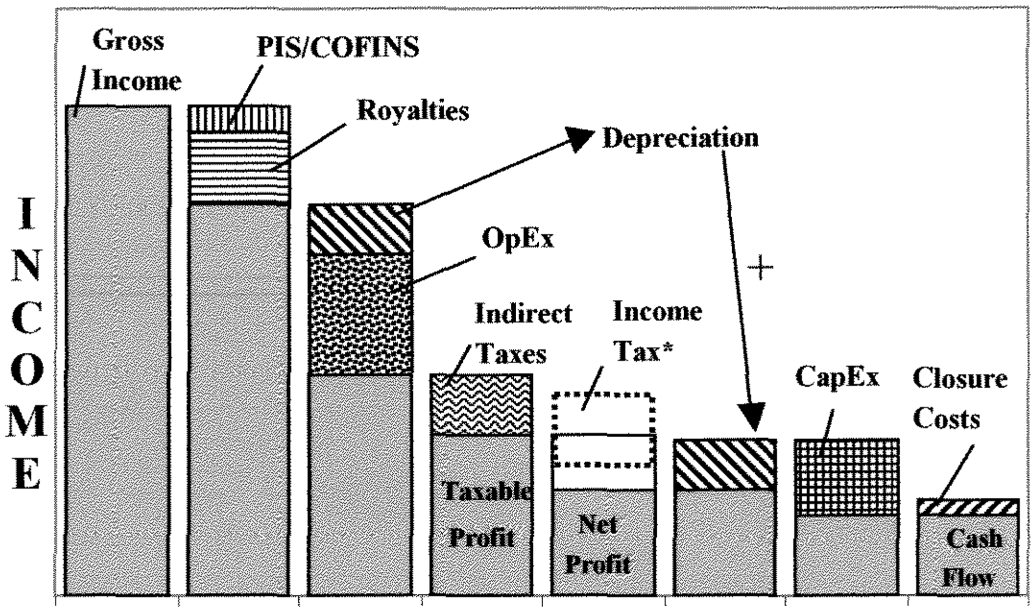

Figure 6.4. Comparison diagram indicating taxes and other government contributions. Based on the proposed fiscal rule currently adopted in Brazil (SCHIOZER, 2002 – MODIFIED).

6.5. RESULTS AND DISCUSSION

Bonding instruments behave differently in terms of allocation of valuable initial resources and in the way taxes and levies are collected. Instrument choice may impact, with distinct intensity, various sections of a project cash flow leading to different NPV and GT outcomes. Choosing the appropriate bonding instrument may determine the viability of some projects; primarily, marginal, and mature fields.

Preliminary results show that, under the proposed regime, total government participations vary from approximately 34% to 38% of the total gross revenue, not including bond-related expenditures. These GT values are calculated through the sum of participations within each group (of governmental participations) divided by total gross revenue. If instead, NPV (with discount rate of 15%) were calculated individually for each participation, summing up all participations, and dividing by total field production, GT values would represent approximately

65.9% (Equations 1 and 2). If NPV were to be calculated with a discount rate of 0%, GT values would represent approximately 55.7%. Results also indicate that among selected instrument options, EIP allows better NPV performances, followed by LOC.

$$\frac{\sum_{j=1}^{n} VPL(k, W_{ij})}{TP}$$

where:

i = number of groups $\rightarrow i = 1,...,5$

n = total number of participations within each group **_Equation (5.1)_**

k = Discount Rate

$W_{ij} = j^{th}$ participation within the i^{th} group

TP = Total Production

$$\frac{\sum_{j=1}^{n} W_{ij}}{TGR}$$

where:

Equation (5.2)

i = number of groups $\rightarrow i = 1,...,5$

n = total number of participations within each group

$W_{ij} = j^{th}$ participation within the i^{th} group

TGR = Total Gross Revenue

All instrument options affect government earnings on direct and indirect taxation. Collateral account instruments (PCCA and LSCA) improve government earnings due to interest revenues from escrow accounts. Options EIP and LOC allow deductions of premiums and fees, significantly eroding government earnings.

Figure 6.5 compares direct and indirect government participations and other project expenditures with total project gross revenue. The three most significant participations are: Operational Costs (OpEx), Investment (CapEx), and Corporate Income Taxes (CIT), respectively. When compared to other project participations, closure costs correspond to a very small fraction of the total gross revenue.

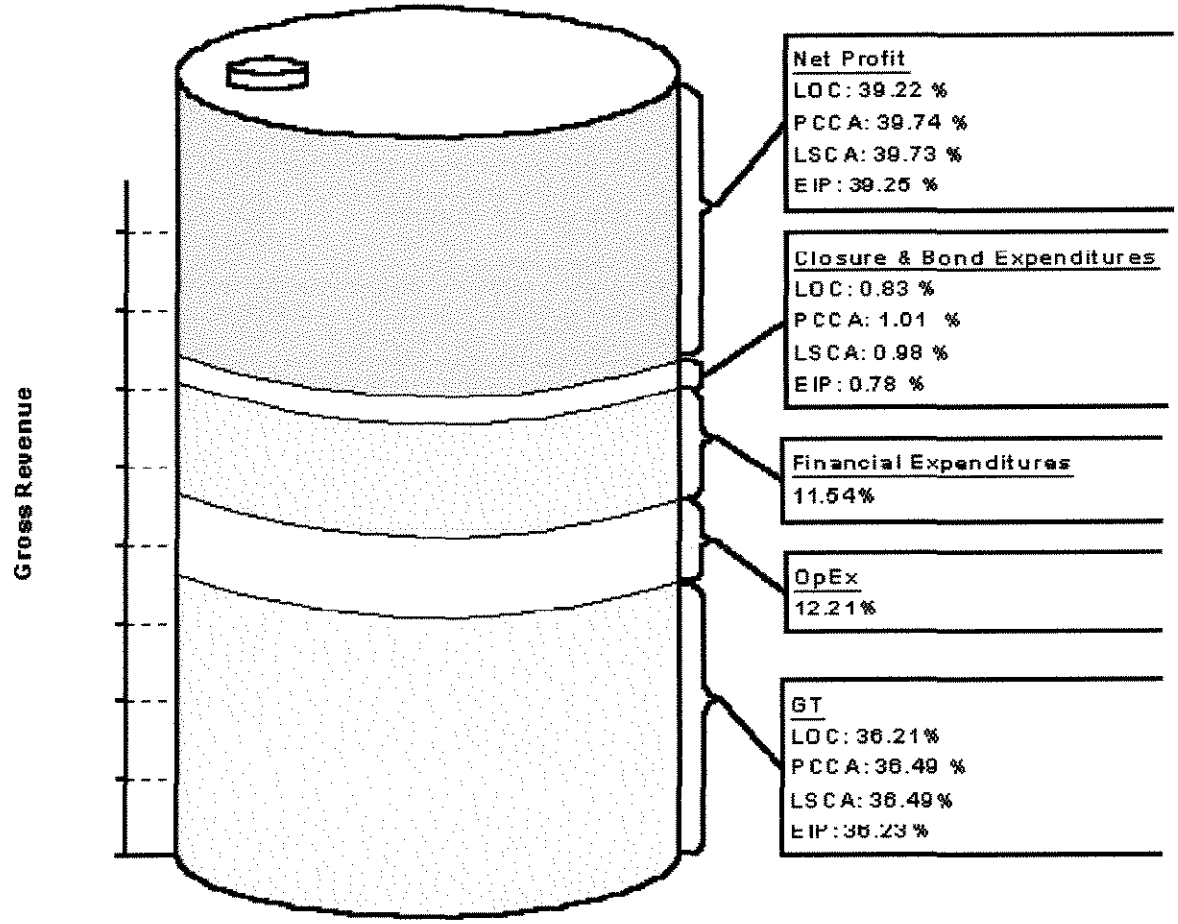

Figure 6.5. Total participations against total gross revenue (100%) for Field C (148 MMbbl). Government participation in this project (GT) constituted, on average, 36.36%, not including bond-related earnings. EIP allows the highest payoff for this project.

Figure 6.6 compares some of Field C cash flow results obtained in the simulations of all four instrument options. The choice of Field C (148 MMbbl) for this comparative representation has to do with its economics. The other projects do not reach the minimum requirement to allow the collection of PE compensations. Instrument choice does not affect financial expenditures (11.54%) or operational cost (12.21%). Option LOC (36.21%) allows the lowest GT participation, followed by options EIP (36.23%), and PCCA and LSCA (36.49%).

Instrument choice affects bond expenditure values as follows: option EIP (0.78%) allows the lowest value, followed by option LOC (0.83%). Low expenditure is due to the payment of annual premiums (around 3% of the total bond requirement) in contrast to the full bond amount required for options PCCA and LSCA. During development and production phases, premiums

can be deducted from CIT. This implies that bonding costs are being shared between industry and government. The small difference between options PCCA (1.01%) and LSCA (0.98%) occurs because option LSCA allows the spreading of bond payments throughout a four-year period, and option PCCA requires the full payment at startup. Since interest earnings from escrow accounts are taxed as ordinary revenue, during the first four years option PCCA generates more taxable revenues than option LSCA. Consequently, GT values from option PCCA are a little higher than GT values for option LSCA.

Sensitivity analyses indicates that instrument option PCCA performs better than option LSCA on small and medium size projects (up to approximately 53-60 MMbbl). According to this model, option LSCA begins to perform better than option PCCA in projects larger than 60 MMbbl. There following aspects may explain this behavior:

- Interest earnings from the money allocated in escrow accounts are not taxed until project net cash flow becomes positive. Since option PCCA allocates more immediate capital than option LSCA, option PCCA allows higher interest earnings, reaching positive net cash flow before option LSCA.
- This model was not designed to take into consideration opportunity costs. A future project should include parameters such as cost of startup money and opportunity costs. Intuitively, it seems obvious that projects allowing the spreading of bond payments over a period of four years would provide better payoffs than projects requiring upfront bond payment.
- Closure costs were stipulated based on a percent of project's gross revenue. In projects larger than 60 MMbbl, high closure costs generate high bond requirements, and, at this point, interest revenues earned during the first four years under option PCCA cease to generate the customary NPV advantages obtained in smaller projects. For larger projects, the negative impact of substantial upfront cash disbursement surpasses the earlier advantageous scenario.

Figure 6.6 shows plots of sensitivity analysis of NPV values against closure costs for Fields A, B and C. Each graph demonstrates five different scenarios corresponding to one of the five instrument options (PCCA, LSCA, EIP, LOC, and, "Nobond", as a base case).

The most conspicuous impacts within this study can be found on Field A simulations. This is due to the size of the reservoir, only 9 MMbbl. Simulations under a "No Bond" scenario allow NPV values varying from 1.01 to 0.51 MMUS$. For option PCCA, NPV varies between 0.91 and – 4.77 MMUS$, and GT varies between 9.59 and 13.71 MMUS$. Option LSCA allows NPV varying between 0.90 and – 5.82 MMUS$, and GT between 9.58 and 11.07 MMUS$. Option LOC allows NPV varying between 0.92 and –1.25 MMUS$, and GT between 9.56 and 6.94 MMUS$. Option EIP allows NPV varying between 0.92 and –1.01 MMUS$, and GT between 9.56 and 7.31 MMUS$.

Instrument option EIP causes the lowest impact on NPV outputs, followed by option LOC. Here, NPV declines and approaches zero as closure cost increases toward MMUS$ 50. Option LSCA performs better than option PCCA. For these plots, NPV becomes negative when closure cost approaches MMUS$ 15. Field A becomes unfeasible at lower closure cost values when compared to the other field simulations. Once again, this is due to the size of the project, which is considered merely marginal.

For all instrument options in Field B simulations, NPV values do not reach zero until closure cost exceeds MMUS$ 100. In this case, option EIP allows the most favorable scenario, followed by option LOC. Curve slopes indicate that instrument options LSCA and PCCA significantly impact NPV outputs as closure cost increases.

Plots for Field C simulations indicate a slope inversion in options PCCA and LSCA, where option PCCA begins to perform better than option LSCA. This inversion occurs in projects involving reserves between 53 and 60 MMbbl. This behavior continues unaltered for all larger fields. The two main reasons for this shifting are:

- For options PCCA and LSCA, all interest earnings are annually withdrawn from the collateral accounts and handed over to the lessee. Tax rates upon interest earnings for these instrument options are the same. For smaller fields (less than 53 MMbbl) instrument option PCCA earns more interest revenues than option LSCA. Therefore, in medium (up to 60 MMbbl), smaller, and, primarily, marginal projects, interest earnings received during the project considerably enhance project cash flow performance. In addition, under this scenario, the upfront bond payment required by option PCCA seems not to impact significantly NPV performances.

- In fields larger than 60 MMbbl, upfront payment of costlier bond requirements becomes a substantial burden on cash flow of projects using instrument option PCCA. The impact remains considerable even taking into account interest earnings during the entire life of the project. Therefore, option LSCA performs a little better than option PCCA, especially in large projects where the possibility of spreading bond payments throughout a period of four years does become a key factor.

Instrument options EIP and LOC allow superior NPV performances in all projects, but especially on projects requiring higher closure costs. Small projects tend to be severely affected by bonding requirements, regardless instrument choice. Instrument options that require allocation of large amounts of cash at the startup inflict high opportunity costs. Regulators should recognize this condition offering flexibilities and alternative bonding instruments.

Regulators should also consider some form of tax incentive in order to extend the life of some small and marginal projects (SCHIOZER, 2002). Due to high operating costs, large companies may not have interest in some of these projects. However, small contractors may recover oil in the same projects at lower operating costs with attractive profit margins. Incentives may reduce direct government earnings, however small and marginal fields will have their lives extended, levering investments and improving competitiveness within the sector.

Figure 6.7 shows sensitivity analysis results under the government perspective (plots of GT against closure costs). For all field simulations, instrument options PCCA and LSCA show a pattern of linear growth for GT. Instrument options EIP and LOC present a trend of linear decline for GT as closure cost increases.

For Field A simulations, option LSCA draws attention to its steep GT increase as closure cost also increases. Option PCCA also displays GT improvement as closure cost increases, though with less intensity than observed in option LSCA.

When options EIP and LOC are compared against the base-case option "Nobond", both instruments show a declining trend as closure cost increases. This occurs because it is possible to deduct premium and fees from CIT. Obviously, the main objective of bond requirements is not enhancing government revenues, however, for comparison purposes, option LOC allows lower GT values.

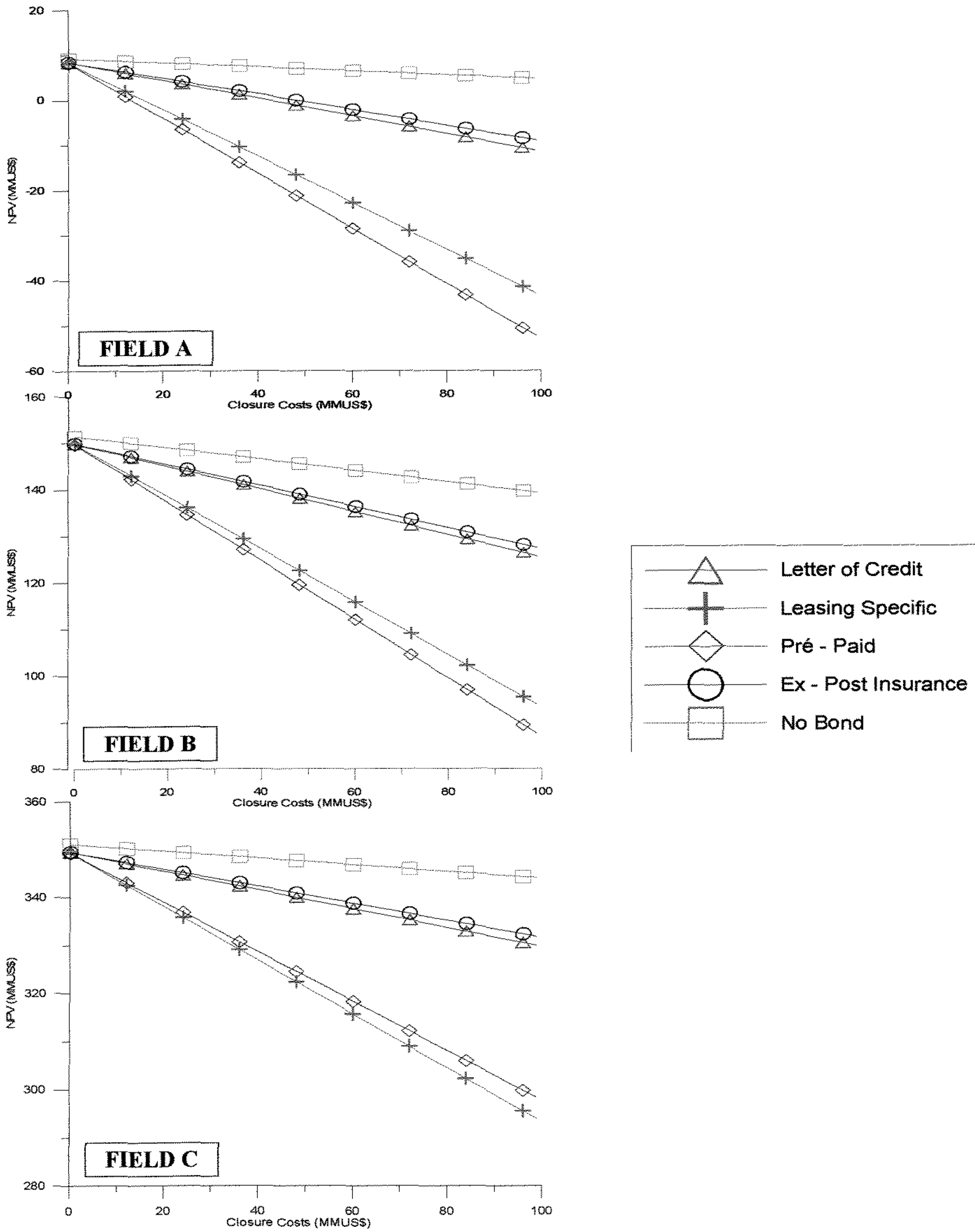

Figure 6.6. NPV vs. Closure Costs. Behavior of Net Present Values against closure costs. Sensitivity analysis from simulations in Fields A, B, and C.

Field B simulations show similar behavior. Because of taxable interest earnings over the entire life of the project, option PCCA accrue more GT than option LSCA. Option LSCA allows the spreading of bond payment during the first four years, accruing comparatively less GT.

Field C simulations involve much larger projects; consequently, instrument options PCCA and LSCA display a very similar behavior. The difference generated because of the spreading of bond payments becomes less significant in projects of such dimensions. As expected, options LSCA and PCCA allow significantly higher GT, and options EIP and LOC, for allowing the deduction of premiums and fees, result in lower GT.

Figure 6.7 indicates that under a "Nobond" regime, GT for the performed simulations do not vary even upon closure cost increases. Obviously, this observation is only valid for direct government earnings. Indirect government participations would involve items such as corporate income tax for third parties performing closure operations and income tax from workers involved in the process. This would lead to higher GT, as closure costs were to increase.

Some agencies do not accept insurance policy instruments. They claim insurance products merely transfer liability from lessees to insurance companies, not providing a factual performance guarantee. On the other hand, insurance companies tend to be very dynamic and creative, and new insurance products are often developed to satisfy more strict bonding rules. Letters of credit are under similar opposition from regulators. Some agencies argue that a LOC is only as good as the issuing institution. If the issuer becomes insolvent, the guarantee becomes void.

Sensitivity analyses were performed in order to verify whether oil price changes create a more favorable scenario for a specific bond instrument. Results confirm that there is a proportional and linear growth pattern for all field simulations involving all bond options. Changes in oil price may be of great importance for deciding project feasibility, but not for determining what is the most appropriate bond option.

6.6. CONCLUSIONS

The choice of bonding instrument is an important aspect of the decision making process and may determine the feasibility of small and marginal projects. Small projects usually imply limited profit margin that can be severely undermined by inapt decision-making.

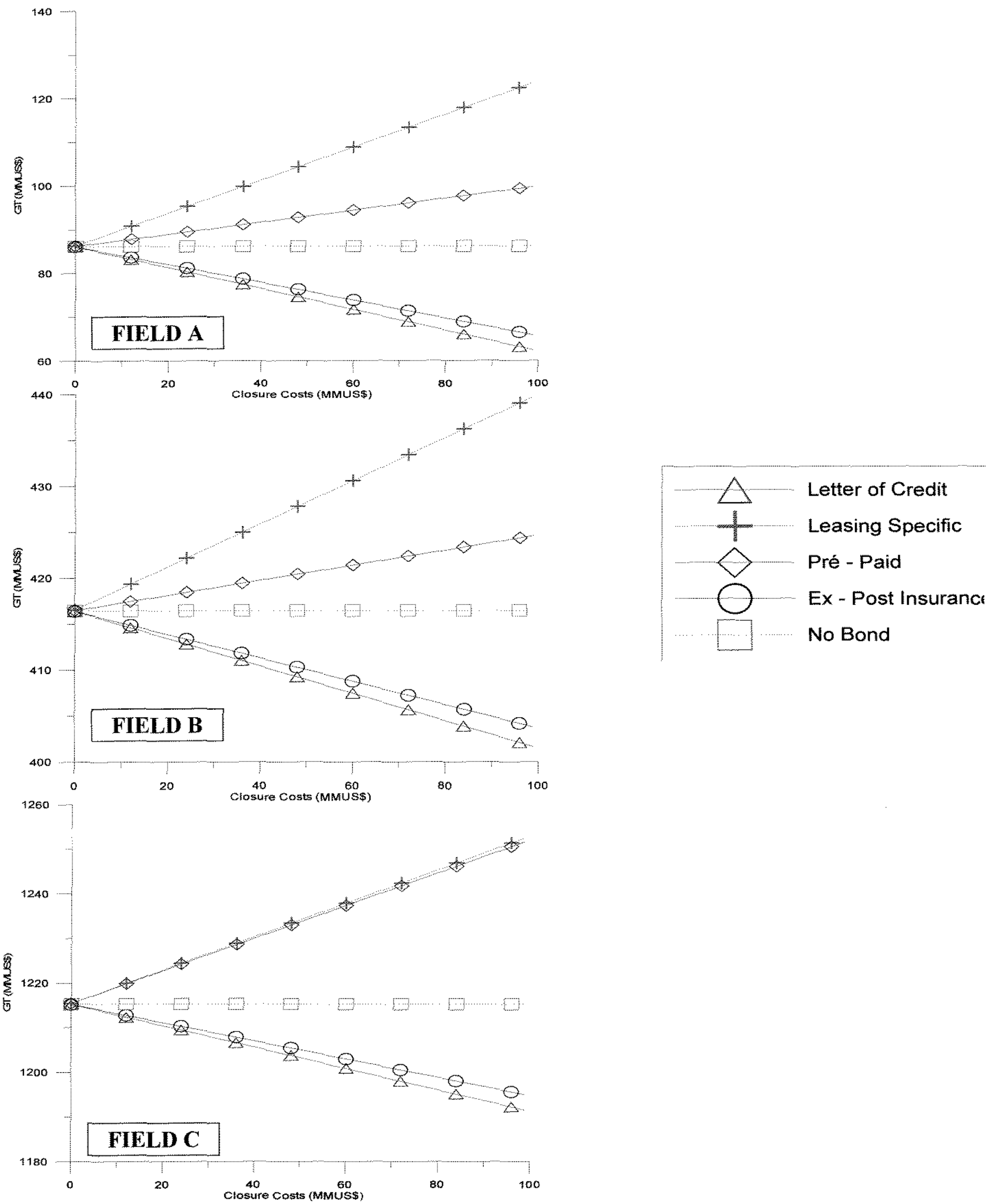

Figure 6.7. GT vs. Closure Costs. Behavior of governmental earnings against closure costs. Sensitivity analysis from simulations in Fields A, B, and C.

The Petrobond algorithm provides useful flexibility for estimating economic impacts of bonding instruments under government and industry perspectives. Option PCCA generates significant impacts on all project simulations. Evidently, cash disbursement in such a manner is not an efficient way to finance long-term closure operations with high costs.

For all simulations, option EIP offered better cash flow performances. Option LOC was rated second best in all field simulations. Nevertheless, all simulations were performed under the assumption that operating companies own top credit rating. This assumption permitted collaterals to be waived and allowed generous premium rates. Future research is needed in order to investigate the performance of LOC instruments under less favorable scenarios. The sensitivity of other components should also be further investigated in future studies.

All simulations involving options PCCA and LSCA show that GT increases along with closure costs, as NPV declines. Options PCCA and LSCA combine significant negative impacts: worse project profitability and higher government take. In order to make these collateral account instruments more competitive with options EIP and LOC, tax incentives would have to be provided. However, it is very unlike that any form of tax incentive would surpass the benefits offered by option EIP, for instance.

Even though much criticism is directed to ex-post insurance policy tools, such as option EIP, some insurance products may provide mechanisms to award lessees with good financial and environmental records; thus, a motivation for companies to pursue similar records.

Proportionally, taxes, levies, and other governmental participations can affect more severely small, marginal, and mature projects. Additional research should be conducted on the impacts of incentives and relief mechanisms on small, marginal, and mature oil fields. This future study would be an effort to extend the life of mature fields and, concomitantly, engineering a viable and sound bonding system for small and marginal fields.

Some indirect effects of bonding requirements may be very appealing. For instance, in order to reduce bond requirements, companies are motivated to find ways of demonstrating to authorities that closure costs can be less than previously estimated. For instance, intensification of investments on research can lead to technological innovations that may reduce closure costs, and, consequently, bond requirements.

The results obtained in this study are primarily useful for overall strategic evaluations. Results may also provide guidelines for determining other potential impacts caused by other

bonding instruments. Decision-makers may use this study to develop general strategies for projects under bonding regimes. Authorities may use the study to determine whether a current or proposed bonding regime provides the necessary protection without discouraging investments. Finally, the proposed model may help in the determination of the approximate financial burden caused by different bonding instruments on different petroleum projects.

II. REFEREED ARTICLE III – Resources Policy, published in 2001

TITLE: IDENTIFYING POTENTIAL IMPACTS OF BONDING INSTRUMENTS ON OFFSHORE OIL PROJECTS

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ABSTRACT

The present paper deals with the potential financial impacts of different bonding instruments on offshore oil projects. Three types of performance bond instruments (corporate surety, leasing-specific abandonment account, and cash) were tested and analyzed for three offshore oil-producing fields under a hypothetical bonding regime. Sensitivity analysis of "net present" and "government take" values indicates corporate surety bonds cause fewer impacts yielding significantly better payoffs. Several related issues are discussed considering government and industry perspectives.

Keywords: bonding policies; decommissioning; bond instrument options

6.7. INTRODUCTION

Due to increasingly stringent policy requirements and higher operating costs, offshore decommissioning has the potential to become one of the major issues facing the global petroleum industry in the near future. Several regulatory approaches can be adopted to guarantee that companies and operators will meet all decommissioning obligations, safeguarding government and taxpayers from noncompliance costs (environmental and financial liabilities). This study focuses specifically on the application of the bonding system, an incentive approach for environmental policy.

Most bonding regimes allow companies to use a variety of bonding instruments. Petroleum companies generally prefer surety bonds since, as this bonding arrangement typically allows significantly better payoffs to a company, as this paper will suggest. Additional options are provided mainly to give flexibility to companies that fail to qualify on the difficult surety bond underwriting process. Even though the superiority of surety bonds may be incontestable, impacts caused by different bonding instruments should be assessed and compared. This paper is a first step in addressing the impact of currently available bonding instruments.

The authors recognize there are other essential economic issues regarding the decommissioning of offshore installations that are not considered in the present study (e.g., optimum decommissioning startup, single or phased decommissioning approaches, technical decommissioning options, and technological innovations). This paper is divided into four sections. The first section briefly describes current decommissioning obligations in the offshore oil and gas industry. The second section offers a concise overview of existing regulatory approaches and a detailed explanation of actual bonding regimes and available instruments. The third section presents a financial evaluation model for three bond options. This model is based on a series of discounted cash flow and sensitivity analyses for three distinct offshore oil-producing fields. The final section discusses some of the regulatory issues involving the application of bonding mechanisms and its financial impact from both government and company perspectives.

6.8. OFFSHORE INDUSTRY AND DECOMMISSIONING

There is no agreement on an exact figure, but it is safe to say that there are over 7,270 offshore oil and gas installations in place around the world today. These installations are distributed over more than 53 countries worldwide (PANE and HENDARJO, 1998; ODCP, 1998; POREMSKI, 1998; GRIFFIN, 1998a; PROGNOS, 1997). Offshore installations are usually planned for 20-year projects, but most platforms can have a functional life ranging from 30 to 40 years. At the end of this period, as recoverable reserves are depleted, unless platforms are reused or relocated, they must be decommissioned. This process involves several stages including closing, plugging and abandoning wells and pipelines; cleaning and making facilities and structural components safe; removing some or all of units and facilities; disposing, reusing or recycling them; clearing sites; and providing monitoring and surveillance where required (FERREIRA and SUSLICK, 2000).

Many aging offshore fields around the world are near the end of their productive lives, and many others have already economically depleted their resources. Consequently, between now and 2025 it should be expected that over 6,500 installations will be decommissioned at an estimated cost of US$ 20-40 billion (COLEMAN, 1998). During the past five years there has been exhaustive discussion in the literature concerning decommissioning costs (UKOOA, 1995; ROBINSON and IRELAND, 1995; ARNEY, 1996; GRIFFIN, 1996, 1998a; DELLA, 1997; TWACHTMAN, 1997; PROGNOS, 1997; MMS 1997b, 1999a; WATSON, 1998; PRASTHOFER, 1998; PHILLIPS, 2000). Due to great uncertainties regarding regulatory trends and acquired experience on the decommissioning of large platforms, cost estimates tend to vary significantly. Nevertheless, decommissioning costs may represent up to 10% of the total investment of an offshore project (BORGHINI *et al.,* 1998).

6.9. THE BONDING SYSTEM

The main approaches to environmental policies are Command and Control (direct regulation) and Economic Incentives Mechanisms (market alternatives). Both Command and Control (CAC) and Economic Incentive Mechanisms (EIM) have been exhaustively discussed in the literature, including their characteristics, applications, and efficiencies (BOHM, 1981; STOLLERY, 1985; WEBBER and WEBBER, 1985; CONRAD, 1987; BAUMOL and OATES, 1988; PERRINGS, 1989; COSTANZA and PERRINGS, 1990; CORNWELL, 1997).

CORNWELL and COSTANZA (1994) compare CAC and EIM approaches, and some aspects are here adapted to the offshore oil sector: The CAC approach consists of establishing and enforcing laws and regulations, and of setting objectives, standards and technologies with which agents must comply. The EIM approach involves providing economic incentives to encourage desired behavior; it encourages the distribution of responsibilities among all stakeholders, decentralizing the decision-making process to protect lease areas; and it relieson performance objectives rather than on a pre-established course of action. Economic analysis indicates that present methods of environmental protection, mostly based on CAC strategies, are inefficient and often provide disincentives for directing resources toward abatement. The main causes are: (1) great uncertainties in calculating end-of-leasing costs; (2) costly and lengthy litigious processes; (3) homogeneous treatment of companies and operators (no record-based assessment); (4) great information burden on the regulatory agency (selecting the best technology and enforcing penalties for noncompliance); (5) little incentive for development of innovations that can result in improvements and cost reductions; (6) incentives for regulatory evasion rather than regulatory compliance; and (7) vague regulatory language allowing companies to build persuasive cases by showing that requirements are unachievable.

The bonding system, also know as financial assurance system, is one of the EIMs presently being applied in the oil sector. In a broader sense, bonds are financial instruments used to provide legal guarantee of indemnity in case contracting parties fail to meet contractual obligations. In the offshore sector, bonds indemnify authorities against failure to comply with lease contractual obligations. They safeguard agencies against technical and financial failure, premature or unplanned decommissioning, and contingencies. The bonding system shifts the financial risk from the potential victims (regulatory agency and taxpayers) to the oil companies or operators by internalizing potential costs. In case of default, funds necessary to complete all decommissioning obligations would be promptly available, avoiding complicated legal processes.

Essentially, bonds are accessories to proposed contracts and they may be used several times within a single contract. There are two major bond categories: (1) financial bond, a bond that guarantees the payment of a specific amount determined by the bond in case a contractual obligation is not met; and (2) performance bond, a bond that guarantees the total completion cost of a contractual obligation (JOHNSON, 1986; ROWE, 1987; CORNWELL, 1997; MILLER, 2000). Bonding instruments come in several forms with unique attributes and requirements: some are the pledged assets of a company (cash, securities, real estate, escrow accounts, etc.); others represent a guarantee for a company's performance or fulfillment of obligations (surety bonds); still others are securities issued by bonding or insurance companies, banks or other financial institutions; and some are instruments that indicate the deposit of cash (certificates of deposit) or the existence of a line of credit (letters of credit) (BRYAN, 1998).

The bonding system used by the United States Minerals Management Service (MMS) for the Gulf of Mexico is briefly described below as an example of a bonding regime currently in place for the offshore sector (information based on the MMS - NTL 98-18N, 1998):

Companies acquiring oil and gas leases from the U.S. MMS post a preliminary financial bond (general bond) guaranteeing financial aspects of the lease contract (regular payments of rents and royalties, civil penalties, fines, etc.). A company holding more than one lease may opt for an areawide bond (blanket bond). In this case, a single areawide bond may cover multiple leases. A lease may be subdivided into several aliquots. Companies wishing to explore, develop projects, and produce hydrocarbon resources within a specific aliquot are required to post a bond in advance (supplemental bond). This supplemental bond is equal to the best-cost estimate for completing operations under the established lease contract. Therefore, before a company is granted licenses or permits to drill, deepen, or alter wells, install platforms, or perform modifications on existing installations, a supplemental performance bond must be posted to cover all plugging and abandonment, decommissioning, and site clearance obligations. Either the leaseholder or the designated operator may place the supplemental bond. Multiple supplemental bonds may be found within a lease, but a single supplemental bond cannot be used to cover multiple operations. At present in the Gulf of Mexico there are 390 active leases and 154 designated operators holding supplemental bonds (WILLIAMS, 2000). Decommissioning of pipelines is covered by a different bond regulation[40] (Pipeline Rights-of-Way).

General bonds must be maintained until the lease has been terminated or transferred. Supplemental bonds must be maintained in effect and in good standing for the duration of the project and until decommissioning obligations are met[41] (or until a new party assumes operations). If decommissioning activities are being conducted concomitantly during the life of the project (phased approach), and if such activities are satisfactorily completed, authorities may authorize proportional releases of the bond.

A bond may be subject to forfeiture for different reasons: (1) if a well or installation has been abandoned or temporarily closed without initiating procedures; (2) if an operator fails to meet decommissioning obligations in accordance with approved plan; or (3) if a company fails to maintain the amount bonded.

[40] A general bond must be posted before a pipeline is put in place (MMS - NTL 98-18N,1998).
[41] Some restrictions apply.

Other countries have adopted, or are in the process of adopting, bonding mechanisms. The UK government requires companies to provide security equal to at least 100% of the expected decommissioning costs of all installations and pipelines of proposed projects (DTI, 2000a). The Brazilian Petroleum Agency (ANP) is in the process of offering bids for its first marginal fields. The Agency is studying the possibility of establishing some form of bonding regime (BRAZIL ENERGY, 1999).

6.10. FINANCIAL EVALUATION OF BONDING OPTIONS FOR THREE PRODUCING OIL FIELDS

The objective in this section is to determine the effect of bonding regulations on offshore project value. Three different bond instruments are used to determine the sensitivity of the variable denominated "bond option". The study shows three offshore oil-producing projects (Fields A, B, and C) in the Brazilian Outer Continental Shelf (OCS) with recovery reserves ranging from 50 to 500 MMboe (million of barrels of oil equivalent). All three projects are carried out under a hypothetical bonding regime. Each scenario involves some convergence factor; in this case, it is the bond option. Each field project is tested for all possible scenarios providing cash flow simulations for all bond options. Each bond option yields different impacts on project profitability, which are based on a discount cash flow analysis. This process identifies the least impacted project.

The available options are indicated in **Figure 6.8** and can be summarized as follow: (1) Cash Bond: the company is required to fund an escrow account in advance (before production starts); (2) LSAA Bond: the company is required to completely fund a leasing-specific abandonment escrow account within four years or by the beginning of the year in which the agency projects that the company will have cumulatively produced 80 percent of the originally recoverable reserves, whichever is earlier; and (3) Surety Bond: the company is required to obtain a corporate surety bond which must cover the entire life of the project. Two additional scenarios (benchmark scenarios) are provided as means of comparison: a "No Bond" scenario where decommissioning requirements are enforced, but no financial assurance is required; and a "No Decommissioning" scenario where no end-of-leasing obligations or bonds are required. The company ceases production and leaves when the field is economically exhausted.

All options are evaluated on the basis of two economic criteria: the weighted Net Present Value (NPV) per barrel discounted at 15%, and the total Government Take (GT) during the entire life of the project. The following approaches are used to consider the results obtained in the simulations: (1) the company's perspective: the preferable choice should have the highest payoff (NPV); and (2) the government's perspective: the preferable choice should consider a reasonable pattern of government earnings (GT) to maintain the regulatory role.

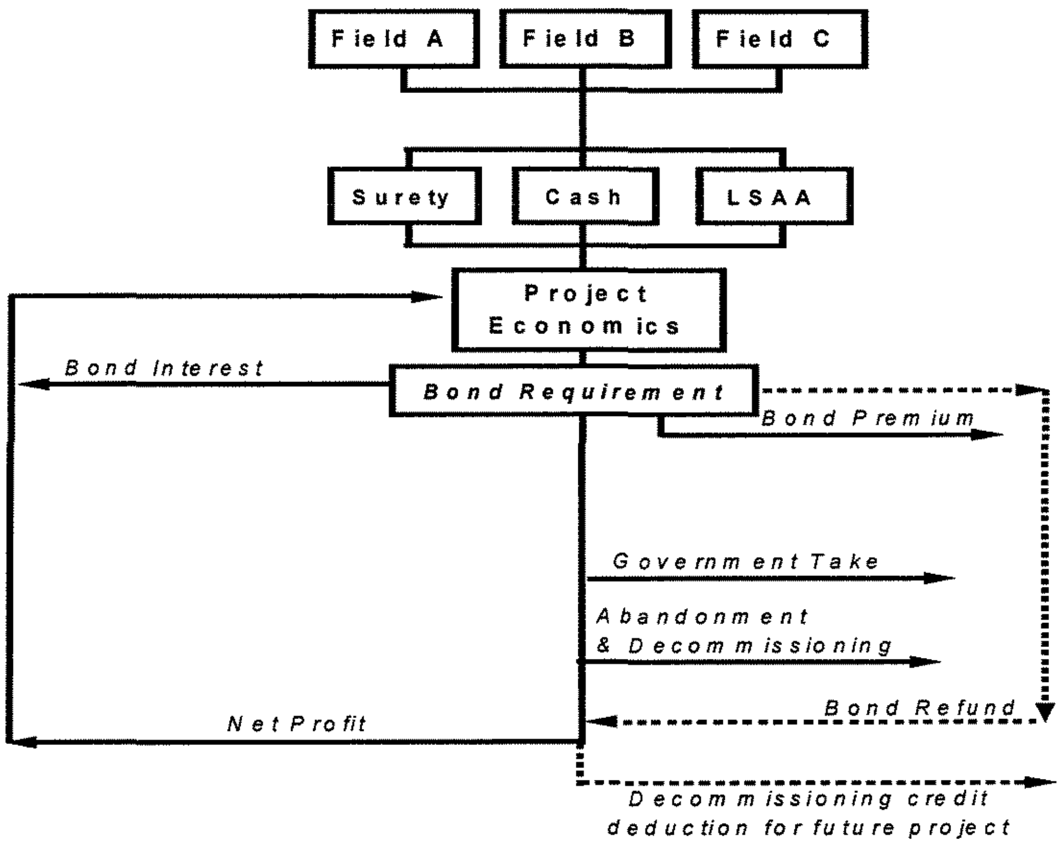

Figure 6.8. Hypothetical bond system. ***Note:*** Scheme showing three fields (A, B and C) and the three bond options available (surety, cash and LSAA). Surety bonds pay premiums, and cash and LSAA earn interest. Bond refund is available for cash and LSAA instruments after decommissioning obligations are satisfactorily met.

Some assumptions and simplifications are used to allow a better differentiation of economic outcomes and a better way of comparing project profitability for each bond option. The main assumptions are: (1) for all project simulations, "end-of-project" coincides with the "end-of-production"; (2) the base-case cost for platform decommissioning is \$15.0 million (including costs to remove and dispose of all platforms within the field); (3) even after complying with all bonding requirements, oil companies still must disburse out-of-pocket funds to pay for

decommissioning operations at the end of the project[42]; (4) bonds are released when decommissioning operations have been satisfactorily completed (in the case of cash and LSAA options, bonds are released and refunded); and (5) production starts at the first year for all projects (since some tax categories depend on parameters such as production, this assumption does affect government earnings).

Under the present hypothetical regime, before a lease is granted operations must be bonded in the following manner (**Figure 6.9**): (1) before exploration is permitted a General Bond of $500,000 is required; (2) when the company applies for the development license, the regulatory agency requires a detailed operation plan for development, production and decommissioning activities, and sets a supplemental bond. The base-case used for all simulations assumes that the cost for meeting all decommissioning obligations is equal to $15 million. The Supplemental Bond is equal to decommissioning costs plus 15%, which covers third party profit and overhead costs in case of forfeit (**Table 6.4**). Decommissioning costs are changed from $0 to $150 million for each project to assess the financial impact of each bond option.

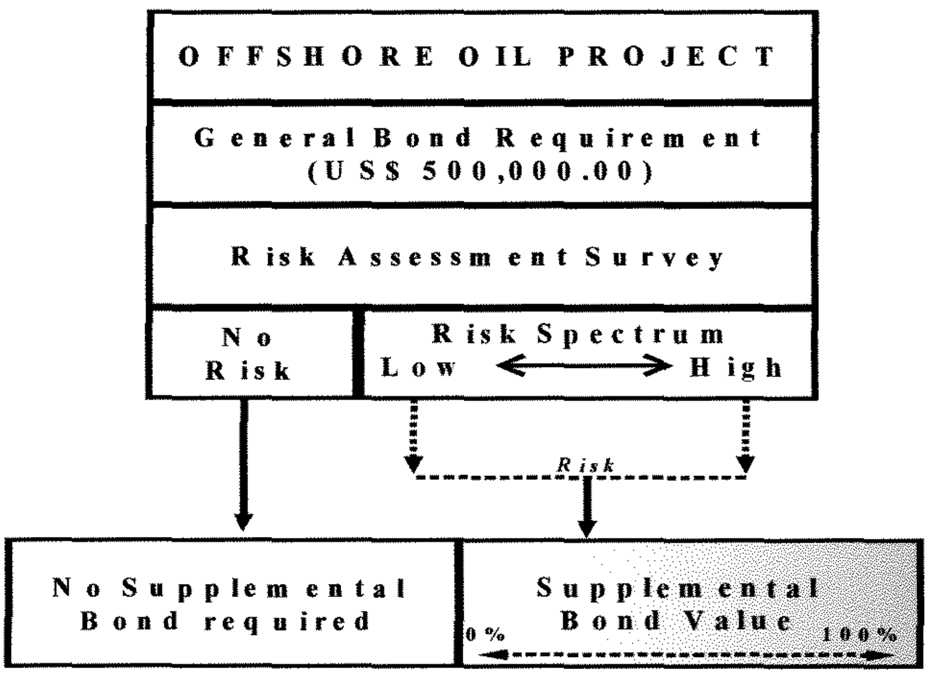

Figure 6.9. Scheme showing the path for the establishment of the bond value (AEP, 1998a - MODIFIED).

[42] Note that the bond was posted only as a financial guarantee, but the company still must pay for decommissioning operations.

The hypothetical fiscal regime used for the simulations is based on the current Brazilian legislation, where the authors have firsthand experience. No capital expenditure is allowable against corporate taxes; consequently, no bond disbursements can be deducted. Annual surety premiums and fees are deductible since they are considered to be valid business expenses. The rules for premium deductions vary significantly. Under this hypothetical fiscal regime, a rate of 40% of the total annual premium amount is allowed against corporate taxes. Decommissioning costs can be treated as typical operation costs. In this case, however, decommissioning-related expenditures take place during non-revenue years, and under such circumstances expenditures cannot be deducted from corporate taxes. Companies may use the allowable deduction (under the hypothetical scenario, 50% of decommissioning costs) as credit for future oil-producing projects. For the present study, such deductions are not incorporated in the cash flows. **Table 6.4** indicates the main base-case parameters.

TABLE 6.4. PROJECT INFORMATION SUMMARY

	Field-Specific Parameters			
	Field A	**Field B**	**Field C**	
Depth (meters)	1000	1000	1000	
Project Life (years)	312	16	19	
Recovered Oil Reserves (million bbl)	53.6	148.9	494.2	
Total Operational Costs (million US$)	348.8	995.3	2662.3	
Total Investments (million US$)	248.7	377.4	1666.5	
	Basic Parameters			
Flat Oil Price (US$/bbl)	20.00			
Decommissioning Costs (million US$)	15.00			
General Bond (million US$)	0.50			
Supplemental Bond (million US$)	17.25			
Total Bond Required (million US$)	17.75			
Deductible Rate for Surety Premiums	40%			
Deductible Rate for Decomm. Costs[1]	50%			
	Bond Annual Rates			
	Interest Earned	**Taxable Rate (Interest earned)**	**Premium Rate**	**Deductible Rate (Premium paid)**
Cash Bond	5.50%	100%	----	----
LSAA Bond	5.50%	100%	----	----
Surety Bond	----	----	1.25%	40%

[1] *Deduction amount can be credited to another project.*

Government take (GT) is affected by variations in decommissioning costs (DC) according to the application of different bond options. Changes in DC first affect supplemental bond values (SPB) and then net revenue values (NR). Net revenue values directly affect GT values. For this reason, NPV values are affected differently depending on the bond option adopted and according to the changes in DC. Government Take includes the following taxes: Royalties (ROY) (10% of gross revenue); corporate taxes (CT) (33% of net revenue); and special government participation (SSP) when production exceeds 50,000 bbls/day. In the case of projects adopting cash or LSAA bond options, Interest Earnings (BIE) from escrow accounts are taxed as ordinary revenue. Government participation in the project is approximately 58%, not including bond-related expenditures.

Figure 6.10 is a representation of the main costs and taxes applicable to the simulation model.

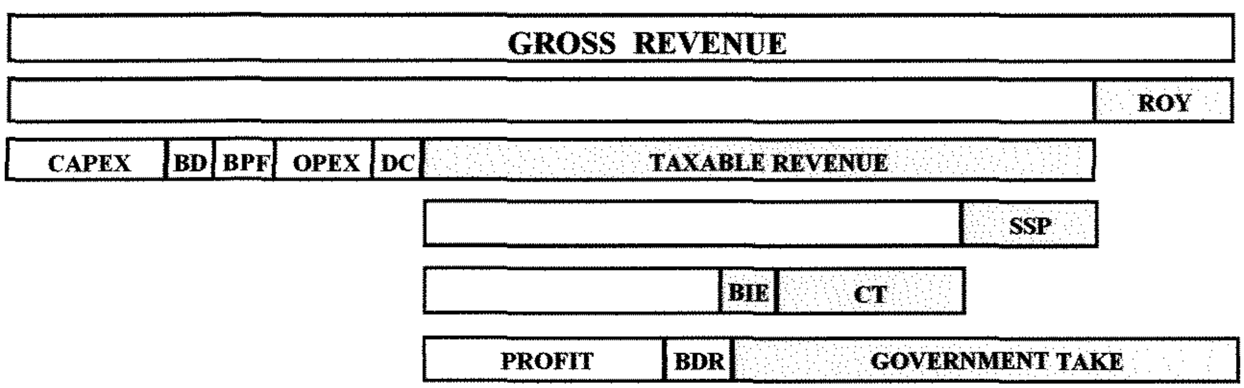

Figure 6.10. Graphic Representation of costs and taxes using the project simulation model.

Note: Capex = Capital Expenditure (includes a straight line depreciation of all equipment and units over a ten-year period); BD = Bond value (*surety* - amount is zero, either *cash* or *LSAA* - amount will be reimbursed at the end of the project); BFP = Bond Fees and Premiums (applicable only for *surety*); Opex = Operating Costs; DC = Decommissioning Costs. Roy = Royalties (10%); SSP = Special Government Participation (only applicable when production exceeds 50,000 bbl/day); BIE = Bond Interest Earnings (applicable only to *cash* and I bonds); CT = Corporate Tax (33%, it includes other government participation); BDR = Bond Return (applicable only to *cash* and *LSAA* bonds). This scheme is for general visualization and does not indicate the correct proportions.

Three bond option scenarios are tested in the financial model. Each bond option is described below:

- *Surety Bond Option:* A surety company writes a bond guaranteeing that a specific oil company wil perform all required decommissioning operations; otherwise, the surety company will pay the regulatory agency the amount bonded. In case of default, the agency

will request an independent contractor to perform the operations. In some respects, surety bonds are analogous to insurance policies in that companies pay annual premiums and fees to keep bonds in place. Each surety company follows its own financial criteria to judge an oil company and fix premium rates: net worth level, credit rating, decommissioning experience, etc. Premiums are based on a percentage of the bond amount. For the simulations where surety bonds are adopted, premiums of $12.50 per $1,000 per year (1.25%) are applied. Premiums and fees are allowable against tax (deduction rate of 40%). The total amount to be bonded is $17.75 million (DC plus 15% for third party profit and overhead costs) (**Table 6.4**). The annual premium for this bond amount is $221,875.

- *Cash Collateral Bond Option:* Cash is placed in a federal insured bank account under an escrow agreement between the oil company, the bank, and the regulatory agency. The escrow agreement specifies that the agency has full control over the account until the bond is released (after obligations are met). Escrow accounts pay annual interest (5.50%) which is available to oil companies as it is earned. The annual interest for the established bond amount is $976,250. Since interest is withdrawn annually, there is no accumulation of funds in the escrow account. Consequently, interest earnings remain the same throughout the entire life of the project. Companies cannot use the deposited collateral cash to fund decommissioning activities. After the successful conclusion of all decommissioning-related operations, the bond is released and the deposited amount is refunded. In case of default, funds are used by the agency to contract an independent operator to complete all necessary decommissioning obligations.
- *Leasing-Specific Abandonment Account Option (LSAA Bond):* For this trust agreement the oil company must fully fund a lease-specific abandonment account within four years or by the beginning of the year in which the agency projects the company will have cumulatively produced 80% of the originally recoverable reserves, whichever is earlier. The initial payment into the LSAA equals 50% of the required bond. **Table 6.5** demonstrates the time schedule for incremental payments of a LSAA bond (this example describes the situation on Field A). The LSAA must be funded with $17.25 million (total supplemental bond amount) and the initial payment is 50% of the required supplemental bond ($8.63 million). By the end of year 4, even if the company does not produce 80% of the recoverable hydrocarbons originally in place, the account must be funded with the full supplemental bond amount.

Interest earned is annually transferred to the oil company. After the conclusion of all decommissioning operations, the bond is released and the deposited amount is refunded. In case of default, funds are used to complete the necessary decommissioning obligations.

TABLE 6.5. MODEL FOR LSAA BOND ANNUAL PAYMENTS

Year	Potential Recoverable Reserves[1] (%)	Actual Recoverable Reserves (%)	$ Required at start of year (US$ million)	Annual Payments (US$ million)
1	20.00	10.28	8.63	2.16
2	40.00	34.95	10.78	2.16
3	60.00	52.78	12.94	2.16
4	80.00	64.97	15.09	2.16
			Total	17.25

[1] Percent of recoverable hydrocarbons produced at the end of year as a % of recoverable hydrocarbons originally in place.

As mentioned before, for benchmark comparison purposes, all project simulations include two additional scenarios: (1) "No Bond" and (2) "No Decommissioning". In the "No Bond" scenario the company is not expected to provide any anticipated funds to guarantee that decommissioning obligations will be met. At the end of the project, during the first non-producing year, the company must pay for all decommissioning operations. The "No Decommissioning" scenario is used to demonstrate the financial performance of a project where no decommissioning or bonding is required. At the end of the project, the company walks away without performing any decommissioning-related operation.

6.11. RESULTS

Effects on NPV values from Field A simulations are more significant than in larger projects (Field B and C). In Field A, when the cash bond option is used, as decommissioning costs increase beyond $90 million, NPV values become negative (**Table 6.6**).

Regardless the size of the field, LSAA bonds yield less significant impacts than cash bonds. For simulations on Fields B and C, although maintaining a declining trend, NPV values remain positive under decommissioning cost variations (from 0 to $150 million).

Surety bonds are the best option in all simulations, in that they yield higher NPV values. Surety bonds are appealing tools mainly because they do not require upfront cash disbursement. Eliminating upfront costs is a good strategy for improving project performance. In addition, annual surety premiums and fees are allowable against corporate taxes. The level of deductibility allowed is debatable and may vary from regime to regime. The deduction rate allowed during simulations was 40%. In some cases, due to surety-related deductions, government earnings (GT) decrease as decommissioning costs increased (**Table 6.6**).

TABLE 6.6. SENSITIVITY ANALYSIS FOR FIELDS A, B AND C, AND BOND OPTIONS

FIELD A						
DECOM	**CASH**		**LSAA**		**SURETY**	
(MMUS$)	**NPV**	**GT**	**NPV**	**GT**	**NPV**	**GT**
150	-0.80	5.12	-0.60	5.07	0.82	4.62
100	-0.07	4.94	0.06	4.91	1.01	4.63
75	0.30	4.85	0.40	4.83	1.10	4.63
50	0.66	4.78	0.73	4.77	1.20	4.64
25	1.02	4.71	1.05	4.71	1.29	4.64
10	1.24	4.67	1.25	4.67	1.35	4.65
0	1.38	4.65	1.38	4.65	1.38	4.65
FIELD B						
DECOM	**CASH**		**LSAA**		**SURETY**	
(MMUS$)	**NPV**	**GT**	**NPV**	**GT**	**NPV**	**GT**
150	1.72	5.60	1.79	5.59	2.39	5.25
100	1.98	5.49	2.03	5.48	2.43	5.26
75	2.12	5.44	2.15	5.43	2.45	5.27
50	2.25	5.39	2.27	5.38	2.47	5.27
25	2.38	5.33	2.39	5.33	2.49	5.28
10	2.46	5.30	2.46	5.30	2.51	5.28
0	2.51	5.28	2.51	5.28	2.51	5.28
FIELD C						
DECOM	**CASH**		**LSAA**		**SURETY**	
(MMUS$)	**NPV**	**GT**	**NPV**	**GT**	**NPV**	**GT**
150	1.26	6.74	1.28	6.73	1.47	6.60
100	1.34	6.70	1.35	6.69	1.48	6.61
75	1.38	6.68	1.39	6.67	1.48	6.61
50	1.42	6.66	1.43	6.65	1.49	6.61
25	1.46	6.64	1.46	6.63	1.49	6.61
10	1.48	6.62	1.48	6.62	1.50	6.61
0	1.50	6.62	1.50	6.62	1.50	6.61

Note: The increasing cash and LSAA values, despite reduction in NPV values, are caused by the taxation of bond interest earned by such bond instruments. All values expressed in US$/boe

For simulations using cash bonds, GT values increase as decommissioning costs rise and NPV falls. The reason for this is that as DC increases, bond values also increase, providing higher taxable interest earnings on escrow accounts.

LSAA is the second preferable bond option. The main difference between cash and LSAA bonds is that cash bonds require immediate cash disbursement. On the other hand, LSAA accounts can be funded in four years. For better comparison, interest rates for cash and LSAA bonds are the same.

Considering all three bonding options, the cash bond option is least preferable. It impacts projects negatively despite interest earned from escrow accounts. Cash disbursement in such a manner is not an efficient way to finance long-term offshore operations with high decommissioning costs. The same is true for LSAA bonds, but impacts are attenuated by time-allowance. The combination of "significant negative impacts on project profitability" and "high government earnings" may provide a disincentive for investment flow within the offshore industry. To make Cash and LSAA bonds more competitive with surety bonds, some tax incentives would have to be provided. It seems though, it would be very unlikely that any form of tax incentive would provide benefits comparable to the ones offered by surety bonds. Surety bonds are a form of award for companies with good financial and environmental records, and an incentive for new companies to pursue similar records.

Sensitivity analyses were performed in order to verify whether oil price changes create a more favorable scenario for a specific bond instrument. The analyses verify that there is a proportional and linear growth pattern for all fields and bond options. Changes in oil price may be of great importance for deciding project feasibility, but not for deciding what is the most appropriate bond option.

Table 6.7 presents an overall qualitative evaluation of the bond-option simulations. Further studies are also needed to better assess cash flow financial performance under different fiscal regimes. The results obtained in this study are primarily useful for overall strategic evaluations. Results may also provide guidelines for determining other potential impacts caused by bonding instruments. Decision-makers may use this study to develop general strategies for projects under bonding regimes. Authorities may use the study to determine whether a current or proposed bonding regime will provide protection without discouraging investments. Finally, the proposed methodology may be used to determine the financial burden to be carried by the main stakeholders (industry and government).

6.12. REGULATORY ISSUES AND BONDING SYSTEMS

Government officials provided the following answers when asked about the motivations for establishing a bonding regime: (1) the government is very interested in achieving appropriate decommissioning and addressing all environmental and safety issues; (2) there is no interest in raising revenues through bonding mechanisms; (3) there is no interest in keeping bonds longer than contractually established; and (4) the government is very interested in safeguarding taxpayers from future liabilities[43].

TABLE 6.7. QUALITATIVE EVALUATION OF BONDS USING THE SIMULATION MODEL

	Regulator's Perspective			Industry's Perspective	
	Level of Security for the Agency	**Cost of Regulatory Compliance**	**Impact on GT Values[1]**	**Impact on NPV Values**	**Level of Difficulty for Instrument Acquisition**
Surety	*****	*	*[2]	*	*****
Cash	*****	***	***	*****	*
LSAA	***	**	**	****	**

NPV = Net Present Value; GT = Government Take.
***** = High; **** = High-Moderate; *** = Moderate; ** = Moderate-Low; * = Low
(1) From Government's perspective; (2) Depends on allowable deductible rate (40% was assumed in the model).

In the oil sector, the main motivation is the concern over small parties acquiring small or marginal production areas from larger companies (MMS, 2000a, 2000e; WILLIAMS, 2000; DTI, 2000b; ANP, 2000b). Without a financial assurance mechanism, large companies could open small spurious companies to evade decommissioning liabilities.

Setting the appropriate bond requirement (amount) may be one of the greatest predicaments within a bonding system. If bonds are set too low, the system may not provide the desired incentive effect. On the other hand, setting bonds too high may discourage investments in the sector. If authorities are primarily concerned with protecting environmental resources, then all externalities must be addressed. If that is the case, the required bond must be high enough to discourage projects involving great environmental risk and uncertainties.

Assessing the monetary value of potential environmental damages may be a problem. It is not always possible to calculate the total monetary value of complex non-market goods such as ecosystem functions and services, though many methodologies currently exist to calculate partial values (COSTANZA, *et al.*, 1997). In the past, due to inadequate bonding estimation, many

[43] This question was addressed to bonding experts from the US Office of Surface Mining - OSM, US Bureau of Land Management - BLM, US Minerals Management Services - MMS, the UK Department of Trade Industry - DTI, and the Brazilian National Petroleum Agency – ANP (between 1999-2001).

problems arose when mining companies became insolvent and the bond in place was not sufficient to cover closure and rehabilitation costs (ALBERSWERTH, 1991).

To avoid liquidity constraints, most companies are encouraged to obtain surety bonds. As mentioned before, these instruments do not require allocation of funds, only annual premiums and fees. However, most small and newly formed companies may encounter some difficulty in going through surety underwriting processes. For this reason, bonding instruments may appear to work as market-restricting agents. As a remedy, most regimes offer alternative instruments. The MMS currently offers two additional options as guarantee: (1) a trust agreement: a Leasing-Specific Abandonment Account (LSAA); and (2) US Treasury Notes. Usually, small companies keep one of these two alternatives during approximately two years until they qualify for the surety bond underwriting process (MMS, 2000b). The UK government accepts cash, irrevocable standby Letters of Credit, on-demand performance bonds, etc. (DTI, 2000a). Although a pool bond alternative is accepted in other bonding systems, such an arrangement is not offered by the U.S. MMS. The MMS argues that it is difficult to measure the potential risks of all companies in a consortium, and consortiums tend to primarily benefit irresponsible parties. At present, for Gulf operations the MMS holds approximately $900 million in surety bonds, $30 million in Treasury Notes, and $10 million in trust agreements (LSAAs) (WILLIAMS, 2000).

Bonds may also appear to benefit large companies since requirements may be waived if certain financial requirements are met (net worth[44], assets, and projected revenue from other fields and activities). The main concept is: low financial risk equals lower bonds. This waiving process is sometimes referred to as financial capability or self-bonding. In the Gulf of Mexico around 80% of the potential bonded operations are waived through such mechanisms (WILLIAMS, 2000).

Costs to make some environmental policies work (monitoring and enforcement) may become a great financial burden for agencies. Bonding mechanisms have been successful in allowing lower regulatory compliance costs (MMS, 2000b). For instance, some monitoring activities that could provide additional financial burden to the MMS are transferred to other parties: (1) surety companies, which provide financial assessments for applicant companies

[44] Some restrictions apply: plugging and abandonment costs cannot exceed 20% of a company's net worth.

(underwriting process), and closely monitor the financial health of their clients; and (2) the U.S. Treasury Department, which monitors surety companies.

Another predicament within bonding regimes is tax treatment. In some countries, the issue of charging taxpayers for decommissioning operations of private oil companies is being severely questioned (PROGNOS, 1997). However, most regimes do provide a legal basis for dividing the costs of meeting end-of-leasing obligations between the public and the industry. For most tax regimes, decommissioning obligations are ordinary and necessary expenses. In general, decommissioning expenditures are tax-deductible only when services have been performed and payments have been made. The same rule applies when progressive decommissioning (the phased approach) is adopted. Under some regimes, deductions are not allowed for decommissioning activities carried out during non-income years (when production has ceased). In this case, companies are allowed to carry a "credit" towards a future project, as is the case in the current Brazilian fiscal regime (ANP, 2000b).

Tax deduction rates vary significantly from country to country. Deduction rates for decommissioning expenditures in the UK range from 50% to 70% (PROGNOS, 1997). In Norway, the government undertakes a great percentage of platform removal and disposal costs. Companies cannot deduct such expenses in their corporate income tax[45] (it does not include other end-of-leasing activities such as well plugging and abandonment, site clearance, etc.). Therefore, platform removal and disposal costs are not subjected to ordinary tax handling; they are kept outside the Norwegian tax system. All other end-of-leasing costs are deductible as ordinary operation costs (NPD, 1993 and NPD, 1999).

Under most financial assurance regimes, there is no deduction available for companies depositing funds into escrow accounts (pledged to the government) until the company loses ownership of funds. However, if a company pays fees or premiums to keep surety bonds or environmental insurance policies, expenditures would be amortized over the time period covered by the bond. The basic rule is that only an ordinary and necessary business expense is deductible; capital expenditure is not. Being contractually liable for decommissioning operations and emitting bonds (in anticipation) to guarantee such operations, does not entitle companies to deduct cost of services before they are actually performed.

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[45] Government covers removal and disposal costs depending on corporate tax rates being paid at the time of decommissioning.

6.13. CONCLUSIONS

The application of bonding policies in the oil sector faces several obstacles. There are different competing interests from several stakeholders, including oil companies, governments, environmental interest groups, and other users of the sea. For this reason, solutions should share the support of all stakeholders.

Simulations performed in this study indicate that further research on bonding instruments is still needed to identify impacts, measure sensitivity of components, and improve the NPV performance of offshore oil projects under bond regimes. Special attention should be given to fiscal planning.

This study concludes that the most favorable bonding instrument under the given circumstances is the surety bond. Surety bonds significantly attenuate impacts on such projects; however, applicant companies must provide good financial and regulatory compliance records. Bonding policies affect government earnings more significantly in small projects; therefore, additional research should be conducted focusing on small and marginal fields.

The impact on GT values is usually slightly negative with the application of corporate surety bonds. For cash bond simulations in medium and large fields, GT values remain mostly unchanged, indicating only minor reductions over significant decommissioning cost variations (0 to $150 million).

Under the bonding system, a company concerned with its image and corporate record is motivated to comply with all decommissioning obligations (good records allow lower bonds and premiums). In addition, to reduce effects on project profitability, companies are motivated to find ways of demonstrating to authorities that decommissioning costs can be less than previously estimated. For instance, investment in research may lead to technological innovations that may reduce decommissioning costs and bond requirements.

CHAPTER VII – CONCLUSIONS

According to the information provided on **Chapter II and III,** the following answers can be given to the questions asked in the introductory parts:

Question 1: *How to guarantee that oil and gas leasing areas will be returned in similar preexisting environmental conditions?*

Answer 1: *The establishment of comprehensive ex-post requirements, which must include well plugging and abandonment, decommissioning of offshore installations, and clearing the area of all obstructions.*

Question 2: *How to ensure that all ex-post obligations will be satisfactorily met, safeguarding public economic interests by maintaining investments in the sector and, at the same time, providing guarantees against negligent lessees and eventual economic and natural contingencies?*

Answer 2: *The establishment of a performance bond regime.*

Question 3: *How to make such regime viable?*

Answer 3: *Make available a portfolio of bonding instruments, providing adequate flexibility for accommodating the needs of different companies, but at same time, not eliminating incentives for compliance; requiring the approval of an ex-post operation plan before operations begin.*

Question 4: *How to anticipate and attenuate the financial impacts caused by each of the different forms of performance bonds required as financial guarantee for the completion of ex-post obligations?*

Answer 4: *Design a decision tool to assist in the financial planning of offshore oil and gas projects, simulating possible scenarios, giving the choice of different bonding instruments, and assessing their respective impacts on the profitability of offshore projects.*

The main contributions provided in the present thesis were: (1) A classification for different forms of environmental damages in the upstream petroleum sector (accidental, continuous, and ex-post damages); (2) The definition between financial bonds and performance bonds; (3) A comprehensive assessment of currently available financial instruments used as bonding tools; (4) A systematic classification for bonding instruments; (5) A series of modeling exercises with the modeling tool STELLA®; and (6) A decision toll for managing offshore oil projects under bonding regimes (Petrobond).

In the upstream oil sector, bonds are aimed at indemnifying authorities against costs related to noncompliance of ex-post environmental obligations. An ideal bonding regime shifts the financial risk from the agency to the lessees, forcing companies to internalize ex-post damages and no compliance costs, motivating lessees to monitor the consequences of their decisions. In case of noncompliance, funds necessary to complete all ex-post obligations would be promptly available to regulators. Though a hybrid of market mechanisms and command and control regulations, bonds are likely to achieve noncompliance protection objectives far more cost efficiently than non-market regulations. **Figure 7.1** illustrates the summary of risks offered to the regulatory agency in case of noncompliance.

Bonds were found to be best suited to cover ex-post environmental damages. The main factors include cost assessment and duration of mitigating operations. Some complications are expected in the near future as emerging ex-post issues are further considered.

Since international legal provisions cannot specify ex-post procedures for internal waters, territorial seas, etc., guidelines and conventions can only be recommendatory in nature, and the nation is sovereign in regulating and enforcing their offshore oil projects. For this reason, local agencies or legislators should work on establishing requirements that may satisfy domestic and international environmental demands and are economically feasible. Solutions must take into consideration technical, environmental, and economic parameters, avoiding unfounded and ineffective restrictive policies that can affect the continuation of long-term investment commitments in the sector. Regulatory costs must be carefully examined. **Figure 7.2** shows a summary of most significant regulatory cost producing aspects.

Compliance with all international, regional, and domestic policies might not necessarily satisfy the expectations of public and interest groups. When oil companies are pressured by public opinion, they will be compelled to surpass current regulations and even scientific recommendations, despite significant economic impacts. To avoid this scenario, an open and transparent dialogue with all stakeholders and an efficient flow of information with the Media is highly recommended.

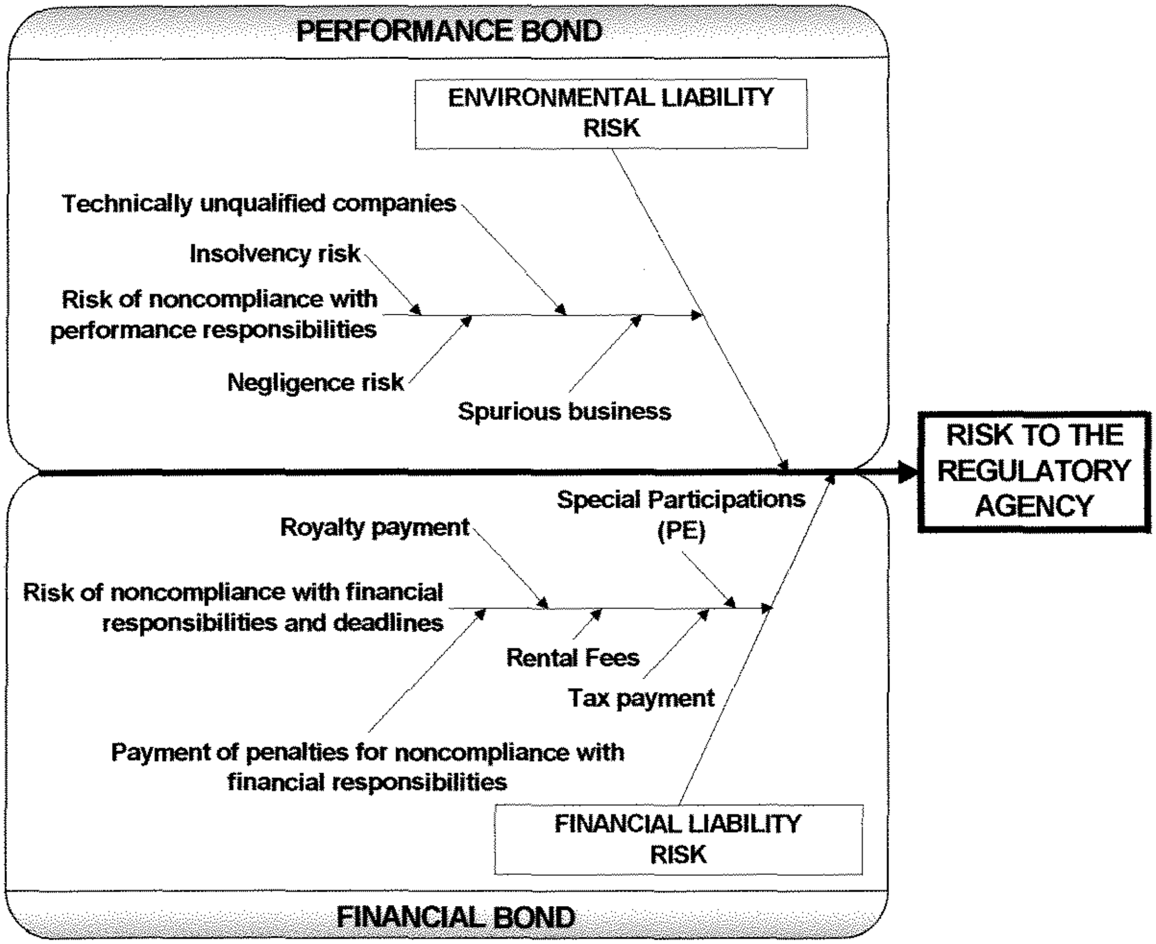

Figure 7.1. Summary of risks to regulatory agencies within bonding systems.

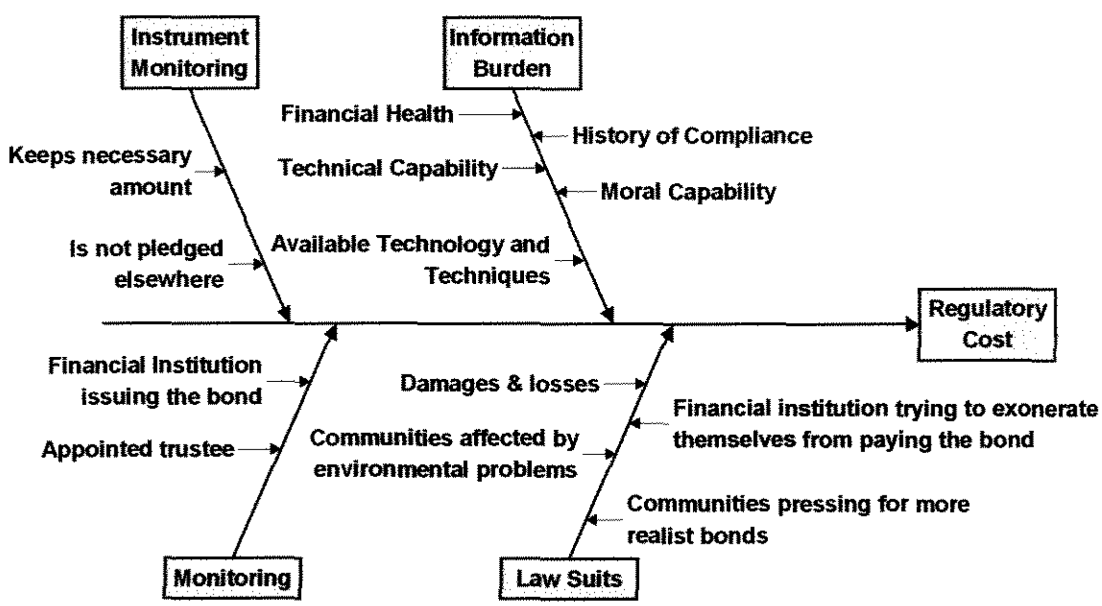

Figure 7.2. Summary of regulatory cost producing agents.

Partial removals cover a great range of different alternatives and combinations, and, if this option were viable, it would represent cumulative savings ranging between 8% and 39%, depending on variants, as it was demonstrated in the North Sea province. The main argument used by interest groups to call for a ban on partial removal is the potential environmental impact generated by partial decommissioning. However, the adoption of high cost solutions offers only marginal or debatable environmental benefits.

Another advisable option for some, not all, environmental settings are artificial reefs, which not only improve ecosystems services but also create new business opportunities. Another interesting aspect of environmental issues is that the fishing industry has greater disturbing effects on biodiversity than the offshore petroleum industry.

Technology leaps may offer, in the near future, profound impact on developments. Minimal facilities and platformless development may become tomorrow's main option, reducing both cost and implementation, and reducing decommissioning costs. It is also noticeable the number of innovative offshore removal technology becoming available since 1995, most of them in GOM and Norway. Incentives should be provided to ensure ever-improving technologies, addressing needs and aspirations of all stakeholders, and, mainly, ensuring that the industry is able to comply with all ex-post obligations.

Since decommissioning is unavoidable, ex-post planning must begin in early stages of project preparation. The 5 R's approach should be considered: reduction, reengineering, reutilization, rigs-to-reef programs, and then recycling, in this specific order. The best strategy is planning, rendering offshore installations long and productive lives, allowing a high facility utilization and delaying decommissioning costs as long as possible. Decommissioning several fields at same time or sharing equipment and expertise may also provide substantial savings.

Observations indicate that, among the bonding systems studied, the MMS has the most efficient system. It is important to emphasize that the offshore oil sector presents different and more favorable characteristics than the remaining agencies and the areas under their jurisdiction. The MMS deals with a scenario where monetary values are usually greater than in other sectors such as hardrock mining, onshore petroleum, and coal mining. Even dealing with greater financial responsibilities, non-compliance risks are significantly lower. The hardrock branch of the BLM seems to hold the most vulnerable bonding system followed by the onshore petroleum branch of the same agency. The main problems include the absence of a true incentive for

compliance by either ignoring true ex-post costs, or by requiring financial bonds instead of performance bonds. Excessive flexibility granted in the form of instruments may be also increasing liability risks.

For the Brazilian scenario, both financial and performance bonds are suggested. All phases of projects should be bonded with financial and performance requirements, except for the bidding phase, which does not offer performance risks. In order to provide the industry with adequate flexibility and the agency with necessary guarantee, four types of financial instruments are proposed: surety bonds, letters of credit, collateral accounts, and insurance policies. These instruments were chosen based on the criteria defined on **Chapter IV**. Surety bonds may pose a problem, since this instrument category is not yet available in the Brazilian market. Models presented on **Chapter VI** also confirm the choice of this portfolio of instruments.

Large and historical companies are not the targets of the proposed bonding system. Since some of these companies tend to accumulate several leases at the same time causing the allocation of large amounts of capital that could be applied in other productive ventures, some form of blanket-bond should be offered. Some well-defined criteria, including a very strict underwriting process, could be establish to provide historical companies with the opportunity to use some form of self-bonding mechanisms. Such flexibility would reduce opportunity costs for large investors, corroborating to the maintenance of investments within the sector.

The implementation of financial assurance requirements, as any other process, demands a learning period that affects all stakeholders. The petroleum sector is very dynamic and the leaning process will follow the same course. The search for deficiencies and, mainly, loopholes should be continuous. Consequently, reviews and minor adjustments should be frequent (approximately every two or three years).

The administrative organization of governments may generate some problems for the implementation of bonding regulations. In order to implement a feasible and efficient regulation, the regulatory agency must coordinate all functions attributed to other agencies or government offices. This will allow a harmonic management. The establishment of a central database is also critical.

For most tax regimes, ex-post environmental obligations, including decommissioning costs, are ordinary and necessary expenses. In general, such expenditures are tax-deductible only when services have been performed and payments have been made. In general, the rule for deductibility is that the expense has to be an ordinary and necessary business expense and not a capital expenditure. The fact that a company is contractually liable for ex-post expenditures or provides anticipated funds to guarantee such obligations (bonds), does not entitle it to deduct the cost of such services before they have in fact been performed.

Additional research should be conducted on the impacts of incentives and relief mechanisms on marginal and mature oil fields. This future study would be an effort to extend the life of mature fields and, concomitantly, engineering a viable and sound bonding system for these fields.

The choice of bonding instrument is an important aspect of the decision making process and may determine the feasibility of small and marginal projects. For this reason, the applicability of bonding systems must consider ongoing projects and projects near the end of their lives.

For all algorithm simulations performed on the Petrobond program, environmental insurance policy options offered better cash flow performances. The next best results were attained by LOCs. Nevertheless, all simulations were performed under the assumption that operating companies own top credit rating. Future research is needed in order to investigate the performance of rating-dependent instruments under less favorable scenarios. The sensitivity of other components should also be further investigated in future studies. Even though much criticism is directed to ex-post insurance policy tools, such as option EIP, some insurance products may provide mechanisms to award lessees with good financial and environmental records, creating a motivation for companies to pursue similar records. Simulations performed in this study indicate that further research on bonding instruments is still needed to identify impacts, measure sensitivity of components, and improve the NPV performance of offshore oil projects under bond regimes. Special attention should be given to fiscal planning.

Simulations performed in the Stella model conclude that the most favorable bonding instrument under the given circumstances is the surety bond. Surety bonds significantly attenuated impacts on tested projects; however, applicant companies must provide good financial and regulatory compliance records. Bonding policies affect government earnings more significantly in small projects; therefore, additional research should be conducted focusing on small and marginal fields. Impacts on GT values are usually slightly negative with the application of corporate surety bonds. For cash bond simulations in medium and large fields, GT values remain mostly unchanged, indicating only minor reductions over significant decommissioning cost variations.

Under the bonding system, a company concerned with its image and corporate record is motivated to comply with all decommissioning obligations (good records allow lower bonds and premiums). In addition, to reduce effects on project profitability, companies are motivated to find ways of demonstrating to authorities that ex-post costs can be less than previously estimated.

Results obtained in this study are primarily useful for overall strategic evaluations. Results may also provide guidelines for determining other potential impacts caused by other bonding instruments. Decision-makers may use this study to develop general strategies for projects under bonding regimes. Authorities may use the study to determine whether a current or proposed bonding regime provides the necessary protection without discouraging investments. Finally, the proposed model may help in the determination of the approximate financial burden caused by different bonding instruments on different petroleum projects.

The application of ex-post environmental obligations and bonding policies in the oil sector faces several obstacles. There are different competing interests from several stakeholders, including oil companies, governments, environmental interest groups, and other users of the sea. For this reason, solutions should share the support of all stakeholders.

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TABLE A.1. QUESTIONNAIRE SUBMITTED TO BOND SPECIALISTS, REGULATORS, AND INDUSTRY DECISION MAKERS.

MECHANISMS & INSTRUMENTS		CHARACTERISTICS & ATTRIBUTES	REGULATOR'S PERSPECTIVE								INDUSTRY'S PERSPECTIVE							
			Level of liquidity in case of default	Ease of collection in case of default	Level of monitoring required	Level of incentive for regulatory compliance	Repeals unqualified & irresponsible candidates?	May provide an extended period of liability after bond is released	Overall cost to the Agency	Overall instrument reliability	Value-protection for capital allocated	Liquidity constraints	Opportunity costs	Potential investment gain (interests)	Investment risk (if any)	Level of difficulty for instrument acquisition (underwriting process)	Instrument availability	Fiscal advantages
Financial Instruments Used to Guarantee or Fund Contractual Obligations		*Example: Cash*	5	5	5	5	5	1	5	5	-	1	1	4	5	5	5	1
		Credit Guarantees: Corporate Surety Bonds																
Collateral Guarantees	Negotiable Instruments	Certificates of Deposit																
		Cash Equivalent (Cashier's Check, Certified Check, Money Order, Cash Deposit, Cash Bond)																
		Letters of Credit																
		Government-Issued Treasury Securities (T-Notes, T-bonds, Deposit of Securities, Investment Grade Securities)																
	Non-Negotiable	(-)Real Estate and other pledge of assets																
		Financial Reserve																
		Security Agreements																
		(-)Salvage																
		Cash Accounts																
		Escrow Accounts																
		Paid-In Trust Funds (Cash Trust Funds)																
		Bank Accounts (in trust)																
		Trust Funds with Periodic Payments																
		Standby Trust Funds																
		External Sinking Funds																
		Lines of Credit																
		Bank Guarantee (undertaking)																
Self Guarantees		Financial Tests, Balance Sheet Tests, Covenants, Self Guarantee, Self-Funding through Financial Reserves																
		Corporate Guarantees, Parent Company Guarantee, Third-party Guarantees																
		Set-Asides Revenues																
Liability Transfer		Environmental Insurance																
		Finite Insurance																
		Life Insurance																
		Annuities																
		Risk Spreading: Pool Bonds																
		Risk Spreading: Designated-Purpose State Funds																

* *Soft instruments*

APPENDIX B – DECOMMISSIONING OF OFFSHORE INSTALLATIONS

TABLE B.1. NONEXCLUSIVE REUSE MATRIX SUGGESTION

LIST CRITERIA / CHANCE OF SUCCESSES (%) / WHO IS BEST AT HANDLING?		SELF	COVERTURES	CORPORATE	BROKER	CONTRACTOR	POTENTIAL CUSTOMER
Water depth	50%	X	X	X	X	X	X
Processing	50%						
Reservoir site/quality	50%						
Geographic location	50%						
Scale of modification	50%						
Cost of modification	50%						
Age of technology	50%						
Early production	50%						
Reputation	50%						
Government influence	50%						
Geopolitics	50%						
Project manager attitude	50%						
Marine rates	50%						
Corporate culture	50%						
NGOs	50%						
Willingness	50%						
Covertures alignment	50%						

18 factors were suggested, but there are many others. Suppose each criterion had a simple 50:50 chance of success. The overall chance of a perfect match would be about 0.0004%, or 1 in 26,200. Finding a perfect match for an installation is not an easy task (Tilling, 2001- modified).

△ NEEDS CULTURE CHANGE ● ATTITUDE DRIVEN

○ STUDY WILL DEFINE X YOU CANNOT DO ANYTHING ABOUT IT

Possibility of recommissioning: Who would be best handling each criterion
(based on methodology by TILLING, 2001)

TABLE B.2. DECOMMISSIONING COST ESTIMATE FORM	
Activities	**Estimate ($)**
Decommissioning Planning ▪ Engineering analysis ▪ Contracting ▪ Operation plan elaboration	
Partial Cost:	
Regulatory Conformity ▪ Permits and licenses (for all activities) ▪ Environmental consultancy ▪ Cost involved in reaching regulatory adequacy	
Partial Cost:	
Decommissioning Preparation Services and "Safeout" ▪ Cleaning and disposal of residual hydrocarbon ▪ Safety preparation ▪ Dismantling and separation of modules and equipment ▪ Structural Reinforcement	
Partial Cost:	
Well Plugging and Abandonment ▪ Assessment of well condition (data collection) ▪ Inspections ▪ Elaborating a P&A plan (method) ▪ Operations ▪ Sale Price of Reusable or Recyclable items	
Partial Cost:	
Conductor Removal ▪ Assessing regulatory requirements and difficulty level ▪ Severing ▪ Pulling (requires rig) ▪ Offloading (requires platform crane) ▪ Transportation and Disposal ▪ Sale Price of Reusable or Recyclable items	
Partial Cost:	
Mobilization and Demobilization ▪ Planning (assessing the type of HLV required and availability) ▪ Contracting the HLV	
Partial Cost:	
Platform and Structural Removal ▪ Planning (Removal in one piece or large pieces, or reducing them to small pieces) ▪ Deck/Topside Removal (including contracting HLV and cargo barge) ▪ Pile and explosive Severing services (cutting and lifting) ▪ Platform/Structural Removal (including contracting HLV and cargo barge) ▪ Sale Price of Reusable or Recyclable items	
Partial Cost:	
Decommissioning Pipelines and Cables ▪ Assessing regulatory requirements ▪ Engineering Planning ▪ Diver related services (surveying, cleaning, cutting, plugging, burying and removing) ▪ Contingencies ▪ Lift vessels ▪ Sale Price of Reusable or Recyclable items	
Partial Cost:	

Transportation and Disposal

- Assessing regulatory requirements
- Cargo Barge Services
- Deciding on disposal methods (refurbish and reuse, scrap and recycle, or landfills)
- Revenue from reuse destination and recycling
- Disposal costs (steel, cement, marine growth, mud, etc.)

Partial Cost: ____________

Site Clearance and Verification

- Pre-demolition side scan sonar survey
- Post-demolition side scan sonar survey
- ROV deployment
- Diving spread
- Trawl test program
- Contingency

Partial Cost: ____________

Miscellaneous

Project Management and Inspection

Contingencies

TOTAL GROSS COST ____________

TOTAL SALE EARNINGS ____________

SALE % OF GROSS COST

NET COST

APPENDIX C – PETROBOND VARIABLES

TABLE C.1. OPERATIONAL VARIABLES

Field-Specific Characteristics	
a) Basin	location of the basin
b) Field	name of the producing filed
c) Oil Reserves	total oil reserves in millions of barrel (MBBL)
d) Gas Reserves	total gas reserves in millions of barrel of oil equivalent (MBBL)
e) Oil type	type of the oil being produced in the field
General Characteristics	
a) Exploration Period	length of the exploration phase (years)
b) Development Period	length of the development phase (years)
c) Production Period	length of the production phase (years)
d) Water Depth	depth (meters)
Production	
a) Given Production	annual oil (MBBL) and gas (Mm^3) production data is provided for the production phase[1]
▪ Gas Royalties	portion of gas production, which will be subjected to the established royalty rate (in %)
b) Simulated Production	the software will simulate the production of the field based on information provided[2]
▪ Production Peak	maximum production value
▪ Declining Curve	declining rate for the oil production curve
▪ Gas/Oil Ratio	Portion of gas in the oil production
▪ Time to Production Peak	time to reach production peak
▪ Gas Royalties	portion of gas production, which will be subjected to the established royalty rate (in %)
▪ Peak Duration	duration of the peak production
Cost	
a) Cost Input	annual operation costs provided in MMUS$ (maximum of 20 years)
b) Calculated Cost	costs may be calculated through an estimation of operational cost per barrel of oil equivalent adjusted by the inflation (inflation is provide in the input of financial parameters)
Investment	
a) Annual Investment	in this input option investments are divided into expenditures (MMUS$) during the exploration phase and well cost, which is depreciable and amortizable (MMUS$) during the first five years of the project
b) Calculated Investment	in this input option the total investment is calculated based on the value provided by barrel of oil equivalent. These values are divided into depreciable and non-depreciable according to the proportion provided. In addition, as in "Annual Investments", values are divided into five years.

[1] Production is then converted in Mm^3 in order to facilitate the calculation of special participation values (PE).
[2] The decline model used was exponential according to the given rate provided by the user.

TABLE C.2. FINANCIAL VARIABLES	
Royalties	royalty rate on gross income
COFINS	social Contribution Tax rate on gross income
PIS	PIS rate on gross income
CIT	tax rate on taxable income
BID	bidding bonus paid in year zero
Depreciation	portion of the investment allowed to be depreciated
Amortization	portion on the investment allowed to be amortized
Discount Rate	discount rate used by the lessee
CSLL	CSLL rate on taxable income
Rent	amount paid by the occupation of the area during exploration, development and production phases. The value is calculated in R$ and then converted to US$ according to the money exchange rate input.
Price	oil price is calculated based on the Brent price according to the respective conversion factors for each oil type. The values are adjusted for current inflation.
Oil Price	given in US$ per BBL
Gas Price	given in US$ per m^3
Inflation	annual rate if inflation
Exchange Rate	US$/R$ exchange rate

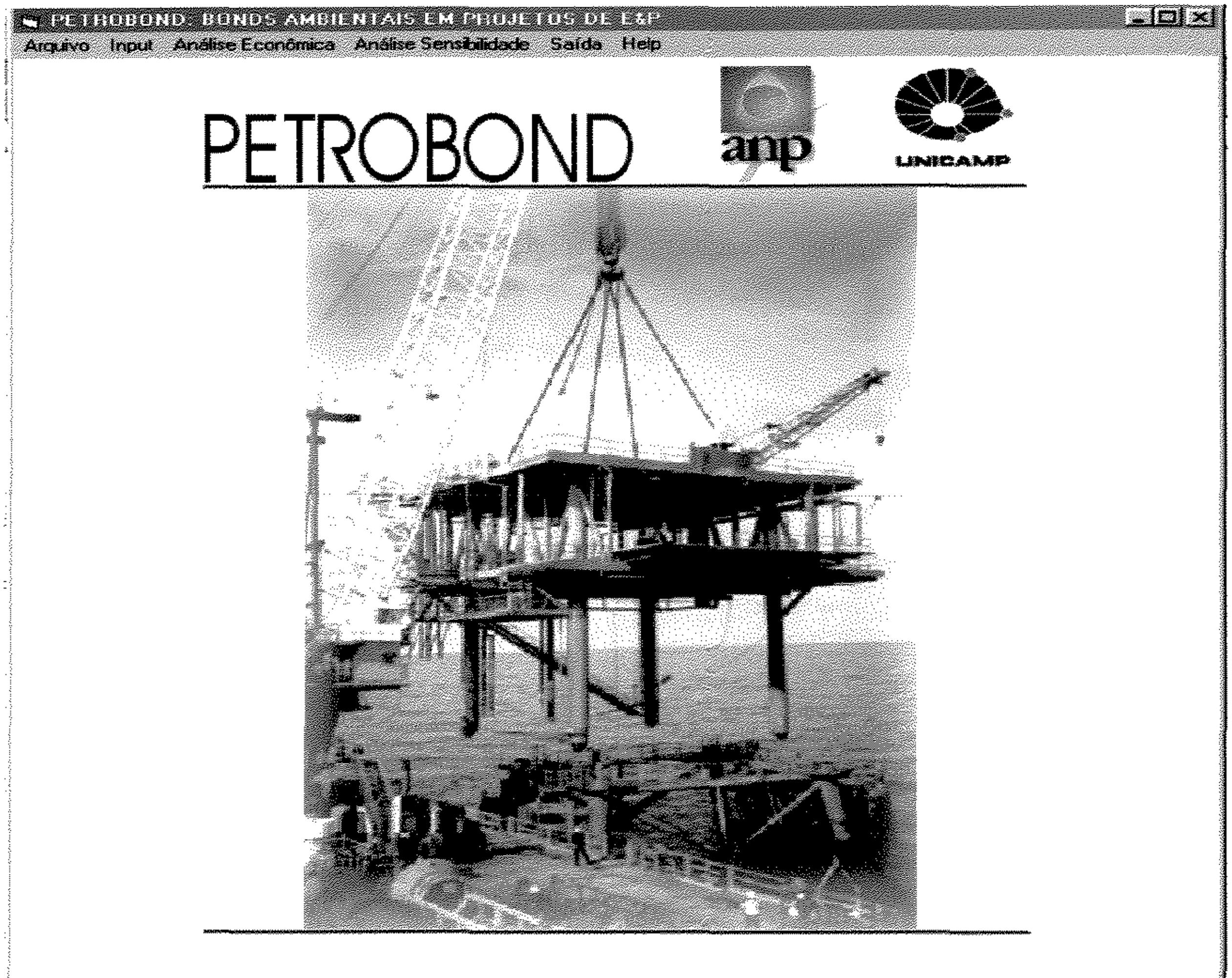

Figure C.1. Petrobond Computational Algorithm (Photo: courtesy of TWACHTMAN SNYDER & BYRD, INC.).

TABLE C.3. BOND RELATED VARIABLES

Instrument Options:	
a) Bidding phase:	(1) Financial Bond – Letter o Credit, pre-paid collateral account, Insurance policy; (2) Performance bond – Not available for this phase
b) Exploration Phase:	(1) Financial Bond – Letter o Credit, pre-paid collateral account, Insurance policy; (2) Performance Bond – Letter o Credit, pre-paid collateral account, Insurance policy.
c) Development & Production:	(1) Financial Bond – Letter o Credit, pre-paid collateral account, periodic payment collateral account, Insurance policy; (2) Performance Bond – Letter o Credit, pre-paid collateral account, periodic payment collateral account, Insurance policy.
Letter of Credit:	
a) Financial Bond	fixed value in MMUS$
b) Rate/Fees	annual rate for maintaining the bond (around 2% of the total bond value)
c) Discount rate	discount rate allowed based on risk offered. Based on the performance bond amount.
d) Performance bond	required bond amount in MMUS$
e) Closure cost	total closure cost (estimation) in MMUS$. Input for exploration and development/production phases
Insurance Policy:	
a) Lessee classification	classification according to the SERASA (Brazilian credit evaluation center – A, B, C and D). The premium rate will be established according to this classification.
b) Financial Bond	financial guarantee amount in MMUS$
c) Premium Rate	annual rate based on the total performance bond requirement (from 1.25 to 3.00%, according to the lessee classification rating)
d) Risk Discount Rate	risk discount rate based on the risk offered by the lessee. The discount is on the performance bond amount.
e) Performance Bond Amount	bond value in MMUS$
f) Closure costs	total closure costs for exploration and development/production phases. Values in MMUS$.
Paid-in Collateral Cash Account:	
a) Financial Bond	fixed value in MMUS$.
b) Performance Bond	performance bond amount in MMUS$.
c) Discount Rate	discount rate based on the risk offered by the lessee. This discount rate will only impact the performance bond amount
d) Interest Rate	Annual interest rate on the total bond amount (usually around 5.5%).
e) Closure Costs	closure costs estimation for the exploration and development/production phases in MMUS$.
Periodic Payment Collateral Cash Account:	
a) Financial Bond	fixed value in MMUS$.
b) Performance Bond	performance bond amount in MMUS$.
c) Closure Costs	closure costs estimation for the exploration and development/production phases in MMUS$.
d) Interest Rate	annual interest rate on the total bond amount (usually around 5.5%).
e) Discount Rate	discount rate based on the risk offered by the lessee. This discount rate will only impact the performance bond amount.

APPENDIX D – STELLA MODELING TOOL: DECOMMISSIONING AND BONDING SCENARIOS

Developing decision tolls, complex models, for managing oil project decisions involving decommissioning and financial assurance mechanisms, provides a way to anticipate economic impacts of the several bond alternatives.

Complex models are essential for managing oil projects. The use of economic models is an innovative approach to deal with the business decision uncertainties involved in the oil sector. This approach integrates multidisciplinary segments (policy, environmental, social, fiscal, etc.) with economics dynamics, providing a way to anticipate the economic impacts of the manifold alternatives. **Figure D.1** illustrates the Interface Level of the Decision Model described in **Chapter 2**, where the current choice of bonding instruments is investigated.

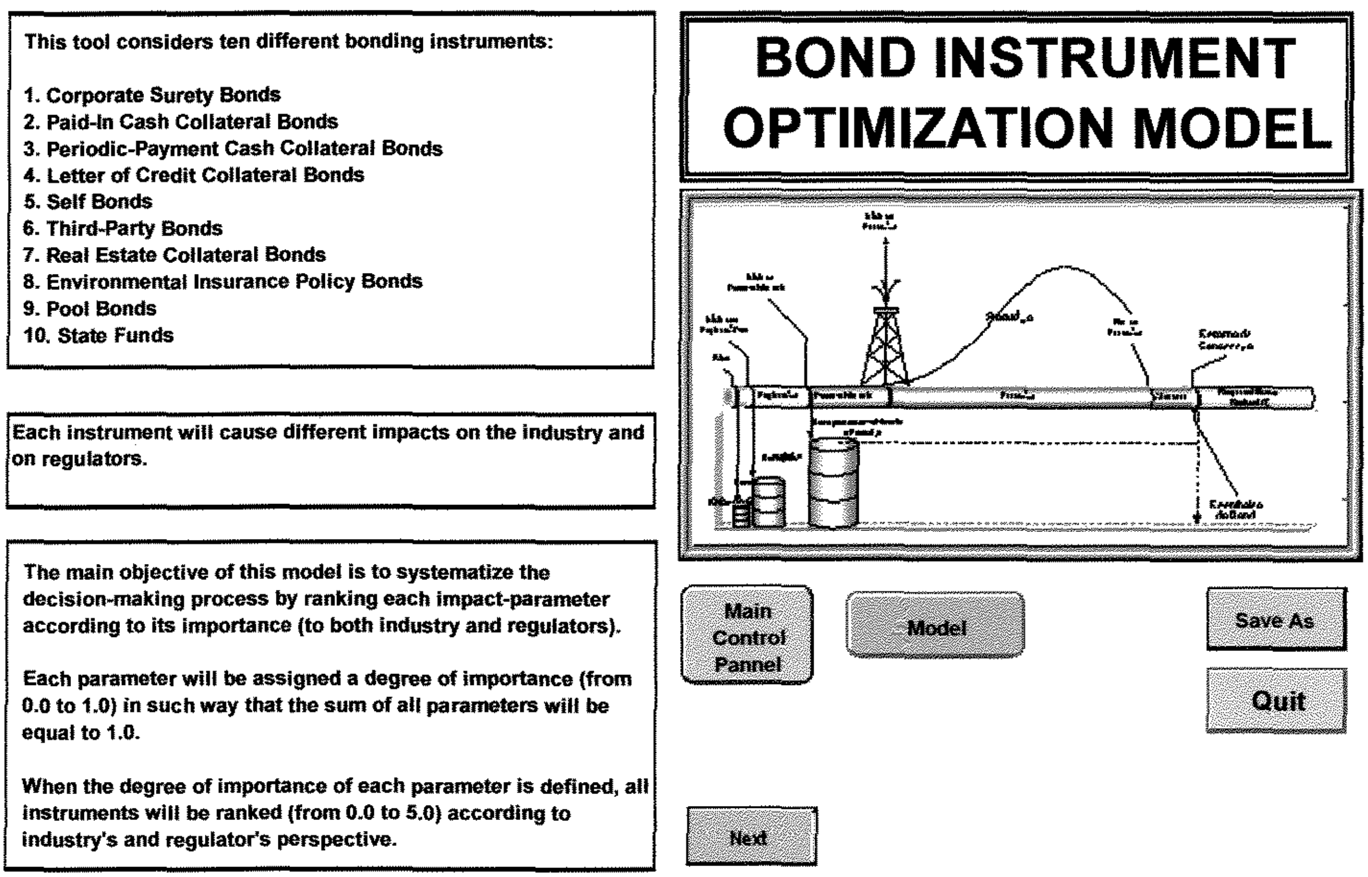

Figure D.1. Part of the conceptual introduction of the decision model designed in the Stella tool. This control panel is located at the interface level of the software.

The three following model exercises were designed using the software package *STELLA*® (Structured Thinking Experimental Learning Laboratory with Animation) which was developed by High Performance Inc. for the Windows™ and Macintosh® operating environments. The *STELLA*® is a multi-level, hierarchical environment for constructing and interacting with models (STELLA, 2001). The present modeling was designed using the STELLA Research version for Windows™.

CORNWELL AND COSTANZA (1994) were the first to apply the *STELLA*® in a dynamic, interactive simulation model intended to examine the pollution abatement systems. As described by Cornwell and Costanza, models are a trade-off between realism, precision, and generality.

D.1. A DECISION MODEL FOR A PERFORMANCE BOND REGIME

The offshore oil industry, by its very nature, is exposed to hazardous events with very large consequences (TOPE, 1999). The economic impacts of safety and environmental regulations are enormous. A company must have a clear understanding how decisions are made, systematizing the decision-making process, and providing an effective consultation and communication tool.

It is evident that regulations will be the main factor, but engineering and good practice will largely form the bases for the decision-making process. It will also include the use of innovative technology, choosing the best decommissioning options, etc. Decisions will sometimes involve higher costs, uncertainties and risk tradeoffs.

The aim of these models is to establish a framework that best reflects the context of the decision being considered. This framework developed is intended to aid in financial management decision-making process. Its structure can be modified and adapted to suit the scenario or situation being considered and to reflect future changes in technology, practices, and values. The use of such framework for decision support may make the decision making process more consistent, but it will not necessarily lead to consistent decisions. The actual decisions will depend on the values and perceptions of stakeholders, which will vary from stakeholder to stakeholder, and company to company. Several steps can be shown in the Interface Level of the Stella model as illustrated in **Figure D.2.** The user, the decision maker, is able to control all variables of the project.

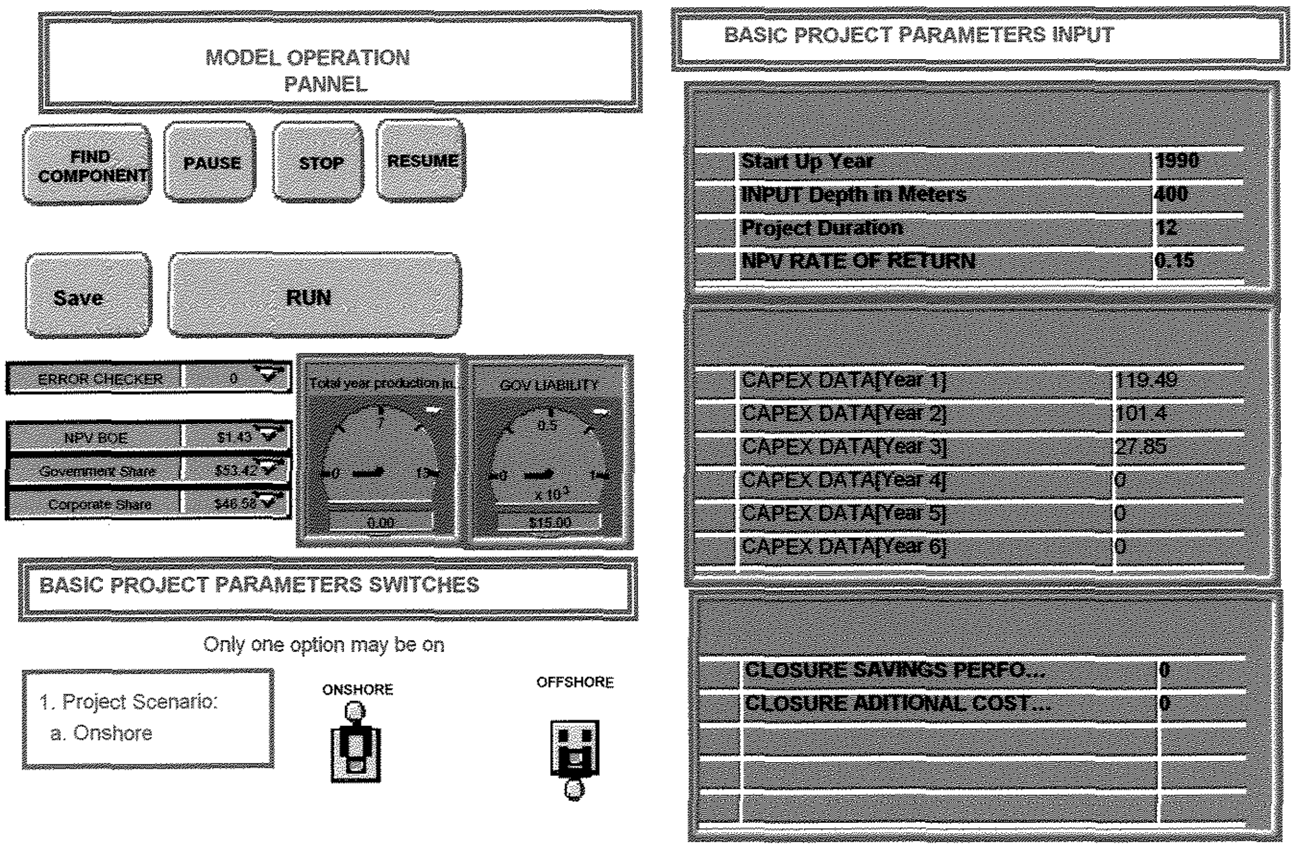

Figure D.2. Interface Level: Basic project parameters Input Window. Knobs are macros to activate commands. Illustration of Stella tools for user input of project type (onshore or offshore). The two meters above show total annual production and total government liability. Alarms go off if current production leads to negative NPV and if liabilities are high.

D.2. FORECASTING

The first approach in this appendix must be to relate the sciences of forecasting and developing models. Analyzing patterns and circumstances of past events and activities, examining the parameters involved in a specific scenario, identifying direct and indirect relationships among cause and effect, understanding the driving forces behind occurrences, systematizing the decision making process, formalizing potential outcomes, what is likely or even could happen in the future, are vital procedures considered whenever there is an important decision to be made. One or several of the steps above may be used unconsciously during common daily decisions. But in fact, the science that systematizes such procedures to improve the decision-making process is called forecasting. The reasoning that generates the fundaments for forecasts can be described as modeling, which is the systematization of all reasoning taking

into consideration all parameters involved in the decision-making process. Even while not always recognized as forecasting, whenever we make a decision on capital goods, we make some assumption on the future value and costs (FERREIRA, 2002).

Numerical forecasts are not meant to produce the factual numerical outcome. The results of such attempts are meant to be interpreted by specialists that will identify probable trends and eventually predict scenarios that will correspond to actual events. If a model is properly designed it will be adequate to point out in the direction that a decision needs to be made, even if the predicted numerical outcome is accurate.

The science of forecasting and modeling, both having the objective of providing the decision-maker with a tool for systematize the decision-making process, is hardly an academic program, but any corporation, government agency, or manager wishing to make successful decisions will make use of such sciences. **Figure D.3.** shows the Mapping Level of the Decommissioning Process Submodel.

Computers have been used to model several scenarios. The use of computers allow the forecast of scenarios taking into account several parameters and allow a range of values that provide the sensibility of the model and its output to realistic variations in the key parameters and assumptions, or scenarios. Alternative views (or scenarios) on how the future may develop can usually be attained by changing the values of the various parameters (FERREIRA, 2002). Computers are used to build and run complex models. Computers also allow the incorporation within the model, of many variables and relationship that can be easily modified. The other advantage provided by computers is the possibility of using a great range of database to run simulations of different scenarios. It can also integrate variables such as policies, historical data, public response, political will, physical data, etc.

- **Defining the issue/problem:** What is the explicit purpose for the modeling effort? The purpose of this effort is to develop an understanding of how different forms of bonds impact the profitability of an offshore project, and then to use this understanding to generate practical charts showing the best types of bonding instruments for different project scenarios – a tool for helping in the decision making process.
- **Developing a reference behavior pattern:** in order to make the written statement of purpose more operational, it will be translated into a Reference Behavior Pattern, a graph over time of the variable which best characterizes or represents the phenomenon attempted to be

understood. Sometimes a good reference behavior pattern is not available to guide the investigation.

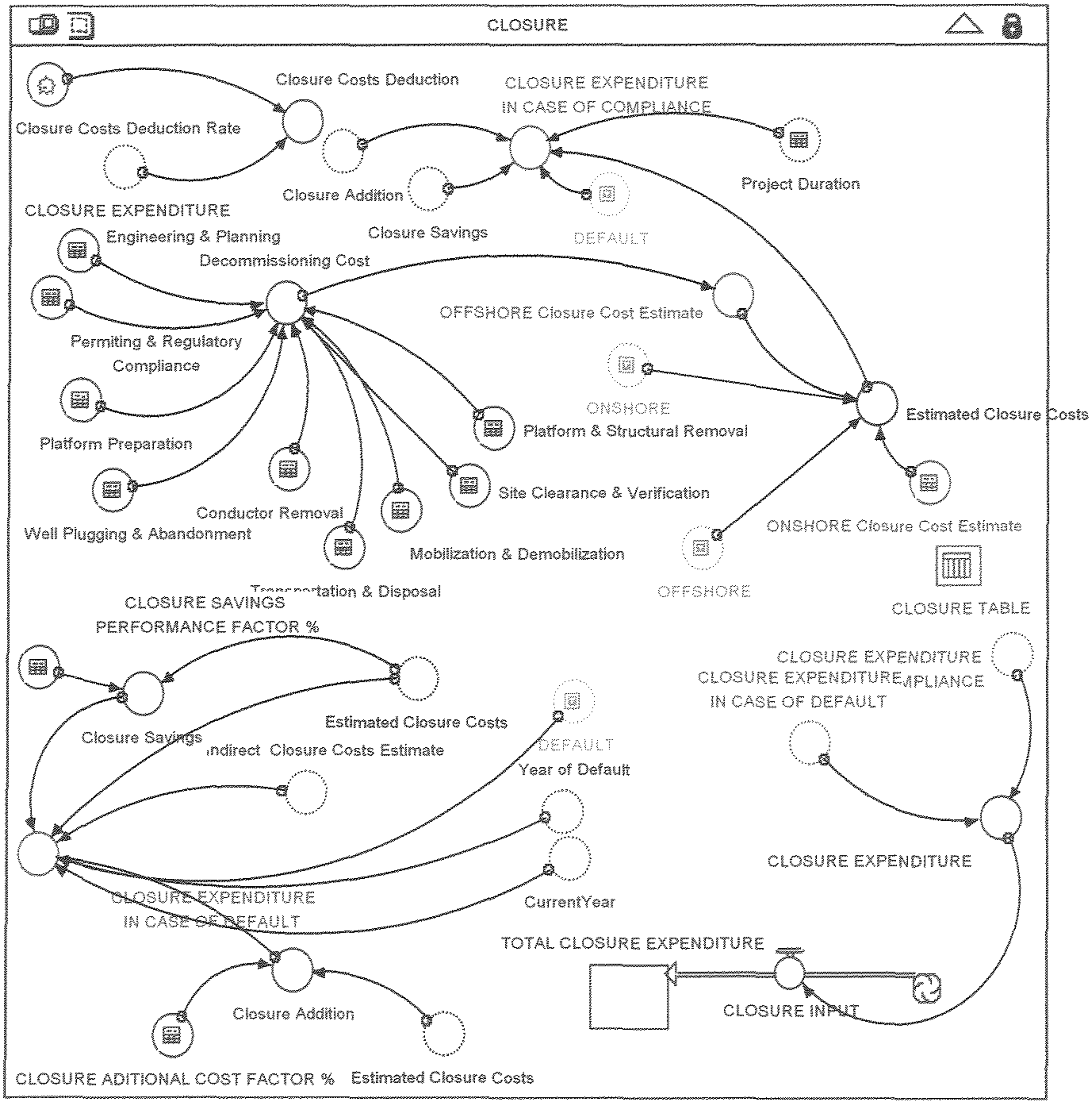

Figure D.3. Map Level view of decommissioning submodel.

D.3. CASH FLOW STELLA SUBMODEL.

This Stella model guides the decision maker through several ex-post related reflections including the use of three different bonding mechanisms (surety bonds, paid-in cash collateral account and periodic payment cash collateral account). At the end, the model provides the user with results in Dollar values, percentages, and BOE. Stella is certainly not the easiest way to create a cash flow spreadsheet, however, it is an excellent didactic tool to demonstrate all the possible changes in variables and parameters and their impact on project value.

D.4. BOND CHOICE MODEL.

This Stella model attempts to systematize the bond choice paradigm. Why the majority of regulatory agencies choose the instruments they choose? In opting from certain instrument regulators try to reach equilibrium. Due to public pressure, regulators must impose sound bonding requirements; however, such requirements will generate some negative impacts on the industry, which in turn, will call for flexibility. Regulators must respond, in order to keep the market competitive and maintain the investment flow in the sector. Flexibility, usually, increase the risk for the regulators. Some instruments will be very positive for the industry, but very negative for the regulators. A balance must be obtained. This cycle is also illustrated in **Figure 2.3**.

The main objective of this model is to systematize the decision-making process by ranking each impact-parameter according to its importance (to both industry and regulators). Each parameter will be assigned a degree of importance (from 0.0 to 1.0) in such way that the sum of all parameters will be equal to 1.0. When the degree of importance of each parameter is defined, all instruments will be ranked (from 0.0 to 5.0) according to industry and regulator's perspective. This is all demonstrated in **Table 2.5**.

D.5. OFFSHORE PLATFORM REMOVAL: ECOLOGICAL IMPACTS.

Some decommissioning activities are likely to have enormous benefits in terms of preventing pollution, environmental degradation, and accidents. Removing offshore structures also has important safety benefits. However, the presence of offshore structures does improve ecosystem services.

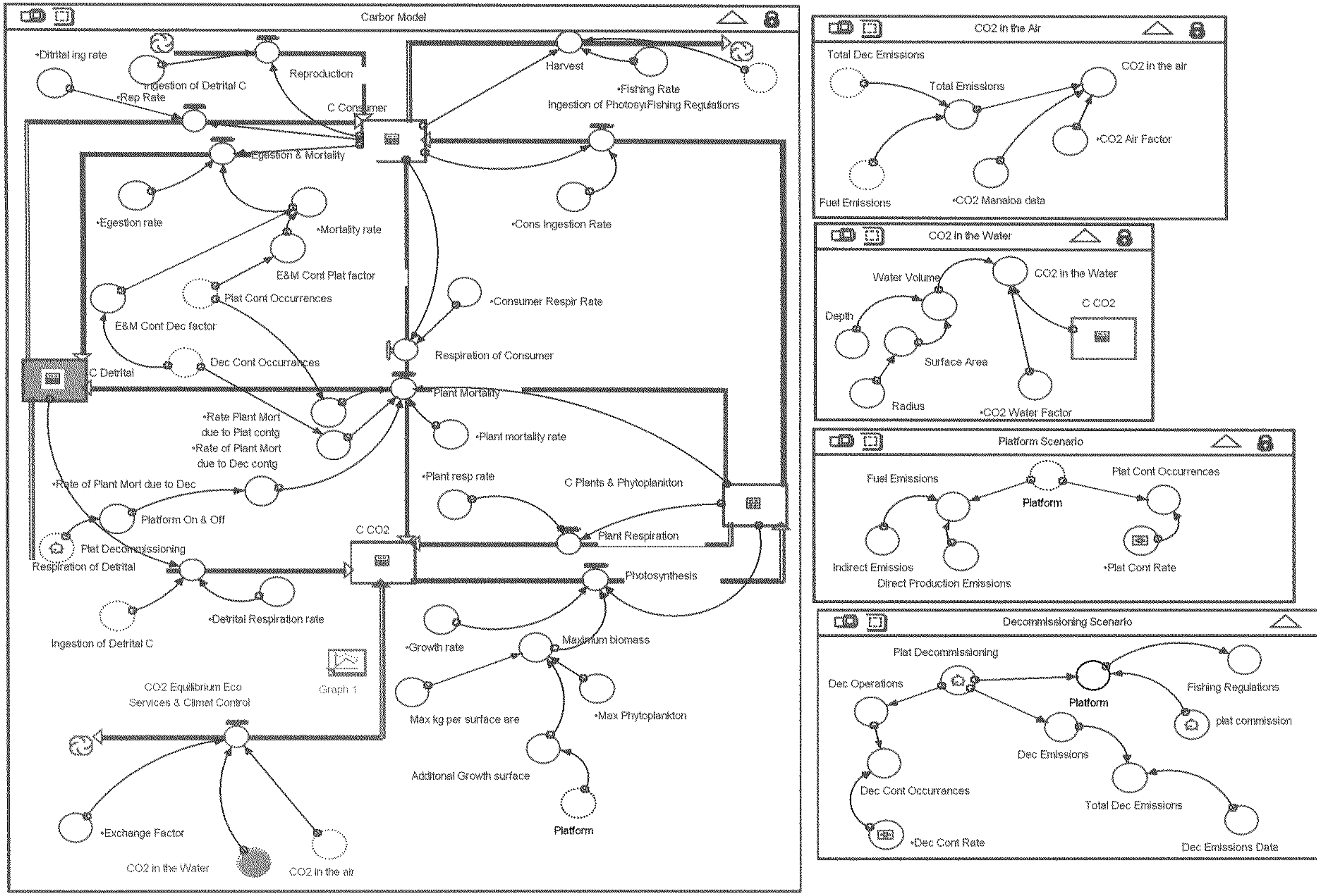

Figure D.4. Carbon Model, map level modeling. This model simulates ecosystems around offshore platforms. The four main stocks include Carbon Detrital, Ca CO_2, Carbon Consumer, and Carbon Plants and Phytoplankton. Submodel "Decommissioning Scenario" internalizes ecological impacts of decommissioning operati including CO_2 emissions (FERREIRA and BOUMANS, 2001).

Several issues rise regarding commercial fishing (i.e. exclusion areas, sanctuaries, etc.). This theme has attracted a passionate discussion between the oil and fishery industry, environmentalists, and several NGOs (MMS, 1997; SANCHIRICO, 2000). As mentioned before, fishing has serious disturbing effects on biodiversity. Plowing the top layer of the soil with heavy nets is very harmful to crabs, shrimps and starfish, favoring only certain worms on which flatfish feed. Offshore platforms, according to the study, even have a beneficiary effect on the ecosystem, because fishing within 500 meters of a platform is prohibited, a interdiction that is very questioned by NGOs connected to the fishery industry. **Figures D.4 and D.5** illustrates a modeling exercise where life around a platform is measured by carbon amounts. Although just a modeling exercise, the output in **Figure D.5** gives an idea of the ecosystem services improvement during the presence of the offshore platform and the fishing (harvesting) restriction in the area.