THE 28TH JAIF ANNUAL CONFERENCE

第28回原産年次大会

APRIL 10～12, 1995

JAPAN ATOMIC INDUSTRIAL FORUM
日本原子力産業会議

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パネリスト

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J．S．キャロル
崔長東
Y．S．R．プラサド
I．H．ケレシー
鷲見禎彦

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発表者：原禮之助
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パネリスト

尹徳敏
ザカリア
S．M．ロゴフ
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於　シェーンバッハ・サボー

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第２８回原産年次大会
プログラム

基調テーマ：アジアと原子力ー新たな発展の段階

平成７年４月１０日（月）～１２日（水）
於　シェーンバッハ・サボー
主催　(社)日本原子力産業会議

４月１０日（月）

<u>開会セッション（９：３０～１２：２０）</u>

議長：那　須　　翔　　東京電力(株)会長

大会準備委員長挨拶
中　根　千　枝　　年次大会準備委員長
対外経済協力審議会会長、東京大学名誉教授

原産会長所信表明
向　坊　　隆　　(社)日本原子力産業会議会長

原子力委員会委員長所感
田　中　眞紀子　　原子力委員会委員長　（依頼中）
国務大臣・科学技術庁長官

＜招待講演＞
「安定な国際社会のための原子力」
Ｈ．ブリックス　　国際原子力機関（ＩＡＥＡ）事務局長

議長：近　藤　次　郎　　(社)日本原子力産業会議副会長

＜招待講演＞
「グローバルな問題からみた北東アジアと世界」
金　　鎭　　炫　　韓国経済新聞社会長
元科学技術庁長官

「開発途上国における原子力発電」
Ｃ．Ｂ．カーチス　　米国エネルギー省（ＤＯＥ）次官

4月10日（月）

セッション1（14：00～17：30）
安定な国際社会をめざして－課題と展望

人類が豊かで安全な生活を営んでいくうえでエネルギーの供給は不可欠な要件である。来世紀において世界人口は大幅に増加することが予想されており、エネルギーの需要は、それをできるだけ効率的に利用することを考慮しても、急速に増大することが見込まれている。なかでもアジア地域のエネルギー需要の増大はとりわけ大きいものと考えられ、安定的な供給の確保や環境との調和は21世紀における重要な課題の一つとなっている。ここでは世界やアジア地域のエネルギー情勢の展望や、安定な国際社会のための原子力の役割や課題などについて、各国の代表者などが講演を行う。

議長：石　渡　鷹　雄　　動力炉・核燃料開発事業団相談役
　　　　　　　　　　　　(財)日本分析センター理事長

「フランスの原子力政策－将来の発展に向けて」
　P．ルビロワ　　フランス原子力庁（CEA）長官

「中国のエネルギー事情と原子力開発」
　張　華　祝　　中国核工業総公司（CNNC）副総経理

「グローバルな原子力コミュニティでのセーフティ・カルチャーの原則」
　I．セリン　　米国原子力規制委員会（NRC）委員長

＜質　疑　応　答＞

議長：三　田　勝　茂　　(株)日立製作所会長

「エネルギーと地球環境」（講演と映像）
　茅　陽　一　　慶應義塾大学教授
　　　　　　　　世界ｴﾈﾙｷﾞｰ会議東京大会 ﾃｸﾆｶﾙ・ﾌﾟﾛｸﾞﾗﾑ委員長

「英国の原子力発電－21世紀に向けてのエネルギー」
　J．コリア　　ニュークリア・エレクトリック社会長

「アジアの発展と原子力の平和利用」
　I．ズハール　　インドネシア鉱山エネルギー省電力・エネルギー局長

＜質　疑　応　答＞

レセプション（18：00～19：30）
於　赤坂プリンスホテル　クリスタルパレス

4月11日（火）

セッション2（9：00～12：00）

アジアの経済発展と原子力

近年、アジアは急速な発展を遂げ、21世紀には、国際社会における政治・経済上の役割はますます重要になると予測される。この急速な経済成長をささえていくため、他のエネルギー源とともに原子力発電開発計画の拡大や新規参入が相次いで発表されており、この分野における国際協力も次第に活発化している。このセッションでは大きく発展しているアジア経済圏の未来を展望し、エネルギー供給に係わる制約要因にも注目しつつ、エネルギー需要を予測する。そのような未来像をふまえて、エネルギーなどの生活基盤を確保するうえで原子力の果たす役割を概括する。さらに、原子力開発計画推進の共通課題について意見交換を行い、二国間ならびに多国間の国際協力のあり方について討論する。

議長：原　禮之助　　セイコー電子工業(株)副会長

＜基調講演＞

「アジアの経済発展と原子力国際協力」

高原　須美子　　経済評論家

＜パネル討論＞

D．アヒムサ　　インドネシア原子力庁長官

P．ベイン　　米国原子力ｴﾈﾙｷﾞｰ協会（ＮＥＩ）理事長

加納時男　　東京電力(株)取締役

ｸﾞｴﾝ ﾃﾞｨﾝ ﾃｲ　　ベトナム原子力委員会委員長

ﾌﾟﾘｰﾀﾞ ﾜｲﾌﾞｰﾝｻﾜｯﾄ　　タイ・タマサート大学国際技術研究所長

＜参加者との討論＞

4月11日（火）

午餐会（12：15～14：15）
於　赤坂プリンスホテル　クリスタルパレス

通商産業大臣所感

<特別講演>
「地震と日本人」
力　武　常　次　　　　　　東京大学名誉教授

原子力映画上映（13：00～14：00）
於　シェーンバッハ・サボー
「もし巨大地震が起ったら」
「セーフティ・カルチャー」
「地層を科学する」

4月11日（火）

セッション３（１４：３０〜１７：２０）

原子力安全確保の文化的側面

原子力発電の安全確保には機械やシステムが優秀であるということが大切であるが、その高い水準を維持していくためには技術のみならず、それを支える技術者や組織の活動が優れていることが重要である。アジア地域においては、今後原子力発電の建設と運転が一層活発に行われ、これに伴い技術の国際的交流が密に行われるものと考えられる。ここでは原子力発電所の建設や運転に関する技術にあわせて、人間や組織が行う安全活動を、アジアをはじめとする各国がどのように共通基盤としていくかなどについて、発表と討論を行う。

議長：近　藤　駿　介　　　東京大学教授

＜基調講演＞

「ｾｰﾌﾃｨ・ｶﾙﾁｬｰによる絶えざる改善ー問題の解明と組織だった学習過程」

Ｊ．Ｓ．キャロル　　　米国マサチューセッツ工科大学教授

「ＷＡＮＯー文化の違いを超えて情報交換をいかに効果的に行うか」

Ｒ．カール　　　世界原子力発電事業者協会(WANO)議長

＜パネル討論＞

Ｒ．カール	同　前
Ｊ．Ｓ．キャロル	同　前
崔　長　東	韓国電力公社蔚珍原子力本部本部長
Ｙ．Ｓ．Ｒ．プラサド	インド原子力発電公社専務理事
Ｉ．Ｈ．ケレシー	パキスタン原子力委員会委員
鷲　見　禎　彦	関西電力(株)副社長

＜参加者との討論＞

4月11日（火）

一般参加者とのﾐｰﾃｨﾝｸﾞ（１７：３０～１９：３０）　於：日本都市センター　第２講堂

今回の年次大会では、アジア諸国でのエネルギー供給における原子力の役割を中心に、安全で信頼性のある原子力発電開発のための基盤整備や核不拡散の徹底などについて討論を行うが、ここでは年次大会に参加する一般参加者と、これらの内容を概括し、質疑応答や意見交換を行う。

ｺｰﾃﾞｨﾈｰﾀｰ：森　一久　(社)日本原子力産業会議専務理事

発表者：原　禮之助　セイコー電子工業(株)副会長
大塚　益比古　(財)原子力安全研究協会常任理事

4月12日（水）

セッション4（9：00～12：00）
燃料サイクル・バックエンドーそれぞれの選択

わが国は資源を有効に利用する観点から、使用済燃料を再処理し、ウランとプルトニウムをリサイクルすることとしている。高レベル放射性廃棄物については、それを安定な形態に固化した後、30年間から50年間程度冷却のための貯蔵を行い、その後地層処分することを基本的な方針としている。アジア諸国の原子力発電開発の進展によって、近い将来これら諸国も使用済燃料の管理や放射性廃棄物の最終処分の計画を検討しなければならないところである。ここでは、わが国が選択した燃料サイクル・バックエンド政策の意義ならびに計画を明らかにし、各国の経験を紹介するとともに、それぞれの方策について比較検討し、最終処分の今後の共通課題について意見交換を行う。

議長：鳥　井　弘　之	日本経済新聞社論説委員

＜基調講演＞
「燃料サイクル・バックエンドー日本の選択、その意義と計画」

池　亀　　亮	電気事業連合会原子力開発対策会議委員長 東京電力(株)副社長

＜パネル討論＞

池　亀　　亮	同　前
T．R．ラッシュ	米国エネルギー省（ＤＯＥ）原子力局長
李　　昌　　健	韓国原子力研究所研究委員
Ｊ.-Ｐ．ルジョー	フランス原子力学会会長
孫　　東　　輝	中国核工業総公司（ＣＮＮＣ）核燃料局総工程師
G．L．ワッツ	英国原子燃料会社（ＢＮＦＬ）取締役（国際担当）

＜参加者との討論＞

4月12日（水）

セッション5（14：00～17：00）
国際核不拡散体制の展望－東アジアを中心として

冷戦の終結は米ソ2極体制の崩壊を招き、国際社会は極めて流動的な情勢にある。このような中で、核弾頭から回収される核物質の管理や核兵器の拡散などの多くの問題が生じてもいる。来週には核不拡散条約の再検討・延長会議が開催され、条約の役割が検討される。このセッションでは特に東アジアにおける安全保障問題と原子力平和利用の進展を念頭において、輸出入管理や保障措置の体制を含む核不拡散体制の充実・強化について討論を行う。

議長：矢田部　厚彦　　ソニー(株)顧問
前駐仏大使

＜基調講演＞
「世界からみたアジア地域の核不拡散問題」
A. フ ラ イ　　米国外交評議会副理事長

＜パネル討論＞

尹　徳　敏	韓国外務部外交・安全保障研究院教授
ザ カ リ ア	元マレーシア外務省事務次官
S. M. ロゴフ	ロシア科学アカデミー・米加研究所所長
武田　修三郎	東海大学教授
A. フ ラ イ	同　前

＜参加者との討論＞

閉　　会

THE 28TH JAIF ANNUAL CONFERENCE
PROGRAM OVERVIEW

MON. APRIL 10	TUE. APRIL 11	WED. APRIL 12
Opening Session 9:30-12:20	**Session 2** 9:00-12:00 Asia's Economic Development and Nuclear Energy	**Session 4** 9:00-12:00 Back-end of Nuclear Fuel Cycle and Options
	Luncheon 12:15-14:15 AKASAKA PRINCE HOTEL **Film Show** 13:00-14:00	
Session 1 14:00-17:30 Seeking for Stable International Society - Tasks and Prospects	**Session 3** 14:30-17:20 Cultural Aspects of Nuclear Safety	**Session 5** 14:00-17:00 Nuclear Non-Proliferation Regime - Focus on East Asia
Reception 18:00-19:30 AKASAKA PRINCE HOTEL	**Dialogue with the Public** 17:30-19:30 LECTURE ROOM (NO. 2) NIPPON TOSHI CENTER	

The 28th JAIF Annual Conference

Basic Theme : Asia and Nuclear Energy
-Now A Stage of Evolution-

April 10-12, 1995

Tokyo, Japan
Japan Atomic Industrial Forum, Inc.

ADVANCE PROGRAM

April 10 (Monday)

REGISTRATION (8:45-, April 10)
Schonbach Sabo (Sabo Kaikan)

OPENING SESSION (9:30 - 12:20)

Chairperson:
Shoh Nasu
Chairman
Tokyo Electric Power Co., Inc.

Remarks by Chairperson of Program Committee
Chie Nakane
Chairperson
Program Committee
Chairman
The Council of Foreign Economic Cooperation
Professor Emeritus
University of Tokyo

JAIF Chairman's Address
Takashi Mukaibo
Chairman
Japan Atomic Industrial Forum, Inc.

Remarks by Chairperson of Atomic Energy Commission
Makiko Tanaka
Minister of State for Science and Technology

Invited A Lecture
"Nuclear Energy for a Stable International Society"
Hans Blix
Director General
International Atomic Energy Agency (IAEA)

<break>

Chairperson:
Jiro Kondo
Vice-Chairman
Japan Atomic Industrial Forum, Inc.

Invited Lectures

"Northeast Asia & the World from a Geo-Energy Perspective"

Kim Jin Hyun
Chairman
The Korea Economic Daily
Korea

"Nuclear Power in Developing Countries"

Charles B. Curtis
Under Secretary of Energy
Department of Energy (DOE)
U.S.A.

SESSION 1 (14:00 - 17:30)

Seeking for Stable International Society - Tasks and Prospects

An adequate supply of energy is indispensable if people are to lead secure, rewarding life. In the coming century, the world population is expected to increase significantly, and a rapid growth in energy demand is foreseen in spite of its improved efficiency. A great demand is newly arising especially in Asia. At the same time, a worldwide key concern of the 21st century will be harmony with the environment in the securing of stable energy supplies. In this session, representatives from various countries will present energy outlooks for Asia and the world, and discuss roles and problems of nuclear power in a stable global society.

Chairperson:

Takao Ishiwatari
Senior Adviser
Power Reactor and Nuclear Fuel Development Corp.
President
Japan Chemical Analysis Center

Lectures

"Nuclear Energy - Development Paths for the Future/The French Policy"

Philippe Rouvillois
Administrateur General
Commissariat a l'Energie Atomique (CEA)
France

"Energy Outlook and Nuclear Development in China" (tentative)

Zhang Huazhu
Vice President
China National Nuclear Corp. (CNNC)
China

"Principles for a Nuclear Safety Culture in Today's Global Nuclear Community"

Ivan Selin
Chairman
U.S.Nuclear Regulatory Commission
U.S.A.

Questions and Answers

Chairperson:

Katsushige Mita
Chairman
Hitachi Ltd.

Lectures

"Energy and Global Environment - How to Sustain our Society on the Finite Globe -"
Yo-ichi Kaya
Professor
Keio University
Chairman, Technical Program Committee
World Energy Council Tokyo Congress

"Nuclear Power in the U.K. - Energy for the 21st Century -"
John G. Collier
Chairman
Nuclear Electric plc.
U.K.

"Asian Development and Peaceful Use of Nuclear Energy"
I. Zuhal
Director General
Electricity and Energy Development
Ministry of Mines and Energy
Indonesia

Questions and Answers

RECEPTION 18:00 - 19:30
Grand Ballroom in Tower (2F), Akasaka Prince Hotel

April 11 (Tuesday)

SESSION 2 (9:00 - 12:00)

Asia's Economic Development and Nuclear Energy

The Asian region has been showing rapid development in recent years, and the role which Asian region could play in world political and economic scene is expected to become important. To sustain the rapid economic growth, projects to expand, or to newly participate in, nuclear power developments together with other energy sources are being announced one after another. International cooperation in this field is becoming steadily more active. Focusing on the outlook of a growing Asian economic zone, this session will address future energy demand, including conditions that restrict energy supply. Based on that future perspective, the session will summarize the role of nuclear power in securing a stable energy supply, which constitutes a foundation for all modern life. In the session, participants will exchange views on common problems in promoting nuclear power developments, and address issues of how regional cooperation should function effectively.

Chairperson:
Reinosuke Hara
Vice Chairman
Seiko Instruments Inc.

Keynote
"Economic Development and International Nuclear Cooperation in Asia"
Sumiko Takahara
Economist

Panel Discussion
Panelists:
Djali Ahimsa

Director General
National Atomic Energy Agency (BATAN)
Indonesia

Phillip Bayne
President and Chief Executive Officer
Nuclear Energy Institute (NEI)
U.S.A.

Tokio Kanoh
Director
Tokyo Electric Power Co., Inc.

Nguyen Dinh Tu
Chairman
Vietnam Atomic Energy Commission (VINATOM)
Vietnam

Prida Wibulswas
Professor
Thammasart University
Thailand

Commentator:

Discussion with the Audience

Note: "Discussion with the Audience" means discussion between the panel speakers and the audience. The audience is invited to exchange their views and make comments during each discussion.

LUNCHEON 12:15 - 14:15
Grand Ballroom in Tower (2F), Akasaka Prince Hotel

Remarks by Minister of International Trade and Industry
Ryutaro Hashimoto
Minister of International Trade and Industry

Special Lecture
"Earthquake and the Japanese"
Tuneji Rikitake
Professor Emeritus
University of Tokyo

FILM SHOW 13:00 - 14:00
Schonbach Sabo

Latest films on Japan's nuclear research and development activities will be presented to those who are not attending the Luncheon.

SESSION 3 (14:30 - 17:20)

Cultural Aspects of Nuclear Safety

It is important that equipment and systems be in good working order, in order to assure the safety of nuclear power generation. To maintain the required high standards, it is equally important that -- in addition to the technology -- engineers and all supporting organizations be of similarly high caliber. Throughout the Asian region with nuclear power plants being built and operated, more international technological exchanges will be undertaken globally. In this session, participants will present and discuss various ideas on how the countries including of Asia can evaluate, as a common base, the same high level of appreciation for safety-related activities, both individually and organizationally, along with their interest in the technologies of construction and operation of nuclear power plants.

Chairperson:
Shunsuke Kondo
Professor
University of Tokyo

Keynotes

"Sustaining Improvements through Safety Culture:
Problem Identification and Organizational Learning Processes"
John S. Carroll
Professor
Massachusetts Institute of Technology (MIT)
U.S.A.

"WANO: How to Improve Information Exchange overcoming Cultural Differencies"
Remy Carle
Chairman
World Association of Nuclear Operators (WANO)

Panel Discussion

Panelists:

Remy Carle

John S. Carroll

Choi Chang-Tong
Director, Ulchin Nuclear Power Division
Korea Electric Power Corp.
Korea

Y.S.R. Prasad
Managing Director
Nuclear Power Corporation of India Ltd.
India

Iqbal Hussain Qureshi
Senior Member
Pakistan Atomic Energy Commission
Pakistan

Yoshihiko Sumi
Vice President
Kansai Electric Power Co., Inc.

Discussion with the Audience

Dialogue with the Public (17:30 - 19:30)

Lecture Room (No. 2, 2F), Nippon Toshi Center

The 28th Annual Conference is focused on the role of nuclear energy as an energy source in Asia, which invites discussions on establishing a ground for a safe and reliable nuclear energy development and strengthening the NPT regime in the region. In this session, these will be open to the public for discussions and exchanging opinions.

Moderator:

Kazuhisa Mori
Managing Director
Japan Atomic Industrial Forum, Inc.

Introduction Speech:
Masuhiko Otsuka
Executive Director
Nuclear Safety Research Association

Reinosuke Hara and so on

Discussion with Audience

April 12 (Wednesday)

SESSION 4 (9:00 - 12:00)

Back-end of Nuclear Fuel Cycle and Options

In Japan, spent nuclear fuel is reprocessed to recycle uranium and plutonium in pursuit of efficient use of resources. As to the high-level radioactive waste, it is the nation's basic policy to vitrify such waste into stable packages, store those packages for 30 to 50 years for cooling, and dispose of them finally under the ground. As nuclear-power-plant developments continue in other Asian countries, they, too, in the near future, will have to address the issues of spent-fuel management and final disposal of radioactive waste. In this session, Japan will outline its nuclear-fuel-cycle back-end policies and plans, and discuss their significance. Participants will compare those policies and experiences with their own, and will exchange opinions on common future problems regarding final disposal.

Chairperson:
Hiroyuki Torii
Editorial Writer
Nihon Keizai Shimbun, Inc.

Keynote
"Nuclear Fuel Cycle and Backend Policy
- The Japanese Choice, Its Program and Meaning -"
Ryo Ikegame
Chairman
Committee for Nuclear Power Development
The Federation of Electric Power Companies
Vice President
Tokyo Electric Power Co., Inc.

Panel Discussion
Panelists:
Ryo Ikegame

Terry Lash
Director of the Office of Nuclear Energy
Department of Energy
U.S.A.

Lee Chang-Kun
Research Fellow
Korea Atomic Energy Research Institute
Korea

Jean-Pierre Rougeau

Chairman
French Nuclear Society
France

Sun Donghui
Chief Engineer
Bureau of Nuclear Fuel
China National Nuclear Corp. (CNNC)
China

Graham L.Watts
Director, International Group
British Nuclear Fuels plc. (BNFL)
U.K.

Discussion with Audience

SESSION 5 (14:00 - 17:00)

Nuclear Non-Proliferation Regime-Focus on East Asia

The end of the cold war has brought the diversification of the world, warning its fragmentation and unstability. There has been substantial number of problems arising related to nuclear weapons, such as the management of fission materials from dismantled nuclear warheads, the proliferation danger of those weapons, etc. As the NPT review and extension conference is to be held shortly, it is of importance to revise roles of the Treaty. During this session, a nuclear nonproliferation regime will be discussed in East Asian context in respect of its security concerns and growing interest in the peaceful use of nuclear energy. It will be accordingly considered how to strengthen the regime with a wide scope for the export control system of nuclear materials and effective safeguards.

Chairperson:
Atsuhiko Yatabe
Adviser
Sony Corp.
former Ambassador to France

Keynote
"Nuclear Nonproliferation: Asian Dangers in a Global Context"
Alton Frye
Senior Vice President and National Director
Council on Foreign Relations
U.S.A.

Panel Discussion
Panelists:
Yun Duk-Min
Research Professor
Institute of Foreign Affairs and National Security
Ministry of Foreign Affairs
Korea

Zakaria bin Haji Mohd. Ali
former Secretary General
Ministry of Foreign Affairs
Malaysia

Sergei M. Rogov

Director
Department of Military and Political Studies
Institute of the U.S.A. and Canada
Russian Academy of Science
Russia

Shuzaburo Takeda
Professor
Tokai University

Alton Frye

Disscussion with the Audience

Closing Remarks by Chairperson

第二十八回原産年次大会会長所信表明

平成七年四月十日
（社）日本原子力産業会議
会長　向坊　隆

議長、ご臨席の皆様、日本原子力産業会議会長の向坊でございます。

第二十八回原産年次大会の開催に当たり、主催者を代表して、一言所信を述べさせていただきます。

私たちは今、まさに二十一世紀を目の前にしております。私たちは未来への大きな希望を抱いて来世紀を迎えようとしているのでしょうか、それとも、重い荷物を引きずりながら新しい時代に入ろうとしているのでしょうか。

九十年十月のドイツの統一、九十一年末のソ連邦の崩壊に始まる動向は、長い間にわたって世界を支配してきた［恐怖の均衡］から、私たちを解き放ちました。それまで停滞していた米ソ両大国による最近の核軍縮への動きは、評価すべき大きな成果の一つといえます。また、欧州統合の強化や自由貿易体制への大きな前進などは、新しい国際社会を構築していくうえでのさきがけとして、曙光を感じさせるものでした。

しかしながら一方で、依然として地上の戦火は消えず、砲声の途絶えることはありません。また、私たちはこの地球上から飢餓をなくすことも、まだできておりません。今後、人口が大幅に増加することを考えますと、地球環境の保全や食糧の安定供給はさらに難しくなる可能性があります。こうしてみますと、私たちは明るい希望だけをいだいて来世紀の門をくぐる訳には行かないようです。私たちは解決されなければならない多くの課題をかかえています。

つまり私達は、米ソ冷戦時代のくびきから逃れて、平和で豊かな社会をつくろうと懸命に努力をしているのですが、次々に生じる新たな問題に翻弄されつづけているともいえます。直面している問題はきわめて複雑で、一面的な解決は難しい状況にあります。

社会がゆっくりと安定的に発展していたときには、人々はそれぞれの専門や得意な分野で、一つの歯車のように役割を分担して行けばよかったかと思います。しかし、現在のような複雑な社会の中では、人々、とりわけ専門家やリーダーたちは将来や他の社会に対する洞察力をもって、互いに協力し、情報を交換しあいながら、問題の解決をはからなければなりません。そして新しい社会秩序、国際秩序をつくって、それを次の世代に引き継いでいきたいものです。

原子力はその大量破壊兵器としての側面と、膨大なエネルギーの供給源を初めとする平和利用の役割とを持っており、すでに私たちの社会に複雑なかかわりをもってお

りますが、その取扱いは二十一世紀における人類の課題でもあり、繁栄の鍵となるものでもあります。私は本日、多くの原子力関係者が集ったこの機会に、冒頭に申し上げたような認識に立って、来世紀へむけての原子力の課題として以下の三つのことを申し上げたいと思います。

第一は、核軍縮と核不拡散の促進であります。

皆様ご存知のとおり、来週からニューヨークにおいて核不拡散条約（ＮＰＴ）の再検討と延長のための会合がもたれます。ＮＰＴが成立してから二十五年が経過し、条約の規定に基づき、延長の期限を決めるわけですが、会議では条約が二十五年にわたって果たしてきた役割を十分レビューし、条約を中心とする核不拡散体制の強化について明確な施策が示されることが望まれます。

核軍縮については、冷戦が終焉したことから、やっと膠着状態から脱したように思いますが、核兵器削減や包括的核実験停止条約（ＣＴＢＴ）交渉の進み具合を見ますと焦燥感さえ覚えます。核兵器の存在は人類にとって脅威であり、悪であります。核兵器国が核兵器に一定の政治的な役割を認め続けていれば、その効果を求めて密かに核を持とうとする国の意図を変えさせることはできないのです。

従って今後核軍縮を進展させることはもとより重要ですが、すべての核保有国が参加して、核兵器の削減からその全廃へとつながるプログラムをつくり、世界に示すことが求められます。また、原子力平和利用に携わるすべての国が、国際原子力機関のフルスコープ保障措置を受け入れることを初めとして、信頼醸成のためあらゆる努力をすることが必要です。自国の原子力活動、特に濃縮ウランやプルトニウムの存在量を適宜公表するなどが重要です。

第二の課題は、発展の著しいこのアジアにおいて原子力平和利用の基盤をしっかりとつくりあげることです。

近年、世界の経済は全般的に低迷状態にありますが、ＡＳＥＡＮ、ＮＩＥＳ諸国は飛躍的な経済成長を続けております。これらの諸国はその経済成長の糧としてエネルギーを必要としており、特に、中国、韓国、台湾、インドネシア、タイなどのエネルギー需要の伸びは極めて高いものがあります。すなわち、これら諸国の二千年のエネルギー需要量を九十二年のそれと比べますと、石油換算で約五億トン増加することになっています。これは現在の日本の年間のエネルギー需要総量にほぼ匹敵するもので、二千年にはもう一つの日本が出現するのと同じことになります。このため、各国ともエネルギー利用効率の向上や節約の努力を行うとともに、石油・石炭の確保と平行して、原子力発電の計画を進展させております。

昨年末現在で、中国、韓国、台湾、インド、パキスタン、タイ、日本で、原子力発電は七十七基が運転中、二十二基が建設中、二十三基が計画中でありまして、この総計はアメリカの運転中の原子炉の数百九基を上回っております。　インドネシアも二千四年頃に最初の原子力発電所を完成させる予定で、中国は二千二十年に三千万か

ら四千万キロワットに原子力発電の容量を拡大する計画であると聞いております。

つまり、アジアにおいて原子力発電はすでに主要なエネルギー源として選択されたわけであり、今後はこれをいかに円滑に推進するかの段階にはいっているといえます。アジアにおいて私たちはアイソトープや研究用原子炉の利用、研究者の交流など多国間の協力を進めてきた実績がありますが、今後は原子力発電の分野においても協力を進めていくべきです。アジアにおける原子力発電分野の国際協力のすすめ方を包括的に話し合うことが、緊急の課題です。このため私は本大会の準備委員長を対外協力の問題にもご造詣の深い中根千枝先生にお願いして、主としてアジアの原子力開発を討論していただくことにした訳です。これを機会にアジアの原子力平和利用の基盤づくりに向けて活発な議論が行われることを望みます。

最後に申し上げたい課題は、私たちがまだ十分に克服していない問題に力を結集することです。

そのひとつには、高レベル放射性廃棄物の処分があります。高レベル廃棄物の処理・処分の技術については、長い間の研究開発の実績があり、その安全性等に関する知見は相当の蓄積があります。しかし実際の処分については、フランスやスウェーデンなどにおいて大きな進展がありますものの、本格的なものはまだ実現されておりません。地層処分の立地はいずれの国においても困難な状況にあります。これは主として高レベル廃棄物処分の概念や事業内容、その安全に対する説明がまだ十分になされていないことにあると思います。

この問題は原子力開発に携わるすべての国にとって共通でありますので、互いに開発の成果や経験を交換し、できるだけ早くこの問題を立派に解決し得ることを具体的に示すべきであります。

科学技術は近年めざましく進歩しましたが、その社会との調和については必ずしも同じ様に発展しているとは思えない点もあります。先端技術の利用と社会や人間との調和は、常に忘れてはならない大切なことだと思います

原子力開発の重要な課題についてはまだいくつかあるかと存じますが、私見と致しまして以上三点を申し上げました。

最後になりましたが、本大会の準備委員長、準備委員ならびに各セッションの議長の方々、ご参集いただきました海外、国内の発表者の方々、そして会場の皆様に心からお礼申し上げ、私の所信とさせていただきます。　ご静聴ありがとうございました。

以　上

JAIF Chairman's address for the 28th JAIF Annual Conference

April 10, 1995
Chairman of JAIF
Takashi Mukaibo

Mr. Chairman, distinguished guests, ladies and gentlemen, I am Mukaibo, Chairman of Japan Atomic Industrial Forum (JAIF).

On behalf of the Japan Atomic Industrial Forum, I am very honored to be able to present my address for the 28th JAIF Annual Conference.

The 21st century is very close at hand, but are we entering the next century with big hopes in the future, or with a heavy burden on our shoulders?

We were freed from the "balance of fear", which had governed the world for a long period of time, by a series of trends, including the reunification of East and West Germany in October 1990 and the collapse of Soviet Union at the end of 1991. The recent movement toward nuclear disarmament by the two superpowers, the United States and Russia, can be said to be one of the most important achievements ever which should be valued highly in light of the deadlock experienced before. We felt the bright morning light, observing the enhanced unification of Europe and great advancement toward the free trade regime, because they served as the harbinger for the new international community to be built.

On the other hand, however, the fires of war are still continuing on the earth, and the roar of artillery never stops. We are also still unable to get rid of hunger from the earth. With the world population expected to increase substantially in the future, the conservation of the global environment and the stable supply of food may become further difficult. In this respect, we cannot enter the new century with just a shining hope. We have a lot of problems which have to be solved.

In other words, we are struggling to build a rich and peaceful society, freed from the yoke of the cold war period we still keep being faced with newly-emerged problems which occurred one after another. These problems are extremely complicated and it is difficult to solve them so easily.

When society was developing slowly and stably, each person could play his or her own role in their respected professional fields. However, in this complicated society, the people, especially the professionals and leaders, have to solve problems with a deeper insight into the future and other countries, while at the same time cooperating with each other and exchanging information. We should establish a new social and international order and pass it on to the next generation.

Nuclear energy has two aspects: it can be used as mass destructive weapons and can also be used peacefully as an important energy source. Nuclear energy is already in close relationship with our society. How to deal with nuclear energy has become an important challenge for mankind in the 21st century, as well as a key to prosperity. Today, taking this opportunity at the 28th Annual Conference in which many officials in the nuclear sector have gathered, I would like to propose the following three points as roles to be played by nuclear energy in the next century from the standpoint mentioned at the beginning of my talk.

The first point is for the promotion of nuclear disarmament and non-proliferation of nuclear weapons.

As you know, the conference for the extension and review of the Treaty on Non-Proliferation of Nuclear Weapons (NPT) will be held in New York from next week. Twenty-five years have passed since NPT was concluded, and the extension term is to be decided under the provisions of the Treaty. I hope that the role which NPT has played during the past 25 years will be fully reviewed and appreciated in the conference and the specific measures will be proposed to enhance the non-proliferation regime based on the treaty.

After the end of the cold war, nuclear disarmament seems to have finally broke out of the deadlock. However, I feel rather irritated to see the slow pace at which negotiations are being held for nuclear arms reduction and Comprehensive Test Ban Treaty (CTBT). Nuclear weapons pose a threat to the whole of mankind; therefore they are a vice. As long as nuclear weapon states continue to recognize a certain political role for nuclear weapons, it will not be possible to change the intention of non-nuclear weapons states which secretly try to develop nuclear weapons or possess them.

Thus, even though it is important to keep promoting nuclear disarmament, it is much more essential that all the nuclear weapons states should jointly formulate and demonstrate to the world a program which will ensure the reduction of them, leading to their total elimination. In addition, all the nations engaged in the peaceful use of nuclear energy should accept the full-scope safeguards of the International Atomic Energy Agency (IAEA) and make utmost efforts to gain the confidence of the public. They should also make public their nuclear activities, especially the inventory of enriched uranium and plutonium, when it is appropriate to do so.

The second proposal is to build up a base for the peaceful use of nuclear energy in Asian countries which are growing rapidly.

In recent years, the world economy has generally been in stagnant conditions, but ASEAN and NIES countries continue to make dramatic economic growth. These countries need energy as fuel for economic growth. Especially, the energy demand in China, Korea, Taiwan, Indonesia, and Thailand is increasing quite rapidly. Namely, the energy demand of these countries in the year 2000 is expected to increase by about 500 million tons in oil equivalent compared with that of 1992. This amount is nearly equal to the present Japanese total energy demand per year. This means that another Japan will emerge in 2000 as far as energy consumption is concerned. For this reason, the nations of the world are now making efforts to save energy and raise utilization efficiency, and promote nuclear power generation programs, while trying to secure the supply of oil and coal.

As of the end of last year, 77 reactors were operating at nuclear power stations in Chaina, Korea, Taiwan, India, Pakistan, Thailand, and Japan. 22 units were under construction and another 23 units were under planning. The total number (122) exceeds the number of reactors now in operation in the United States (109). Indonesia is also planning to complete its first reactor project by around 2004, and we hear that China plans to increase nuclear power generation capacity from 30 million to 40 million kilowatt in 2020.

All this means that Asian nations have already selected nuclear power generation as a major energy source and that they have entered the stage of how to promote it smoothly and effectively. In Asia, we have cooperated with each other in utilizing radioisotope and research reactors and exchanging researchers. In the future, we should also promote cooperation in the field of nuclear power generation. It is urgently needed to discuss comprehensively how to promote international cooperation in developing nuclear power generation in Asia. For this purpose, I asked Professor Chie Nakane, who has a deep knowledge of international cooperation, to be Chairperson of the Program Committee of this Conference and to talk about nuclear development mainly in Asia. I hope that active discussions will be held to help build a base for the peaceful use of nuclear energy in Asia, even after this Conference.

My last proposal is to concentrate our efforts to solve the pending problems.

One of these problems is the disposal of high level radioactive waste (HLW). We have long made research and development on disposal of HLW and accumulated a considerable store of knowledge concerning its safety, etc. As for actual disposal, however, even though such nations as France and Sweden have made substantial progress, full-scale disposal has not been undertaken yet. Every nation has faced difficulties in siting geological disposal facilities. I think that this is because not enough explanation has been given concerning the concept and operations of HLW disposal as well as its safety.

This problem is common to all the nations that are engaged in nuclear power generation. Therefore, the nations should exchange their development results and experiences with each other, and specifically demonstrate as soon as possible that this problem can be fully conquered.

In recent years, science and technology have made remarkable progress, but in some cases, they have not necessarily harmonized with the society properly. I think we should always place much emphasis on the harmonization between the utilization of high technology and society.

Even though there are still other important issues on nuclear development, I have pointed out the above three points as my personal opinion.

Lastly, I would like to express my heartfelt appreciation to the Chairperson of Program Committee of this Annual Conference, Committee members, and the session chairmen, as well as those who have gathered here both from Japan and abroad to make presentations, and all the participants of this Conference.

Thank you very much for your attention.

第二十八回原産年次大会

原子力委員会委員長所感（メモ）（案）

本日、第二十八回原産年次大会が、内外からの多数のご出席を得て、かくも盛大に開催されましたことは、まことに喜ばしく思います。

この年次大会は、毎年、その時々の世界の原子力をめぐる諸課題を的確に取り上げ、関係国の政策についての相互理解の増進や、共通の課題の克服に向けた国際的な取り組みの醸成に多大な役割を果たしてこられていることに、まず敬意を表したいと思います。

向坊会長、中根大会準備委員会委員長をはじめ、本大会の開催にご尽力された方々に

心からお祝いを申し上げます。また、本大会のために、はるばる世界各国から御参加された方々に敬意を表します。

本日の開会に当たりまして、一言御挨拶申し上げます。

（エネルギー需要）

まず、二十一世紀を展望いたしますと、地球人口の増加や開発途上国を中心とした世界経済の飛躍的発展などが予測される中で、今後の世界のエネルギー需要の増加は避けられません。とりわけ、今回の年次大会の基調テーマとなっているアジア地域は、かつてない高い経済発展に伴い、急速なエネルギー需要の増大が見込まれ、これに適切に対応していくことが必要となっています。一方、

人間活動の増大に伴って顕在化している二酸化炭素による地球温暖化等の地球環境問題に世界的な関心が高まっています。

　こうした中で、私たちは、石油をはじめとする貴重な資源を浪費することなく、また、地球環境との調和を図りながら、豊かで潤いのある生活を営み続けていかねばなりません。そのためには、より一層の省エネルギー化に

努めることはもとより、太陽光等の新エネルギーを積極的に開発・導入していかねばなりません。原子力は、二酸化炭素を排出せず地球の温暖化を招くことがないこと、貴重な化石エネルギーを節約できることなどの特徴を持ち、世界のエネルギー問題、地球環境問題の解決に貢献できることから、その果たす役割は非常に大きいものと考えます。

（放射線利用）

エネルギー利用以外にも、放射線は医療、工業、農業等各般の分野で広く利用されています。とりわけ、我が国では、重粒子線がん治療装置によるがん治療において画期的な成果が上がりつつあるなど、生活により身近なものとしての利用が期待されています。

（長期的視点に立った原子力開発）

このような認識の下、我が国の原子力委員会は、昨年六月に、二十一世紀に向けての原子力政策の基本的方向を示すために、「原子力の研究、開発及び利用に関する長期計画」を策定しました。

申し上げるまでもなく、原子力分野の研究、

開発及び利用の推進に当たっては、原子力技術の特徴を十分に踏まえなければなりません。すなわち、巨大科学技術システムとして具体化される原子力技術は、その開発の成果が実用技術として社会に貢献するようになるまでに長い年月、多額の資金、多数の人材を必要とします。また、二十一世紀の発展のためには、将来にわたりエネルギーの安定供給を確保していかなければなりません。こうした意味からも、原子力開発利用を進めるに当たっては、長期的視点に立って計画的に取り組んでいくことが重要です。

この長期計画においては、平和利用と安全確保を大前提として、四つの基本方針が示されています。

（核不拡散）

その第１の柱は「原子力平和利用国家としての原子力政策の展開」です。

東西冷戦構造の崩壊を背景として、核兵器の大幅な削減に伴う核物質の取り扱い問題や、北朝鮮の核開発問題など、核不拡散に関する世界の関心は非常に高まっています。

我が国においては、これまでも原子力開発利用を平和目的に徹して推進してきており、核不拡散との両立を図ることを基本方針としています。

国際的な核不拡散体制の維持・強化は、新たな核兵器国の出現を防止するだけでなく、世界の原子力の平和利用が円滑に発展していく上で不可欠です。「核兵器の不拡散に関する条約」、いわゆるＮＰＴは国際的枠組み

として、その中心となる柱であると認識しています。そのため、我が国としてはＮＰＴの無期限延長を支持します。その際、世界の平和と安全のために核兵器の究極的な廃絶に向け、全ての核兵器保有国は、より一層の核軍縮を進めることが重要であると考えます。

　さらに、北朝鮮の核開発問題については、昨年十月に米朝間の合意が成立しており、今後はこれが確実に履行されていくことが重要です。特に、その中心をなす軽水炉支援については、「朝鮮半島エネルギー開発機構（ＫＥＤＯ）」が本年三月に設立されました。我が国は、このＫＥＤＯに積極的に参加し、北朝鮮における原子力活動が平和目的に限られ、また、十分な安全の確保が図られるよう適切に対応していく所存です。この支援が

朝鮮半島ひいては北東アジアの緊張緩和につながるものと期待しています。

（原子力発電）

第二は、「整合性のある軽水炉原子力発電体系の確立」です。

米国で世界最初の原子の火が灯ってから約五十年、我が国で日本原子力研究所が原子力発電に初めて成功してから約三十年の年月が経ちました。現在、我が国においては、四千五十三万キロワットの原子力発電所が運転中であり、今後とも高い安全確保の実績を積み重ね、基軸エネルギーとしての役割を果たしていくよう関係者が引き続き努力していくことが重要です。

（地震対策）

ご承知のとおり、本年一月の阪神・淡路大震災においては、多数の尊い命が奪われました。この震災に対し、多くの国から暖かい援助をいただきました。この場を借りて改めて御礼申し上げます。私たちは、二度とこのような大惨事を起こさないためにも、今回の地震の教訓をあらゆる方面で活かしていかなければなりません。

我が国の原子力施設では、これまでも地震に対する安全対策が講じられており、今回の地震でも原子力関連施設への影響はありませんでした。しかし、これに安住することなく、関係者が気を引き締めて安全対策に徹底して取り組んで行かなければなりません。そのため、より一層の万全を期すとの観点から、

原子力安全委員会は耐震安全検討会を設置し、今回の地震から得られる科学的事実の調査分析を進めているところです。

（バックエンド対策）

原子力発電を進めるに当たって、放射性廃棄物の処理処分と原子力施設の廃止措置、即ちバックエンド対策は重要であり、原子力による便益を享受している我々の世代は、その責任を果たしていかねばなりません。

我が国においては、低レベル放射性廃棄物の処分について、既に六カ所村の埋設センターの運営が軌道に乗っているところです。一方、高レベル放射性廃棄物の処分については、ガラス固化した上で、長期間にわたって人間環境から隔離させるため深地層処分すること

を基本方針としています。実際の処分については、二〇三〇年代から、遅くとも二〇四〇年代半ばまでには実施できるよう、処分事業の実施主体の検討や地層処分技術の確立を目指した研究開発を進めています。

なお、我が国の電気事業者は、原子力発電所から生じる使用済燃料の再処理の一部を英仏へ委託しています。現在、この再処理により生じた高レベル放射性廃棄物ガラス固化体の我が国への最初の返還輸送が進められています。この輸送について、内外のご理解の下、円滑に行われますよう、安全確保に万全を期すとともに、可能な限りの情報の公開に努めてまいりたいと考えています。

（核燃料リサイクル）

第三は、「将来を展望した核燃料リサイクルの着実な展開」です。

核燃料のリサイクルは、長期的なエネルギーセキュリティの確保、放射性廃棄物の処理処分の適正化という観点から、我が国の原子力平和利用政策の基本としています。今後とも国際的な理解を得ながら、核燃料リサイクルを着実に進めていきたいと考えています。

昨年四月に初臨界を達成した原型炉「もんじゅ」を中心とする高速増殖炉の開発については、これは計画的に進めます。また、環境への負荷の低減、核不拡散抵抗性の向上等の観点から期待される新たなアクチニド・リサイクルについては、研究開発を進めることとしています。

我が国が、内外の理解を得つつ、この核燃料リサイクルを推進するに当たっては、核拡散に係る国際的な疑念を生じることのないよう核物質を厳重に管理することはもとより、必要な量以上のプルトニウム、即ち、余剰プルトニウムを持たないとの原則を堅持しつつ、合理的かつ整合性のある計画の下でその透明性の確保に努めてまいります。そのため、我が国が提唱しているプルトニウム利用計画の透明性向上に向けた国際的枠組み作りについても、今後とも積極的な役割を果たしてまいります。

（多様な展開）

第四に、「原子力科学技術の多様な展開と基礎的な研究の強化」です。

多様化、高度化する原子力へのニーズに適切に対応し、国民の福祉の一層の向上を図るという観点や、国際公共財というべき人類の知的ストックの蓄積に我が国が貢献するという観点から、既存の原子力技術の高度化とともに、新しい原子力技術の創出が必要です。原子力技術は、核融合、高温ガス炉による熱供給、加速器によるビーム利用など、応用範囲は極めて広いものであり、今後とも多様な展開を図って行くことが重要です。同時に、我が国の原子力開発活動に関しても、国際的にも開かれた体制を構築し、原子力の先端的研究開発を活性化していくことが重要です。特に、核融合分野のＩＴＥＲ計画等の国際協力に主体的かつ積極的に参画してまいります。

（情報公開）

さて、原子力開発利用を円滑に進めていくためには、「国民とともにある原子力」であることが重要であり、国民に対して可能な限り情報を提供するとともに、国民との対話の努力を続けていくことが必要です。今次大会においても、そのような試みがなされると伺っています。

我が国としては、以上のような原子力開発利用長期計画に基づき、平和利用と安全確保、情報公開と透明性の確保を原則として、国内外の理解と協力を得つつ、核燃料リサイクルをはじめとする原子力開発利用の着実な推進を図ってまいります。また、アジア地域を含む世界の原子力平和利用に関し、これまで

我が国において培った経験を活かして積極的に貢献していきたいと考えています。

エネルギー資源に乏しく、唯一の被爆経験を有する我が国といたしましては、核不拡散と両立し得る原子力平和利用体系を定着させ、長期的に世界の持続的発展に寄与していくことが重要と決意を新たにしています。

今日から三日間にわたり、参加された皆様により活発な議論、意見交換が行われ、本大会が有意義なものとなるよう心からお祈り申し上げ、私の御挨拶とさせていただきます。

平成七年四月十日

国務大臣　科学技術庁長官

原子力委員会委員長

田中　眞紀子

Check against delivery

"NUCLEAR ENERGY FOR A STABLE INTERNATIONAL SOCIETY"

Hans Blix
Director General
International Atomic Energy Agency

Opening Session, Annual Conference of Japan Atomic Industrial Forum

Tokyo, 10 April 1995

In this last decade of the 20th century our global population will grow from 4 to 5 billion people, most of them needing drastic improvement in their living conditions, *inter alia* through greater use of energy, particularly electricity. During this decade the world will shrink further and we shall all get even more dependent on each other. We shall be in great need of international stability to avoid death and destruction through armed conflicts, to free scarce resources through disarmament and to promote trade and development. Two of the most important questions we must ask are:

Can we contain and eventually eliminate the threat of nuclear weapons? and

Can we use nuclear power as a major part in responding to our growing energy needs?

I can think of no place more appropriate to discuss and reach a hopeful conclusion to these questions than Japan, a great power that has been uniquely successful in rapidly raising the living conditions of its population, that has categorically renounced nuclear weapons and that is rapidly developing nuclear power as a major economic, safe and environmentally benign source of energy.

But the questions must be examined not only with Japan but the whole world in view. I shall begin with the nuclear weapons.

At the terrible dawn of the nuclear era, fifty years ago, there was only one nuclear-weapon State. It did not take many years before there were five declared nuclear-weapon States and a few more having or being close to having these weapons. The stockpiles of warheads in the superpowers grew to many tens of thousands, sufficient to wipe out civilization.

It is claimed that the possibility of mutually assured destruction brought stability and that the greatest danger to the world lay and still lies in a spread of nuclear weapons, to further countries. There would be fingers on more nuclear triggers. While it is easy to see the danger of proliferation, we would certainly wish our confidence in international stability to be based on something less threatening than nuclear deterrence.

Fortunately today the ideological and power struggle that dominated most of the past fifty years has come to an end. All great powers and most other States, too, seem ready to accept that boundaries shall no more be changed by force. This shift in attitude, which we hope is permanent, and which is certainly linked to the awareness of our modern potential for destruction, is leading to increased confidence in the stability of peace and international borders in most parts of the world and particularly between great powers. It is also rapidly leading to accelerating disarmament.

The superpowers are now dismantling their nuclear weapons so fast that there is a major problem of what to do with all the excess fissile material and how to provide assurance that its removal from military inventories is irreversible. We are also hopeful that a world wide ban can be reached on the further production of nuclear material for weapons use and that a comprehensive ban on any further testing of nuclear weapons can be agreed. Can we thus begin seriously to hope for fulfilment of the double aim of the nuclear non-proliferation treaty - disarmament by the declared nuclear-weapon States and renunciation of nuclear weapons by all others? If so, it would mean that the States of the world eventually abandoned the option of war in international relations and turned to settle conflicts by other means. If so, vast resources now devoted to armed forces could be released for development. Some hard-headed statesmen are, indeed, *beginning* to think of a world in which the only remaining nuclear weapons would be controlled by some international security body. Evidently such a state of affairs is far away, however, and we must now focus on maintaining stability and balance during the first steps in the march away from the nuclear brink. Effective verification will be an indispensible element in all measures leading to nuclear disarmament. The IAEA, which has a long experience in this field, is ready to provide verification services. It is building on its experience and seeking to strengthen and develop the effectiveness of its verification.

The production of nuclear material for weapons and the construction of weapons will be within the ability of an ever growing number of States in a technologically advancing world. It remains important to avoid any incentives to such weapons production by creating or maintaining detente globally and regionally. Another matter of importance will be to demonstrate that any departure from nuclear disarmament or arms control agreements would be dealt with decisively. A third requirement will be for *effective international verification.*

In one week's time a conference begins in New York to examine whether the *Non-Proliferation Treaty* is to be extended for an unlimited or a specific period of time. There can be no doubt that this treaty and the other treaties under which States have renounced nuclear weapons, the Tlatelolco Treaty and the Rarotonga Treaty, are contributing to stability. With Cuba recently signing the Tlatelolco Treaty we can expect that this treaty will soon enter into force fully and make Latin America and the Caribbean a nuclear-weapon-free zone. With South Africa and Algeria having joined the NPT and a treaty for an African nuclear-weapon-free zone already drafted, we may also soon see such a zone become a reality.

Some outstanding areas remain. In the Middle East one may hope and expect that a continued peace process will lead to agreement on a zone free of weapons of mass destruction. On the Indian subcontinent the renunciation of the nuclear weapon option would become less difficult if the global disarmament process continued further and if regional detente were brought about. It may be hoped, lastly, that continued stable great power relations in East Asia and enlightened self-interest of all parties concerned will bring arrangements, particularly regarding the Korean peninsula, guaranteeing an exclusively peaceful use of nuclear energy .

To proceed with disarmament and remain committed to non-proliferation States need to feel confident that others are fully respecting their commitments. In no area is verification of implementation more important than in nuclear commitments. After the discovery that Iraq, a party to the NPT, had secretly developed the ability to enrich uranium and begun to design a nuclear weapon, the world is looking to the IAEA to supplement its effective verification of nuclear material in declared installations by verification that there are also no clandestine nuclear installations. Proposals to respond to this concern, and to make a successful hiding of nuclear activities much more difficult, were endorsed in a general way in March by the IAEA Board of Governors. While these proposals will considerably strengthen the effectiveness of safeguards, they are really not very onerous and the increased cost for some of the new measures are likely to be offset by savings through the elimination of certain routine inspections. Implementation of the proposed measures will, however, call for the exercise of good will and full co-operation with the IAEA. In return the new measures will provide a higher level of confidence that non-proliferation commitments are respected and thus contribute to international stability.

I turn now to the question whether nuclear power can contribute to greater stability in the international society.

Let me first note that experience has shown us that nuclear power and nuclear weapons are not, as alleged by some, inseparable Siamese twins. A large number of States, including Japan, are using nuclear power without having nuclear weapons and one may even be hopeful, as I have explained, that the process of nuclear disarmament will eventually result in no single nation possessing such weapons. As we proceed in this direction, reducing the nuclear weapon arsenals and their role, we may hope that people's perception of nuclear energy will shift from its destructive to its productive capacity - that is its capacity to contribute to our welfare by generating heat and electricity. I submit that this contribution is indispensible for stable and sustainable development and that it is high time that governments publicly recognize it. Let me explain.

An increasing world population demanding more food and better living conditions will need more energy. Greater efficiency in energy use will not by far offset the expanded need, which naturally will be the greatest in the developing countries. Today a Swede uses some 17 000 kWh/year and a citizen of Bangladesh uses 80. Where is the added supply of electricity to come from?

The dominant sources of energy today are fossil fuels - oil, coal and gas. They will remain dominant for a long time still, but oil and gas reserves are expected to be exhausted within less than a century at the current rate of consumption.

Having considered our concern that nuclear energy in military use may threaten peace and stability, we should remember that fossil fuels, too, sometimes pose a threat to peace and stability. Indeed, the interest to control oil resources and oil supply has led to great international political and economic convulsions and even to armed conflicts. While it is true that nuclear energy can provide horrendous means of warfare, and that nuclear installations could be the subject of attack in armed conflicts, wars are not fought over power reactors or uranium resources. On the contrary reliance on nuclear power plants reduce our dependence on fossil fuels and give a measure of energy independence, as uranium fuel can be stored for several years' operation. Countries like Sweden and France with much nuclear power use little or no fossil fuel for electricity generation. In Japan some 30% of the electricity is nuclear generated. It is true, of course, that the world's uranium resources, though ample today, are also finite. However, reliance on breeder reactors could give an almost limitless supply of fuel for nuclear power if, in a future, uranium resources should become scarce.

Other alternatives to fossil fuels than nuclear power and hydro - solar power, wind power, geothermal power, biomass - today provide only a fraction of a percent of the world's commercial energy. Although the share of these sources can and should increase, they are not expected by authoritative energy institutions like the International Energy Agency of the OECD or the World Energy Conference to be able economically to provide even as much as 10 percent of the world's needs for commercial energy by 2020. This conclusion, I must add, is not accepted by those who do not want to be driven to the conclusion that nuclear power is indispensible, because they are opponents of nuclear power or because - without being opponents - they despair about public acceptance of nuclear power.

An important issue is now the concern that increased global use of fossil fuels must be avoided, indeed that the use should be reduced, in order to limit emissions of greenhouse gases, notably CO_2, which inevitably occurs in all combustion of coal, oil and gas. There is a similar concern about the leakage of methane - another greenhouse gas - from extraction sites and gas pipelines. This leakage is estimated to be anything between 5-12% of the world wide natural gas production.

The global warming issue contains a considerable amount of political and economic dynamite and it is fast moving up on the world agenda. The fear stirs us all that we may be significantly affecting the world's climate and living conditions - making the atmosphere warmer, perhaps making the weather more volatile and perhaps even causing a rise in sea levels. If sustained by further data this fear will prompt even stronger demand for stabilizing action.

But what action?

Some developing countries are already rightly pointing out that it is the industrialized countries' burning of enormous amounts of fossil fuels that has led the world to this threat. At a recent Asia-Pacific Leaders Conference in Manila it was argued that the industrialized countries should *reduce* their greenhouse gas emissions by 20% by the year 2005. It was not fair to demand that developing countries that emit little CO_2 per capita should hamper their development by abstaining from using more fossil fuels, like coal, particularly if these sources exist domestically. While this argument is not rejected by industrialized countries, they have yet to present and implement concrete policies to reduce CO_2 emissions. Some experts and policy-makers point out that, although the rise in CO_2 levels in the atmosphere is already a measurable fact, the climate models pointing to a further warming contain many uncertainties and warn against very expensive policies which might later turn out to have been unnecessary. They do not advocate that we should remain passive and they realize that our grandchildren might regret it if we did not take the threat seriously. They rather advocate that we should pursue policies which *would* help counter global warming, if one is occurring, but which we would not later regret as wasteful if the threat of global warming turned out to be a mirage. They urge a so-called no-regret policy.

Stimulating the *efficient use of energy* is often described as a no-regret policy, because it would generally help to reduce energy use and restrain CO_2 emissions and if the investments were profitable no resources would be wasted.

Shifting from coal to *natural gas* may also be a policy one would not regret, because combined cycle gas use is at present very economic and gas emits about 40% less CO_2 per energy unit as does coal. However, the security of supply could be somewhat uncertain at the end of a pipeline and the stability of future gas prices is uncertain. Nevertheless an increased use of natural gas seems at present to be a preferred option in many places, because it is less environmentally objectionable than coal and it is less politically objectionable than nuclear.

Shifting from fossil fuels to *renewables* like solar, wind and biomass cannot be advocated as no-regret policies at present since these sources, in particular solar generated electricity, are more expensive. Research and development is recommended and large sums are in fact used for this purpose.

It would seem evident that a greater use of *nuclear power* would be a no-regret policy. It results in practically no CO_2 emissions, nor in any emissions of SO_2 and NO_X. It is competitive even with coal and it provides energy independence. It can be used to generate electricity for which the demand is increasing the fastest. It could also be used for generating industrial heat, for district heating or for water desalination. As large numbers of warships and some ice-breakers are propelled by nuclear power, we know that nuclear power has a potential - not much exploited - use for commercial ship propulsion. It cannot, however, be used as an energy source for automobiles, trucks or aeroplane - which do consume vast quantities of oil-based fuel. However, greater future reliance on electric trains, subways, trams, trolleybuses, could reduce or at least restrain the consumption of fossil fuels, especially oil-based ones for transportation purposes. Should we succeed in making electricity-driven automobiles economic and practical, a huge reduction in oil consumption - and pollution - would become possible. Also, in the long term, there is even a possibility to produce hydrogen from water using high temperature heat from nuclear energy. The hydrogen can propel automobiles. In Japan a high temperature gas cooled reactor to provide such high temperature nuclear heat is under construction and hydrogen-propelled automobiles are also under successful development.

The threat of global warming has elicited different response scenarios described by the International Panel on Climate Change (IPCC) which was set up by the World Meteorological Organization and United Nations Environment Programme and which is the most authoritative international body dealing with these matters. These scenarios show that an option known as the "High Nuclear Variant" and relying on greater use of nuclear power, has considerable CO_2 abatement capacity. However, the Panel's latest draft report underlines various concerns about nuclear power, such as safety, waste and proliferation. Also it highlights a "Low Nuclear Variant" scenario under which by the year 2100 renewable sources, including biomass and hydro, would provide some 83% of the world's total commercial energy supply and more than 90% of its electricity. While this "low energy scenario" may appeal to specific environmental constituencies around the world, it is questionable how credible and how useful it can be as an answer today to the problem of increasing greenhouse gas emissions. Nor can we see evidence that governments, authoritative energy organizations or utilities place much faith in it. The needs for energy are immediate but the technologies envisaged in this scenario are not mature, and not economically competitive.

It is undeniable that nuclear power, whose share in the world's electricity generation increased rapidly from 5% in 1975 to 15% in 1985, has since then stagnated everywhere except in East Asia, where it is providing a large part of the electricity needed for rapid economic growth. It is also undeniable that while, earlier, recession was responsible for nuclear power's stagnation in many Western industrialized countries, today a main reason for the stagnation is rather that many political parties and governments without necessarily being negative to nuclear power, know that they can win some votes by staying away from more nuclear power but are not likely to win many votes by advocating its use. This situation could change if the fear of global warming increases and sharper demands are raised for effective action to restrain CO_2 emissions. While it would not be argued that a much increased reliance on nuclear power, alone, would allow a sufficient restraint on fossil fuel use and CO_2 and methane emissions, such restraint is unlikely to be achieved without a much increased reliance on nuclear power. In a speech before the recent Berlin Conference on Climate Change, a representative of the International Energy Agency of the OECD pointed out that there had been an annual average improvement in carbon intensity per unit of energy of about 0.4 percent between 1971 and 1992 and that it was attributable to the substantial growth in nuclear power over that period. He was apparently the only speaker referring to nuclear power at the Conference and remarking that nuclear power's share in the world's fuel mix is expected to decrease, the CO_2 emissions can be expected again to follow energy demand growth. Was this sustainable, he asked.

As a result of the dilemma that improvements in energy efficiency will not offset increased energy needs, that renewable sources of energy - apart from hydro - are not economically competitive and that nuclear power in many countries is not at present, shall I say, "politically competitive", there is in fact a continued global increase in the use of fossil fuels and consequent emissions of CO_2 from their burning and an increase in methane leakage from natural gas production and transportation.

What actions can we recommend to promote the role of nuclear power as an economically viable major source of energy in today's world and as a no-regret choice to help meet the concern about global warming? I am relatively optimistic. Someone said he had great confidence in governments: when all other options have been exhausted, they will choose the rational course. Let us hope so.

The attitude of the public seems decisive to influence the governments - even though, to be sure, the latter *can* influence the views of the public. Even though governments can influence the views of the public and should have a moral-political duty to provide leadership, it seems that in the question of nuclear power it is at present mostly the public's attitudes that influence government action. A simple conclusion is that one must listen to the concerns which lead the voters to be unconvinced about the merits of nuclear power and either persuade the voter that their concerns are unfounded or take action to reduce concerns that may be understandable.

A first answer must be to promote more education and public information about nuclear energy - through schools, utilities, media. The most dedicated opponents of nuclear power may not listen to such information, but many will. The information must, of course, show not only what benefits but also what problems are connected with the use of nuclear power and how these are met. It must remind the public that no energy generation is without some risk to health and the environment and that the only rational approach - if we want energy - is to *compare* not only the economic costs and reliability of different sources of energy but also the risks to life, health and environment which they pose. Such studies are in fact carried out by a number of international organizations, including the OECD, the European Union and the IAEA and a conference next year will highlight the results.

Clearly a major source of public concern about nuclear power relates to safety, in particular the fear of accidents involving radioactive releases. In response it is not enough to refer to more than 7000 reactor years of safe operation with Chernobyl as the only case leading to significant radioactive releases into the environment. It must be shown that through international co-operation and assistance safety upgrading is speeded up wherever needed, in particular in plants in the former Soviet Union. Much has been attained already but some further efforts do remain to be made. We should also show that new nuclear power reactors designs lead to continuously increased safety. Indeed we might seek agreement on safety criteria for future power reactors, e.g. a requirement that their safety level shall be such that no plans need be made for measures to be taken outside the plants in the case of an accident. Such a requirement is already written into new German law.

We must also demonstrate that, in addition to the national legal and supervisory systems which have the direct responsibility for nuclear safety, an international infrastructure relating to nuclear safety is put in place, creating international standards to which all are committed and supplemented by services and co-operation to maintain a safety culture that is, I think, unmatched by any other industry, except possibly aviation. The latest addition to this infrastructure is the International Safety Convention which was signed under IAEA auspices in Vienna last September. In the next few years we can expect the conclusion of conventions on safety in the disposal of radioactive wastes and about liability for any damages caused by nuclear accidents. Perhaps utilities operating nuclear power plants should also contemplate contributing to a joint international fund that could be used for compensation and clear-up if any radioactive releases were to occur from nuclear plants.

The second most important public concern about nuclear power relates to *wastes*, which may remain radioactive for tens of thousands of years. It must be pointed out, of course, that the limited volumes of these wastes make it possible to isolate them in their entirety and put them deep down in stable geological formations - something that is simply not possible to do with the wastes of fossil fuels because of their enormous volume. The stark reality today is that the wastes from fossil fuels *cannot* be handled in a manner that is responsible vis-a-vis future generations. The world's atmosphere or the surface of the earth are the final disposal sites of the heavy metals that are toxic forever and the CO_2, SO_2 and the NO_x that are released in the combustion.

Action to build intermediate storages for high level nuclear waste and repositories for low and medium level radioactive wastes must be speeded up. There is nothing to prevent us in the meantime from exploring whether economically viable methods can be developed that would drastically shorten the time during which presently long lived nuclear waste remains radioactive.

A third concern of the public has been that the development of nuclear power might risk to increase the capacity of countries to make nuclear weapons. It is true, of course, that the large cadres of nuclear scientists and engineers which are needed for a nuclear power programme can also provide the talent needed for the production of fissile material for weapons. However, it must be pointed out that, contrary to President Kennedy's pessimistic prediction years ago that there would be dozens of nuclear-weapon States, the expansion of nuclear power in the world has gone hand in hand with *increased* commitments to an exclusively peaceful use. I am not suggesting that there is ground for complacency. The case of Iraq has demonstrated that there *can* be clandestine programmes and that vigilance is necessary to remove incentives to weapons developments and to sharpen verification. Nevertheless the world as a whole is turning its back to the nuclear weapons era. It is no longer unrealistic to raise the double aim that those who do not now have nuclear weapons should commit themselves not to acquire them and that those who have the weapons should rapidly move to nuclear disarmament. Freed form the evil shadows of the nuclear weapons, the tremendous force of the atom might be welcomed as naturally as the force of gravity and be accepted as a sustainable, environmentally benign source of energy contributing to and not disrupting stability in our international society.

Northeast Asia & the World From a Geo-Energy Perspective

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I. The Challenge Facing Humanity

In the middle of the 21st century, 10 to 15 billion people will inhabit the earth, according to current population estimates. This increase poses a serious challenge to our civilization, and can easily develop into the major crisis of the 21st century.

Of the billion years of earth's long history, it is only after the 20th century that the earth's population has surpassed the one billion mark. When Jesus Christ was born 2000 years ago, the population of the earth was only 100 million. The population of mankind reached 1 billion during the course of 400,000 years, but, it has increased by 10 times during the course of 200 years. Can the human civilization and science of the 20th century and 21st century really sustain such a growth in population with any quality of human living standards?

Responsible people must now address this question to the earth, the sun and the rest of the universe, and most of all, to ourselves.

The environmental problem can be defined among the subjects of wastes and environment. On assuming that there are two sides on energy, one is the problem of the environment and the other is about supply. How could the current population and 1.5 billion human lives in Northeast Asia, in countries such as Japan, China, Taiwan, and Korea, secure clean and safe energy resources with the effect of producing a respectable life style.

In the technologically advanced countries, 700 million people are supplied with relatively clean and safe energy. However, this energy production has been detrimental to the environment of our planet. Our global environment is a victim of this mass energy production and consumption.

The rapid population growth projected for the next century can be expected to cause major changes in the future. These changes can be summarized as follows:

- Firstly, as the global population increases, the gap between rich and poor countries will widen.
- Secondly, the cost of clean and safe energy will increase, making it difficult for poorer countries to develop "high quality" energy production systems.
- Lastly, the natural trend towards urbanization contributes to the degradation of the world's environment.

I would like to present the following recommendations to address these crucial predicaments.

1) We should endeavor to reduce or at least maintain the current population;
2) We should shift our focus from trying to accumulate wealth to improving the quality of life; and
3) Through technological innovations and inventions, we should try to ensure low cost, clean and safe energy for the entire population.

We must either accept fundamental changes to our life style or produce a technological breakthrough to our energy problem. Either solution is a huge challenge for humankind's ingenuity and survival.

The wastes produced during the process of human development are now jeopardizing humans themselves. In the past, we could count on natural cycles to eliminate much of our wastes. Sadly, our environment can no longer sustain the natural cycle of waste elimination.

The problem of waste management is particularly serious in underdeveloped countries due to the combined effect of commercialism and a large, growing population. Household waste problems may be resolved by relying on market mechanisms. The problem is easily perceived by our senses and is part of everyday life to the general population; industrial waste, however, is not readily part of everyday life and therefore is not perceived as a problem. This does not, however, imply that it is not as serious a problem.

II. Global Testing Ground: the Yellow and East Seas (Sea of Japan)

The Korean peninsula, located between the Yellow and East Seas, can be seen as a good example of the energy and environmental problem which we are facing. The population density of the peninsula and the other countries of the area — China, Taiwan, Hong Kong and Japan — is the highest in the world. Many large, overpopulated cities are located in the region, as are the Yellow Sea and the East Sea, which are, respectively, the second and third most polluted bodies of water in the world. World Watch reports that air pollution in Chinese cities is the worst in the world, and that the ozone level in large metropolises is three times that of Los Angeles, USA. Coal consumption, which accounts for 76 percent of the total energy consumption in China, is the main offender. Unless alternative energy sources are introduced urgently into China, the surrounding countries of North and South Korea and Japan will be subjected to the ravages of acid rain and the greenhouse effect.

The Xinhwa News Agency of China reported on January 9, 1995 that as of 1993, acid rainfall fell on 2.8 million square kilometers of China's total 9.6 million square kilometers of land. This represents an increase of 60 percent compared to the figures reported in 1985.

The director of the Environmental Protection Center of China expressed anxiety that the areas affected by acid rain had spread as far north as the northern part of the Yangtze River. Furthermore, when the director was interviewed by the China Daily on January 7, 1995, he stated that he "is considering imposing an extraordinary environmental tax" on the ten top polluted metropolises such as Beijing and Shanghai.

The Associated Press reported on May 20, 1994 that the economical losses caused by environmental pollution in China amounts to 11.5 billion annually, representing 3 percent of China's GNP. The same report stated that in a city of 4 million people in the Sichuan province, black acid rain pours down on the populace. Also the report commented that an industrial city located in China's northern province near North Korea cannot be photographed by satellite because the air is heavily contaminated.

An unpublished report by the World Bank, quoting materials provided by the Chinese ministry in charge of health, states one out of every four deaths in 1988 was due to chronic lung disease, which in turn can be traced back to air pollution.

The people in the areas surrounding the Yellow Sea and East Sea are in danger of health problems caused by air pollution and destruction of natural environmental systems. This danger is accentuated if China's economy continues to grow at the current rate.

Environmental problems concern developed and developing countries equally. Are advanced countries better able to cope with the problem? Developing countries need to consider the consequences to the environment of their population growth, urbanization, and growth of their manufacturing industry which are the highest growth rates in the world. Worldwide energy consumption could increase at unprecedented rates.

III. Change of Northeast Asia — Focusing on Yellow Sea and East Sea

The area along the Yellow Sea and East Sea including the Republic of Korea, Japan, China, Taiwan, and Hong Kong has become a center of world economy.

In reference not only to the population, manufacturing, trade, and capital but also to a growth trend in the area along the Yellow Sea and East Sea, it is certain that this area is

[Table 1] Production by Industry and Region

(unit:%)

	Northeast Asia [1]	EC	USA	Other Areas	
Automobile [2]	31.0	26.1	22.3	20.6	100.0
Shipbuilding [3]	75.6	16.4	-	8.0	100.0
Semiconductor [4]	47.7 (Japan: 40.4)	9.0	40.5	2.8	100.0
Textile [5] (Including clothes)	35.3	32.0	5.8	26.9	100.0
Machine tool [6]	37.5	40.6	11.6	10.5	100.0

1) Japan, China, Korea, Taiwan & Hong Kong included
2) Cars produced in 1993
Source: "Current Status of the World Automobile Industry: 1993"
The Korea Automobile Manufacturers Association
(Source: SMNT, National Sources LMC Forecasts)
3) Gross tons of 1993
Source :"Information on Shipbuilding in 1993"
The Korea shipbuilders' Association
4) Sales in 1993
Source: DataQuest
5) Exports in 1991
Source: OECD
6) Production in 1993
Source: American Machinist

becoming a center for world economies.

Considering the economic growth rate, energy consumption increase rate, urbanization rate, population mobility rate, and information processing rate, this area is likely to be a center of environmental and social problems as well as that of a world economy.

Combining values, politics, and culture to the economic and social factors, Northeast Asia is expected to be an influential place with growing dynamism from this time forward.

Today, it is a historical fact that the area along the Yellow Sea and East Sea has become a center of the manufacturing base for the world. After the Industrial Revolution, Europe and the American continent assumed the leadership in modern manufacturing. However, after the 1980's with the incorporation of the US and Northeast Asia into a trading area, the trade of the Pacific Basin countries began to increase over that of the Atlantic Basin countries. Entering the 90's, the Pacific Basin took the top place in the world for manufacturing main items as indicated in Table 1. Items such automobiles and semiconductors are not the outcome of oriental culture and life, but of Europe and North America.

In the near future, taking into account the dynamic growth of China, the role of this area along the Yellow Sea and East Sea as a central place in the world will be strengthened. In addition, considering ASEAN's growth and its relationship, it can be easily seen that the acceleration of the growth rate through change in the central place of the manufacturing base of the world is accompanying the increase of the corresponding weight of GNP and intra-trade.

The GNP rate of Northeast Asia as a percentage of the US's GNP is rapidly catching up to the US with a rate of 20 percent in the 70's, 51.1 percent in the 80's and 75.6 percent in 1992.

Due to this centralization of manufacturing and to the rapid growth of Northeast Asia, development in this region is occurring at a faster rate than has ever been seen before in

[Table 2] The tendency of the ordinary GNP in the US and Northeast Asia

(in billion of US dollars)

	1970	1980	1985	1990	1992
USA	1,017	2,742	4,054	5,525	6,046
Japan	203(19.9)	1,059(38.6)	1,348(33.2)	2,952(53.4)	3,695(61.1)
Korea	8,8(0.8)	61(2.2)	91(2.2)	252(4.5)	306(5.0)
Taiwan	5,7(0.5)	41(1.5)	63(1.5)	161(2.9)	211(3.4)
China	-	298(10.8)	291(7.1)	370(6.6)	435(7.1)

Note: Figures in parentheses indicate the rate(%) in comparison to the US.
Source: Bank of Korea, 1994

the world. Already, a decrease of offshore trade and an increase of intra-trade in all countries in Northeast Asia has been observed.

An increase of intra-trade in comparatively fast and continuous economic growth and the centralization of the major manufacturing activities to Northeast Asia does not simply mean physical dynamism. It is expected that capital, transportation, social overhead capital, communication, information, education, etc., will remarkably change.

It has been learned through Europe's experience of modern economic growth that a continual growth of manufacturing and an increase of trade accompany the change of capital, finance, shipping, overland transportation, air transport, population mobility, tourism, communication, urbanization, information, and education.

As shown in Table 3, Japan was the top-class capital exporter with net foreign assets of $513.6 billion as of 1992, and as of 1993 it reached over $600 billion.

As shown in Table 4, Japan turned into the largest country for overseas investment.

As long as dramatic political changes do not occur in the future, the capital of Japan, Taiwan, and expatriate Chinese in Asia will be the largest source of financing and the position of Northeast Asia as an investor of overseas resources will be much stronger. Northeast Asia's position will be gradually globalized in terms of financing power and

[Table 3] Net Foreign Assets of Japan (end of 1992)

(unit: $ million)

	Assets	Debts	Net
Long-term	1,315,551	658,469	
Short-term	719,687	889,150	
Sub-total	2,035,238	1,521,619	513,619 P: (393,056) G: (120,563)

Note:* P: Private Sector G: Government Sector

* *Germany: $343.4 billion*

Britain: $30.1 billion

US: $-361.56 billion

Source: Ministry of Finance, Japan, 1993

[Table 4] Net International Investment Status of the US, Japan and Germany

(unit: $ billion)

	'84	'85	'86	'87	'88	'89	'90	'91
US	223	139	19	-27	-184	-312	-295	-362
	176	142	109	54	-38	-519	-272	-386
Japan	88	138	223	310	390	447	483	55
Germany	28	42	78	123	171	228	278	26

Note: 1) The first row is based on the current price and the second row on the market value.

Source : OECD, Economic Outlook, 1992

scale of capital.

As product and financing scales increase, a jump in distribution, communication and information is expected. Also, it will not be a long time before Northeast Asia becomes the main area for worldwide trade of energy and resources. Furthermore, all the flows of resources, energy, population, capital and information will be centered in this area.

IV. A New Road to Development and Energy Problems

It is clear that the gap between advanced nations and underdeveloped nations will further deepen in the future, due to prominent trends of regionalism based on protectionism and hegemonism in technology.

The concept of sovereign power in the future will not be in the economic concept as in these days, and also not in the concept of military power as in the past, but will be technical sovereignty in the future. Thus the nation with decisive power in technology will be the nation with the most powerful sovereignty.

P.F. Drucker emphasized a "new sense of value, new concept and new human ability" and D. Bell foresaw the future society to be a nonindustrialized society through "innovations in science, technology, enterprise, consumption and society."

And, A. Toffler strongly asserted that an information-oriented society will begin, where information will play a decisive role, and knowledge will attain superiority over military power or economic power as well. Mr. Sakaiya Taiichi in Japan has a view that value of knowledge will be the important source of economic growth and capital accumulation.

It is needless to cite more words of scholars that the first and last ranking of nations in the new world order will be decided by securing scientific knowledge in the future.

It is expected that the underdeveloped nations vulnerable in scientific and technical capability will suffer severe impact in their economic and industrial development, if advanced nations take excessive technical protection policies, etc., in the era of technical sovereignty.

However, energy and environmental problems are issues to be resolved at least together by global communities and they are very important issues to take counter actions by both advanced and underdeveloped nations in mutual cooperation.

It can be said that the course of human development is the history of changes in energy sources, resulting in the Industrial Revolution with the advent of steam locomotives using coal through the invention of the internal combustion engine using petroleum. Yet another new energy is expected to appear in the 21st century — the technology intensive industry is growing with the advent of electric energy source in this century as well.

In the current component ratio of energy consumption, chemical and petroleum energies account for no less than 69 percent and environmental problems have recently become serious issues due to the increase of quantity used. It is expected that chemical and petroleum energies, such as petroleum and coals, will also keep the main position of energy sources in the future unless substitute energy sources are developed.

These global environmental problems are the depletion of the ozone layer, global warming, acid rain, etc., resulting in the danger of annihilation of all species of animals and vegetation, and the destruction of the natural ecosystem through rising sea water surface levels, devastated forest, and polluted atmosphere and water quality and even contaminated soil.

Current deposits of energy sources are estimated to be 1,365 TOE of petroleum, 1,018 TOE of natural gas, and 7,573 TOE of coal, with about 40 years of exploitation for petroleum, about 60 years for natural gas and about 230 years for coal.

It is a fact that these chemical and petroleum energies act as elements to cause economic stagnation of consumer nations since they are prone to maldistribute sources, not to speak of their limitation due to drain of resources.

However, above all, most industrial structures of the least developed among developing countries (LDDC) and developing countries depend much on chemical and petroleum energies, and it is expected that these countries will be affected greatly in their economic development when the International Environmental Protocol is enforced in the future.

For example, when we see the fact that coal is a major energy resource in underdeveloped countries in Asian and Pacific regions, accounting for no less than 38.1 percent, these countries will suffer a great blow as they are poor in other energy resources.

As positive action to prepare for this situation, issues are being raised to clean-up chemical and petroleum fuels. The method to resolve this issue has no other way but to develop technology.

I would like to present my view on some common matters in a more concrete way.

Firstly, let me address energy savings by efficiently using energy. Energy is a material, and has a role to contribute to human civilization by its consumption and if energy consumption is an inevitable and essential requirement, it should be used more efficiently.

Secondly, I think petroleum is too precious to be consumed as an energy source alone. It should be saved to be used for the production of high value-added products from petroleum energy, such as synthetic rubber, high-density polyethylene and petroleum resin. In other words, it is pointless to say that energy generated from petroleum is a great loss to mankind if we look at it from the point of consumption of resources and an enemy of mankind, as well as if we look at it from the point of view of contamination. We must make every effort to save petroleum to the maximum extent by increasing heat efficiency in the field where only petroleum can be used as energy.

Thirdly, it is important to develop and utilize pollution-free energy resources which can substitute petroleum, thereby ensuring safety. We must devote ourselves to develop and utilize energy in the fields of natural cycles, such as cleaning inexpensive coal, solar energy, wind force, tide water power, other marine forces, etc.

Recently it has been proved that some of the energies mentioned above are intended for practical use by continuous effort exerted to develop technology for their use. Korea has a national plan to utilize substitute energy resources at 3 percent of total energy consumption by the early 2000's.

Fourthly, it is important to recycle resources. Recycling is an important field to change the awareness of energy consumers. It is needless to say that recycling of resources is the best means not only to control energy consumption, but also to reduce environmental pollution.

About 47,000 tons of wastes are generated daily in 6 large cities in Korea, and in particular, combustible wastes convertible into energy amount to 25,765 tons, accounting for 54.3 percent of total wastes generated in the cities. However, serious problems are gradually caused by securing necessary burial sites, pollution, etc., as only 2.3 percent of wastes are recycled with currently available technology employed. Most of the remaining wastes are processed by burial.

In addition, industrial wastes such as waste oil and used tires are generated yearly with a volume of 2,970 thousand tons, and it is estimated that 1,250 thousand tons of these wastes are recycled.

I think these problems are common issues facing not only Korea alone, but also global communities.

V. Cooperation for Nuclear Energy

Nuclear energy is Janus-faced energy relaying both hope and disaster in energy for human beings.

If nuclear safety can be enhanced remarkably and if radioactive waste disposal technology, especially transmutation technology of long-lived rad wastes, can be developed, then nuclear energy will be the most environmentally friendly power and also the best source from the point of view of environment conservation. However, we cannot be satisfied with the current level of safety. Specially, Northeast Asia is an area remarkably increasing its dependence on nuclear energy. Due to the enormous scarcity of energy in Chinese factories and the increasing request for prevention of environmental deterioration in Korea and Japan, a long-term nuclear energy supply plan up to the 21st century is being pursued over safety concerns. In comparison the nuclear generation in the US, Europe and Russia has been mostly frozen.

Is this really a sound phenomenon?

Firstly, due to safety, environmental protection and energy demand, Northeast Asia is finding it necessary to ensure the transparency of the nuclear generation plan and the progress in ROK, China, Japan, Taiwan, and DPRK. Eventually, the whole of Northeast Asia is to be denuclearized with continuous efforts. Secondly, for epoch-making improvements in safety technology and waste treatment technology, joint endeavors are inevitable. At present, the US, Europe and Russia are prominent in the technology and industry of nuclear energy. Hence, they have almost had a monopoly on the supplying capability of nuclear facilities and technology. However, the nuclear energy demand is concentrated in Northeast Asia. Therefore, the world is put in the unbalanced structure in the nuclear industry.

Now, I would like to underscore that the cooperation for technology and industries is indispensable in Northeast Asia.

Because Northeast Asia is the most populous and sensitive to the environment, the above-mentioned cooperation must be accommodated toward the safety and environmental protection of the nuclear facilities much more than those in the US, Europe and Russia. We must give attention to this matter and it must not come solely from the economical and industrial aspects.

VI. Conclusion

With 1.5 billion humans in Northeast Asia consuming a consistently increasing amount of energy, the deterioration of the environment in this area is of paramount concern. Currently, China and North Korea are not the major energy supplying countries. However, if China maintains its rapid economic growth, it will soon consume energy at the rate of intermediate-class countries. China will then move into top place as an energy consumption country as well as a major importer of energy resources. Consequently, China could be the first country in Asia responsible for major pollution.

In this regard, I would like to emphasize that the organization for cooperation preparing for the future in Northeast Asia should be started now, and this must be a cooperative organization containing the vision and policy for harmonizing energy, environment, life for our descendants and life for 1.5 billion people in this part of the world.

As the European Union was initiated by the cooperation for coal and iron production, it is desirable that the start of the true peace in Northeast Asia will be out of the collaboration for energy.

In the future, the unique energy supply source will be from Siberia. If China, Japan and Korea, the large energy consuming countries in Northeast Asia, do not prepare for the upcoming era in organization of cooperation for energy, the development of energy in Siberia may be a cause for breakout of tensions and troubles in Northeast Asia.

Being a member of a community under the umbrella of life along the Yellow Sea and East Sea and pursuing the safety of 1.5 billion lives, we have to endeavor to organize the cooperative body for energy in Northeast Asia on either a civilian or governmental level with the spirit for re-creation of the future and human society.

From now on, 1.5 billion lives should be dedicated to study and work for organizing the cooperative body for peaceful symbiosis in order to hand over a clean environment using clean energy and for preventing the Yellow Sea and East Sea from becoming polluted.

We must not take a back seat to our future; economic interest alone cannot solve this matter.

Can we recognize the current situation only to meet with catastrophe in the future?

I am sure that the system, policy, and vision for symbiosis for 1.5 billion lives in this area can be applied to 5 billion, 10 billion, or 15 billion people spread over the entire globe.

The "creature" of the symbiosis for 1.5 billion lives is the essence of creating peace for the human community on earth. Also, no problems can be solved without a strong will and spirit in us.

Thank you so much for your attention.

ADDRESS BY

CHARLES B. CURTIS
UNDER SECRETARY
UNITED STATES DEPARTMENT OF ENERGY

TO

JAPAN ATOMIC INDUSTRIAL FORUM

TOKYO, JAPAN

APRIL 10, 1995

INTRODUCTION

Good Morning -- It is a pleasure and an Honor for me to participate in the 28th Annual Conference of the Japan Atomic Industrial Forum. It is very important that we are here today to share our experiences, ideas, and visions for the future on energy security, nuclear energy, and nonproliferation -- for Asia and for the rest of the world. I especially want to thank our distinguished hosts for their initiative in organizing this forum, and to compliment Japan for the excellent leadership it is providing APEC this year in its role as President.

I will be talking today about the energy, economic, environmental, and security challenges facing the Asia-Pacific region; about the United States vision for the role of nuclear power now and in the future; about the challenges of nonproliferation, and about the importance of continued U.S./Japanese collaboration in addressing these matters.

Together, the United States and Japan account for 40 percent of the world's GNP, 30 percent of the world's primary energy consumption, 35 percent of the world's consumption of petroleum, and over 40 percent of the world's installed nuclear capacity. Because of this, the United States and Japan have a mutual responsibility to provide world leadership in all energy matters. We have a firm foundation of past cooperation upon which we can build a broad range of future collaboration to foster the development and deployment of sustainable energy technologies with particular emphasis in the areas of clean coal utilization; energy efficiency and conservation; and the reduction of transportation sector petroleum demands.

History has taught us that a balanced approach is best, that security of supply can best be achieved through diversity, efficiency, and flexibility within the energy sector. We need to consider all the options -- fossil fuels (oil, natural gas, and coal), new and renewable sources of energy, nuclear power, and energy efficiency. Within economic reason, the fuels used within and across sectors and the sources of those fuels should be as diverse as possible.

In these circumstances, continued joint development of safe, proliferation resistant nuclear power systems has been and will continue to be, an important component of our collaborative relationship and our diversification strategy. The U.S. and Japan already have a long history of successful cooperation in nuclear power which provides us with a firm basis for meeting current and future challenges. U.S.-developed light water reactor technology, built here in Japan under license, is the original basis for Japan's nuclear power industry. Under the 1988 U.S.-Japan nuclear cooperation agreement, we have continued to work closely together. We now have the opportunity to further and expand on our cooperation on the design, development, and demonstration of advanced light water reactors, the enhancement of nuclear safety through innovation in technology, human factors, and organizational techniques, and in the development and use of policy planning tools for sustainable energy programs.

Through continued close cooperation, the United States and Japan can work together to play a leadership role and, by virtue of the example we set for the rest of the world, jointly promote the adoption of energy strategies that enhance our mutual objectives of energy security, environmental enhancement, economic efficiency, and nuclear nonproliferation.

ENERGY AND DEVELOPMENT IN ASIA

The Asia-Pacific area is the dynamic growth center of the world economy today. Moving successfully along the path toward sustainable development will mean securing reliable supplies of energy, at reasonable prices, in a manner that supports the objectives we all share -- national security, economic growth, and environmental protection. The United States believes the policies directed toward ensuring adequate and secure supplies of energy need not be incompatible or mutually exclusive with these overarching objectives.

Energy supply, composition and price are and will remain a central question for policymakers, economists, and businesses worldwide. Global energy demand will continue to grow in parallel with population and economic growth. In many countries, particularly in the Asia-Pacific region, the impacts of future increases in energy consumption per capita could turn out to be especially large[1]. Many projections today expect that:

- Energy consumption in the countries outside of the OECD will exceed that of OECD countries early in the next century and rise to nearly two-thirds of total world energy consumption by the year 2020.

- The consumption of fossil fuels (oil, natural gas, and coal), which currently account for about 87 percent of world primary energy consumption, will supply the bulk of the growth in energy demand, especially in developing countries, and account for over 85 percent of total demand well into the future.

- Carbon dioxide emissions will grow roughly in line with energy consumption and nearly double by 2020.

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[1]For example, recent projections prepared by the Department of Energy, Energy Information Administration; the International Energy Agency; and the Japanese Institute of Energy Economics.

> The concentration of world oil resources in the Middle East will lead once more to a growing critical dependence on that region to supply the world's oil needs.

Herein lies the challenge: How can we supply the energy necessary to sustain world economic development and rising populations in an environmentally acceptable manner that is consistent with our geopolitical security interests? Or if I may borrow a statement from another forum of this character: our challenge is to chart a safe, secure and environmentally responsible energy path to sustain human progress of future generations. No easy undertaking, but one which requires our urgent and serious attention.

In the dynamic Asian-Pacific context, where net additions to electricity capacity alone are expected to grow by 700Mw per week between now and the year 2015, this challenge is especially pronounced. The search for safe, secure, and diverse supplies of energy here will be extremely important, not only for the region, but for the rest of the world as well.

The U.S. and Japan have an impact on other countries' policy choices by virtue of the example we set and the strategies we pursue and urge on others. As leaders, we need to recognize that circumstances can and will change, and that we need to be prepared to respond to changing circumstances. We need to continuously re-evaluate our past decisions in the light of new developments and to make mid-course strategic adjustments when necessary to ensure that our policy approaches remain valid.

In the United States we are pursuing a comprehensive set of policies to improve our energy security. We are encouraging the domestic production of indigenous resources and new and renewable forms of energy. We are also reducing our dependence on imports through cost-effective encouragement of conservation, efficiency, and fuel-switching and through policies designed to increase competition in our electric and gas utility sectors. Americans now use one-third less energy than they did twenty years ago to produce each dollar of gross domestic product.

We are also supporting, in our Congress, legislation to provide for royalty relief to encourage the production of domestic natural gas and oil resources in deep water areas of the Gulf of Mexico, and the export of Alaskan North Slope oil (ANS) production. The export of ANS oil will not only stimulate our domestic production but offer the Asia-Pacific area another competitive and stable supply of crude oil.

The Role of Nuclear Power

Each sovereign in the family of nations must judge for itself in view of its own particular circumstances whether or not nuclear power is a viable option for its energy mix. In the Asia-Pacific region, many countries have decided to meet a portion of their electricity needs with nuclear power, and others have not.

Nuclear energy currently provides approximately one-fifth of all electricity generated in the United States. Economics and a continuing public debate regarding the continued appropriateness of nuclear power have resulted in no new orders of nuclear plants since 1978. However, our government has continued to invest in technology development in preparation for expected future orders of advanced evolutionary reactors. Through these efforts -- which have been sustained in the current U.S. Administration, and are increasingly concentrated on advanced light water reactor technologies -- we have developed some of the most advanced, safest, and proliferation-resistant technologies in the world. Assuring that nuclear energy remains an option for future electricity supply remains an important component of our energy strategy.

We also soberly recognize that nuclear energy raises a number of serious concerns that require better and more effective solutions than we have yet been able to achieve. In the United States, waste disposal is top among these concerns, although the significant front end cost of the nuclear option continues to relegate the option to a low order rank in the current suite of energy supply options. For other countries, the portfolio of choice may be less, but the concerns of relative cost, safety and proliferation risk should shape their decisionmaking. These issues prompt a two-part fundamental question: whether and, if so, how should emerging economies go about undertaking nuclear power development?

Given that industrializing countries are choosing nuclear power to meet part of their growing energy needs, the United States, Japan, and other industrialized countries have a responsibility to help foster first a disciplined evaluation of alternatives to nuclear power, and, second, if the nuclear option is still selected, an approach to nuclear power development that emphasizes safety, and minimizes proliferation risks. Meeting these goals will help assure that the nuclear option is selected wisely and for peaceful purposes. It will also assure the vitality of the nuclear option for the future.

The United States, Japan, and others have much to offer emerging nuclear power programs. First, we can provide access to the safest and most advanced technology. The United States pioneered light water reactor technology, we have deployed it in over 100 plants, and it is now setting the worldwide standard in the design of advanced light water reactors. My Department's budget request for this program is approximately $50 million for fiscal year 1996, a considerable amount in times of increasing fiscal stringency. This technology includes both evolutionary, large units (such as the General Electric Advanced Boiling Water Reactor and the ABB Combustion Engineering System 80+) and mid-size reactors (such as the Westinghouse AP600 and General Electric Simplified Boiling Water Reactor). These plants have been designed to meet extremely high standards of safety, reliability, operational simplicity, and economy. I should also note with appreciation and respect the large Japanese contribution to development of the General Electric design.

We can also share our hard-won knowledge regarding nuclear safety. Based on more than three decades of experience operating commercial nuclear reactors, the United States has learned much from both routine operations and extraordinary incidents, including Three Mile Island. We have incorporated this experience into retrofits of existing plants, design requirements for new reactors, and new approaches to facility management, organization, and operations. Emerging nuclear power development programs in other countries if first validated through a disciplined exploration of alternatives need not repeat the mistakes of those who have gone before. Through cooperation with us, at both the government and commercial levels, emerging programs can benefit from the lessons we have learned.

At the same time, we have much to gain from such cooperation. First, we can learn from emerging programs. Some industrializing countries themselves have many reactor-years of operating experience, and we can benefit from their perspective on safety and reliability. Second, we will obtain reciprocal benefit from their adoption of the advanced light water reactor technologies developed in the Department of Energy's cooperative work with our private sector research partners. The United States believes these are the safest designs available, and achieving very high levels of safety is critical in the development of nuclear power programs. Further, light water reactor technology employing a once-through fuel cycle minimizes the proliferation risk relative to other designs and fuel cycles. Third, cooperation promotes transparency, which helps build confidence in the peaceful intent of nuclear power development programs.

World Security and Nuclear Power

Along with all of the benefits of nuclear power, the world community must recognize and take seriously the proliferation implications of nuclear development. The dawn of the 1990s increased U.S. and international sensitivity to the threat posed by nuclear proliferation. While a large part of this was due to the disintegration of the former Soviet Union, the discovery of Iraq's clandestine nuclear weapons program clearly highlighted the proliferation danger that can be associated with the development of a nuclear infrastructure ostensibly for peaceful purposes. This event illuminated already existing concerns about the use of fissile materials for civil purposes.

President Clinton and our administration have made stopping the proliferation of nuclear weapons one of its highest international security priorities. To address this threat, the President in 1993 issued a U.S. policy directive on nonproliferation that focuses on the need for fissile materials contro . That policy states, inter alia, that the United States seeks to secure and reduce stockpiles of highly-enriched uranium and plutonium, and that it does not engage in or encourage others to engage in the civil use of plutonium or plutonium reprocessing.

In accordance with this policy, the United States has terminated its pursuit of spent fuel reprocessing and breeder reactor technology programs. We have concluded that these technologies are uneconomical and present too great a proliferation risk. The United States has sought to lead by example and abandon these technologies. While the United States and Japan have agreed to disagree on the merits of breeder reactor and reprocessing technologies, the United States respects Japan's decision and we will not interfere with or obstruct Japan's plans to continue the development and implementation of actinide recycle fuel systems to meet Japan's indigenous energy requirements. We intend to continue to work closely with Japan and the IAEA to ensure that all such activities are subject to effective safeguards and physical protection measures.

At the same time, we strongly believe that countries embarking upon nuclear energy programs should utilize advanced light water reactors with a once-through fuel cycle. The U.S. believes that these systems are safer, more economical, and raise fewer proliferation concerns than alternative nuclear technologies.

The promotion of the peaceful and civilian use of atomic energy while guarding against the proliferation of nuclear weapons is the essence of the Nuclear Nonproliferation Treaty, which marks its 25th anniversary this year. In just a few weeks, signatory nations will vote on the extension of the treaty. The United States believes that the indefinite extension of the NPT, without conditions, is a firm basis for improving and expanding the international nonproliferation regime.

The United States, in its efforts to further develop barriers against the spread of nuclear weapons and in support of the indefinite extension of the NPT, has proposed a comprehensive set of actions and policy prescriptions. These include a nuclear testing moratorium and comprehensive test ban treaty; expedited ratification of START II in the United States and Russia; collaboration with Russia on accounting for and securing existing stocks of fissile materials; a worldwide cutoff in the production of fissile materials for weapons; subjecting excess U.S. fissile material to IAEA safeguards; reductions in the use of highly-enriched uranium through expansion of the program on Reduced Enrichment for Research and Test Reactors to Russia and China; and limits on the production and stockpiling of plutonium.

The vigorous effort of the United States in this important security area is prompted by the changing nature of the nuclear proliferation threat. In many ways this threat is becoming more insidious and difficult. The nature of the problem requires an intensified effort to better control and account for fissile material. The need for improved control of the materials produced for Cold War weapons is urgent and obvious to all readers of the press accounts of nuclear smuggling incidents over the past year or so. But the United States believes the control of the civilian use of fissile material also needs further international attention. The risk associated with these programs is likely to grow as an increasing number of nations of varying technological sophistication and political ambition turn to nuclear power to meet their expanding energy requirements in the future.

The United States and Japan can and must play a leading role in assuring that any such nuclear energy programs are safe and secure from the threat of proliferation. In order to preserve the legitimacy of the civilian nuclear option for meeting growing energy needs, we must continue to work together to meet higher standards, and we must play a role in helping to inform and improve upon the analytic basis for the energy choices made by our fellow states.

Conclusion

I want to end these remarks by again stressing the importance we place on continuing our long, close and productive cooperative relationship with Japan and other countries of the APEC region. With Japan, we have long enjoyed a close cooperative relationship in basic science and technology research, in high energy and nuclear physics, and in the development of sustainable energy technologies. This collaboration has not only contributed to our mutual security, brought both of us economic benefits, and helped us realize our full human potential, but it has also taught us to respect each other's culture, to search for common ground, and to expand the scope of our engagement whenever possible.

Our history of close cooperation and collaboration in the field of nuclear energy has served us well in the past and it will undoubtedly continue to serve us well in the future.

Thank you.

SESSION 1
Seeking for Stable International Society - Tasks and Prospects

"Nuclear Energy - Development Paths for the Future/The French Policy"

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Commissariat a l'Energie Atomique (CEA)
France

NUCLEAR ENERGY

THE FRENCH APPROACH TO THE NEXT CENTURY ISSUES

Ladies and Gentleman

I would first like to express my deep pleasure to be a guest of the 28th JAIF conference and all the more to share this honour at this session with such distinguished speakers.

This afternoon is devoted to the role of nuclear energy as a stability factor for the international community. As a matter of fact energy is indispensable to economic growth which in turn is a factor of peace and stability.

According to the most authorized forecast, the total world energy consumption will at least double in the first half of the century. Today, despite two serious warnings in 1973 and 1979, oil and natural gas are easily available and relatively inexpensive. This creates a feeling of durable abundance and at least in the developed countries, the public fears, which in the seventies were focused on the threat of an energy shortage consequently to the oil shocks are now concerned with ecological matters. Nuclear industry is perceived as risky and this feeling has been dramatically enhanced since the Chernobyl accident. In addition, people live more and more with what they feel as the so called "unsolved" problem of long-lived nuclear waste.

As a result, we can see a loss of interest for nuclear energy throughout the world, with the notable exceptions of East and South-East Asia and France. This rather bad situation of the nuclear energy prospect is due to what I would call two misunderstandings of the actual picture :

1. as to the abundance of cheap natural resources, the truth is that no significant discovery has occurred in the last two decades. Furthermore, a

huge proportion of all the inexpensive oil reserves is located in one single region of the planet, a situation which creates an additional vulnerability.

2. concerning ecology, under normal operation, a nuclear station creates much less damage to the environment than any fossil-fueled power plant. The mediatic problem of long-lived nuclear waste itself is not really a technical problem : the ways of solutions are already known even though some amount of research and development remains necessary.

But whether public concern is technically relevant is not the problem. We must admit its existence and learn to deal with it. The conviction of specialists that the main problems are or will be solved is not enough. We must gain public acceptance, it is a new challenge set before us and we have to cope with it.

Of course, information is not enough to obtain public acceptance. I would mention three issues which must be dealt with successfully : safety, solving the back end of the fuel cycle issue, and finding the most adequate way to manage plutonium. Incidentally, all nuclear countries are facing these challenges and international cooperation is now a necessity. The achievement of one can become a benefit to all, just as a problem occuring to one can become a concern to all.

As you know French nuclear electricity represents about 77% of the total output of France. I wish to point out briefly three general features of the French system, which, I believe, have played a key role in that achievement.

1. first of all, continuously **setting a high value on the long run.** That principle led, during the "the oil shock mood" when the threat of an energy resource

shortage seemed likely to happen, to the choice of developing fast breeders and reprocessing used fuels.

2. second, the success of the French program certainly owes much **to the high level of standardization** thus allowing to make the best of experience feed-back to improve the cost and the safety of nuclear power plants.

3. third, I would like also to say a word of the French nuclear system. It has gradually evolved towards a situation in which **each different function**, namely reactor construction, utility, fuel cycle, licensing, management of waste, research and development **is devoted to a different entity**. The rôle of Public Authorities is to stipulate the guidelines related to strategic aspects, for example the safety policy. An other example is the law enacted by the French Parliament in december 1991 about high level waste management. This Act stipulates the procedure which will lead to the final choice for the management of these wastes within fifteen years. It has been voted after a national debate which set the pace toward public acceptance on that sensitive issue. Two major research programs of the CEA, SPIN (Separation and INcineration of minor actinides) and CAPRA (Concept to Amplify Plutonium Reduction in Advanced fast Reactor), have been developed as a consequence and that law may be considered as a major breakthrough in the decision making process.

Let us now have a look to the main guidelines of the Research and Development program.

1. Economic competitiveness

transparent 1 : l'évolution des coûts

Competitiveness of nuclear energy is proved as long as standardized plants are built whithin an appropriate framework and as long as strict operation procedures are respected. However, the margin has decreased since the early eighties, therefore improvement must be still sought to confirm the economical advantage of nuclear energy.

transparent 2 : coût du Kwh/h en 93

The French example shows that this competitiveness is acquired when external costs are accounted for (provision for decommissioning, waste management......). A survey made in 1993 showed that he cost of nuclear electricity in France for baseload supply was 0,241 F/KWh compared to 0,288 for coal and 0,294 for gas.

One fourth of the fuel cycle cost is due to the back end, that is to say 1 cF per kilowatt. Provision for decommissioning is included, it represents 15% of the total investment cost and about 50% of the nuclear island cost.

As nuclear power is very capital intensive, the best ways to improve competitiveness is to **increase life expectancy and availability of the plants** . EdF has set up two programs to meet these goals :

1. the program "*disponibilité*" (availability) sets a 85% availability factor target by the year 2000 (in 1994, it was 81,2%). With more than fifty plants on operation, a mere 2% increase in availability is worth the total production of one unit.

2. according to results of the program "*durée de vie*" (lifetime) today's reactor which were designed to have a 30 year life will probably last up to 40, 45 years. Future plants must be designed to operate reliably during at least 40 years and possibly even more. This is possible, for example, with improvements in maintenance operations, making the best of experience feedback. Reaching very long lifetime also requires taking full advantage of the potential of advanced materials, more resistant to ageing and radiation damage, less corrosion-prone, less activable, etc.

Significant savings could also come from the fuel cycle:

- Concerning laser separation enrichment, the target is to reach a separative work unit (SWU) cost , including investment, half the present one in the Eurodif plant, excluding investment. The feasibility is expected to be demonstrated before 2000.

- the increase of fuel burn-up will also play its part : though the average discharge burn-up was initially 33 000 MWd/t of heavy metal, it is already possible to reach 47 000. The target of the French R and D program is to reach 60 000 within 15 years.

- as to the fuel cycle back end, the main saving may come from reduction of the low and medium activity waste volume. The recent achievement is to produce 1 m^3/t which is slightly less than direct storage. The target we expect to reach by 2000 is $0.3m^3/t$.

2. Safety

For the future of nuclear energy, the other major issue is of course safety.

During the sixties and seventies, the effort has been focused on the improvements in order to decrease progressively the likelyhood of a core meltdown. This so-called probabilistic approach aims at keeping at an acceptable level the total risk, as expressed by the probability of occurrence combined with the potential consequences to the public . In other words, the effort was to make the risk of a core meltdown so low that the research on the consequences of such a meltdown was considered as unnecessary.

After the the Three Mile Island accident, research to drastically reduce that probability of core meltdown adopting new approaches such as for example "passive safety" was intensified. Basically, however, the concept of the probabilistic approach remained unchanged.

The Chernobyl disaster, though it did not occur in a light water reactor , has shaken public confidence in nuclear safety. This led French and German utilities along with authorities to edict new requirements for future reactors : beyond the goal of still further reducing core melt probability, and *no matter how low a probability* can be reached for such an accident to occur, its overall consequences must be limited. Whatever its probability, the worst possible accident should not lead to long lasting evacuation of nearby populations, which means no massive release of radioactivity out of the containment of the reactor.

To meet that goal, demonstration will have to be made that in the case of a meltdown,

- either the "*corium*" remains inside the pressure vessel (TMI-like situation)
- or, if it melts its way through the vessel, it remains inside the containment building, and the containment retains its integrity.

In that respect, very significant R&D programs are in progress, many of them carried out whithin the framework of various international cooperations. The two purposes of these R&D program are :

- to understand and to modelize the physical phenomena occuring during and after core melting.

- to propose technical solutions such as corium catcher, hydrogen recombiner, or else, which guarantee the mitigation of the consequences of such an accident, and to ensure the protection of the environment.

The Commissariat à l'Energie Atomique is deeply involved in such R & D programs with facilities such as PHEBUS-PF which aims at studying the behavior of fission products after a core melting (with a participation from United States, European Union, Japan, Korea, among others) or VULCANO for the study of the core itself, after melting.

3. Waste management of high level waste.

An other "mediatic topic" is the management of high level waste

transparent 3 : la loi de 1991

The law enacted in 1991 sets the framework of the research related to high level waste management.The law lays down that the final decision for high level waste management will be worked out in 2006 at the latest after a debate in the Parliament and the vote of a new law. It specifies three main directions for the investigation :

1. improving fuel reprocessing by increasing as much as possible the separation and transmutation of long lived radioisotopes,
2. research on the feasibility of deep underground storage,
3. research in waste packaging.

The first issue is the SPIN program which I would like to illustrate briefly.

transparent 4 : le programme SPIN

SPIN means separation and incineration of radionuclides. It aims first at separating minor actinides and long-lived fission products from the other high level waste and then to burn them either in reactors or accelerators.

The feasibility of the separation is already demonstrated for some of them. I would mention Neptunium, which could be separated with a mere modification of the La Hague plant. Research for a further separation of Americium, Curium and long lived fission products are under way with new processes. The first experimental results for Americium and Curium are promising.
With regard to incineration, computer codes calculation has demonstrated that the transmutation of minor actinides like Neptunium and Americium was possible either in PWR's or in FBR's with better results for the latter. The behavior of such fuels is yet to be tested through experiments which will be carried out from 1995 in Phenix or Superphenix.

As to underground storage, three sites have been selected and two of them will be chosen soon to become experimental laboratories. Afterwards, investigation will be performed so that the final decision on the management of these wastes is made by 2006.

4. Plutonium management

The last item I wish to talk about is the sensitive issue of plutonium management which often seems to gather in the public opinion all the fears routed by nuclear energy.

Plutonium is commonly associated with proliferation : in may 1995, States Parties to the NPT will decide on the extension of the Treaty. A successful outcome of the Conference is not only the prerequisite for a satisfactory non proliferation regime in the next century, the NPT is also the basis for international exchanges in the peaceful uses of nuclear energy. The collective confidence to be provided by the implementation of the Treaty by both nuclear and non nuclear weapons states is needed for the development of peaceful nuclear programs and international trade.

Yet, plutonium is also a high-value energy resource, each gram of it being equivalent to two tons of oil. However, it is true that in the short and medium run, it is important to find a proper way to manage plutonium, as long as its extensive use as an energy resource is not indispensable. Therefore, the French strategy is to burn it so that the overall plutonium balance is controlled with the advantage of using its valuable energetic potential. This can be done by loading PWR's with MOX fuel. The French Safety Directorate already allowed EDF to load 16 reactors with MOX fuel, that would burn 6 t/year of plutonium, slightly more than the half-year production. The number of plants licensed for using MOX will be progressively extended. Today, 7 French PWR's are operated in the MOX recycle mode, and the first industrial MOX fuel fabrication plant, MELOX, has just started production in Marcoule. Furthermore, MOX reprocessing has been demonstrated in 1992 with the dissolution of 4.5 tons in La Hague.

In present generation plants, MOX recycle is limited to loading one third of the core with MOX assemblies, these have to be designed for cohabitation with standard uranium oxyde assemblies, leading to additional complexity and cost in MOX fabrication. We therefore believe that forthcoming nuclear plants should be *designed to allow for full MOX recycle*. Such is the case for EPR, which is now developed in the frame of French-German cooperation.

Even with the partial MOX recycle mode today in use, MOX recycle breaks even, economically speaking with standard loading. Full MOX recycle should prove very attractive.

Eventually, further degraded plutonium can only be used in fast neutron reactors, in which the ratio of fission to capture cross-sections is much more favourable. This is the main motivation for the CAPRA program initiated by France and implemented in a very international framework. It is worth mentioning that one experimental subassembly made of second generation plutonium (reprocessed from spent MOX elements) will be loaded in SUPERPHENIX by the end of this year.

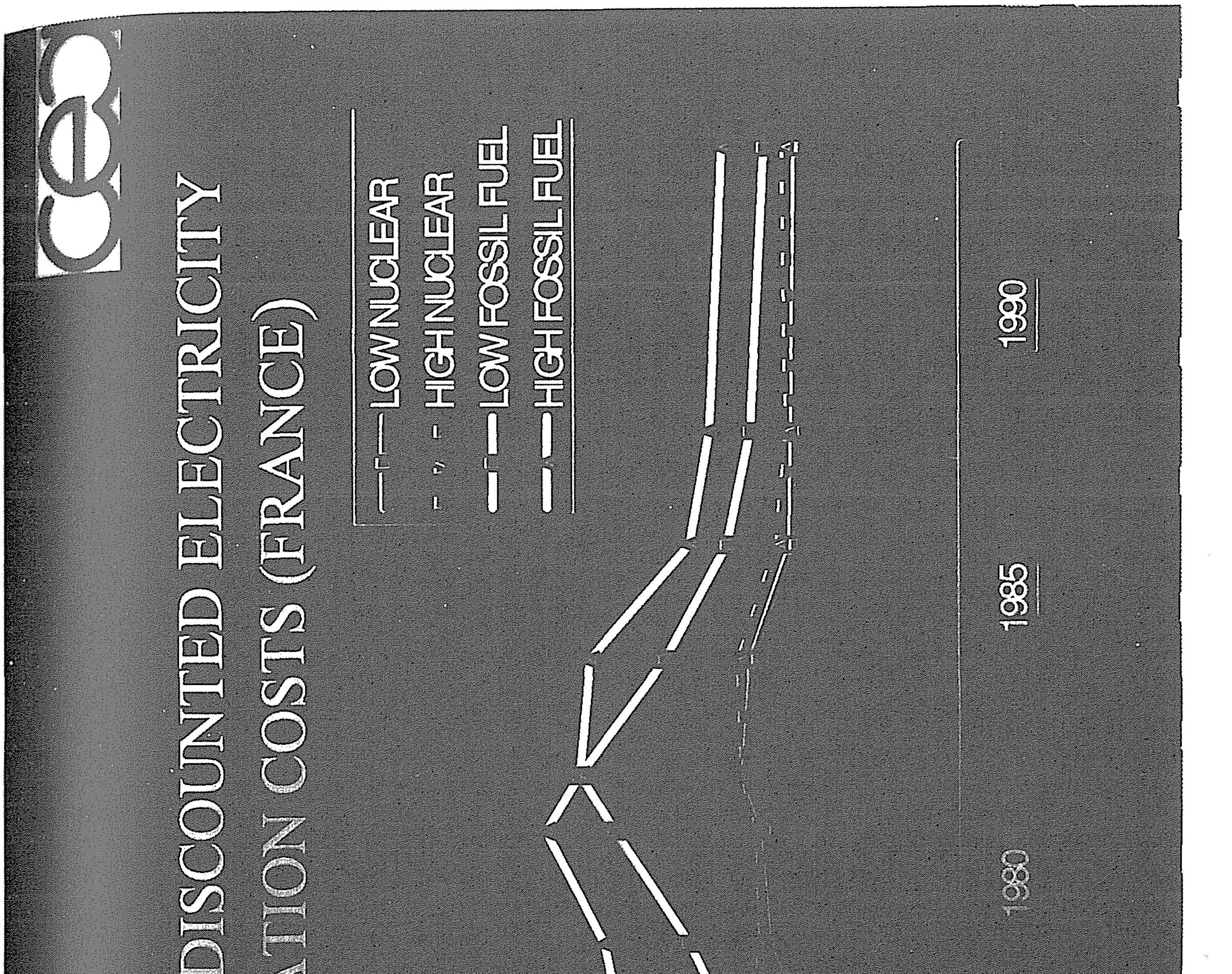
CONCLUSION

In conclusion, we would remind once more that even if we are now living in a world in which the threat of energy shortage seems to have disappeared, this is not granted for ever. We must also be aware that this is partly due to the achievement of nuclear energy. As to France, a survey made in 1992 showed that the "non nuclear option" consequence on the French economy would have been more or less equivalent to a third oil shock.

Nuclear energy is a fantastic tool. Unfortunately, it came to the public consciousness with an ordeal and has to face public fears more than any other industry. The consequence is that, as far as I know, there are no other example of an industry which is that much commited to safety and to the management of its wastes. It is now a mature industry and we may be proud of that achievement. It is a key to economic growth and , as such, its development in Asia seems indispensable.

We must now do our best to leave that heritage to the future generations. We know the remaining problems, the solutions are already on the tracks. We just have to work. Therefore, as Japanese put it, "gambarimashô" !

Gambarimashô" signifie à peu près "allons-y avec courage". C'est une expression très connue et très conviviale au Japon, que l'on entend très souvent surtout lorsque l'on est en face d'un défi à relever.

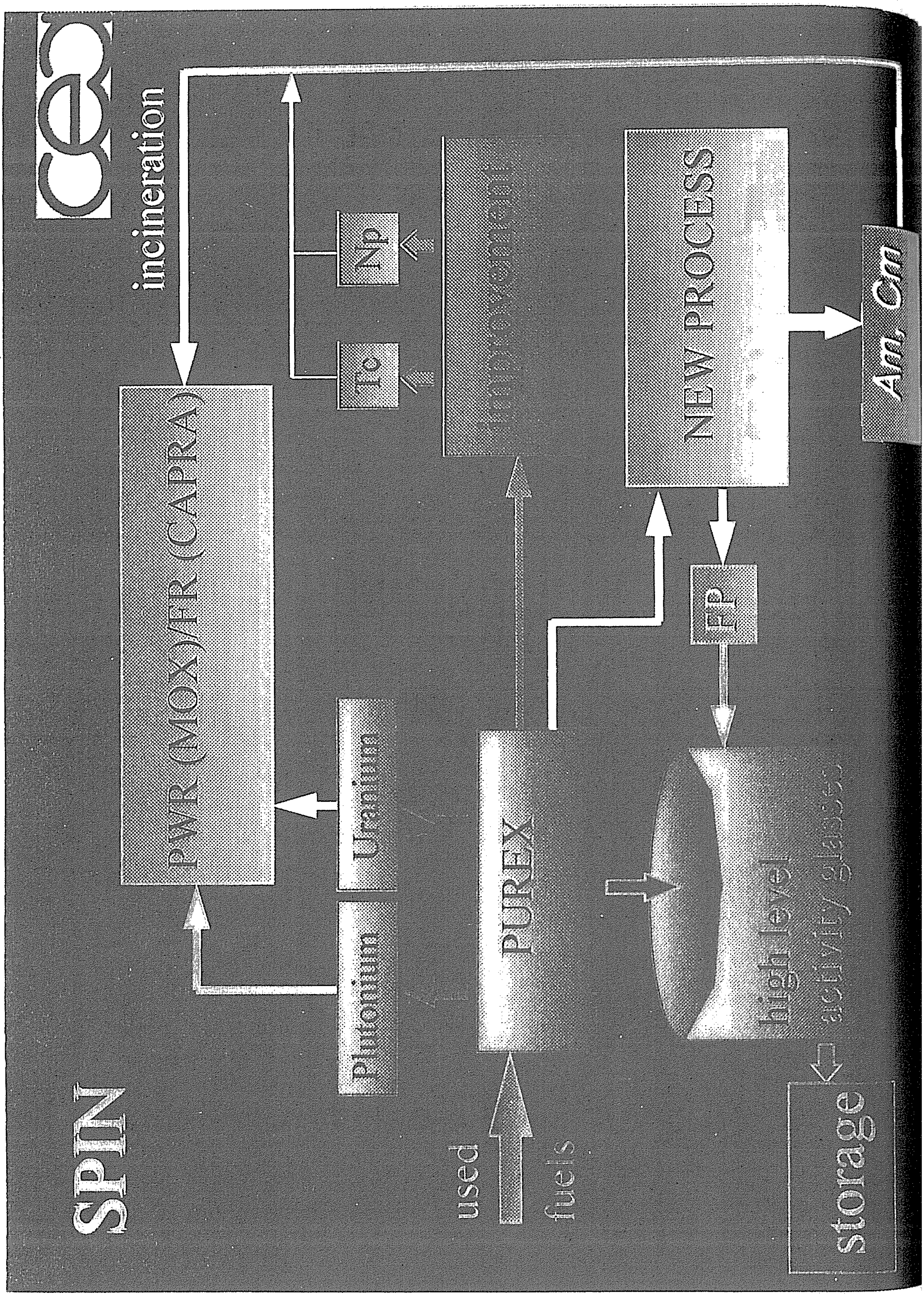

LEVELIZED DISCOUNTED ELECTRICITY
GENERATION COSTS (FRANCE)
LOW NUCLEAR
HIGH NUCLEAR
LOW FOSSIL FUEL
HIGH FOSSIL FUEL
cF93 per kWh
70
60
50
40
30
20
10
0
1970
1975
1980
1985
1990

electricity production cost (France) (baseload, cF93/kWh)

	nuclear	coal	gas
investment	13,6	11,3	5,9
operation	5,6	5,8	2,4
fuel	4,5	11,7	21,1
R and D	0,4		
TOTAL	24,1	28,8	29,4

high level waste : 3 directions for R and D (law of december 30th 1991)

- separation and transmutation (SPIN)
- deep underground storage (reversible or irreversible)
- packaging and surface disposal


SPIN
incineration
PWR (MOX)/FR (CAPRA)
Plutonium
Uranium
Tc
Np
improvement
used
fuels
PUREX
NEW PROCESS
Am, Cm
FP
high level
activity glasses
storage

Statement by Mr.Zhang Huazhu
Vice President of China National Nuclear Corporation
at the 28th Annual Conference of Japan Atomic Industrial Forum

Mr. Chairman,
Ladies and Gentlemen,

At the outset, please allow me, on behalf of the China National Nuclear Corporation and in my own name, to warmly congratulate the convening of the 28th Annual Conference of Japan Atomic Industrial Forum. I would like to thank Chairman, Mr. Mukaibo for his cordial invitation and meantime I would also avail myself of this opportunity to give credit to our host, Japan Atomic Industrial Forum, for its outstanding arrangement to this Conference.

I feel very privileged of having this opportunity to discuss and exchange our ideas with colleagues of other countries attending this conference on the subject issue of the important bearing of peaceful uses of nuclear energy on the economic and social development in various countries. At the same time, I wish also to address the conference our opinions and propositions on the international cooperation in the peaceful uses of nuclear energy.

Mr. Chairman,
Distinguished Delegates,

1994 was an important year in the history of Chinese nuclear power construction. Qinshan NPP and Daya Bay NPP (Unit1 and Unit2) were put into commercial operation respectively in the year. At present, there are two NPPs in operation, one under construction, three planned to be constructed in China. We also have an overseas NPP project being built.

Qinshan NPP of 300 MW PWR designed and constructed on self-reliance is now being operated well. Its load factor was attained to 66% in 1993 and 68% in 1994 respectively. The first fuel reloading and maintenance as scheduled were started on October 21 last year, followed by connection to the power grid again on January 21 this year. Now the reactor is operating with nominal load. The inspection and testing results are showing that the plant design and domestic fabrication of key components such as SG, Turbine sets and nuclear fuel assemblies are satisfied and reliable. Since its operation, radioactive release to the environment is far below the standards set by the state, without increasing the background level on the site. The safety evaluation conclusions given by concerning departments and experts at home and abroad has been verified through its first fuel cycle operation, i.e., Qinshan NPP's operation will not give unfavorable impact on the environment with its high level safety and qualified design and construction.

Guangdong Daya Bay NPP (2x900 MW PWR) was put into commercial operation on February 1 and May 6 last year respectively, and has been operating well since then. Our goals, such as operation with safety, stability, economy have been reached The load factor of the two units on average is up to 83.6%. Especially Unit 2 has been under safe and continuous operation for 239 days by the end of last December ever since it was brought into commercial service. Unit 1 was scheduled to be shutdown for the first refueling and maintenance on December 17 last year and will startup in the near future. The first refueling and maintenance for Unit 2 has begun at present. The safe operation record has shown that the construction and operation of Daya Bay NPP is of high quality and safety.

The construction of the second phase project of Qinshan NPP(2x600MW PWR) was started last year which is one of the major engineering projects of the state. The excavation work is well underway with smooth engineering progresses in all aspects. So far the primary design has been reviewed and approved by the government and the detailed design is being carried out in full swing. We are following the principle of mainly relying on our own efforts to build the plant while seeking foreign assistance and cooperation. The local manufacturers for the main components has been determined, and foreign suppliers of equipment will be selected by competition. Negotiations on both technical and commercial issues have been engaged with foreign companies from countries such as France, U.S.A., Japan, R.Korea, Britain, Spain, etc. The first concrete pouring for Unit 1 is to be done next June, and the whole project is scheduled to be completed at the beginning of next century.

While developing nuclear power plants at home, China also exports Chashma NPP(300MW PWR) to Pakistan based on the principles of assurance for peaceful purposes, being subject to the safeguards and supervision by IAEA. The project is being implemented well on schedule since the first concrete was poured on August 1, 1993, and its quality has been highly appreciated by both Pakistan and IAEA.

The pre-feasibility study of the second phase project of Daya Bay NPP(2x900 MW PWR) has been approved and its site has been decided at Lingao, about one kilometer from Daya Bay NPP. A memorandum of understanding on joint construction was concluded this January for the project between French and Chinese governments. Preparations for engineering work and negotiation are being conducted. And it is scheduled the plant will be put into operation at the beginning of next century.

Since Sino-Russian agreement on cooperation in nuclear power plant construction was signed at the end of 1992, siting for Liaoning NPP was fixed at Wentuozi of Liaoning Province. A preliminary technical and financial study was satisfactorily conducted by experts of both sides. The final feasibility study is being made by a Chinese engineering design institute and will be submitted to the government for approval.

Sino-Canadian agreement on nuclear cooperation was concluded last December when Mr. Christian, Canadian premier, visited China. Both sides discussed the possibility for Canadian government to provide with preferential loan for exporting two units each with 700 MW CANDU VI. The minutes of meeting on joint construction of the heavy water reactor NPP was signed between CNNC and AECL. With the support of AECL, the Chinese engineering institute has finished preliminary study for the project. NPP of CANDU could be expected to be set up near Qinshan site if negotiation is well conducted and approval is finally granted by Chinese government .

PWR is adopted by Chinese government as the standard reactor for NPP, and policies of standardization and construction in series have been made. However, with a view to meeting the urgent demand for power supply, if favorable loans are available and construction cost and electricity price are both acceptable, building NPP with reactor types other than PWR could be considered.

Mr. Chairman,
Ladies and Gentlemen,

The rapid growth of Chinese national economy longs for sharp increase of electricity which cannot be realized without nuclear power development. Nuclear power will have an important bearing on future energy development in China.

Chinese national economy is growing rapidly in recent years and the demands for energy and electricity are being increased quickly. In order to achieve the long-term economic goals, China must have a good solution to the energy problem. Electricity has become the "bottle neck" which retards the current economic development in China. The average shortage of electricity in our country was over 20% last year. Some enterprises cannot be run with full capacity. The situation is even more serious in the economically-developed coastal areas. The total installed capacity of the electric power in China was about 183 GW in 1993 and 198 GW, or 0.165 kW per capita only by the end of last year. This figure approximate to 1/3 of the world average. A net capacity of 300 GW should be added so as to reach the world average.

Therefore the needs for the electricity in China is pressing and huge both in the near and long terms.

At present more than 80% of electricity production in China comes from thermal power, only 1.5% from nuclear power and the others from hydropower. There are three outstanding obstacles in further developing thermal power. Firstly, it is very difficult to exploit millions of tons of more coal in a year even China is rich in coal resources. Secondly, the uneven distribution of energy resources brings about a great burden and severe difficulty to transportation. 78% of coal resources is located in the north and northwest areas of China. In contrast the southeast coastal areas, which are the densely-populated and economically- advanced regions, lack coal and hydropower resources seriously and consume 50% of total electricity production capacity with 8% sharing of total energy resources in the country. So it makes more difficulties to the transportation. Thirdly, burning of large amount of coal will bring a series of ecological and environmental problems which affect the people's living standard and the development of national economy. As to the hydropower, the resources are mainly concentrated in the southwest area of China. Therefore, to develop hydropower is restricted to a certain degree. From the discussion above, we can come to the conclusion that in the long run, developing nuclear power and making a full use of Chinese rich uranium resources are forced by the realistic situation of power shortage and demanded by the increasing economy.

According to the anticipation of Chinese national economy development, 500 GW installed electricity capacity should be added from 2000 to 2020 which needs 1.3 GTons of coal supplied only by thermal power. It is very difficult and even more impossible to realize the above program solely by thermal power and hydropower because of the huge quantity of coal and limitation of hydropower. Therefore, development of nuclear power in China will be roaring and have a brilliant and attractive prospects in next century.

Based on the forecast made by experts on nuclear power strategies, the installed nuclear power capacity in China shall increase to 50GW at least by 2020 occupying 6% of total power capacity at that time. The figure should be 10% if the aim of 1 kW installed capacity per capita needs to be reached. These goals are feasible from the demands of the market and the capability of the country. Many provinces such as Guangdong, Fujian, Zhejiang, Jiangsu, Shandong and Liaoning have taken nuclear power as an important solution to their energy shortage. Preliminary works such as siting are underway actively.

The development of nuclear power has a bright future in China, but a key difficulty is that we are short of funds. The initial capital investment is huge and the construction period is rather long for the nuclear power plants. Especially the cost of nuclear power is a slightly higher than that of thermal power since the price of coal is cheap in China nowadays. However, along with the adjustment of China's electricity price system, the coal price will be increased steadily, therefore, the good economic performance of nuclear power will become more apparent. We plan to raise funds widely by means of all ways for nuclear power construction, to perform share-holding system in economically-advanced coastal areas, to maximize funds raising within China. The another important way for raising funds is to actively attract and use foreign investment through extensive cooperation with other countries.

China also has a lot of advantages to develop nuclear power. China, rich in uranium resources, has proven techniques of uranium exploration, mining and metallurgy as well as facilities. A fairly complete nuclear fuel cycle system has been formed. Now China is in a position to produce nuclear fuels for 300 MW NPP and also for other types of reactors. A production line to provide fuels for 1,000 MW scale nuclear power plants has been established in cooperation with FRAGEMA of France. In addition to the existing reprocessing facilities for the production reactors, a pilot plant for reprocessing the spent fuel from the power reactors is being built with the support of the state. Remarkable progress on management and disposal of the radioactive wastes has been achieved.

Bituminization and segmentation for low-level radioactive wastes, underground hydra fracture processing for medium-level radioactive wastes have been developed and put into operation. Vitrification for high-level radioactive wastes and their final disposal have gained certain progress. In recent years, much effort has been made in the fields of advanced pressurized water reactor, fast breeder, high-temperature gas-cooled reactor, low-temperature heat-supply reactor, small sizes reactor, nuclear fusion, etc., progress of different extent have been achieved. The successful experience in the construction of Qinshan and Daya Bay NPPs and the fairly complete nuclear fuel cycle system as well as lots of experts are the most favorable factors for developing nuclear power in the country.

China always regards nuclear safety and reliability as top priority. A complete set of regulatory system has been established such as nuclear safety code system and management system for the purpose of nuclear power quality and safety. All of these are switched to conducting overall inspection and supervision for siting, design, construction and operation of NPP so as to reach the goal of "Safety and Quality First".

We have carried out extensive international cooperation in the field of nuclear safety and nuclear power construction. China has joined the nuclear safety convention and would like to make its own efforts to maintain high-level nuclear safety world wide.

Mr. Chairman,
Distinguished Delegates,

Peaceful uses of nuclear energy constitute the legitimate and just right of countries. For many years, numerous developing countries have attached great importance to the development and utilization of nuclear energy, and called for international cooperation in this field. This is entirely just and reasonable. Needless to say, more extensive and in-depth international exchanges and cooperation in peaceful uses of nuclear energy will contribute to the development in these countries of the cause of peaceful uses of nuclear energy. However, the current state of international cooperation is far from satisfactory. There is no fundamental change in the situation of industrialized countries monopolizing nuclear science & technology and technology related to nuclear energy. Developing countries continue to encounter such difficulties as financial shortfalls and lack of technical conditions. Some developed counties view in an unfavorable light the international cooperation with developing counties in peaceful uses of nuclear energy. This cannot but cause serious concern among developing countries.

We consider it necessary, where international cooperation in peaceful uses of nuclear energy is concerned, for the countries to adopt appropriate measures to prevent the proliferation of nuclear weapons, including nuclear explosive devices. This constitutes the precondition for cooperation. However, this should by no means hamper or restrict international cooperation in peaceful uses of nuclear energy, thereby compromising the legitimate rights of countries, particularly developing countries to peaceful uses of nuclear energy.

The Chinese government has always taken positive, prudent and responsible policies regarding international cooperation in peaceful uses of nuclear energy. China has adhered to three principles in her nuclear exports, i.e., exclusive use for peaceful purposes, acceptance of the Agency's safeguards and non-transfer to third countries without China's prior consent. As a developing country with a relative capability of nuclear industry, China adheres to the relevant rules in the world and has conducted fruitful cooperation in the field of peaceful uses of nuclear energy with other countries, where exclusiveness of peaceful applications should constitute the precondition for cooperation. We are confident that, along with further development of economic reform and opening to the outside world, China will enlarge its international cooperation in the peaceful uses of nuclear energy. China is ready, together with other countries, to continue to make its own contribution to the thriving and developing cause of peaceful uses of nuclear energy in the world.

Asia is one of the most promising and prospective nuclear power markets in the world. China will make its efforts in maintaining and developing the international cooperation with other countries, including Japan, in the fields of nuclear power construction and operation so as to contribute its own bit to the economic prospect.

Thank you for your kind attention.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
Office of Public Affairs
Washington, D.C. 20555

REMARKS BY IVAN SELIN
CHAIRMAN, U.S. NUCLEAR REGULATORY COMMISSION
AT THE
JAPAN ATOMIC INDUSTRIAL FORUM
TOKYO, JAPAN
APRIL 10, 1995

PRINCIPLES FOR A NUCLEAR SAFETY CULTURE IN TODAY'S GLOBAL NUCLEAR COMMUNITY

Introduction

Good Afternoon. I am very pleased to be here today to discuss with you the crucial role a well-developed nuclear safety culture plays in any nuclear power program. This is as true for mature nuclear nations with years of reactor experience, as it is for nations on the brink of developing a nuclear program, a stage which several states in the Pacific Rim are currently entering.

Economic Growth & Electricity Demands in Pacific Rim

The Pacific Rim of Asia, the fastest growing market for electricity in the world, will help determine the scope of world electricity demand for decades to come; fueling an almost 100% worldwide increase of electricity consumption over the next 30 years. The Asian Development Bank projects that the Pacific Rim will spend $1 trillion by the year 2000, primarily on energy, mainly electricity, telecommunications and transportation.

Given the steep rate of economic development in Asia, nations are scurrying to meet the rocketing electricity demands of this region. The demand for power far outstrips the supply. Several Asian countries depend heavily on imported fuel for generating electricity. Oil supply difficulties in the 1970's led the oil-importing nations of Japan, Korea, and Taiwan to develop well-planned nuclear power programs to ensure the long-term availability of electricity. Even Indonesia, an oil exporting country, could become a net importer by the end of the decade, based on growing domestic demand. At the same time, there is mounting awareness of the environmental consequences of burning soft coal and other fossil fuels, leading many to look for other fuels for electricity -- and in this search for the optimum fuel mix, many Asian countries are looking to nuclear power as a viable option to address the electricity shortage.

The Post-Chernobyl Nuclear Community

As more and more countries embark on nuclear programs, it is important that they know how much the nuclear community has changed since the pre-Chernobyl era. Nuclear programs are no longer simply national programs; nuclear energy has **global** implications -- and international cooperation is key to a successful program. Nuclear technology is no longer produced by autonomous national industries; it has evolved into an international network of scientists and technologists, a single global language, so to speak, with national dialects. The manufacture of nuclear plants is not a national matter; it is an international affair involving the harmonization of national and sometimes sub-national views.

For instance, when we look at China, we see a nation that has attempted to develop its nuclear energy program through indigenous technology and capital resources. China recognizes that this will prove inadequate as she strives to meet her growing demand for electricity across the country; China has recently cited an average shortage of electricity of 20% last year and plans to increase installed nuclear power capacity by 50 Gigawatts by the year 2020. In order to meet this upsurge of energy demands and to strengthen its domestic technology base, China will place a greater reliance on foreign nuclear technologies. For this reason, China is looking beyond its borders and seeking cooperation with Japan, Russia, the U.S., Canada and other European nations.

Furthermore, nations like Indonesia, which has just recently completed site surveys for a nuclear power plant and stated its strong interest in continuing development in the nuclear energy arena, are looking to learn from the experience of the more established, mature nuclear programs.

This, in turn, places a responsibility on the older nuclear programs, given today's global nuclear environment, to share their experience with the newer nuclear programs by continuing in the tradition of international cooperation. It is particularly important that competition be encouraged between vendors, not among nuclear states. National competition, when done by making unfavorable comparisons of various national nuclear programs, has the hazard of breeding chauvinism, protectionism, and unwillingness to share objectively evaluated information. Competition is good as long as we can keep it within its legitimate boundaries: an unbiased, non-chauvinistic comparison of available nuclear designs and technology. Emphasis should be placed on respecting differences in our nation's nuclear strategies and cooperating where there is common ground -- this will serve to benefit everyone.

I would like to make it clear from the outset that the U.S. Nuclear Regulatory Commission (NRC) has no vested interest in whether, or to what degree, any country decides to establish or further develop nuclear power. The right mix of energy sources for any nation depends on many factors unique to that nation, and ultimately must be that nation's own choice. Rather, our interests lie in the development and consistent practice of a vigorous nuclear safety culture. All countries using, or planning to use, nuclear energy to produce electricity share a common interest in achieving the highest levels of nuclear safety in their national programs. Not only could an accident cause radiological damage to its local citizens and to those of neighboring states, but unsafe programs also tend to be uneconomical.

Therefore it is vital for each country embarking on a nuclear program to establish, right from the start, a solid safety culture as the cornerstone of such a program as outlined in the International Convention on Nuclear Safety. This is the lesson the world learned from the Three Mile Island and the Chernobyl accidents, and since then, from comparisons of the nuclear safety history of G-7 countries compared to developments in the Former Soviet Union and Eastern Europe. We have learned that it is not only cheaper, but also safer, to establish and implement the necessary safety infrastructure from the beginning.

The community of mature international nuclear programs has a responsibility to cooperate with the newer nuclear programs to help ensure that nuclear power is developed safely from the start. By promoting a nuclear culture in which safety is a high priority in the decision-making process, experienced nuclear societies can greatly influence the attitudes of developing countries. Japan, with the most advanced nuclear program in Asia, shoulders a great share of this responsibility to cooperate closely with its young Asian neighbors expecting to develop nuclear power rapidly in the near future. Masao Hori, Executive Editor of Plutonium magazine, echoes this very idea in the Winter 95 issue: "Over the years, we [the Japanese] have learned a lot of valuable technologies from the U.S. and advanced nuclear-energy states. Now, we must return them with what we can do by way of international cooperation. From our position as one of the Asian nations, we are also expected to do what we can in cooperation with Southeast Asian countries, as they are expected to achieve rapid development in the years ahead."

The U.S. Nuclear Program

I want to emphasize that the U.S. has by no means abandoned nuclear power as a viable option for future energy needs. On the contrary, the U.S. nuclear program is progressing on schedule. Our program of new construction is quiescent precisely because we have already undergone the type of growth Asia is now experiencing, and we don't yet have an increased need for baseload power. Nuclear now generates about 22% of our domestic electricity -- more than double the contribution in 1975. The U.S. produces more nuclear generated electricity than anyone else in the world -- in fact, we generate almost one-third of the world's nuclear electricity. It also appears that our plant life extension program is succeeding, which will help the U.S. continue to reap the full benefit of existing nuclear plants.

As for new reactors, the U.S. NRC has issued design approvals for two evolutionary standard reactor designs -- the General Electric Advanced Boiling Water Reactor and the ABB-Combustion Engineering System 80+ [in July 1994]. In another year rulemaking certification of these designs should be completed, in keeping with worldwide expectations. In keeping with my theme of the global nuclear village, I should note the large Japanese contribution in the GE design and Korean content in the CE design.

Our review of an even newer generation of nuclear power plants is also well along. These novel designs employ passive safety features and modular construction that should make the reactors easier to build and operate, while increasing their economic competitiveness. NRC-certified designs for passive reactors, achieved after an exhaustive analytic and experimental review process of unprecedented thoroughness, should be available later this decade, well in time for those programs in the U.S. and abroad which are considering using these designs. Again, research conducted here in Japan and in Italy is critical to the success of these projects.

The overall outlook for nuclear power in the U.S. depends primarily on timing of future baseload demand and on the economic competitiveness of nuclear power. The issue is one of economics -- there are no insuperable safety, regulatory, political, or environmental obstacles to new nuclear power plants in the U.S. We believe that this is as it should be -- that economics, and not politics, should determine the choice of power generation technology.

U.S. Cooperation in the Nuclear Community

Given the fact that the U.S. maintains the world's largest nuclear power program (with some 108 reactors in current operation), we have broad experience in the technical, legislative and regulatory aspects of nuclear safety. The U.S. learned the vital importance of the "human factor" in nuclear safety in 1979 after the accident at Unit 2 of the Three Mile Island plant. The former Soviet Union learned an even more painful lesson in 1986 at Chernobyl. In the wake of the Chernobyl disaster and the dissolution of the Soviet Union itself, the NRC has focused much of our nuclear safety assistance on the established programs in the states of Eastern Europe and the former Soviet Union, to help them establish a nuclear safety philosophy based on a strong and independent regulator.

However, not all our international programs are "get-well" programs. In addition, we have expanded information exchange and cooperative programs with Pacific Basin countries. The primary focus has been on providing training, through formal coursework at our Technical Training Center in Tennessee and long-term on-the-job training assignments with NRC staff; on exchanges concerning nuclear safety and technical issues; and furnishing a full library of NRC safety and regulatory documents.

Given my belief in the importance of getting nuclear safety right the first time, our most recent exchange agreements have been with countries considering nuclear power programs, such as Indonesia and Thailand. These agreements have centered on the importance of a strong, independent nuclear safety and regulatory program. It is crucial that safety consciousness be raised at the earliest stages of nuclear development. The U.S. NRC has long provided its support to other governments seeking to improve as well as build nuclear regulatory programs and has established thirty-three regulatory exchange arrangements.

Nuclear Safety Defined

As more and more nations choose nuclear energy as a major energy source, it is important that all the nuclear economies of the world cooperate in regulatory and safety matters -- in addition to continuing cooperation in science and technology. We have found that certain fundamental principles must be followed to ensure a safe nuclear program.

Nuclear safety is like a three-legged chair. If all three legs hold up, the chair will be very stable. But if one leg buckles or wobbles, the chair will tip over. The first leg is technical safety, which is the usual focus of safety and regulatory programs. Technical safety is important, but it is only one of the three legs.

The second leg is economics -- a nuclear program must be well funded; profitable enough to permit continued heavy investment, maintenance, and training; and make good business sense. An uneconomic program will eventually try to cut costs by compromising on safety.

The third leg is organization and management -- training, staffing, safety culture, standardization, responsible leadership, realistic goals, and a solid mandate for safety from the national government.

The safe use of nuclear energy depends on the integration of several factors: economic, scientific, industrial, institutional and legal. One of the most important of these elements is a nuclear safety culture derived from certain fundamental principles that are applicable worldwide. To prove this point, one only has to compare the safety history in the OECD countries with corollary developments in the FSU. Such a comparison will show that one key difference is the role a strong, independent regulatory authority has been able to play in monitoring the nuclear industry's commitment to safety.

With specific regard to the regulatory dimension, four principles are especially important in establishing and maintaining an adequate nuclear safety culture.

First, every nuclear nation must provide a firm legal foundation for a strong and independent regulatory authority to monitor and enforce high levels of safety. Where regulators have not had the independence or political authority to carry out their job effectively, when there is no effective oversight body with the power to close down nuclear power plants for safety violations, there is a tendency to cut corners in order to produce needed power as efficiently and as cheaply as possible.

Second, no amount of regulatory authority is going to be effective if the regulator does not have the resources to get inside the nuclear power program. This means a well-trained and adequately paid staff able to perform on-site inspections, to review plants at all stages from design to decommissioning, and to analyze errors to improve operations in the future. It also means a confirmatory research capability.

Third, both the industry and the regulators must apply rigorous nuclear safety standards such as the principles covered in the International Nuclear Safety Convention.

Fourth, by national law or international commitment, a state must put into place legal liability and financial protection arrangements which would provide adequate compensation for damage in the event of a nuclear accident, while setting appropriate limits on third party liability. Such protection holds both the nation and the nuclear power plant operators responsible for safety while assuring the public redress for any injury it might suffer as a result of negligence or improper operation.

Where these principles have been adhered to from the beginning, a culture of safety has permeated both nuclear operations and management, and this has produced a successful nuclear industry. Where these principles have **not** been followed, the drive to maximize electricity production has too often led the industry to override safety objectives when the two came into conflict.

Role of the International Nuclear Safety Convention

Three years ago, not long after assuming my post as Chairman at the NRC, I spoke at this same forum about the importance of an international nuclear safety convention which would codify the basic fundamentals of an effective nuclear safety regime. In Spring of 1992, formal efforts were just getting underway under IAEA auspices. It gives me great satisfaction to stand before you today and discuss how the International Convention on Nuclear Safety (CNS) is now becoming a reality.

Since the CNS was opened for signature last September, more than 50 countries have become signatories, including the U.S., Japan, China, and many others in the Pacific Rim.

The Convention, which took three years to negotiate, includes principles and standards which both the industry and the regulators must apply, covering all safety relevant aspects of the nuclear fuel cycle. The CNS establishes that it is the license holder, and **not the regulator**, who is ultimately responsible for the safety of the installation it is operating. Nevertheless, the CNS also requires each contracting party to "maintain a legislative and regulatory framework to govern the safety of its nuclear installations." This includes:

- establishing national safety requirements and regulation
- a system of licensing nuclear installations and a prohibition against operating a nuclear installation without a license;
- a system of regulatory inspection and assessment to make sure licensees are in compliance with applicable regulations; and,
- enforcement of these regulations, supported by sanctions that could lead to suspension, modification or revocation of the operating license.

All CNS members are obligated to show they have established an appropriate regulatory and legal framework and each is required to establish a well-funded, strong, independent regulatory body. Moreover, the functions of this regulatory body must be effectively separated from those of any other national "body or organization concerned with the promotion or utilization of nuclear energy." The obligation of each member to submit safety reports for peer review on nuclear power facilities guarantees the exchange of critical information about each member's nuclear power program, its strengths and weaknesses, further enhancing safety cooperation. The Convention therefore serves as an important tool in assuring each member of a safer, more stable global nuclear environment.

The signatories are now developing options for implementing the obligations of the Convention. Experience from the Institute of Nuclear Power Operations, the World Association of Nuclear Operators, and from the various safety missions of the IAEA will be of great assistance in preparing and reviewing individual reports.

Once 22 countries, at least 17 of them with operating nuclear facilities, ratify their signatures, the Convention will come into force, hopefully by 1998.

Japanese Nuclear Power Program

I recognize the challenge to Japan's energy industry in dealing with the pressure to reduce electricity prices -- which are now among the highest in the world. In the U.S., we have also struggled with this difficult issue. I would like to note, however, that we have learned that industry's efforts to trim corners and cut costs, in order to produce electricity as cheaply as possible, must not compromise the bedrock principles of nuclear safety. As I mentioned earlier in my three-legged chair analogy, a nuclear program must be well funded -- the "economics" leg of the chair must remain solid, and the independent regulator given its political authority to do its job, to ensure the program's continued safe, thus successful, operation.

The devastating earthquake that hit the city of Kobe on January 17 demonstrates how important it is for a nuclear power program to be designed from the start to protect the health and safety of the public. The Takahama nuclear power plant, 70 miles northwest of Kobe, was the closest nuclear plant to the epicenter of the quake. I understand that the earthquake, which officials measured to read about 7 on the Richter scale, produced a small tremor that was only 14% of the strength needed to trip one of the reactors because of their advanced seismic designs. The reactors continued to operate throughout the disaster in Kobe.

The steps Japan has taken to make nuclear power safe and therefore successful are the same steps any country developing nuclear power must take. **There can be no shortcuts.** This may not always be a welcome message in developing countries, but it is an essential message nonetheless. Forums such as the International Conference for Nuclear Cooperation in Asia, led by

Japan, must continue to serve in carrying this message to countries such as Indonesia, China, Malaysia, Philippines, Vietnam and Thailand.

I see the key factors contributing to Japan's success broken down into the following five basic elements:

- Japan's long-term national commitment to nuclear power,
- large investments in research and development,
- creation and support of academic programs to provide trained personnel,
- aggressive international cooperation and information exchange, and
- a favorable operating environment for utilities.

These elements have resulted in one of the highest standards of excellence in the world for its nuclear program involving 48 reactors operating at 17 sites, and providing over 30% of the nation's electricity. Although Japan is grappling with two issues that all mature nuclear nations must deal with, that is, the location of new sites and the disposition of spent fuel, Japan still plans to almost double its nuclear generating capacity by 2010.

One element that has greatly enhanced the success of Japan's nuclear program -- an element I believe crucial in today's nuclear environment -- is its cooperation with the global nuclear community. U.S. technology has contributed greatly to Japan's nuclear industry, and the reverse is also true. Japan has benefitted greatly from this technology transfer; in fact, all Japan's LWRs are based on designs originally licensed in the U.S. Japan continues to be one of the U.S. NRC's most active partners in nuclear safety exchanges, involving cooperative research, information on regulatory programs, and exchange programs involving personnel and training. Because nuclear regulatory responsibilities are split between two Japanese government agencies, NRC has regulatory information exchange agreements with both the Ministry of International Trade and Industry (MITI) and the Science and Technology Agency (STA). Since 1982, there has been an exchange of regulatory personnel between NRC, MITI, and STA which has contributed to daily dialogue on safety matters. NRC also has extensive research agreements with several Japanese agencies. In fact, Japanese research institutions are playing a significant role in conducting and confirming research for NRC on passive-safety system performance.

Continuing exchanges foster the spirit of nuclear safety cooperation. It is important that we continue with this tradition and guard against chauvinism, protectionism and undue competition. Respecting differences in our nations' nuclear strategies and cooperating where there is common ground will benefit all parties involved. Only then will attention be focused on areas where we can mutually gain; reaping benefits from this cooperation not only for our respective countries, but for the international community as well.

China's Nuclear Power Program

Given Japan's proximity to the Peoples Republic of China, I'm sure that China's nuclear program is being watched closely. The demand for electrical energy is outrunning supply by more than 20% in China. And to meet this demand, China's nuclear energy plans for the future are ambitious. During the past two years, China placed three nuclear power plants into operation -- two 900-MW PWRs of French design at Daya Bay, and one 300-MW PWR unit of indigenous design at Qinshan -- and is already planning several additional reactors, including four 600-MW PWRs at Qinshan, and four additional 900 MWe units for the Daya Bay area. By the turn of the century, China expects to have 10,000 megawatts of nuclear power operational or under construction and it plans to install 150,000 megawatts of nuclear power by 2050. China's plans, if followed through, would result in one of the largest nuclear programs on earth.

China is well aware that extensive foreign capital is necessary for almost any large-scale expansion of electricity in a developing country. Since foreigners will not invest in the industry if safety isn't assured, a strong regulatory program is important for both the sake of attracting capital as well as for safety. And China is clearly taking nuclear safety seriously. Several weeks ago, U.S. Secretary of Energy O'Leary successfully presided over the signing of several contracts and accords for the American power-generation industry during a six-day visit to China, accords which will also have the helping side effect of increasing communication between China and American organizations that have fire safety experiences to share with China.

At China's invitation, last year the IAEA conducted a review of its nuclear regulatory system. The review team found that China's regulatory system corresponds to those in use worldwide and that its program meets international guidelines. This is very encouraging.

Nonetheless, there is still cause for concern. As the production side of China's nuclear program expands, China will need to ensure that its regulatory capability does not lag behind. I see four issues that I see becoming increasingly important: regulatory resources and authority, design standardization, transparency, and coordination of emergency preparedness. These are factors crucial to the viability of any nuclear program worldwide:

Resources and Authority: One key resource is an adequate number of well trained and highly competent staff. As the number of nuclear plants multiplies, the regulator will need greater numbers of personnel to be able to keep up in any meaningful way. To ensure retention of competent staff, it is crucial that salary levels for regulatory personnel be set at a level comparable to industry salaries. A related issue is independence and authority. If the regulator does not have the final authority on whether to license operations or to close a reactor for safety violations, its effectiveness will be seriously limited.

Standard Reactor Designs: Efficiency can be achieved by limiting the construction of nuclear plants to a few standard reactor designs. With 41 nuclear utility companies and 109 individual reactor designs, the U.S. knows first-hand the large number of people required to regulate effectively a variety of reactor types. For a regulator to be able to maintain an adequate base of knowledge and confirmatory research capability, it is imperative that nations new to the nuclear market limit plant construction to just a few standard reactor designs. Indeed, the U.S. is now moving toward standardized designs.

Transparency: A third issue central to nuclear safety, commonly referred to as transparency, is the reporting of all nuclear incidents both to the domestic public and to appropriate international oversight organizations. The number of incidents, even minor, is one of the best objective indicators of the state of a nation's nuclear safety program. Not only is the public entitled to this information, but investors need this information to help determine if their investment is safe and secure.

Emergency Preparedness: Lastly, coordination of emergency preparedness is critical to any serious nuclear safety program. Emergency planning and response during the early phase of an accident are particularly important for plants in highly populated areas and for plants near international borders.

U.S. - India Nuclear Safety Cooperation

Nuclear safety is of such vital importance globally that it should be possible to conduct a colloquy on this issue with any country, irrespective of cultural and political differences.

Just a few weeks ago, I had the opportunity to visit India, continuing a nuclear safety dialogue begun last July. My visit was a follow-on to an earlier visit to the U.S. by Dr. A. Gopalakrishnan, Chairman of the Indian Atomic Energy Regulatory Board. While in the U.S., Dr. Gopalakrishnan's delegation conducted technical discussions with NRC staff, visited the NRC's Technical Training Center in Chattanooga, Tennessee, toured a U.S. nuclear power plant, and concluded the trip with meetings at Brookhaven National Laboratory. In turn, while in India, I met with a cross section of Indian political, energy and nuclear power officials, and, with my delegation, was given a useful opportunity for access to one of their indigenous nuclear power plants (Narora) and the nuclear research facilities at the Bhabha Atomic Research Centre (BARC), as well as to review current operation of the Tarapur Atomic Power Station with its General Electric manufactured reactors.

In the wake of what India has characterized as a peaceful nuclear explosion in 1974, nations which had previously conducted broad-scale nuclear cooperation with India (including the United States) adopted more stringent non-proliferation technology controls on exports to nations--like India--which had not accepted IAEA safeguards over their entire civil nuclear programs. This development forced India to turn more inward in its nuclear program, giving it a more "indigenist" character. This situation has had the undeniable effect of preventing Indian nuclear scientists and engineers from benefiting fully from the most current work in the rest of the nuclear world in areas important to safe operation of nuclear plants. However, this relative isolation has also meant that the Indian nuclear program has explored some different approaches to technical issues.

As India stands on the brink of unprecedented growth and prosperity, a factor directly impacting it's ability to sustain this growth will be the availability of safe, reliable and economical electric energy. India at present is facing an energy peaking shortage on the order of 20%, which is likely to persist until adequate capacity can be added for meeting the rapid growth in demand for electricity. Nuclear power is part of the mix the Indian Government will draw upon to meet that need. As it presently exists, the Indian program is too small to make a real contribution to India's large and growing energy needs, but large enough to pose significant safety risks, if not implemented to the highest levels of safety. The Indian nuclear program has developed a sufficient number of well-trained nuclear personnel. It has a strong legal basis, and with recent changes in government, has developed an openly aggressive regulatory infrastructure.

Conclusion:

In conclusion, I wish to emphasize that the nuclear safety program as we knew it in the pre-Chernobyl era has changed from several national individualized programs to a global one. Active participation in today's international nuclear community is key to ensuring a successful nuclear program in any nation. Competition needs to stay confined to where it legitimately belongs: an unbiased comparison of available nuclear designs and technology. Competition by tearing down each other's national nuclear programs, however, will only serve to bring out prejudices against nuclear energy and ultimately undermine confidence in nuclear power. In the end, we would all miss out on the benefits of nuclear safety cooperation. Only by continuous involvement in the global nuclear community can the mature nuclear economies achieve what we all are striving for -- a healthy international nuclear economy and safety culture which fosters the safe development of nuclear power. And the International Convention on Nuclear Safety is one instrument which opens the way to this achievement. Let us continue working together toward this end.

Check against delivery

"NUCLEAR ENERGY FOR A STABLE INTERNATIONAL SOCIETY"

Hans Blix
Director General
International Atomic Energy Agency

Opening Session, Annual Conference of Japan Atomic Industrial Forum

Tokyo, 10 April 1995

In this last decade of the 20th century our global population will grow from 4 to 5 billion people, most of them needing drastic improvement in their living conditions, *inter alia* through greater use of energy, particularly electricity. During this decade the world will shrink further and we shall all get even more dependent on each other. We shall be in great need of international stability to avoid death and destruction through armed conflicts, to free scarce resources through disarmament and to promote trade and development. Two of the most important questions we must ask are:

Can we contain and eventually eliminate the threat of nuclear weapons? and

Can we use nuclear power as a major part in responding to our growing energy needs?

I can think of no place more appropriate to discuss and reach a hopeful conclusion to these questions than Japan, a great power that has been uniquely successful in rapidly raising the living conditions of its population, that has categorically renounced nuclear weapons and that is rapidly developing nuclear power as a major economic, safe and environmentally benign source of energy.

Recent Critical Issues in Energy Area

1. Instability in Energy Supply

2. Emergence of Global Environmental Issues

3. Changes in Characteristics of Energy Systems
   - Limits to Economy of Scale

Principle of CO2 Factor Analysis

$$C = \frac{C}{E}\,\frac{E}{G}\,G \qquad (1)$$

$$= C_e\,E_g\,G \qquad (2)$$

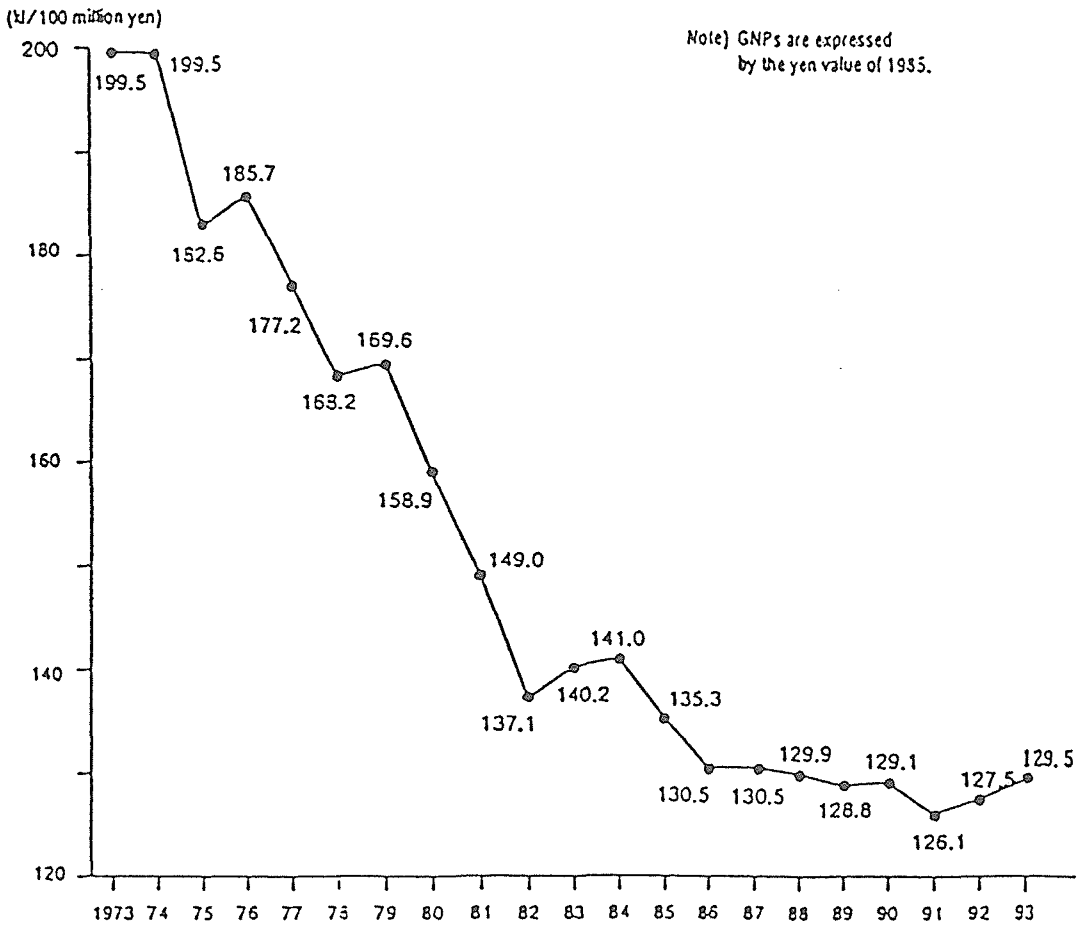
$$\frac{dC}{C} = \frac{dC_e}{C_e} + \frac{dE_g}{E_g} + \frac{dG}{G} \qquad (3)$$

Table 1 Four Factors in major developed countries rates of change, %/year

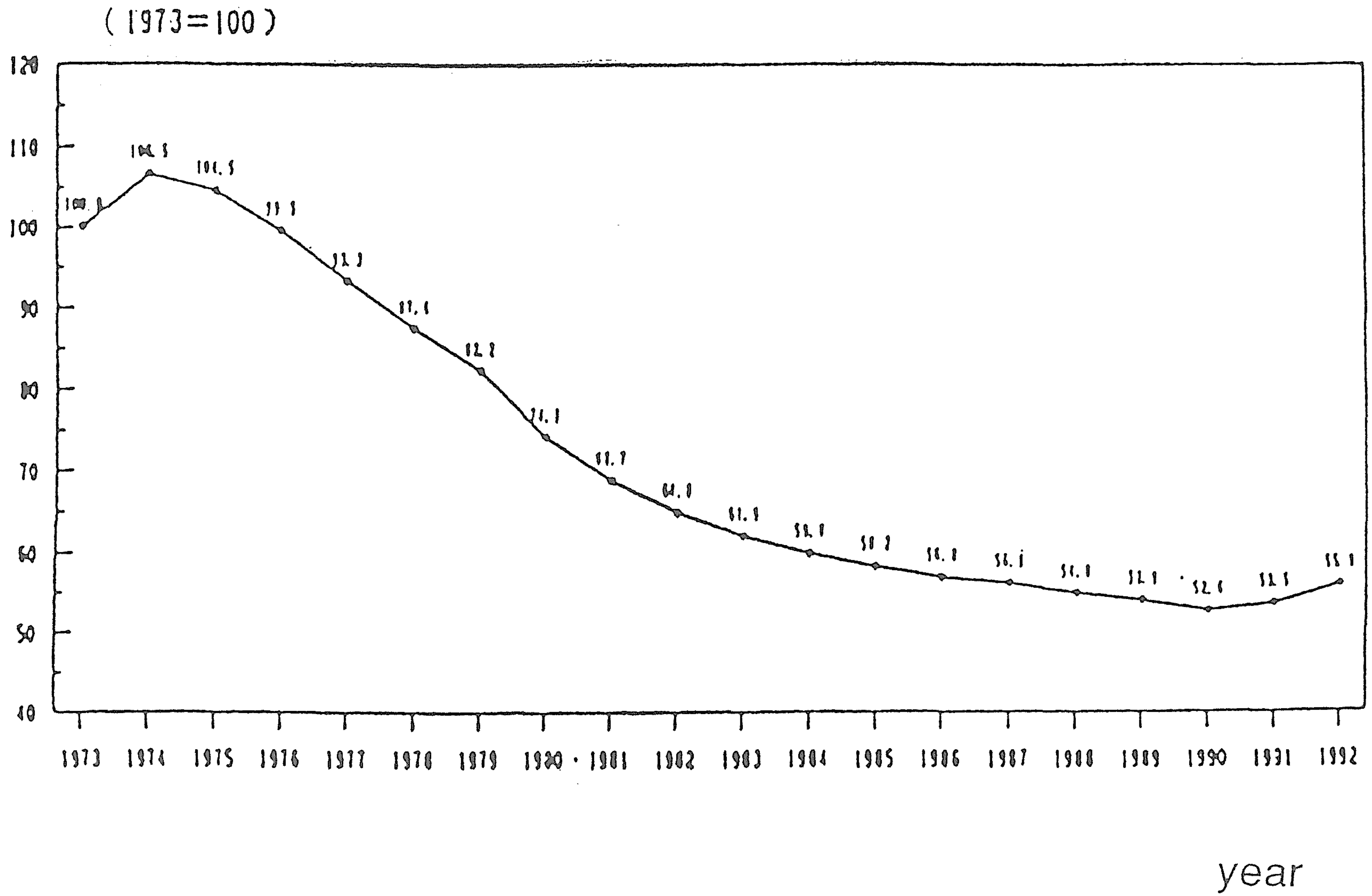
	C/E	E/G	G	CO2	F	C/E + F
	carbon intensity	energy intensity	GDP		nuclear power	C/E; nuclear moratorium
Last 100 years						
World	- 0.3	- 0.9	+ 3.0	+ 1.8	--------	--------
1980-1989						
France	- 3.4	- 0.4	+ 1.9	- 1.9	3.8	+ 0.4
Germany	- 1.2	- 1.7	+ 1.7	- 1.2	1.1	- 0.1
Japan	- 0.7	- 2.0	+ 3.7	+ 1.0	0.7	0
UK	- 0.6	- 2.0	+ 2.5	- 0.1	0.5	- 0.1
USA	- 0.2	- 2.0	+ 2.8	+ 0.6	0.4	+ 0.2

* data source : IEA statistics, 1980-1989

Change in energy consumption per unit of GNP



Energy intensity (all manufacturing industries) : Japan



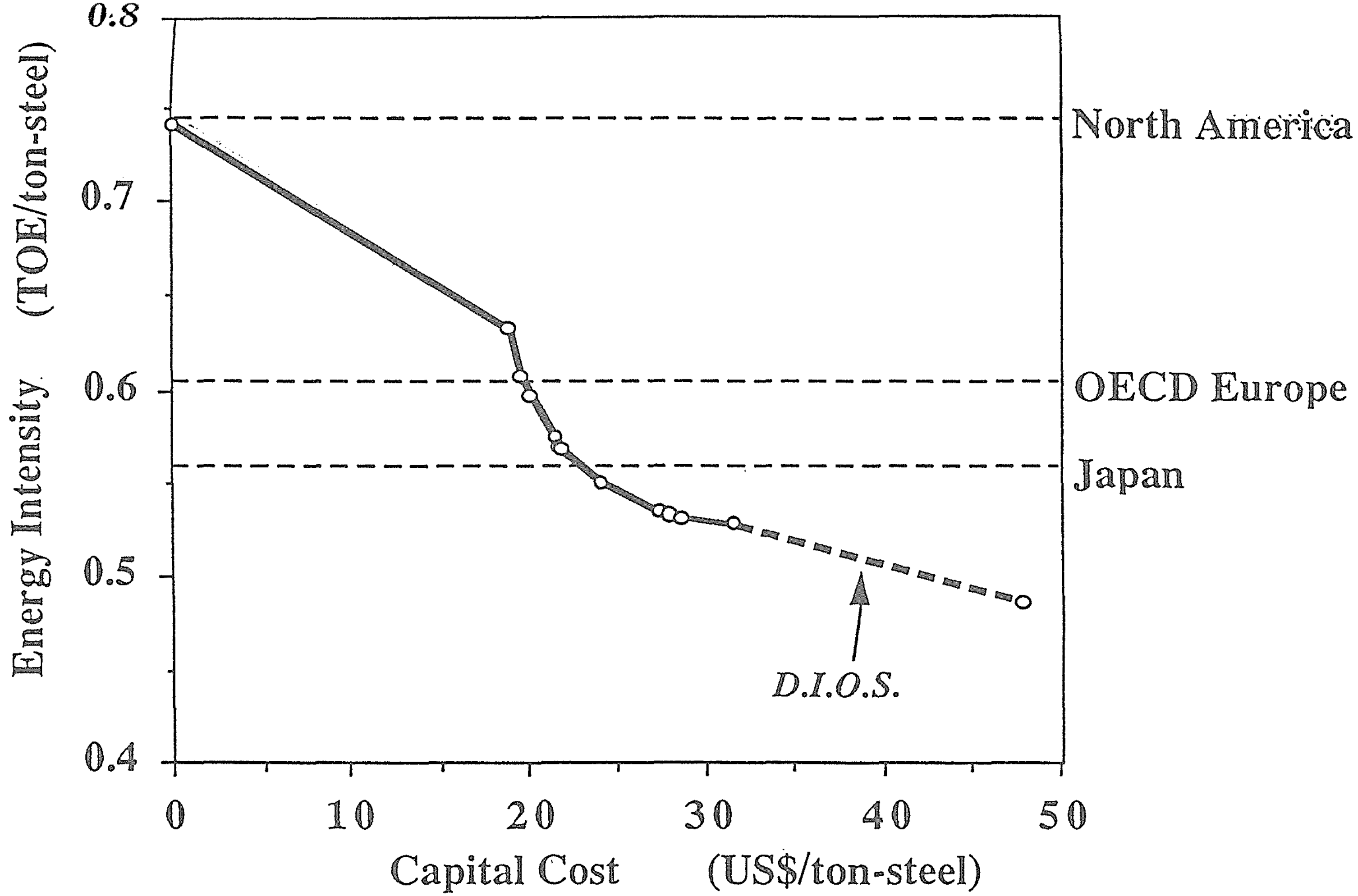


Fig. 4 Relationship between Energy Intensity and Cost in Iron & Steel Industry

Potential of PV

1. The constraint due to the output changeability with time

   load at night : to be covered by <u>non - PV</u> supply

   Tokyo area :

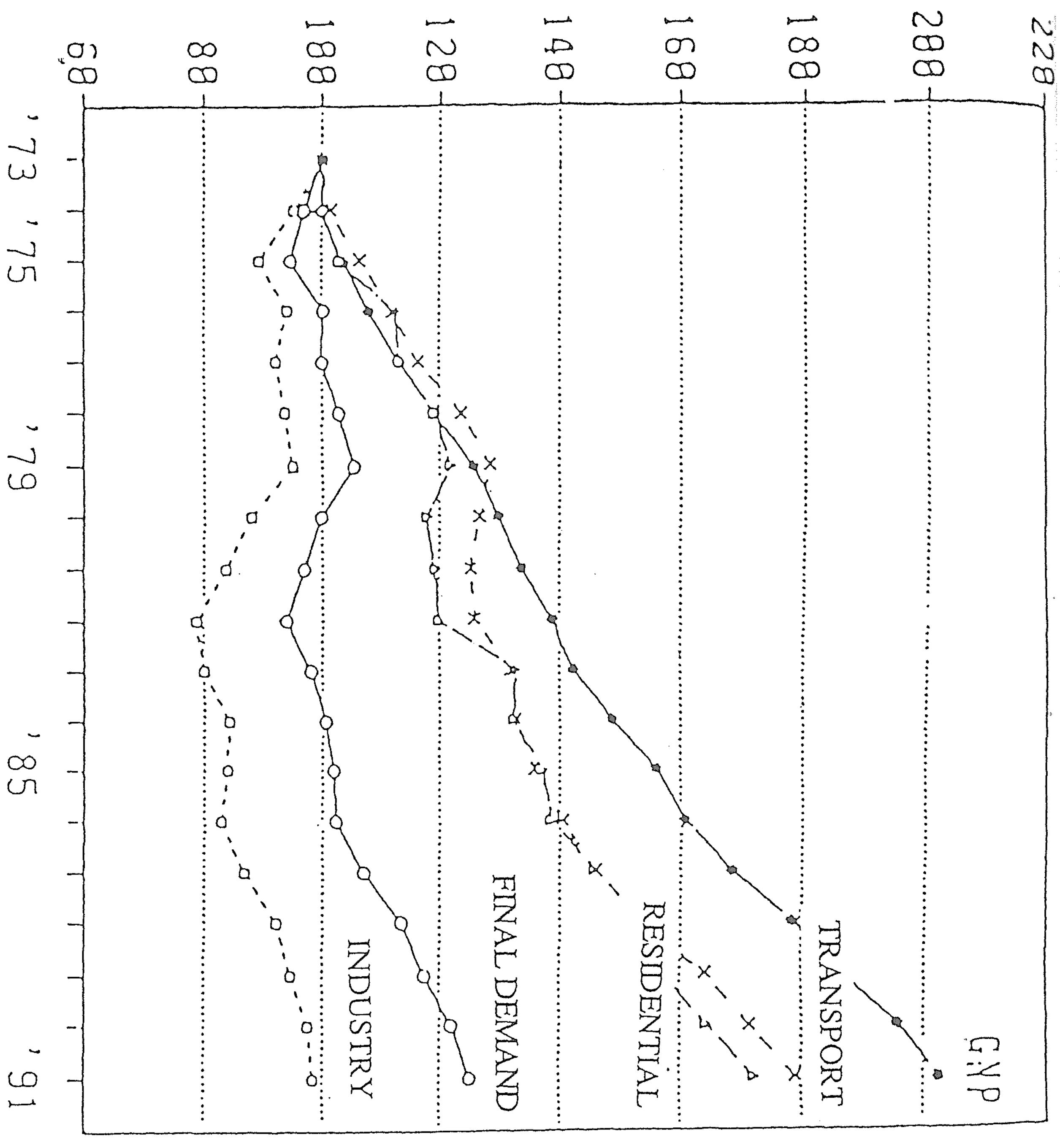
   max capacity - 36% of the total
   max energy - 7% of the total

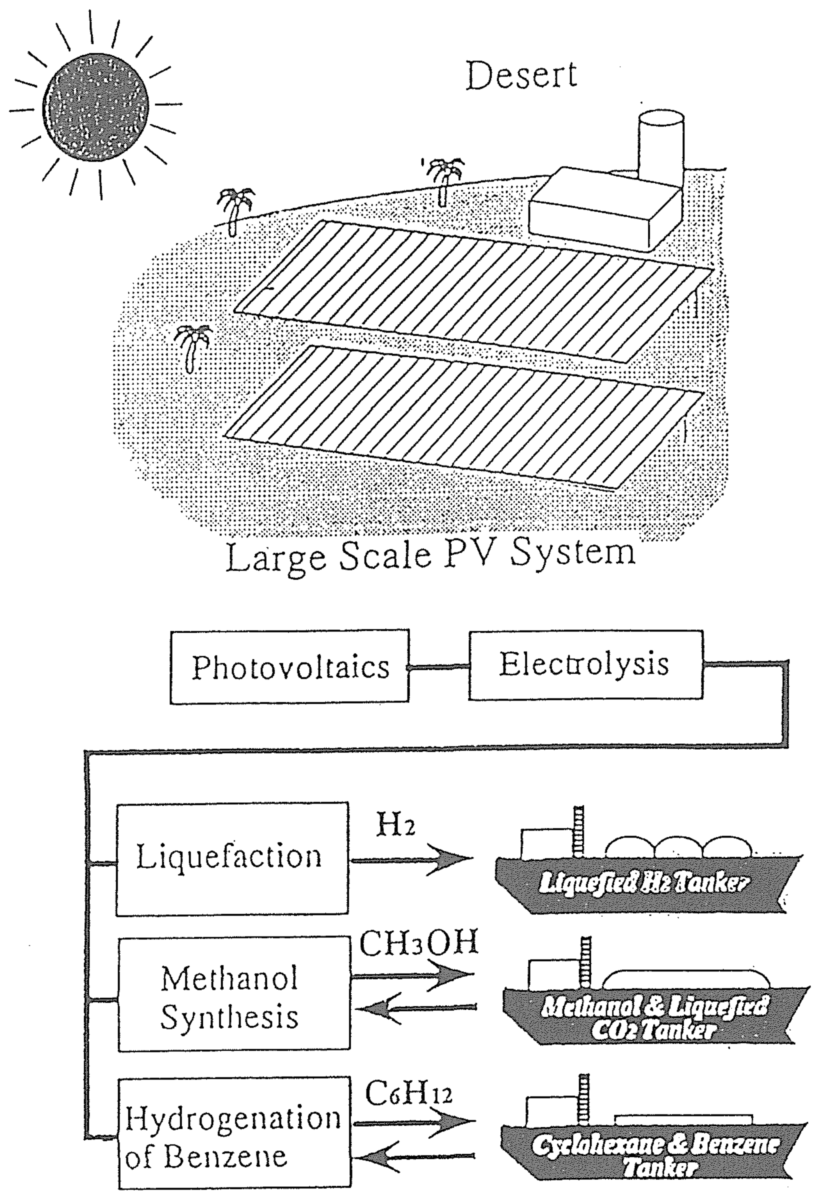
2. Limitation of the available space

   assumption : all house roofs available for PV

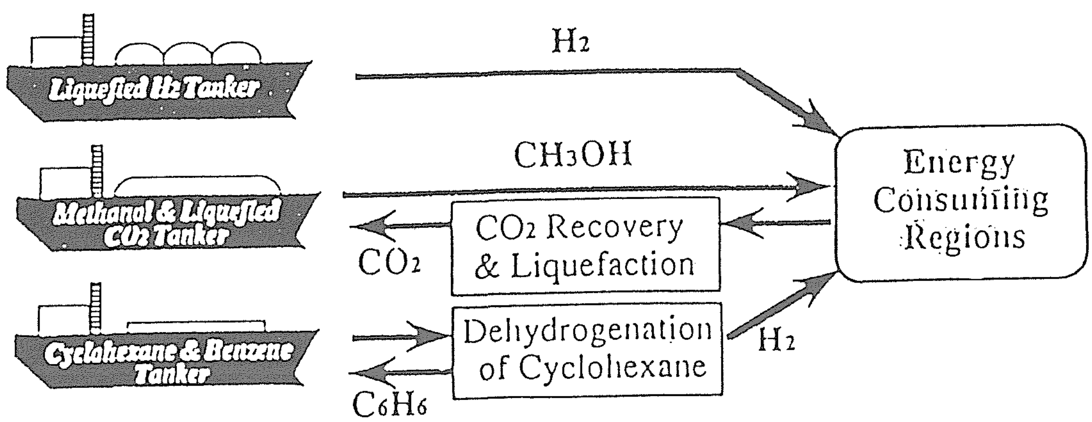
   Japan :

   max capacity - 90% of the present total
   max energy - 24% of the present total

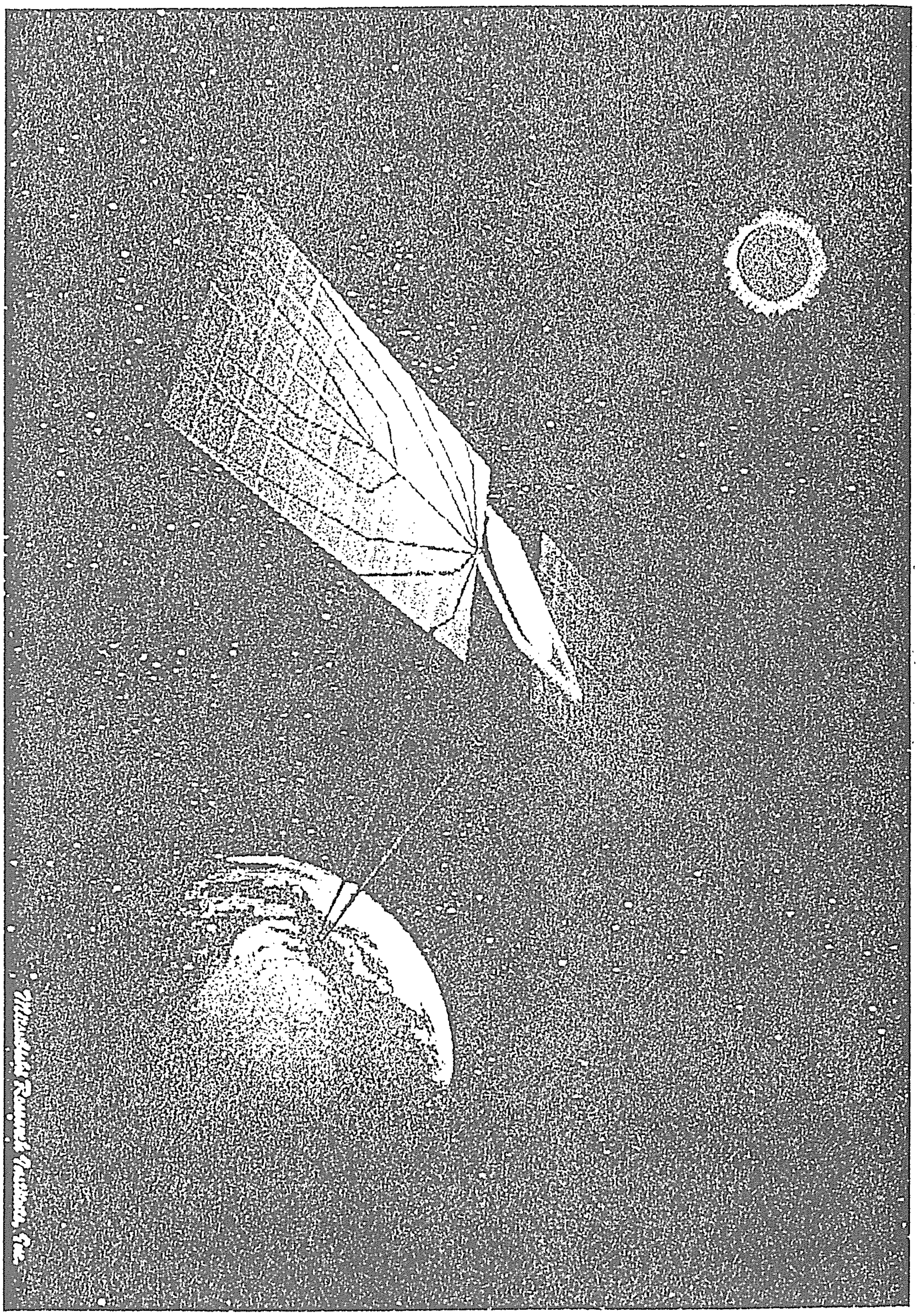

220
200
180
160
140
120
100
80
60
'73
'75
'79
'85
'91
GNP
TRANSPORT
RESIDENTIAL
FINAL DEMAND
INDUSTRY



Energy Exporting Regions



Energy Importing Regions



Solar Power Satellite

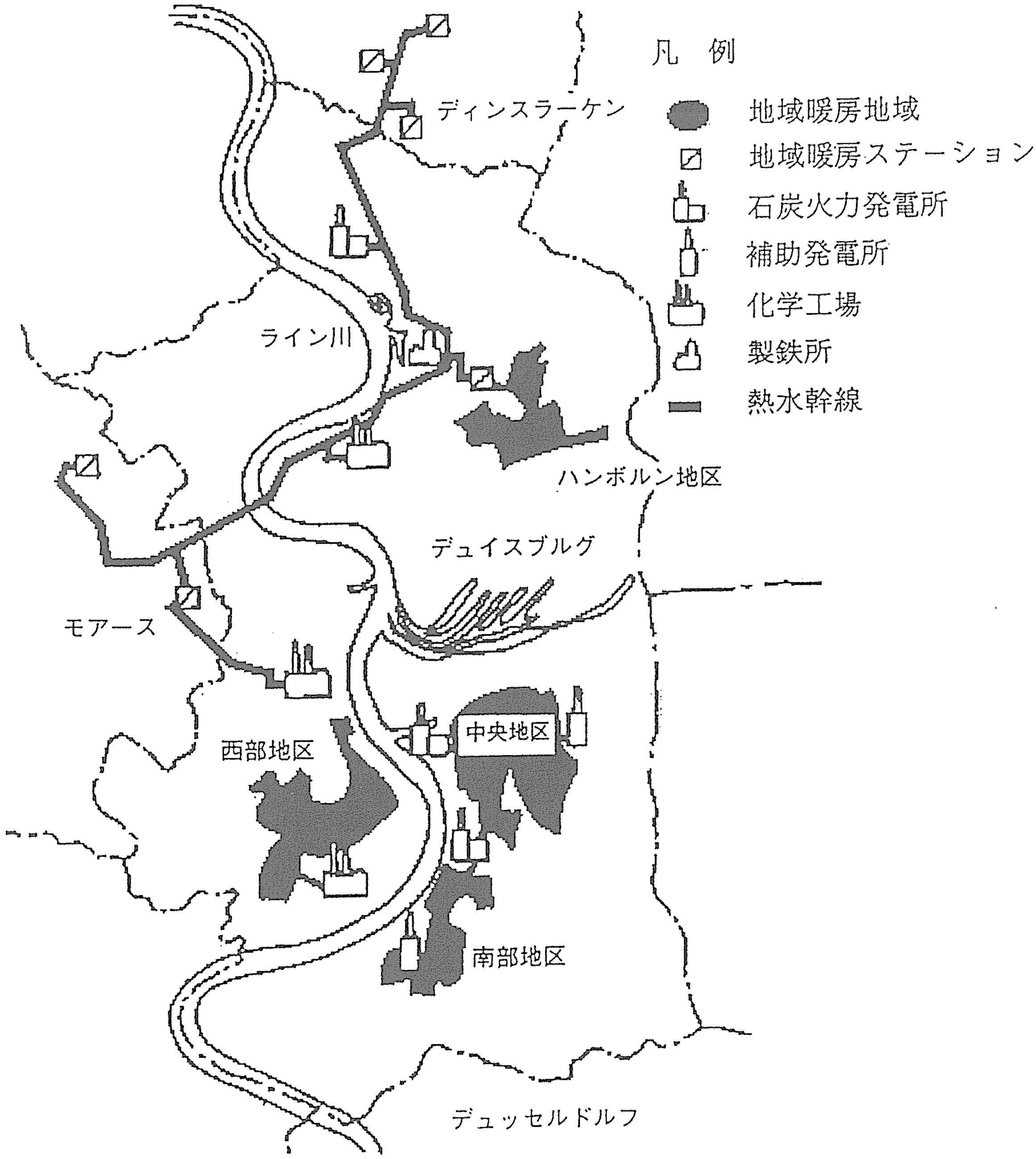


図 7.2: ドイツ・デュイスブルグでの熱供給システム [52]

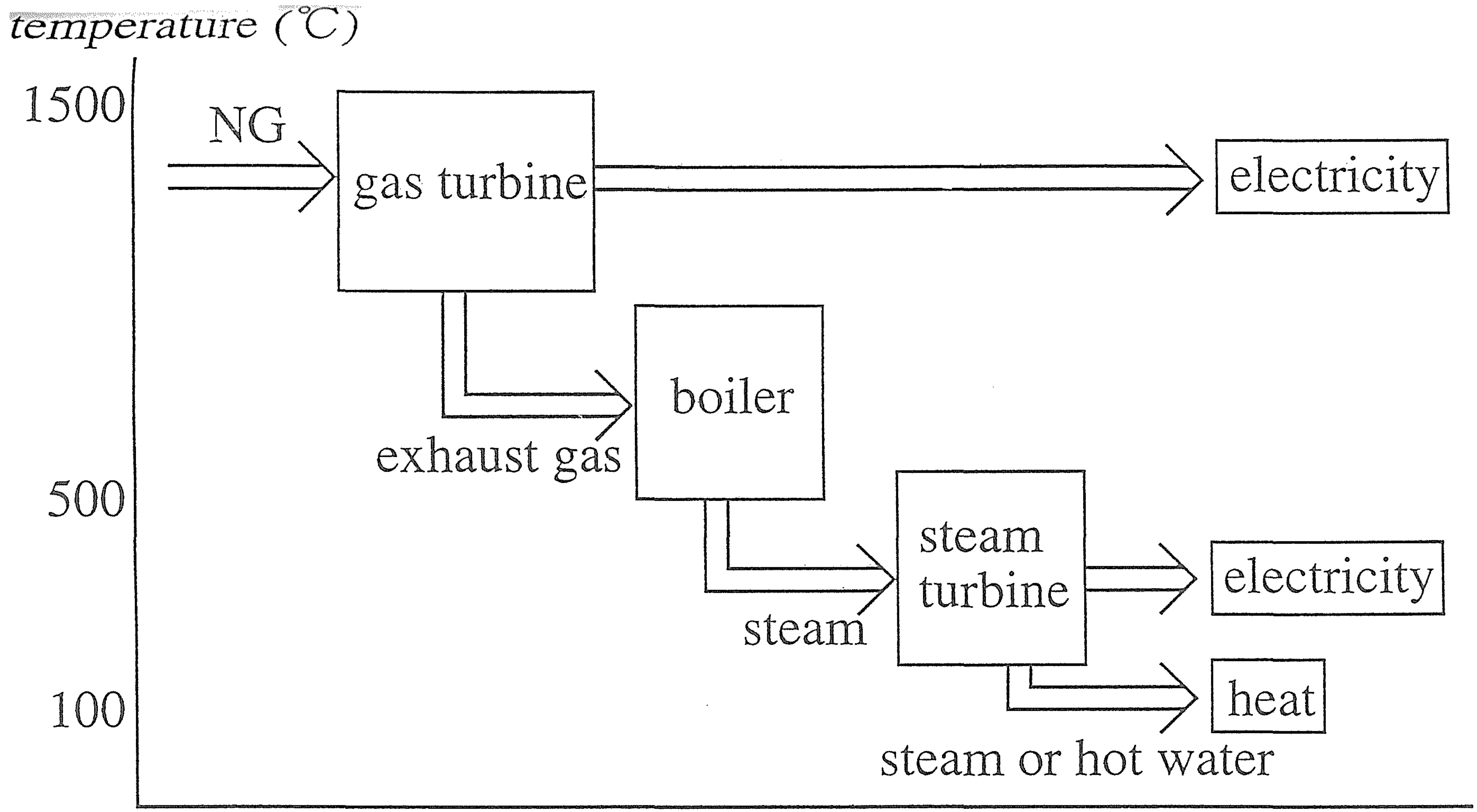


Fig. Combined Cycle and Cogeneration

JAIF CONFERENCE, TOKYO
10/12 APRIL 1995

"Nuclear Power in the UK - Energy for the 21st Century"

J G Collier FRS FEng
Chairman
Nuclear Electric plc

Introduction

Manufacturing economies such as the UK and Japan demand reliable and - if at all possible - cheap sources of energy for their industries. Energy costs are a key determinant of a nation's competitiveness in the international market place. Energy security of supply is essential. Nations therefore try to balance the short term needs of the economy with the long run imperative of security of supply. Usage and mix of fuels also influences a nation's ability to meet international environmental obligations. "Sustainable development" would not have been a phrase to trouble policy makers as recently as 6 years ago. The Rio and more recently Berlin summits, concerned with global warming, have changed all that.

In this context this paper compares and contrasts the development of - and prospects for - electrical power generation (and, in particular, nuclear generation) in the UK and Japan.

UK/Japanese energy scene

The UK is blessed with plentiful indigenous fuel resources. Its industrial revolution was fuelled by coal. More recently has come the discovery and exploitation of North Sea oil and gas.

With indigenous energy supply and demand in balance to satisfy the security of supply condition, the UK has been able to afford the luxury of a market based energy policy - for electricity, and, shortly, also for gas. Competition opens the way to cheaper prices for customers as market forces work to drive down costs. But competition brings risks as well as benefits: for instance - so called "short-termism", the failure of the market to look beyond short investment horizons to the longer-term needs for security of supply and environmental balance and problems in establishing a stable market which embodies a satisfactory mix of regulation and free market forces.

Countries without significant fuel reserves of their own are wary of such risks - and inclined to place much greater emphasis on security of supply rather than on cost. Japan, for instance, is heavily dependent on fuel imports, and therefore favours a more structured system of energy planning to meet its needs. Vertically integrated electricity utilities face only limited exposure to competition.

Comparisons are, of course, difficult, but it is generally accepted that energy in Japan is comparatively expensive. *Figure 1* shows how the price of electricity to Japanese industry compares with the price to UK industry. But high energy prices also favour energy conservation and efficiency.

Competition in the UK

The United Kingdom Government's energy policy aims to achieve, through the mechanism of the market, secure, diverse and sustainable supplies of energy, at competitive prices. In 1989, consistent with its political philosophy, the Government privatised much of the UK electricity supply industry. Nuclear generation was, however, withdrawn from this privatisation late in the day when the Government could not agree terms for the inclusion of the nuclear assets.

The state-owned bulk supplier and transmitter of electricity to England and Wales, the CEGB, was broken up into four separate companies (Scotland has separate arrangements):-

- National Power and PowerGen, large, privately owned fossil-only generators;
- Nuclear Electric, the state-owned all-nuclear generator; and
- National Grid, a company which owns and operates the transmission system.

The twelve privately owned Regional Electricity Companies can purchase where they wish, invest in own-generation or enter joint ventures with independent generators. Therefore electricity supply is <u>not</u> vertically integrated as in Japan but allows competition at both the generation and supply levels.

Consequences of Privatisation

This market led approach has certainly brought benefits:-

- a growth in competition in both generation and supply;
- market led investment decisions (both as regards new plant construction and plant retirements);
- lower costs and lower prices for consumers;
- improvements in productivity and efficiency; and
- an increase in UK activity in export markets.

The market is still evolving. Transitional arrangements, designed to enable the smooth introduction of market disciplines, are gradually being removed. The Government aims to minimise intervention into the workings of the market. However, the market has also been subject to occasional and abrupt intervention by the Government appointed Regulator. His influence recently brought about a sharp reduction in the value of shares throughout the electricity sector causing a financial, political and industrial furore.

These are teething troubles. However, in the long term, there can be no doubt at all that a market-driven energy policy stands the best chance of getting pricing right in the UK.

Consequences for fuel mix - Coal

Competition has inevitably brought casualties. Exposure to the market has accelerated the decline of the UK coal industry as transitional arrangements, which were designed to ease the path of coal into the market, have been scaled down. Consumption of coal for electricity generation has fallen to close to a half since privatisation. Government projections suggest that consumption could halve again by 2000.

Gas

Gas, however, goes from strength to strength *(Figure 2 shows the contrast between coal and gas)*. Natural gas became available as a fuel for electricity generation in the UK in 1990. Its popularity has surged for two reasons:-

- proximity to the considerable North Sea reserves makes it a cheap option; and
- the newly created market favours gas with its quick return on capital - an attractive characteristic for investors in a young and relatively immature market.

The UK Government forecasts that around half of Britain's electricity will be generated using gas by 2020.

However, the most optimistic Government estimates imply that the UK's own North Sea gas could last only until 2025 unless supplemented by imports from Europe; but Europe too is becoming increasingly reliant on gas from further and further afield. The risk for the UK of greater reliance on imported gas is exposure to the kind of supply shock risk not seen since the oil crises of the 1970s.

Consequences for the Environment

The switch from coal to gas has contributed to a downward trend in CO_2 emissions in the UK - as has the sharply improved output from the nuclear stations. The UK Government is now confident of meeting its commitment under the Climate Change Convention to return emissions of carbon dioxide to 1990 levels by the year 2000 *(See Figure 3 for projections under various scenarios.)* Last month the UK Secretary of State for the Environment announced his intention to call on developed countries to agree a new objective for the year 2010. He recommended aiming for total greenhouse gas emissions reductions in the range of 5 to 10 percent below 1990 levels. But beyond 2000, under all scenarios, UK CO_2 emissions look set to rise *(See Figure 4)*.

Consequences for nuclear power

To summarize, in the short term the UK enjoys diverse and plentiful energy supplies. The Government is confident of meeting its immediate environmental targets.

Longer term trends, however, suggest a continuing need for a significant tranche of nuclear generation in the UK energy mix to ensure security of supplies and environmental balance.

UK nuclear industry's current structure is as follows: Nuclear Electric owns and operates all the nuclear power stations in England and Wales - 5 AGR stations, 6 Magnox stations and 1 PWR *(see Figure 5)*.

Scottish Nuclear owns and operates both nuclear power stations in Scotland.

The British Government's nuclear Research and Development body, the United Kingdom Atomic Energy Authority, is now split into two divisions:-

- the commercial wing - AEA Technology - a broadly based science and engineering business; and
- UKAEA Government division which has the core task of caring for and decommissioning the Authority's nuclear facilities.

British Nuclear Fuels Limited manufactures and reprocesses nuclear fuels. Originally set up to help meet Britain's domestic needs, their fuel services now serve customers all over the world.

<u>Achievements of the UK nuclear industry over the past five years</u>

Nuclear Electric

Nuclear Electric has responded to the same downward pressure on costs and the same commercial disciplines as the privatised generators. Since its formation:-

- Output is up 44% to 61 TWh. The performance of the AGRs has been transformed - their output is up more than 80%.
- Productivity in terms of output per employee is up 100%
- Unit costs are down 40%.
- Market share has risen to nearly a quarter of the market.

Completed to time and within cost, Sizewell B, the UK's first PWR, began to supply electricity to the grid in February this year. Adapted from a proven design by Westinghouse, Sizewell B has additional design features which will make it exceptionally reliable. Nuclear Electric are confident that construction to time and cost will be followed by high operational and safety performance.

Scottish Nuclear

Scottish Nuclear now supplies around half of Scotland's electricity, having increased output by 16% to 14.2 TWh and improved productivity by a third since their formation.

AEA Technology

The Government intends to privatise AEA Technology which has developed its customer base well beyond the nuclear industry. It now has customers for its science and engineering services in defence, manufacturing, transport, oil and gas, energy supply, chemical, health care and other industries.

BNFL

The UK reprocessing industry is thriving and received a major boost with the start up last year of BNFL's new Thermal Oxide Reprocessing Plant (THORP). BNFL combines extensive overseas business with a solid base of orders for nuclear fuel cycle services on the home market. Scottish Nuclear have recently concluded an agreement with BNFL for nuclear fuel cycle services for the lifetime of its AGRs. BNFL report that the additional reprocessing business from Scottish Nuclear more than offsets the tonnage cancelled recently by two German customers.

At the end of last month, Nuclear Electric and BNFL finally signed the key contracts in a £14B package covering nuclear fuel services, completing one of the biggest commercial deals negotiated between two companies anywhere in the world. These contracts cover the reprocessing of all Magnox and around half the AGR lifetime fuel arisings. THORP now has a total of over 4,500 tonnes of UK AGR fuel for reprocessing under contract, over half of that in the post-baseload period.

This is a major vote of confidence in BNFL's reprocessing capability. It increases Britain's commitment to its domestic reprocessing company. For BNFL it gives predictability for its principal business over more than a decade, securing further work for THORP.

In line with the UK's recognition that plutonium is a valuable resource, BNFL are also applying their fuel fabrication skills to the manufacture of MOX, recognising its conservation and potential economic benefits.

Costs

The UK's market-driven energy sector places the focus on costs, for existing and for future plant. *Figure 6* lists typical values for costs for different types of existing power plant including Nuclear Electric's stations. AGR costs have fallen steeply. These stations are now fully competitive with alternatives in the market place.
The forecast accounting unit cost for Sizewell B is about 3.4 yen/kWh - less than the forecast market price. Therefore Sizewell B is expected to make a profit.

As *Figure 7* shows, new construction will be needed if nuclear power's contribution in the UK is to be maintained as the gas-cooled stations reach the end of their lives. Such new construction will probably have to involve private finance.

The best design option for the UK is a new station based closely on the Sizewell B design, thus avoiding the first-of-a-kind costs of importing new technology. Further economies could be achieved by building a twin reactor beside Sizewell B - what Nuclear Electric call Sizewell C - with a generating capacity of over 2600MW and a capital cost of ¥500 billion. Nuclear Electric is exploring the feasibility of building and operating such a station through a joint venture in which they, the major partner, would have a significant share.

Sizewell C would have a lifetime levelised unit cost of 4.5 yen/kWh, calculated at 8% real rate of return. This is a very good deal indeed for a power station with the highest standards of safety in the world. However, as *Figure 8* shows, relative to cheap gas in the UK - and from the narrow point of view of investors in the UK electricity market - forecast returns on investment are not as attractive as those from a gas-fired plant. The low capital intensity of CCGT plant, together with currently low gas prices, leads to low lifetime unit costs.

These costs do not, however, reflect the environmental and diversity benefits of nuclear power. Moreover, the price structure of the electricity market does not recognise such benefits. Neither does it recognise that the nuclear generators, quite rightly, meet the full environmental costs of generation while the fossil fuel rivals do not.

From a national point of view, the case for new nuclear generating capacity in the UK is strong. It will become stronger still. However, the market signals which drive investment decisions are not geared to reflect environmental priorities - or to guarantee diversity or security of supply.

<u>The Nuclear Review</u>

The UK Government is considering these matters in the context of a review of nuclear power in the UK. They announced this review when nuclear generation was withdrawn from the privatisation programme in 1989. The review has been under way since last summer. Key issues include:-

- the economic and commercial viability of new nuclear power stations in the UK; private sector financing being a key test;
- whether new nuclear power stations offer particular diversity, security of supply and environmental benefits; and
- possible options for introducing private sector finance into the nuclear industry.

An important outcome of the Review would be a Government decision to complete their privatisation programme by moving Nuclear Electric and Scottish Nuclear to the private sector. This would give the generators the same commercial freedom which their competitors enjoy. Privatisation would bring the commercial flexibility which the generators need to prosper and grow at home and overseas.

Whatever the outcome of the Review brings, Nuclear Electric will continue to aim to produce a favourable track record in the eyes of existing and prospective shareholders. This will provide the base from which the Company can extend its horizons, to develop as a world class power company.

International Opportunities

In the meantime, the international market opens up increasing opportunities for the UK nuclear industry. At least 125 nuclear power plants are either under construction or definitely planned worldwide. The strongest growth will occur in the Pacific Rim *(see Figure 9)*; much of it in countries without highly developed nuclear design and construction capabilities.

Britain is a strong contender in the emerging global market across the board of nuclear expertise, in fuel services, plant life management, decommissioning and radwaste and new plant construction.

British Nuclear Fuels are a leading supplier in the fuel cycle services market which will be worth over $35 billion by 2010. AEA Technology have combined their nuclear heritage and highly qualified and flexible workforce to treble their international turnover to $100 million over the past four years.

Nuclear Electric is pursuing opportunities on the strength of the Sizewell design. We have distinct advantages to offer:-

- The British nuclear safety regime is one of the toughest in the world.
- Sizewell B construction demonstrates first-class project management skills.
- Sizewell B is at the top of the range and one of the two or three advanced nuclear plant designs competing for world markets.
- Nuclear Electric is an owner-operator with extensive practical experience, not simply a consultant-contractor.

In partnership with the Westinghouse Corporation, Nuclear Electric is one of three companies short-listed to design and build a twin-reactor plant at Lungmen in Taiwan. Nuclear Electric's expertise lies in station design, project management and engineering; Westinghouse will manage the supply of the nuclear and steam supply system - that is a very strong combination.

Nuclear Electric also acts as consultant to East European utilities on the strength of its technical, commercial and safety records. Furthermore, utilities are seeking advice on commercialising their activities; they are looking to Nuclear Electric as a model of business transformation.

The UK and Japan

In the near term, the prospects for nuclear growth in the UK and in Japan differ sharply. Japan aims to increase nuclear capacity from over 40,000MWe to 70,500MWe by 2010. The UK has yet to establish when further nuclear construction will take place. "Short-termism" in the UK electricity market, characterised by the popularity (and availability) of cheap gas, is not a climate in which new nuclear construction can easily flourish, despite:-

- dramatically improved performance;
- an advanced, economic reactor design; and
- strategic, environmental and other benefits.

This contrasts with the Japanese system of examining national and strategic factors such as population growth, resource limitations and growing energy demand and developing specific national goals to assure a stable supply of energy. Given Japan's energy needs and circumstances, this, in turn, assures the central position of nuclear power in its energy policy for many years to come.

It also means that Japan has continued to make substantial progress towards closing the nuclear fuel cycle. The UK developed reprocessing, plutonium fuel manufacture and fast reactor systems early. Japan is now progressing quickly to close the fuel cycle.

Of course, the characteristics of the Magnox and AGR stations have limited the UK's options on use of MOX. Now, however, Nuclear Electric expects to burn MOX in Sizewell B, although they will not do that until they have gained confidence through experience of running that plant. Furthermore, the fast reactor's time will come in the UK as well as in Japan: it is just a matter of patience. There are no right or wrong answers on timescales for closing the fuel cycle. Each country has to look at the available energy resources and programme their use over future decades.

Public acceptance

The island states of Japan and the UK both recognise that the future of nuclear power in a democratic system ultimately depends on the will of the people.

It seems that the policy of plutonium recycling raises particular public sensitivity - this is a matter for regret, particularly given the good environmental case for this aspect of the Japanese nuclear programme. In Japan, the Atomic Energy Commission's long term plan refers to the need to base the development of peaceful nuclear power on a national consensus. This requires the confidence of the public in the Government and private operators and in standards of safety. In the UK too, the nuclear industry works hard to increase public confidence in the industry and public recognition of its competence to operate safely and responsibly.

Anything which raises doubts in the public mind must also be of concern to nuclear industry people. If industry employees thought that their activities were likely to cause harm, they would not live with their families close to nuclear plants. That is an important message to communicate, and one which is, perhaps, better understood by people living in proximity to nuclear installations - people who live and work with nuclear industry employees - than by the public at large.

The nuclear companies have publicised their wish that the public should visit operating nuclear power stations and nuclear sites at Sellafield and elsewhere. They have had a good response. Sizewell B and THORP, in particular, have attracted much favourable media coverage.

As *Figure 10* shows, majority public acceptance in the UK is still a long way off. Over the last five years public attitudes in the UK have not varied significantly. Opposition to nuclear power has tended to hover around the 50% mark. Something over 30% have been in favour, with the balance made up with those who express no opinion. There are hopeful signs, though. For instance, nearly three quarters of the UK population are open to at least some of the arguments in support of nuclear electricity and see a need for future nuclear plants. Nuclear Electric strives constantly to communicate with the public and to promote understanding of the importance of nuclear power for the well-being of future generations.

Conclusions

There is reason for confidence that the world will see overall growth of clean nuclear power into the next century; but only if the industry earns and maintains the trust and confidence of the public, its customers. Each country will proceed at the pace which suits its circumstances and its political and other priorities. The UK nuclear industry looks with some envy on their colleagues in Japan where prospects for growth in nuclear capacity seem so very much more certain than they do at home.

It must be recognised, though, that in countries which are short of low cost or indigenous fossil fuel alternatives, sheer need for energy will encourage investment in nuclear plant, while in countries like the UK where there is at present no shortage of cheap indigenous fuel, short term market forces will tend to dominate; with the benefits - and the risks - which they bring. So it may be that the construction of further nuclear power stations in the UK in the near term requires some form of Government encouragement or support in the market place. In the meantime, the international market opens up opportunities of its own. In that arena the UK nuclear industry has much to offer and much to gain.

There is much to admire in both the Japanese and the UK approaches to energy policy and planning. There is, and there will continue to be, much which the two countries can learn from each other.

Figure 1

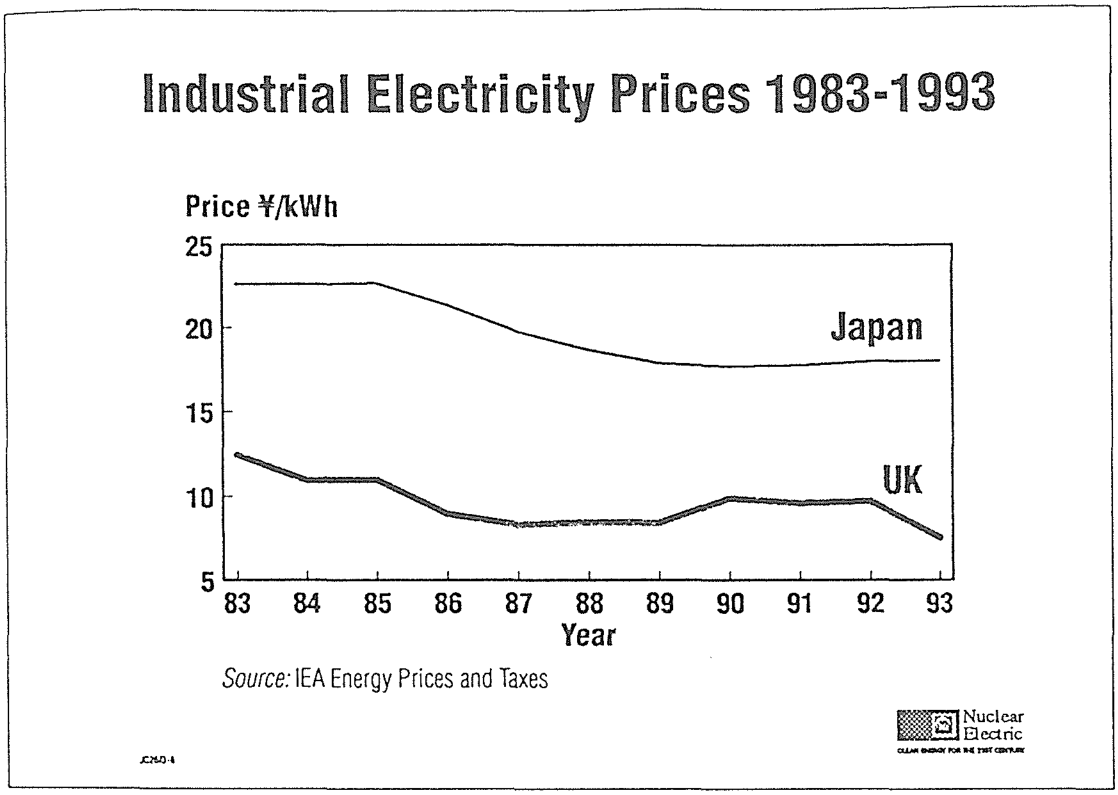
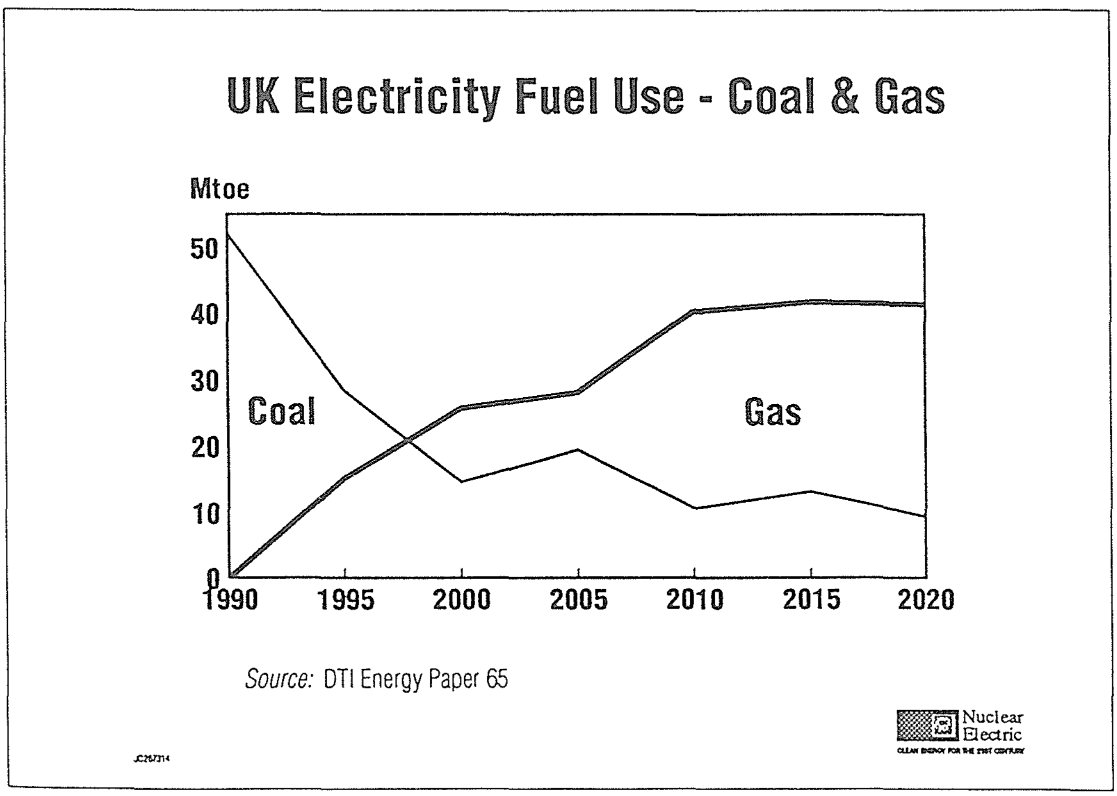


Figure 2



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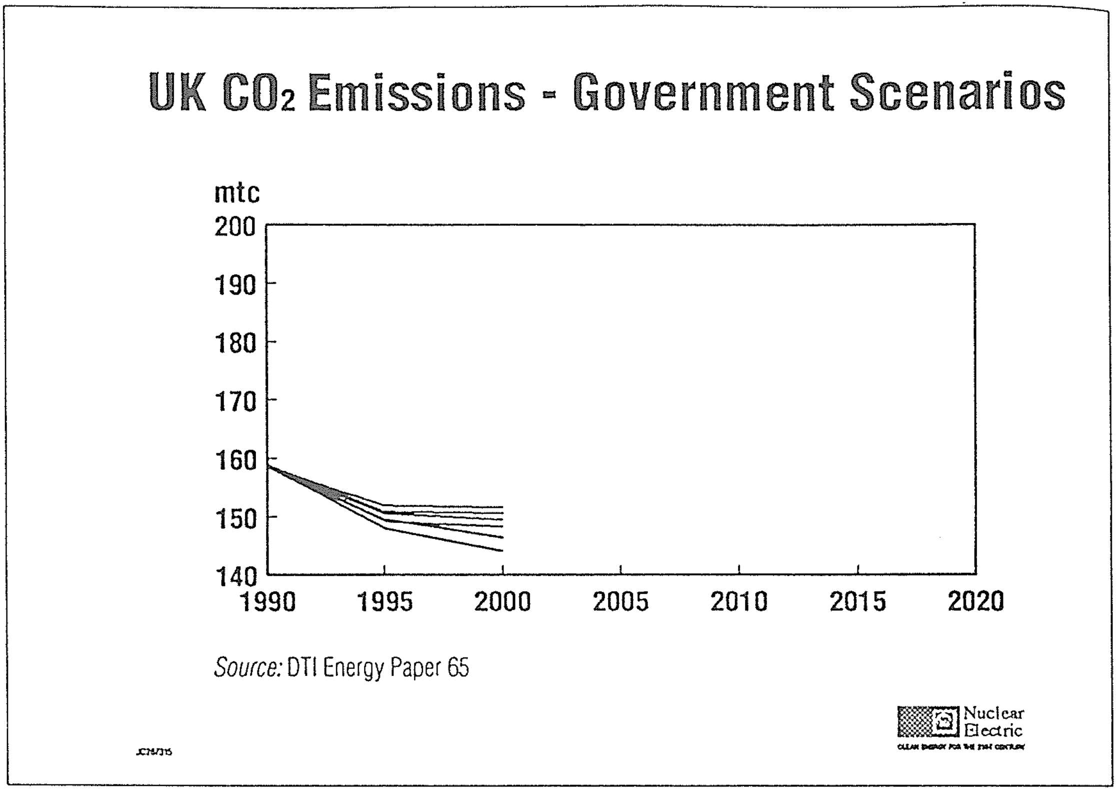
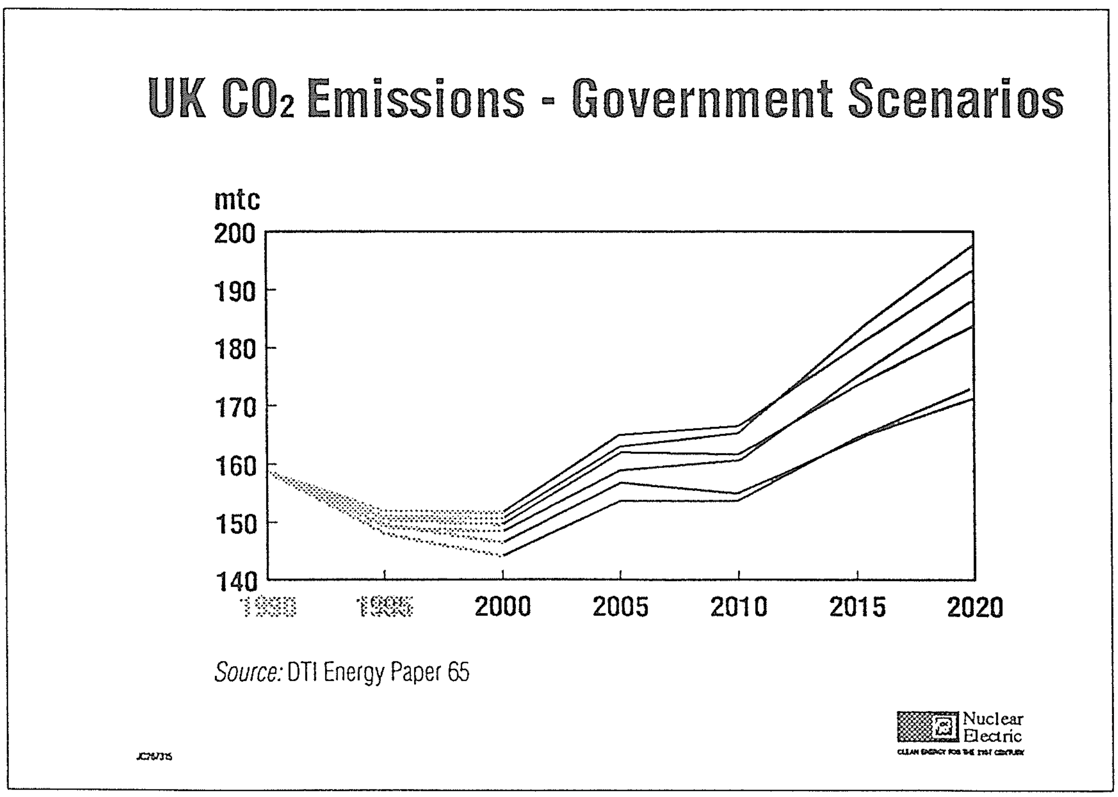


Figure 4



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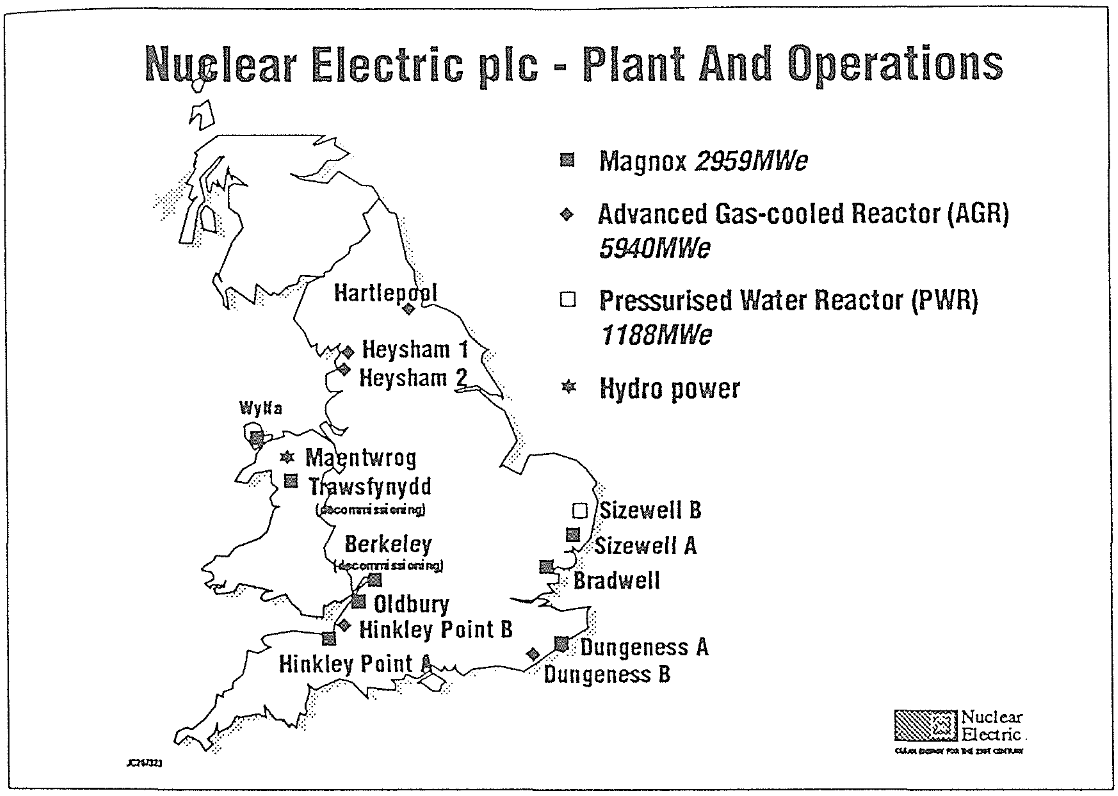


Figure 6

Comparative Accounting Costs For Plant Types

Existing plant type	Accounting cost (Y/kWh)
Nuclear - Magnox	5.3
Nuclear - AGR	4.0
Nuclear - Sizewell PWR	3.4 (forecast)
Coal*	3.6 to 4.4
CCGT (gas)	3.1 to 3.6

* Includes retrofit of flue gas desulphurisation for large stations

Nuclear Electric

Figure 7

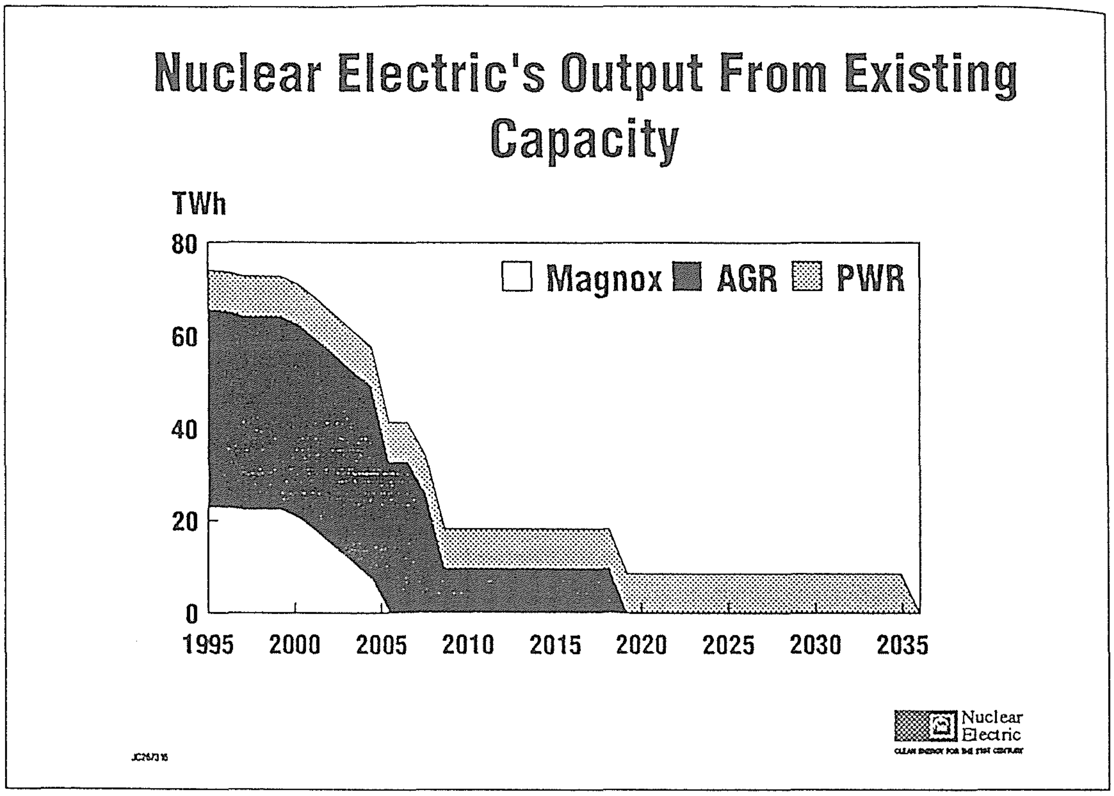


Figure 8

Comparative Lifetime Levelised Costs

Proposed New Plant	Lifetime levelised cost (¥/kWh) at 8% real rate of return	Typical capital cost (¥/kW installed capacity)
Nuclear - future twin PWR	4.5	211,160
Coal - new technology	4.7 to 5.5*	140,773
CCGT (gas)	3.6 to 4.0*	78,207
Wind	6.3 to 9.4+	172,056

* Figure depends on fuel price + Figure depends on site

Nuclear Electric

Figure 9

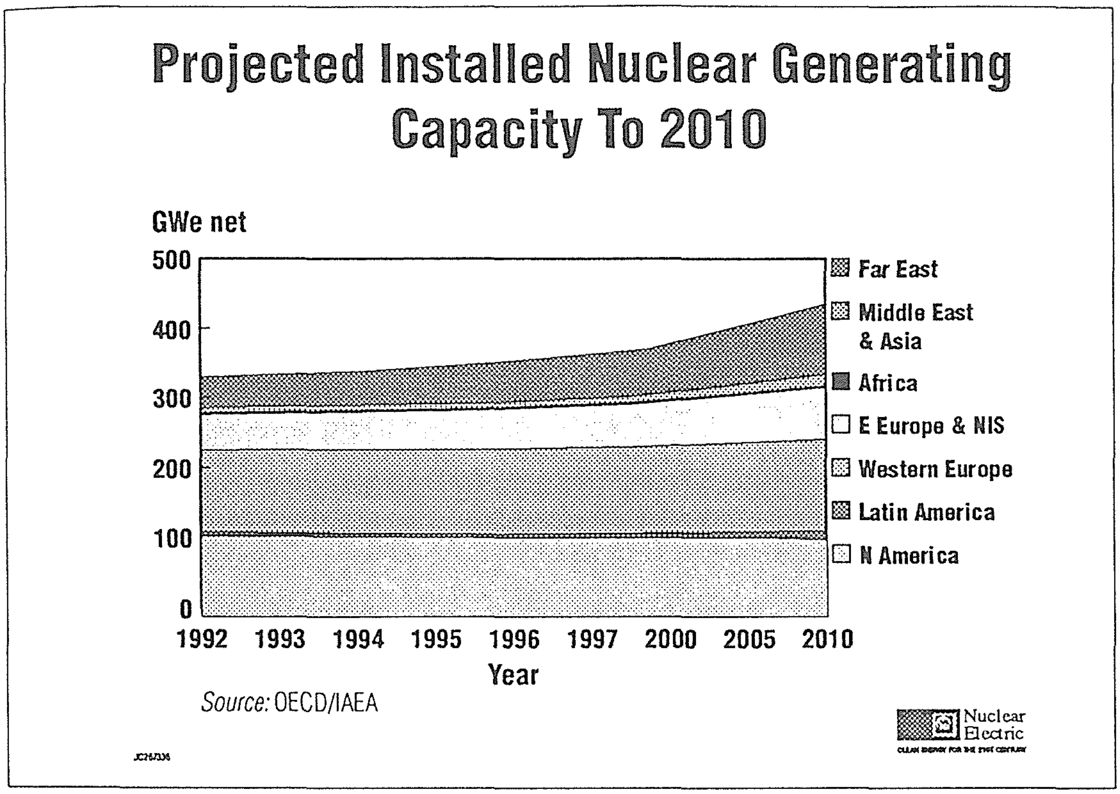
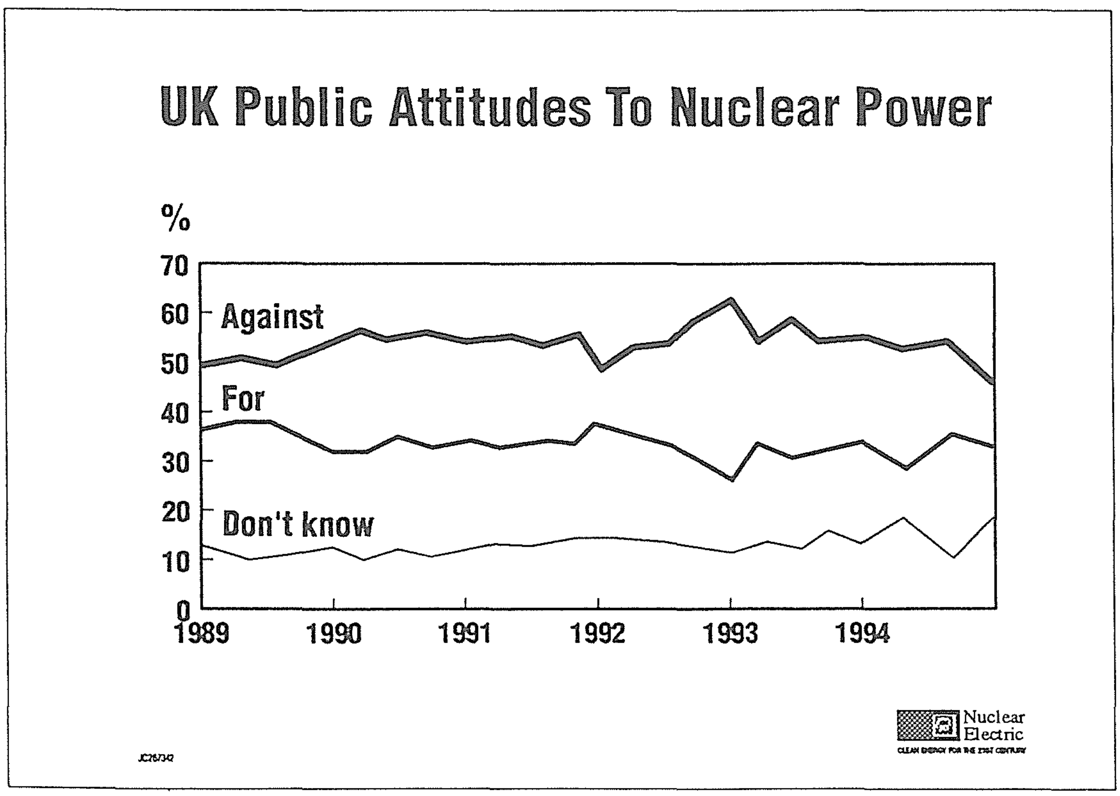


Figure 10



ASIAN DEVELOPMENT AND PEACEFUL USE OF NUCLEAR ENERGY

by

DR. ZUHAL

Director General of Electricity and Energy Development
Ministry of Mines and Energy
The Republic of Indonesia

Distinguished Guests, Ladies and Gentlemen,

It is my great pleasure to attend and to address this 28th Annual Conference of Japan Atomic Industrial Forum in this beautiful city of Tokyo. I was asked to present a paper providing the outline of future Asia. Specifically, a paper describing the link between Asian development and the peaceful use of nuclear energy.

To start with such presentation, allow me to start by taking Japan development as a starting point. We all agree that Japan has achieved the prominent status in economic power and science and technology. It is not exagerating if I say that nowadays we depend on Japanese technology in our everyday life. Besides using equipments with such technology, consuming countries also benefit from technology advancement in the form of the technology transfer. Moreover, this technology development has encouraged the neighboring countries to achieve higher status in science and technology development. We have witnessed the progress of countries in the Pacific basin transforming rapidly to become prosperous and developed countries. All is originated from the adoption of higher technology speeding up the industrialization process in a remarkable pace.

In order to achieve such fast industrialization development one important input required is energy. Not all developed countries, like Japan, are blessed with abundant energy resources. However, while they depend on imported energy, their human resources development has created engineers and scientists mastering all aspects of science and technology who can use scarce energy supply efficiently. This success of Japanese development has induced a spirit of development followed by countries in Asia-Pacific region.

Ladies and Gentlemen,

It is very appropriate, I believe, that the remarkable achievement of Japan can be used as a model for Asian countries. Other countries should follow what the Japanese has done in the last decades. Nevertheless, it must be noted that there is no similar path of development. Each country has its own cultures, values, and needs which form the character of the nation. What I would like to emphasize here is that we should follow the hard work, the strong need of achievement, and the spirit of Japanese people to achieve their objectives. This is, I think, the most important message that I would like to address.

Ladies and Gentlemen,

The logical consequence of rapid industrialization is the need for a lot of energy supply. There is a linear relationship between industrialization and energy need. Statistic shows that energy consumption in industrialized countries such as Japan or Korea is probably several fold than even a larger countries such as Indonesia. While Japan and Korea depend on imported energy supply to meet domestic demand, Indonesia is blessed with abundant energy resources for domestic need as well as for export. Both Japan and Korea have been trying to release themselves from energy import dependency by developing nuclear power plants. Indonesia, on the other hand, has been trying to slow down the depletion of its oil reserves by developing non-oil resources, of which nuclear power is also in the list.

The extreme condition of the two sides shows that there is an interlink among countries in this region so that each country can benefit among themselves. This would lead to an interdependence that could enhance the economy of the countries should they adopt cooperation rather than confrontation for energy supply.

Ladies and Gentlemen,

I would like to mention some issues in the nuclear power development in Asian countries as an illustration. Some Asian countries have been relying on nuclear energy for power generation. Japan is the largest energy consuming country in Asia with 30% of its electricity need is supplied from nuclear power plants. Japan has a long history of nuclear development. This country has been involved with nuclear power since 40 years ago. The role of nuclear energy to meet the growing demand will be as important as before.

South Korea is one of the leaders in promoting nuclear energy considering that more than 40% of its electricity demand is met by nuclear power plants. In anticipating additional demand growing at a rate of approximately 15 % per year South Korea plans to have more reactors in the power plant mix.

The People's Republic of China and Taiwan are newcomers in the nuclear power plant's business. China has been using nuclear power since two years ago with the current 3 reactors installed capacity of 2100 MW. Besides planning to construct more foreign-made reactors, China is also building reactors with its own technology.

Meanwhile, Taiwan plans to construct two units of nuclear power plants starting this year. India and Pakistan are the two countries having interests in developing nuclear energy for power generation.

My own country, Indonesia, is also considering to construct nuclear power plants. It is one option along with other energy resources such as hydropower, natural gas, geothermal and coal. Currently, only a small portion of our hydropower potential has been tapped hampered by the remoteness of locations. Our natural gas potential is abundant and gas is preferable since it is relatively clean. Coal is expected to be the main energy sources for power generation in the coming years since its reserves are abundant. This rich energy sources mix will give us more flexibility is using any kind of energy sources.

However, to anticipate future demand of electricity growing rapidly, nuclear power is seriously considered as an energy source for the future. Preparation for this purpose has been carried out long time ago in the field of law, human resources development, and nuclear science and technology. Research and Development facicilites in Serpong is one of the most modern facilites in Asia. The main facility is a multi purpose research reactor of 30 MW associated with various research installation and fabrication such as post irradiation examination, radio active waste management installation. Besides, there is a 1 MW reactor constructed in 1965 in Bandung and self-manufactured reactor of 100 kW in Yogyakarta commissioned in 1979.

The feasibility study of constructing the first nuclear power plant has been carried out since 1991 with the assistance from NEWJEC, a Japanese consulting company. This study consists of siting and feasibility studies. The siting study covers the assesment of potential sites of the plants, environmental impact, socioeconomic and sociocultural aspects. The feasibility study covers energy economic, financing, engineering and safety, fuel cycle and wastes management, and general management aspects. It is expected that all studies would be completed in 1996 which then allow the Government of Indonesia to decide on the nuclear power development.

Before embarking on nuclear power programs, we consider it very important to have close cooperations with other countries having years of experiences dealing with nuclear power. It is expected that such cooperations is to be carried out in the framework of economic as well as science and technology aiming at increasing the quality of life of the Pacific Rim countries.

Ladies and Gentlemen,

Our future is not clear to us right know since we do not know exactly what may happen in the future. However, we know that our population is growing, our energy demand is growing while the energy resources themselves are depleting. Nuclear power seems to be an answer to solve the problem of less energy availability. However, there are many issues related to nuclear power besides the issue of availability itself. Many issues that are beyond the border of a country and related to the life of our people. Our efforts to face these issues would be much easier if countries in this region cooperate with each other.

The forms of cooperation that could be done are in the following areas:

a. Information exchange among countries about all aspects of nuclear power development. In this case more experienced countries will share their experiences with less experienced ones in order to help develop nuclear power smoothly and to avoid any mistakes that experienced in the past. For countries having already developed nuclear power, this forum can be used to enhance their skill and expertise.

b. Creation of a regional nuclear power training center to broaden the knowledge of nuclear energy. Such a center would help provide basic training required to run nuclear power plants as well as advanced training to master new hardware and software.

c. Developing joint research among countries to solve any technical problem related to nuclear technology and to seek the types of technology appropriate for local condition of the countries. This research should be carried out mainly to increase awareness of Asian countries to find better use of nuclear technology.

Experiences show that such cooperation in other fields have produced fruitful results. At least, there has been understanding among countries about issues related to their fate. With such cooperation, potential problems can be identified earlier and conflicting objectives among countries could be resolved peacefully. Nuclear power is considered safe but in some countries people still have some trauma of past and recent nuclear accidents. Besides, nuclear proliferation is a sensitive issue from the security point of view. Regional cooperation is unable to solve all problems but it is expected to minimize the problems that may arise.

Ladies and Gentlemen,

In conclusion, I would like to address that our future depends entirely on our efforts today. In this era of globalization, joint efforts among countries in the region are an unavoidable need. Individual country's resources may be limited but regional resources could secure our future needs. The use of nuclear power must be regarded as an effort to utilize any resources available. I believe, we have the same final objective, that is to reach a secure and prosperous country for the benefit of our people. With such condition, our region would become more stable and cooperative.

Tokyo, 10 April 1995

The 28th JAIF ANNUAL CONFERENCE
April 11, 1995, Tokyo
Economic Development and International
Nuclear Cooperation in Asia (draft translation)

Sumiko Takahara, Economist
Former Minister of State for
Economic Planning Agency

Introduction

While I was listening to my previous speakers from various countries and international organizations in the Annual Conference of the Japan Atomic Industrial Forum, which opened yesterday, I could not but be keenly impressed by three points.

First was the Asian potential for vigorous economic growth.

Second was the magnitude of the impact Asia will have on natural and energy resources and the environment, toward and into the 21st century.

Third was the importance of international cooperation aimed at making development compatible, on a global level, with the availability of natural resources and environmental conservation.

I am representative director of a group called "Energy: Think Together" (ETT), engaged, with citizen participation, in an exploration of various energy-related issues. Today, from our perspective, I would like to discuss the relationships among the developing Asian region, energy, and nuclear energy.

1. Asia as a World Growth Center

Asia, along with Africa, was long a most slowly developing region of the world. It has changed remarkably, however, during the past 40 to 50 years.

The following characterize the region in this respect: (1) rapid population increase, (2) high economic growth rate, yet (3) continued low per capita energy consumption.

1.1 Rapid Population Increase

Last year, the Asian Games were held in Hiroshima. I attended the opening ceremony in my capacity as president of the Athletic Association of Japan, and, as the participants from China and so many other Asian nations marched proudly by, eyes shining, I felt anew the power of Asia.

In 1950, according to United Nations statistics, world population was 2.5 billion. It is now 5.5 billion -- doubled over the last 40-odd years -- and is conservatively expected to reach 10 billion by the year 2050.

Asia carries great weight in global demographics. Over the some 40-year period, population in the Asian region has increased 2.3 fold, from 1.4 billion to 3.3 billion -- accounting for 60 percent of the world's population growth. By the year 2050, when world population is expected to reach 10 billion, almost 6 billion people will live in Asia.

1.2 High Economic Growth Rate

The second key point is that Asia, particularly East Asia, is registering a higher economic growth rate than any other region of the globe.

For example, from 1988 to 1993, while growth rates for the G7 industrialized nations were 2 percent or less, the East Asian NIES, ASEAN and China saw rates of 7 - 8 percent. (Figure 1)

Our group, "Energy: Think Together," distributed a questionnaire to Asian students in Japan, surveying their expectations for the own countries 10 years from now. The replies were interesting.

Forty-seven percent of the respondents said they wanted their lives to be as in the advanced nations; while 45 percent said they wanted richer lives, even if not at the same level as the developed countries.

Asked how household energy consumption in their country would change in 10 years, 85 percent replied that it would increase.

When I visited China last autumn, I was surprised at the extent of that nation's rapid growth. The Chinese economy has chalked up double-digit growth rates for three years running: 13.6 percent in 1992, 13.4 percent in 1993, and 11.4 percent in 1994. This is comparable to Japan's performance during its dynamic, high-growth period, and has naturally resulted in increased incomes for the Chinese people.

A department store in Beijing was quite crowded, and the market for consumer goods was more active than I had expected. For example, room air conditioners priced at the equivalent of ¥220,000 - ¥230,000 -- more expensive than in Japan -- were selling well.

In Japan, during the course of the post-war economic recovery, electric home appliances appeared and became popular consumer items one by one; in China, it looked to me like all those products were on the shelves at the same time.

Today, the stars among durable consumer goods are VCR's, room air conditioners, and microwave ovens.

1.3 Continued Low Per Capita Energy Consumption

The third characteristic of Asia is that per capita GNP and per capita energy consumption are still quite low, because of centuries-old under-development.

For example, while current annual per capita energy consumption is 5.4 oil-equivalent tons in the G7 nations, it is approximately half that, 2.7 oil-equivalent tons, in Asian NIES, and only one-thirteenth, 0.4 oil-equivalent tons, in ASEAN. As those Asian economies strive to attain the prosperity levels of the advanced nations, rapid increases in energy demand can thus surely be expected. (Figure 2) (Figure 3)

2. Latent Problems

While Asia evidences the greatest potential for growth and development, latent problems are coming to light and will have to be overcome.

2.1 Infrastructure Development in the Wake of Urbanization

One problem is that population is concentrated in large cities. According to the United Nations statistic data, of the 20 mega cities of the world in 1950, only seven were in developing nations; but, in the year 2000, 17 will be. Among those seven mega cities in developing nations in 1950, only four were in the Asian region; by 2000, 11 will be. In addition to Shanghai, whose present population is 17 million, Calcutta, Greater Bombay, Beijing, Jakarta, Delhi, Tianjin, Dacca and Manila -- and perhaps others -- are certain to have populations of more than 15 million.

As population continues to be concentrated in larger cities, social services and facilities will have to be developed urgently, including employment opportunities, roads, transportation, communications system, energy, education and medical care.

Indeed, the problems of overcrowded cities -- over-centralization, poverty and pollution among them -- are becoming increasingly serious.

2.2 Rapid Increase in Energy Demand

As mentioned, low per capita energy consumption suggests the possibility that consumption will increase rapidly as industrial modernization and improvements in standards of living take place.

This Figure 4 illustrates oil consumption levels, with population on the horizontal axis and per capita oil consumption on the vertical axis.

China, with a population of 1.2 billion, has a per capita oil consumption of only about 0.1 tons; thus, its total oil consumption, a product of population and per capita consumption, is very low, indicated by C0 in the figure.

But China's per capita oil consumption will surely shoot up with progress in motorization, development of petrochemical industries, and increased use of heating oil. If, in the near future, China's per capita oil consumption is raised to the average world level -- about the level of Latin America -- then China's total annual oil consumption will become comparable to that of Western Europe (C1 in Figure 5).

Moreover, when China's per capita oil consumption reaches one ton, the level of South Korea, early in the 21st century, it will stand at level C2 in Figure 6, or the sum of the United States and Western Europe -- even without considering an increased Chinese population. If Chinese per capita oil consumption were two tons, the present per capita level of Japan, as it may well be in the future, China's total annual consumption would be C3 in Figure 7, three times that of the United States.

These are estimates, but they serve to show the magnitude of the impact a developing nation with a large population can have on the world energy situation.

In fact, oil consumption is increasing sharply in the Asian region. China, long an oil-exporting nation, has become an oil importer. And it appears demand for oil may exceed output in Indonesia, an important member of OPEC. As far as the whole of East Asia is concerned, an increase in oil imports seems unavoidable.

2.3 Necessity of Urgently Developing Power Sources

As industrial development proceeds, energy consumption increases, along with a growing preference for electric power in industry and information/communications.

As a result, all developing countries in Asia face electric power shortages, which are further obstacles to their development. There are many areas where electric power cannot be supplied continuously, but only in a system of rotation.

In China, which I visited recently, annual per capita energy consumption has been increasing, but is still only 630kWh -- the level of Japan about 40 years ago. In Japan, meanwhile, it has shot up twelve-fold, to 7,000kWh. Given an annual increase in per capita power consumption in a country with a population of 1.2 billion, a sharp advance in electric power demand is naturally to be expected.

China, of course, has aggressively taken up the challenge of developing its energy facilities, including electric power sources. China's electricity production ranked fourth in the world in 1993, after the United States, Russia and Japan, and is expected to exceed the level of Japan this year. The reality, nevertheless, is that electric power in China is in short supply. China plans to develop 15 million kWh of generating capacity every year, but even this appears to be a conservative target, in the face of an annual population growth of 18-20 million, and trends in urbanization and industrialization.

2.4 Importance of Environmental Issues

Increases in energy demand as population grows rapidly and energy consumption per capita rises will inevitably have an impact on the environment.

In Asia, the use of fossil fuels, particularly coal, is widespread; China depends on coal for 75 percent of its power generation.

Expanded use of fossil fuels affects the environment in two ways. First is air pollution and acid rain caused by SOx, NOx and other emissions. In Japan, 90 percent of poisonous SOx and NOx gases produced in the generation of electricity is collected. In developing Asian nations, however, there exist many power plants without desulfurization or denitration equipment -- a situation calling urgently for improvement.

Second is the increasing level of CO_2 in the atmosphere, which, as a greenhouse gas, creates concerns about global warming, as well as about the long-term accumulation and concentration of the CO_2 itself.

In talks with people in developing countries, however, we often hear opposing views.

When I attended the last World Energy Conference, in Madrid, Spain, I heard many leaders from developing countries express themselves as follows:

The people of the industrially developed nations, which account for only 25 percent of the world's population, consume 70 - 80 percent of the world's energy. It is those developed countries, therefore, that are responsible for the global environmental problems we are discussing here. We hear people say that energy consumption should be restrained for the sake of the environment. But that position is not acceptable to us -- we who will be achieving our economic progress from now on. No advanced nation should have the right to suggest such a thing.

Such statements impressed me greatly. Developing nations have the right to grow and advance, and advanced nations have no right to interfer with that progress. I think there is no alternative for us but to cooperate with developing nations and assist them in this respect. At the same time, I hope people in the developing nations will look at the impact of large-volume energy consumption on natural resources and the environment, and seek ways to reconcile growth with the environment -- a not-impossible goal, I am sure.

3. Keys to the Solution: The Three D's

What, then, is necessary to attain economic growth, mainly in the developing countries of Asia, and conservation of energy, natural resources and the environment at the same time?

I do not believe nuclear energy is a panacea. It is most important, first, that we depart from our attitude of seeking satisfaction through material things: We must "dematerialization." Second, we must "decouple" energy consumption and GNP; that is, as GNP increases, it is not necessary that energy consumption do so, too. Third, where energy, or more energy, is nevertheless required, non-carbon, non-fossil, sources must be found: "decarbonization."

3.1 Dematerialization

First, people must reconsider the modern "throwaway" economy, and move to create a recycling society. It is required of the Japanese that they recognize their good fortune, being, as they are, able to lead such convenient, comfortable lives. At the same time, they should ponder that they, too, are victims of the global environmental deterioration being inflicted, at least in part, by such lifestyles.

As I mentioned, our group, "Energy: Think Together," surveyed Asian students in Japan. One of the questions asked was, "What do you think of Japanese responses to environmental issues?" Twenty-five percent said they thought the Japanese are not very responsive, or not responsive at all.

Asked why they thought this, 80 percent said Japanese throw away things that are still useful; 60 percent said they use a great many disposable products; and 30 percent said they leave electric lights, TV's and radios on when they are not using them. These actions they consider to represent problems with the Japanese lifestyle.

It is important for industrially developed countries to help developing nations find new ways to grow, rather than simply following the growth patterns of the already advanced nations, which were based on mass production, mass consumption and mass disposal. "Energy: Think Together" made a proposal in October, 1992, aimed at making our convenient, comfortable lifestyles compatible with conservation of the global environment. In it, we emphasized that, "We are unwillingly playing a role in the deterioration of the global environment, through our use of goods and services," and that, "We, as individuals, should act in our daily lives, instead of leaving the matter to the authorities and to enterprises." In June of last year, we made a further proposal on the structuring of a "lifestyle oriented toward effective utilization of energy and conservation of the global environment." We suggest the following as a guide to action.

1) Let us use equipment that is highly energy efficient.
2) Let us use excellent insulating materials when building or remodeling homes.
3) Let us use recycled products.
4) Let us participate in discussions on the "summer time" system.
5) Let us take longer summer vacations -- and not all of us at the same time.
6) Let us discuss the utilization of non-fossil energy.

3.2 Decoupling

Second, it is essential that we make more efficient use of energy; it is particularly important that we should be more energy-efficient in our daily lives. In 1992, with GNP double what it was in 1973, the time of the Oil Crisis, energy consumption as a whole was only 30 percent higher -- apparently showing that energy was being used very efficiently. But in fact that efficiency was only in the industrial sector. In residences, the commercial activities and transporation, energy consumption had almost doubled, essentially paralleling GNP growth. What is needed, therefore, is greater effort at energy-saving at the grassroots level, by ordinary citizens on a daily basis, and we would like the discussions of Asia to be from a down-to-earth perspective such as this.

3.3 Decarbonization

Third, it is necessary to promote the decarbonization of energy sources. Expanded use of nuclear power should be cited in this context, along with thorough utilization of natural energy, such as hydro, solar and wind power. More efficient use of fossil fuels, too, combined with cleaner technologies, will continue to play a leading role for some time to come.

Nuclear energy is highly technology-intensive. It is described as "technology energy" because the cost of the technology is greater than the cost of uranium as a material. A small quantity of uranium goes a long way, and the fact that only a small amount must be mined, transported, stored and disposed of, means that security is excellent.

Nuclear power can replace oil for electricity generation, and, in fact, nuclear-generated electricity amounts to the oil-equivalent of 10 million bbl/day. There is no doubt nuclear power was a major factor in keeping oil prices from skyrocketing during the Gulf War, and in the stabilized prices and supply we see today.

Environmental compatibility is another advantage of nuclear power. Nuclear generation results in no SOx, CO_2 or other harmful gaseous emissions. The relatively small amount of fuel involved also means only a small amount of waste is produced.

It is because of these advantages that there are such high expectations for nuclear power in the Asian region, where a rapid increase in energy demand, especially electricity demand, is foreseen.

As we heard yesterday, worldwide, seven nuclear power plants began operation in 1994, and six of them were in Asia. Five nations and one region -- Japan, Korea, China, India, Pakistan and Taiwan -- already use nuclear power, with Thailand and Indonesia reportedly planning to join them. In the United States and Europe, nuclear-plant expansion plans have run their course, whereas there are many areas in Asia newly commencing nuclear generation, or planning its rapid expansion.

4. Conclusion: International Nuclear Cooperation in Asia

All useful scientific and technological achievements carry with them potential dangers. Mankind has faced this fact squarely, and, rather than focus only on the dangers, rejecting the advances, has structured technical and social control systems to maintain appropriate balances, thereby reaping incalculable benefits. The general public entertains three broad concerns about nuclear power: accidents, waste, and proliferation.

These are issues that will be discussed at this annual conference, and I will not dwell on them now.

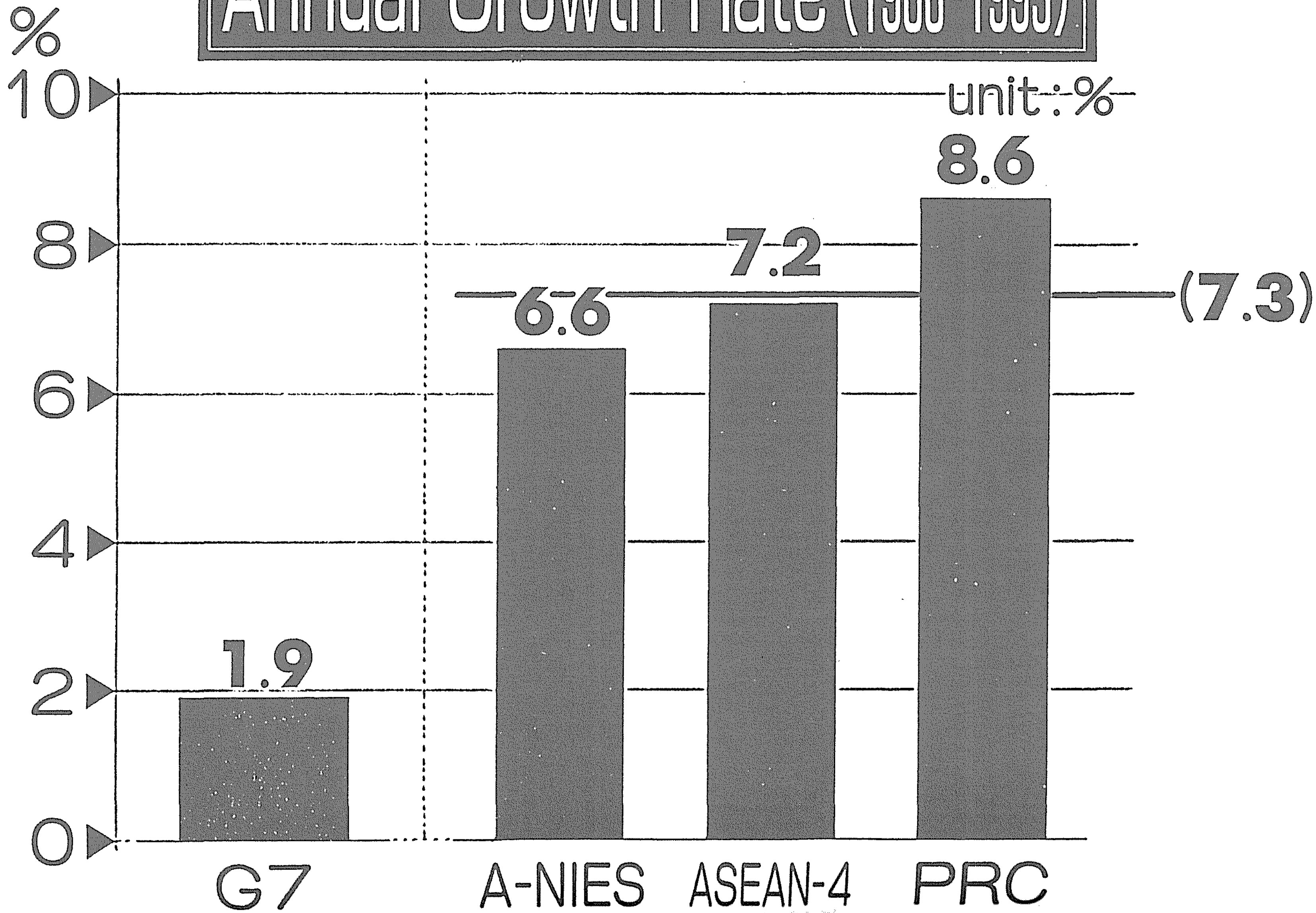
What I wish to stress here is that nuclear power involves the utilization of highly technology-intensive energy, and international cooperation is essential if different countries and regions are to give play to their particular strengths.

As seen at Chernobyl, once a major accident occurs, its consequences extend beyond national borders. In regard to the nuclear fuel cycle, there are many situations in which international cooperation, rather than narrowly focused nationalism, is advantageous. Some areas are rich in uranium ore; some countries have the advanced technologies for enrichment, conversion and fabrication; some utilities have extensive experience with the safety technologies for nuclear generation; and some nations have advanced nuclear-fuel recycling capabilities.

From a non-proliferation point of view in particular, it is essential that the transparency of peaceful utilization plans, and their implementation, be ensured under an international framework.

Internationally in Asia, extensive multinational, bilateral, private-sector, and public-private cooperation has already been promoted. In view of the rapid development of nuclear energy utilization in the region, I think it is necessary to provide a new framework of regional cooperation embracing all facets of the nuclear fuel cycle, as well.

Annual Growth Rate (1988-1993)



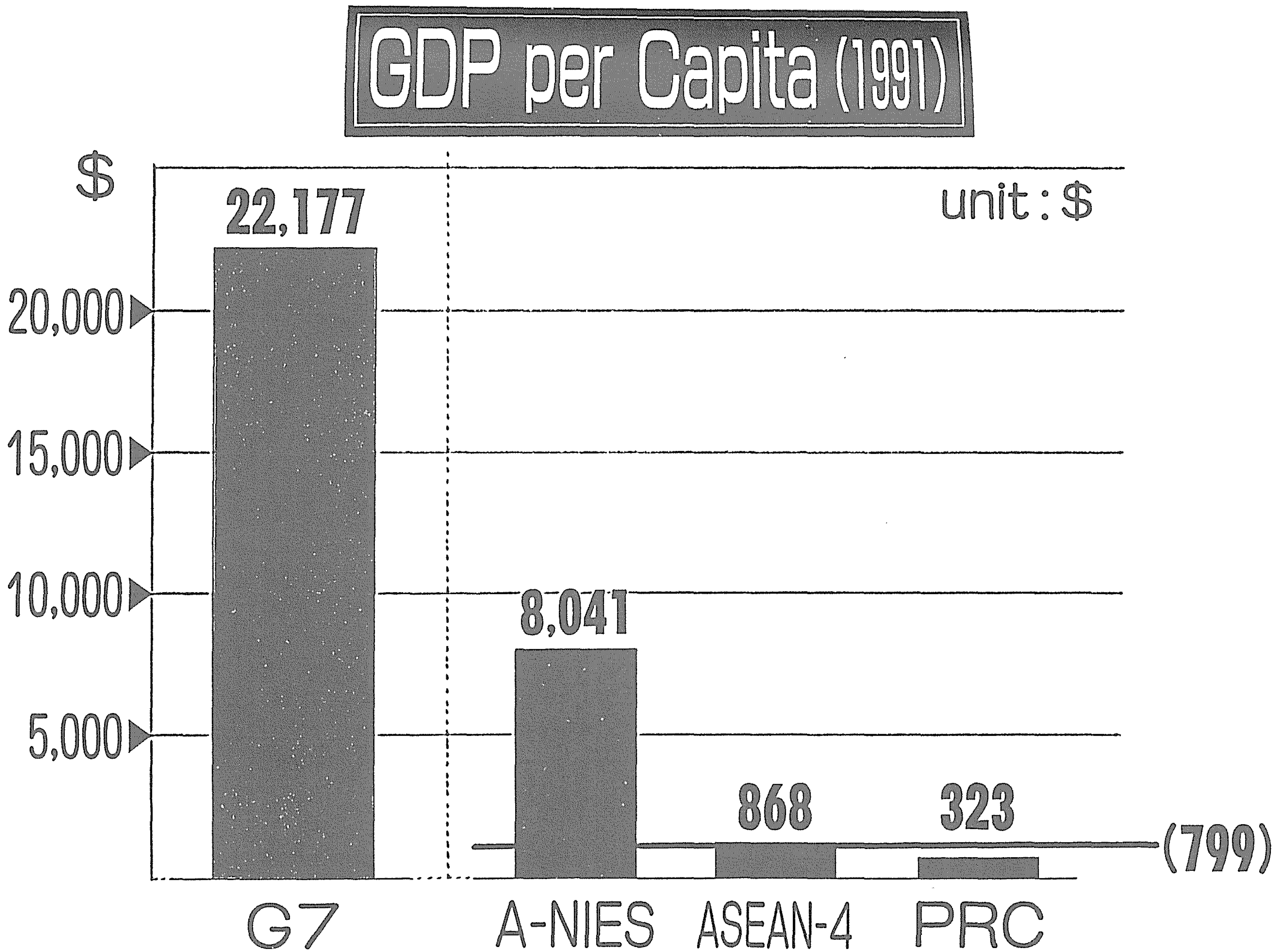
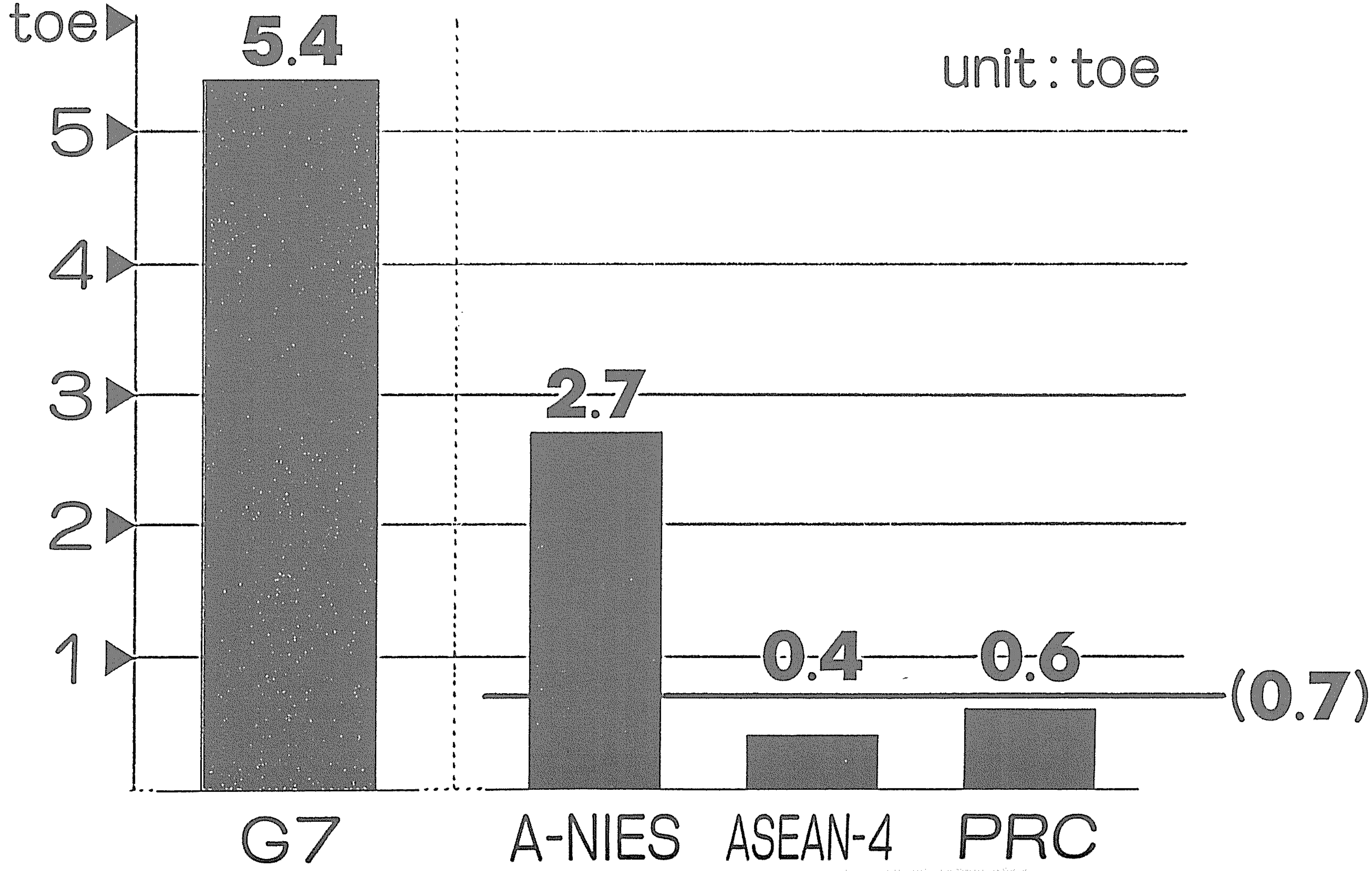

GDP per Capita (1991)
$
unit : $
22,177
20,000
15,000
10,000
5,000
8,041
868
323
(799)
G7
A-NIES
ASEAN-4
PRC

Figure 2

Primary Energy Requirements per Capita (1992)



Population and Oil Consumption -1990-

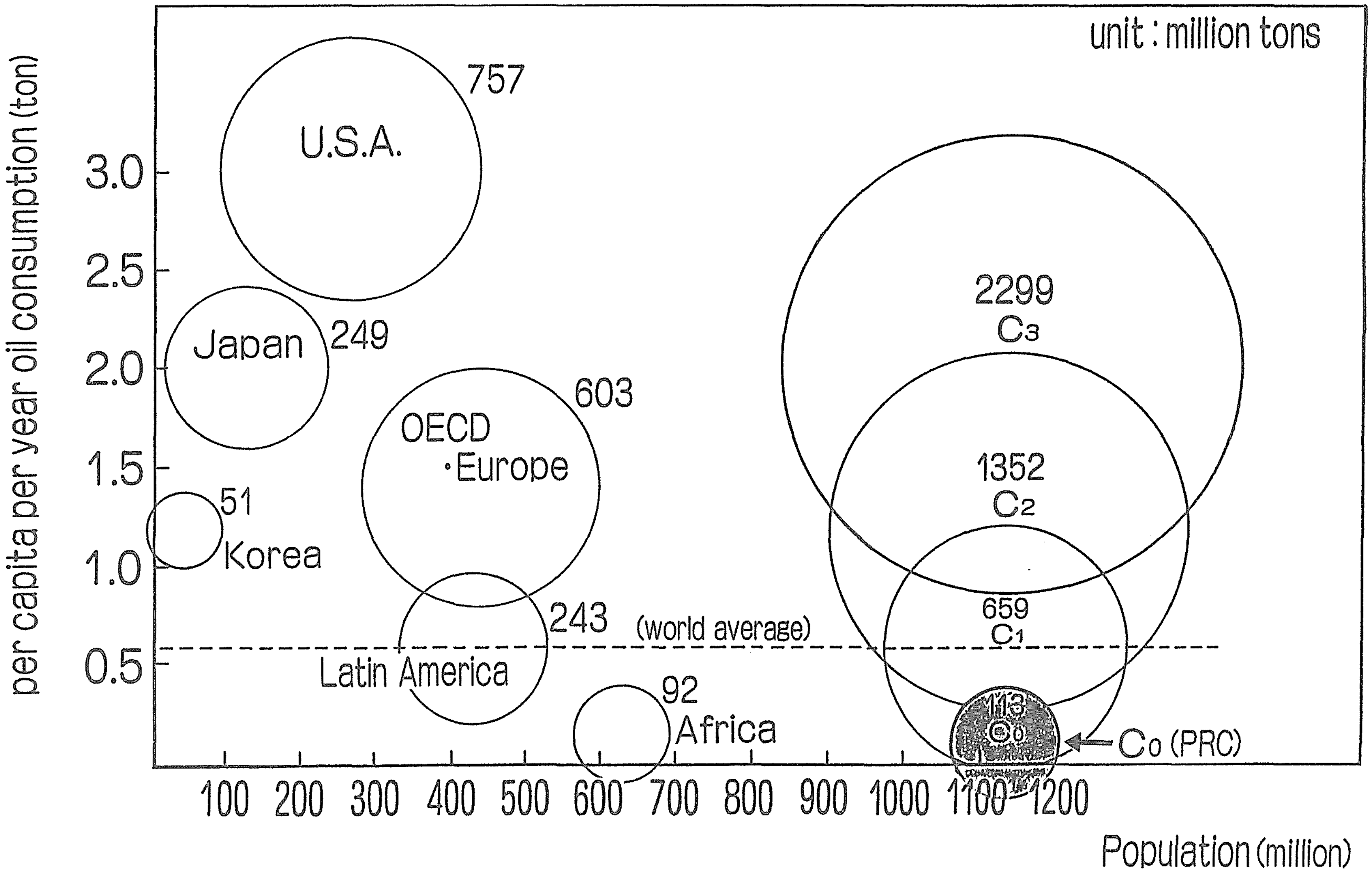
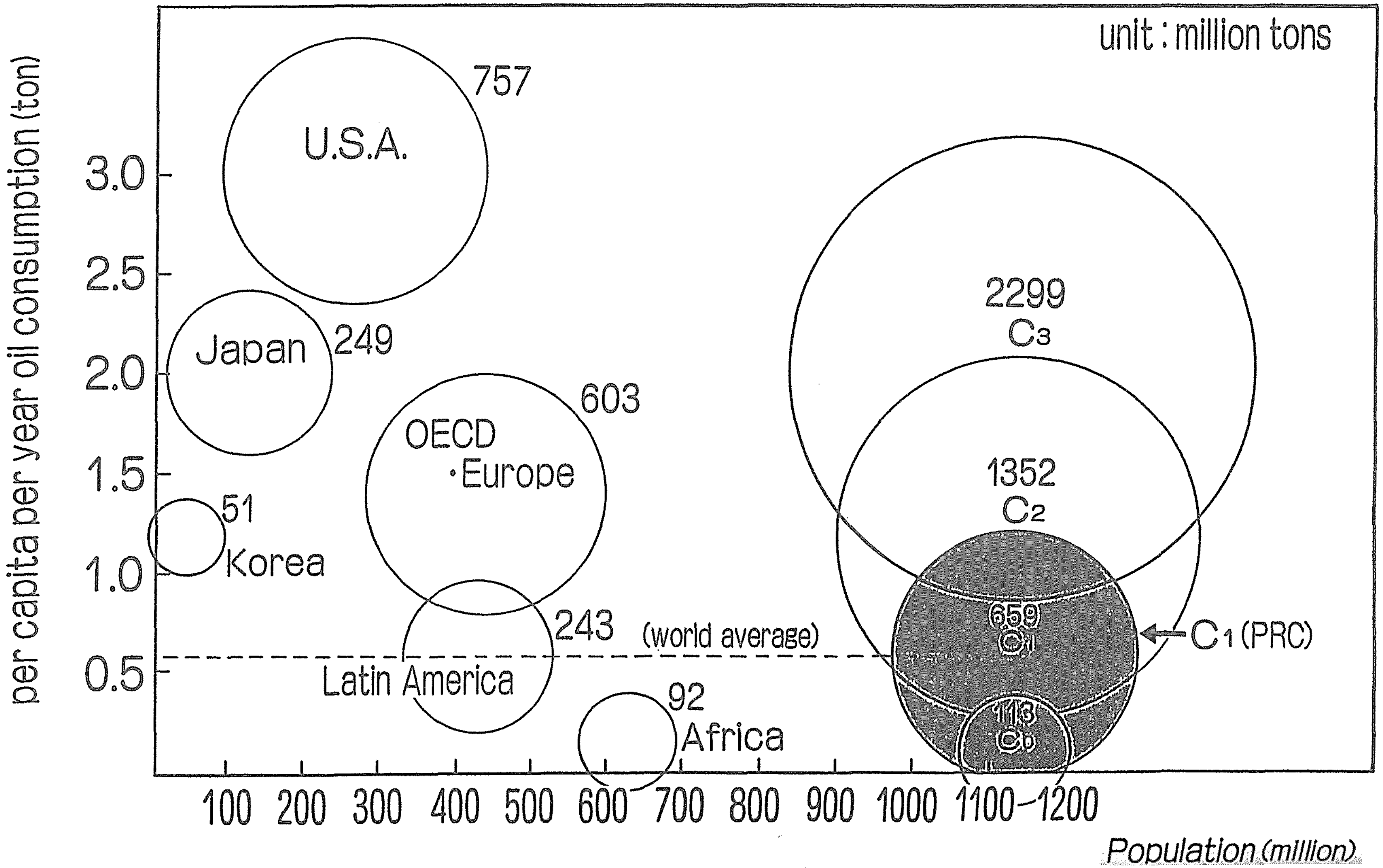
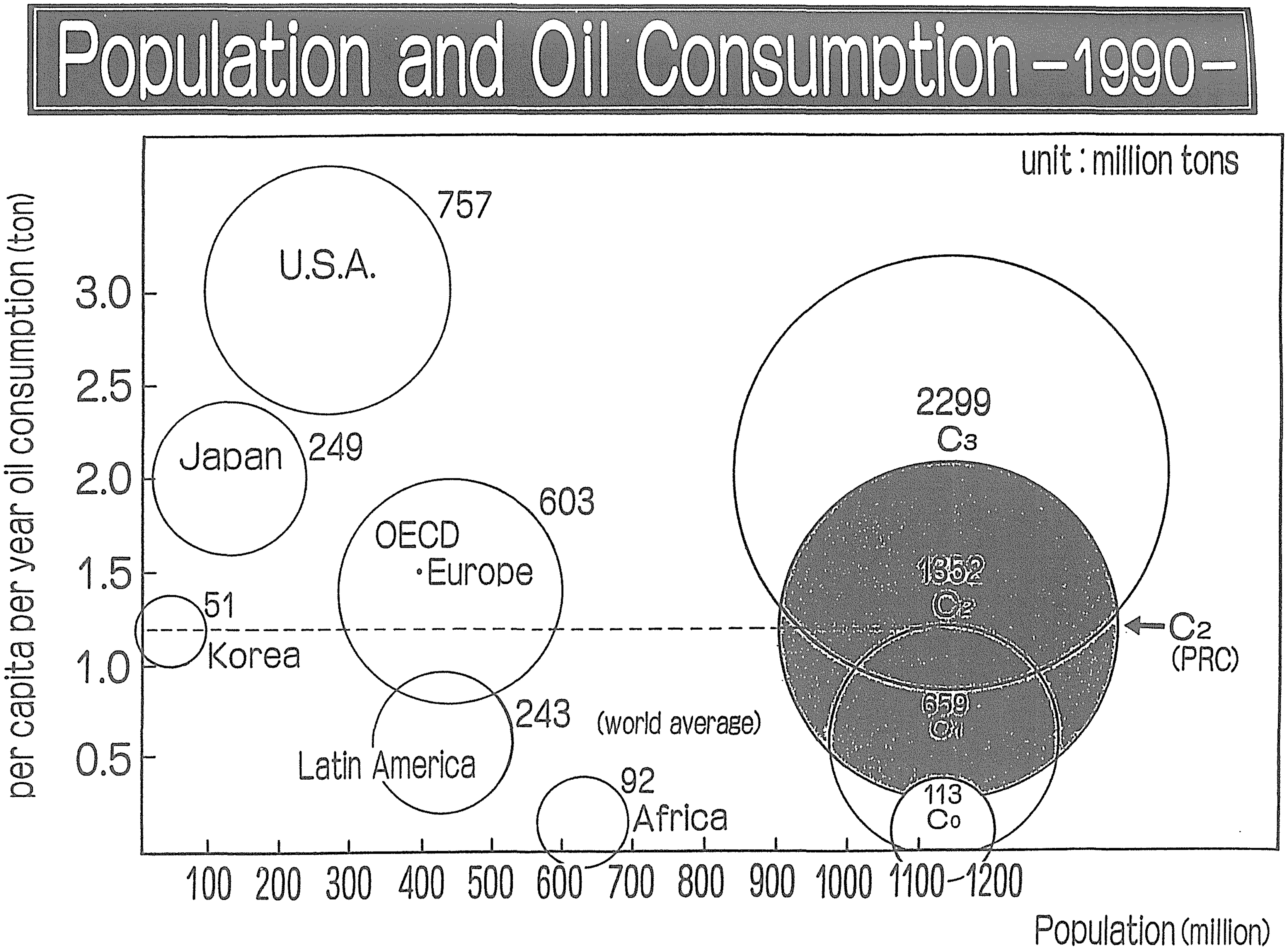


Figure 4

Population and Oil Consumption -1990-

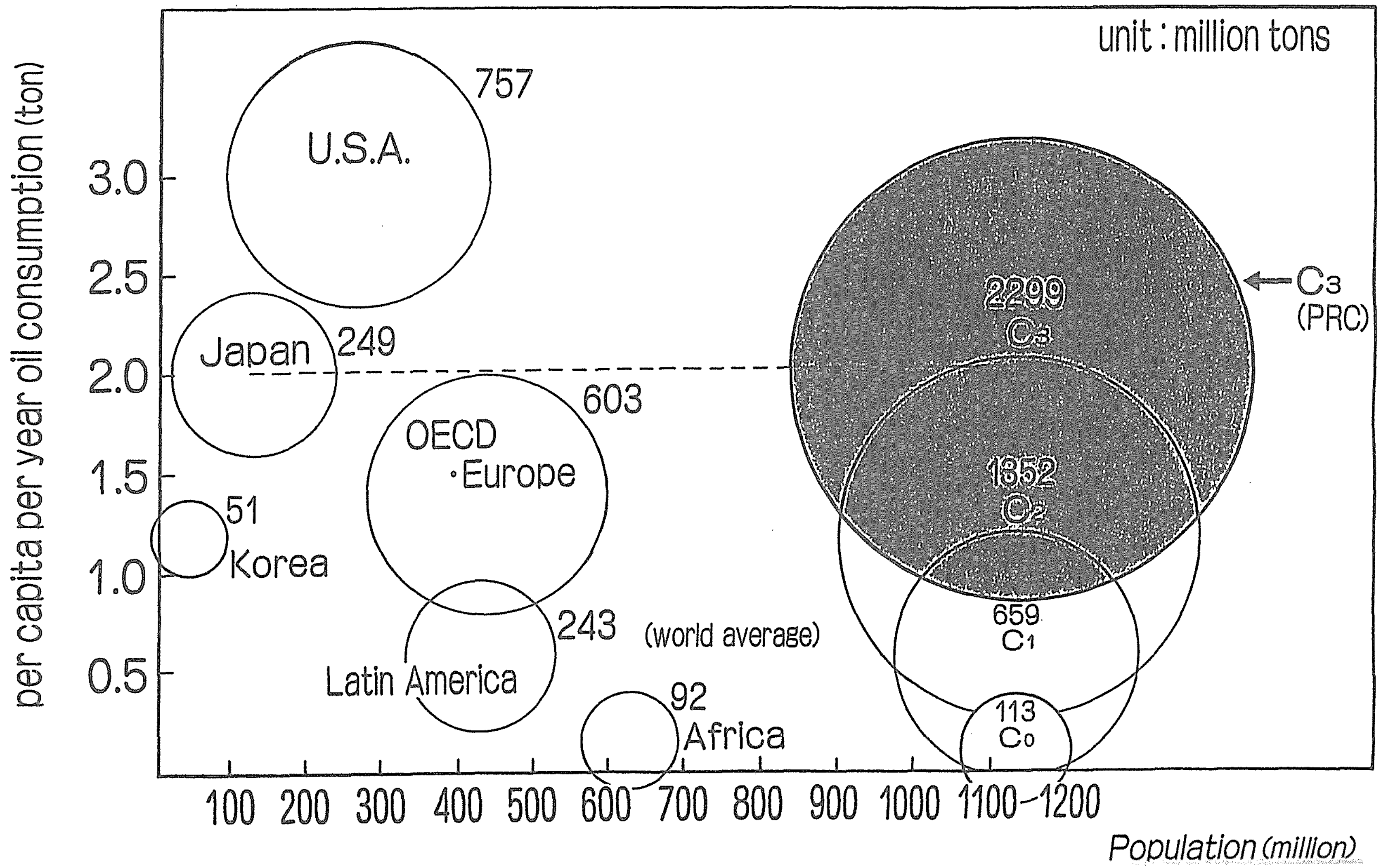




Population and Oil Consumption -1990-
unit : million tons
per capita per year oil consumption (ton)
3.0
2.5
2.0
1.5
1.0
0.5
U.S.A.
757
Japan
249
OECD
·Europe
603
51
Korea
Latin America
243
(world average)
92
Africa
2299
C3
1352
C2
659
C1
113
C0
C2
(PRC)
100
200
300
400
500
600
700
800
900
1000
1100–1200
Population (million)

Figure 6

Population and Oil Consumption -1990-



NATIONAL ENERGY POLICY, PROSPECT OF NUCLEAR POWER AND NUCLEAR STRATEGY IN INDONESIA

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NATIONAL ATOMIC ENERGY AGENCY

I. INTRODUCTION

The main objective of the Indonesian Long Term Development Programme is to improve and strengthen the structure of the economy, to develop a more active and advanced national industry supported by a strong agriculture, which in turn will create a strong basis for a self-sustaining growth and development in the efforts toward better social justice and welfare of the people based on our Five Principles (Pancasila) ideology. It is always stressed that the growth of this development be maintained widely and proportionally spread.

These principles give an important guideline in establishing the national energy policy for the future in supporting the Second Long Term Development Programme (PJPT II, 1994-2019) whereas the main objective would be the creation of an advanced quality of the Indonesian people, high standard of living and a nation with peaceful and prosperous environment.

Consequently the above national objectives will need the supply of reliable and abundant energy.

In line with the national energy policy in promoting intensification, diversification and conservation of energy, some important steps need to be taken in order to establish alternative energy strategies which will be decisive in the formulation and development of the national energy in the future. The introduction of Nuclear Power Plants in Indonesia is not only to reach an ***optimum energy mix*** based on cost and environment considerations, but also to relieve the pressure arising from increasing domestic demand of oil and gas. Therefore, oil and gas could be used for other strategies : as export commodity and feedstock to support the take-off are towards the 2nd Long Term Development Programme. This strategy is an integral part of the overall energy strategy.

Even though Indonesia has some oil and gas resources, it has to be realized that these resources are not unlimited. The roles of Nuclear Power Plants are clearly to stabilize the supply of electricity, conserve strategic oil and gas resources and protect the environment from deleterious pollutants.

In Indonesia, the energy consumption since 1970 has been continually increasing with an average rate of 10.6%/year in support of the national development in all sectors. In the case of electric energy for the whole of Indonesia, in the year 1990-91 the installed capacity was 9275 MW in the Electricity Company (PLN) network. However, the actual consumption during the first years of fifth Five Year Development grew, respectively, at 17% in 1989/1990; 18.4% in 1990/1991 and 12.2% in 1991/1992.

Specifically for the Islands of Java and Bali, which accounts for 80% of all of the Indonesian electricity consumption, the installed capacity by PLN in the year 1990-91 was 6363 MW (the same amount of capacity also exists outside PLN), and increased by 17%/year during the last three years. It is worth noting that, for example, the projected installed capacity for 2003-04 is now 31.8 GW, which is far higher than the previous projection for 2010-11 of only 25.5 GW. Electricity demand gap to be fulfilled increases from 19.1 GW to 25.4 GW. In view of this the government has decided to conduct feasibility studies of the nuclear option, in the goal to fulfil the deficit or gap in supply where other options are likely to reach their limitations in terms of resource, geographic location and environmental concerns.

II. THE NATIONAL ENERGY POLICY

Historically, Indonesia's energy policy and petroleum policy were synonymous. Oil had the dual role of being the nation's prime source of commercial energy and of providing both foreign exchange and Government revenue to finance economic development. By the late 1970's however, domestic consumption grew at an annual rate of up to 15%. Domestic consumption began to divert oil from the export market. In the late 1970's, the Government embarked on an ambitious programme to move domestic energy consumption away from crude oil in order to maximize the amount of oil production available for export. The indirect result of this diversification effort was the construction of electrical generation facilities which utilize non-oil energy sources such as coal. Cement plants were converted from burning oil to using coal. Diversification also led to increasing use of liquefied petroleum gas by households. There are also plans for increasing utilization of natural gas in domestic industry and for electricity generation.

Briefly, the National Energy Policy has four main objectives. These objectives include :

1. To secure the continuity of supply of energy for domestic use at prices affordable to the public,
2. To enhance the quality of life of the people,
3. To stimulate economic growth, and
4. To serve an adequate supply of oil and gas for export, in order to provide an important source of foreign exchange to fund national development programs.

The are three policy measures adopted by the government to meet these objectives :

1. Intensification : to increase and expand exploration of energy sources available in the country
2. Diversification : to reduce dependence on only one type of energy (i.e. petroleum), and later to replace it with other available sources in Indonesia
3. Conservation : to economize on the energy production and use.

Implementation of the energy policy covers several aspects such as issuance of regulations, standards, energy pricing incentives and disincentives, and the application of appropriate technologies. The technologies that would be considered are identified as follows :

a. Technology to produce substitutes for oil, as oil is non-renewable and gasification, liquefaction of coal could well meet the fuel needs of the future.
b. Technologies to support a more sustainable energy supply, through the harnessing of renewable energy sources.
c. Clean and efficient energy technologies to support environmental concerns.

Since both intensification and conservation measures only cannot fulfil the presently high energy demand rates, diversification measures should be pursued intensively to reach the above objectives. We are stressing that diversification policy should not be limited to one or two alternatives, ***but it should give*** access to all kinds of feasible energy sources which cover : coal, nuclear and renewable energy sources. And in accordance with optimization principle we should only impose following requirements to the alternative energy systems : technology provenness, high safety standard, environmental cleanliness and competitive economy.

Here we clearly see the synergistic role of nuclear energy and its strategic position within the national energy policy.

III. PROSPECT OF NUCLEAR POWER

The National Energy Coordination Board (BAKOREN) based upon energy situation in Indonesia and the national energy policy, decided in September 1989 that a comprehensive and in-depth feasibility study of the nuclear option should be carried out. The National Atomic Energy Agency is to undertake the study in cooperation with BPPT and PLN under the directives of the Energy Technical Committee of the Department of Energy and Mines.

On August 23, 1991 an agreement was signed in Jakarta between Ministry of Finance and BATAN on behalf of Indonesia and consultancy company NEWJEC Inc.

The feasibility study will take four and a half year and cover the following scope of works :

1. The non-site study, covering energy demand and supply, economics, financing, technology, safety, fuel cycles, waste management, human resource and management development.
2. Site and environmental studies, covering field investigations and assessment of site selection, evaluation and qualification; and environmental, socio-economic and socio-cultural impacts.

Each part of the study includes a technical transfer and training for the Indonesian counterparts. The whole feasibility study is carried out under a comprehensive quality assurance programme developed by NEWJEC, which complies with IAEA recommendations, and approved by BATAN.

The result of the non-site study chows that the Indonesian energy demand will increase by 6-7% per year during the study period of 30 years (1990-2019). The following table shows the average growth in successive ten year periods, and the total primary energy demand according to macroeconomic model.

	GROWTH OF TOTAL ENERGY DEMAND (%/YEAR)	ELECTRICITY DEMAND GROWTH (%/YEAR)
1990 - 2000	6.27	10.30
2000 - 2010	7.20	9.64
2010 - 2019	7.09	8.27
AVERAGE GROWTH	7.18	9.41

The primary energy supply will consist mainly of oil, gas, coal and nuclear while the remaining portion (renewable energy) would remain a small figure of less than 3%. The share of each primary energy in % during the study period is shown in the following table.

PRIMARY ENERGY	1990	2000	2010	2019
OIL	60.21	60.79	51.14	34.34
GAS	32.52	18.60	7.01	3.41
COAL	5.72	18.21	35.55	54.29
NUCLEAR	0	0	3.92	6.18
OTHER (hydro, geothermal)	1.55	2.40	2.38	1.79

The study also shows the following trends with regards to the utilization of resources :

Oil production will continue to decline in the early next century, which in turn may affect the amount of oil for export. If domestic demand finally exceeds the production intended for domestic use then this will spur the import of oil. However, the import of oil will rise further to meet the demand of new refineries producing products of higher added value than crude alone.

Gas production will keep decreasing throughout the analysis period unless new reserves are found and extracted. Most of gas will be supplied to LPG and LNG plants dedicated for export, while a small portion of gas will be consumed for electricity generation. Gas being used for households are gradually substituting kerosene, but this is very small compared to the amount of gas used for electricity generation.

Coal production will increase sharply in order to meet the demand in the manufacturing and electricity sectors and also for export. The infrastructure, such as for coal transportation and distribution, should be developed to support the coal demand which is increasing tremendously. The coal power plants will dominate the PLN electricity generation system with concomitant increased risks of pollution and transportation accident.

Here, as shown by the study, the role of nuclear in line with diversification and resource conservation policy comes into picture. The scenario shows that nuclear is feasible starting in 2004 and the composition of generating systems at the end of the 2nd Long Term Development Plan (2019) will be :

Hydro	:	3,524 MW
Nuclear	:	12,600 MW
Coal	:	72,950 MW
Oil	:	0 MW
Gas	:	30,060 MW
Geothermal	:	880 MW

With a total installed capacity of 119,134 MW

It is clear from this study that the prospect of nuclear power plants in Indonesia is very good. The role of nuclear will be even higher if gas burning is reduced and we use gas for more useful purposes. Additionally, if we use more efficient de-SOX system the role of coal will be some what reduced and consequently increase the role of nuclear.

Some more pertinent results of the feasibility study can be mentioned here, they are :

a. The introduction of a nuclear power plant with a capacity of 600 MWe or 900 MWe in the year 2004 to the Java-Bali electric grid system will have no hindrances and would be a sound solution.

b. The construction of nuclear power plant units with a capacity of 600 MWe and 900 MWe fulfils the least cost criteria for a specific schedule.

c. The generation cost of electricity generated from nuclear power plants is competitive to electricity generated by coal fired plants of similar size.

d. From the results of the BOO/BOT financing scheme studies, the average electricity selling price will be more expensive compared to the conventional financing method due to high rate of investment return (ROI) which is estimated to be around 20% to 30% needed to cover all costs and risks.

III. NUCLEAR STRATEGY

Every endeavour or effort to launch something new is always questioned : Are we ready ? Do we have the means ? Do we have the manpower ? Are we able to sustain it once we have it ?

In preparing Indonesia for going nuclear we have conducted activities to achieve our missions covering the following programs :

1. *Nuclear Energy Research and Development*

The research and development program being implemented needs to be directed to support the nuclear power program. This program covers the efforts in providing recommendations to decision makers on every level of activity in the nuclear power program, the development of technology connected with the national participation program for the development of NPP, and the implementation of technology transfer in the nuclear field.

The nuclear ***Science and Technology Base*** (STB) in the Serpong area, with complete and sophisticated equipment is already in operation, and can be utilized beneficially in NPP technology research and development activities. This nuclear Science and Technology Base consists of a G.A. Siwabessy multipurpose testing reactor and its supporting laboratories. The maximum thermal power of the reactor is 30 MW and the average thermal neutron flux is 2 x 10^{14} neutron/cm^2 sec., a neutron flux which is comparable to a power reactor.

The activities implemented by BATAN in the research and development of NPP technology has been done through STB with the aim to master : design, manufacturing, construction, QA, operation and maintenance of NPP's.

This nuclear STB is also able to develop advanced nuclear technology through research and development activities as depicted in BATAN's Strategic Plan.

2. *Manpower Development*

The aim of manpower development program is to prepare very skilled and high quality personnel to handle the NPP program in every phase. The BATAN Centre for Education and Training is implementing this program in the frame of supporting the development of NPP in Indonesia. This aim is further supported by sending personnel abroad to obtain Master/Doctoral degrees, sending of personnel abroad to General Electric and Westinghouse companies to participate in their NPP design activities, the design participation in Indonesia for Pipe Stress Analysis of Advance Passive NPP 600 MW, and the establishing of a school for Nuclear Techniques in Yogyakarta, in cooperation with IAEA, industries, educational institutions and universities, such as the Bandung Institute of Technology, The University of Indonesia, and The University of Gajah Mada.

These manpower development programs and activities have been conducted not only for BATAN personnel, but participated also by various potential institutions and companies, like the Agency for the Application and Assessment of Technology, the Indonesian Electric Utility Company (PLN), and local engineering and Consulting Firms.

3. *Public Acceptance*

To enhance the perception and understanding of the public on the peaceful uses of nuclear technology including the aspects of nuclear power plants, an interdepartmental organization has been established since the year 1990. This interdepartmental organization, coordinated by the National atomic Energy Agency, has made efforts in promoting, giving information, and discussing openly to the public on the peaceful uses of nuclear energy and especially to the immediate environment where the feasibility studies are being conducted. Efforts such as these form a continuing program, as also practiced by many other countries.

But here we are developing a new PA strategy, with the following objectives:

1. To curb the influence of anti-nuclear campaign, especially their influence to the general public.
2. To reach effectively key target groups within society.
3. To develop new constituencies of support for nuclear energy.

Various programs will be devised to address specific topics for each key target group. In this way we will be able to reach above objectives more effectively.

4. *Financing*

The financing problems is the most crucial one for a late comer and a developing country like Indonesia. At the present time, in order to prepare alternative options to the government, we are finalizing the analyses of the following strategies :

a. Conventional.financing sheme using export credit.
b. Build-Operate-Own (BOO) strategy.
c. Modified BOO : in which the government also shares in the investment of the NPP's.

In this opportunity, I would also like to propose to the audience especially the program committee of the JAIF conference to look into the possibilities of holding Financial Forums with banks and other financial institutions in the region with the aim of discussing, facilitating and supporting nuclear power projects investments.

I believe this will be a great assisstance.

Thank you !

Remarks by
Phillip Bayne
President and Chief Executive Officer
Nuclear Energy Institute
to the
JAIF Annual Conference
Tokyo
April 11, 1995

Good afternoon. I'm honored to have been invited to speak at the 28th annual conference of the Japan Atomic Industrial Forum.

Just a few days ago in Washington, D.C., we celebrated our Cherry Blossom Festival.

We have thousands of pink and white flowering cherry trees in Washington. They line the tidal basin. And brighten the grounds at the White House.

The beautiful thing about them is that many of the trees were a gift of friendship from the people of Tokyo three-quarters of a century ago. Almost a thousand of the original trees are still blooming each year—a living symbol of friendship between Japan and the United States.

How fitting that we have enjoyed the cherry blossoms in the last couple of weeks—just before this conference, centered on the theme of progress through cooperation.

What a rich opportunity all of us here have for cooperating with each other, for sharing experiences, for building on each other's technologies.

That may seem like a radical idea. Can nations that are in competition with each other really share their technologies?

Ladies and gentlemen, we already are sharing innovations in nuclear power plant design, construction and operation. The nuclear energy industry has already become so intertwined, one nation with another, that we can no longer talk about an American nuclear energy industry. Or a Japanese nuclear energy industry.

We are now truly a worldwide industry.

Let me give you a few examples.

Here in Japan, Tokyo Electric Power Company is building two General Electric Advanced Boiling Water Reactors at the Kashiwazaki site. When the first unit goes on line next year, it will be the first advanced boiling water reactor built anywhere in the world. The lead designer, GE, is an American company.

So is this an American plant being built in Japan? Yes, partly. GE led the design team. But it was an **international** team. The maintenance plans for the Advanced Boiling Water Reactor, for example, are so precise they will reduce worker radiation exposure to a fraction of today's rate. Who designed these maintenance plans? GE's Japanese partners: Hitachi and Toshiba.

In the Republic of Korea, ABB Combustion Engineering is building several System 80 reactors, upgraded to include features from the advanced System 80+. One unit came on line earlier this year, and five more are under construction.

An American plant in Korea? Yes, but consider this: Korean engineers studied the design of the System 80 under construction at Yonggwang, added safety margin and operational improvements, then renamed the enhanced version the "Korean standard nuclear power plant." That is the plant they intend to build in the future.

American companies are developing two more advanced designs —the Westinghouse AP600 and the GE Simplified Boiling Water Reactor. These two mid-size 600-megawatt plants are also international programs.

The design team for the Westinghouse AP600 includes participation by 21 countries, including Japan, the Republic of Korea and many European countries. A portion of the engineering is being handled in Indonesia.

The design team working on the GE Simplified Boiling Water Reactor includes participants from 11 countries, including Japan, Indonesia, Taiwan and several European nations.

The best and the brightest—no matter where they're from—are collaborating to create designs better than any of them could create separately. The payoff comes from innovations that make these nuclear plants simpler, safer and more efficient.

Does it matter which nation gets the credit for the design? It doesn't if the team produces a superior product.

Now, notice that for both the Westinghouse and the GE plants, I mentioned that Indonesia was a partner in the design effort. I find their participation very exciting. As you know, Indonesia does not yet operate any nuclear power plants. Yet their engineers are playing an important role in nuclear power plant design. Their entrance into the nuclear energy industry—along with the other newcomer nations on this panel, Vietnam and Thailand—is thoughtful, deliberate and effective. To simultaneously meet the demands of their burgeoning economies and to spur the economies to further growth, they are wisely considering the use of nuclear energy. They are entering the field responsibly, and I applaud them for that. We look forward to working together in the future.

Now, some of you may be wondering about nuclear power plant development in the United States.

The U.S. leads the world in operating nuclear power plants. We have 109 currently operating. Yet, while American-led designs are under construction in Japan and Korea, it has been many years since a U.S. utility placed a plant order.

I believe nuclear energy does have a bright future in the United States—but the orders will not start coming in this year, or even next year.

Let me explain. U.S. utilities right now see no need for additional large-scale power plants. The Nuclear Energy Institute's latest study forecasts a need for baseload power plants only after the turn of the century. When utilities are ready to start building large-scale plants again, the nuclear energy industry will be ready for them.

We have four advanced designs moving steadily through the certification process at the U.S. Nuclear Regulatory Commission.

The two large 1350-megawatt evolutionary designs—ABB-CE's System 80+ and GE's Advanced Boiling Water Reactor—won final design approval from the NRC last summer. That means the designs have satisfied all NRC safety requirements. Now they are in a public comment period, to be followed by design certification, which is expected in mid-1996.

The two mid-size designs—the Westinghouse AP600 and the GE Simplified Boiling Water Reactor—are also being reviewed. They should be certified in the 1997-98 timeframe.

So, before the turn of the century, we will have a selection of plant designs on the shelf and ready for order—in the American market as well as overseas.

Until then, we will benefit by your moving ahead with new plant construction. Your successful projects are proof that these designs are cost-effective and can be built on a predictable and timely construction schedule. They are proof that nuclear power is an economically viable source of energy for a thriving economy.

Nuclear energy, in fact, is an important technology for developing, as well as industrialized, nations. We know that developing nations, as they endeavor to advance, will increase their use of energy far more rapidly than the industrialized economies.

The question is: What kind of energy will they use? Will it be mostly coal?

Just imagine for a moment the environmental impact if China, India, South Korea and other rapidly growing countries continue to expand their use of coal exponentially. Air pollution. Global warming.

When we fully realize the potential environmental impact, we can only conclude that nuclear energy is an *absolute, unconditional imperative*. Nuclear energy is just about the only practical, economical, large-scale source of electricity available today that does not pollute the air, that does not produce carbon dioxide.

We in the U.S. bring to the table a mature nuclear energy program, based on more than 30 years' experience in operating nuclear power plants. We have important lessons we can share with our Asian colleagues as they move into the field. The possibilities are exciting for us to contemplate. The emerging nuclear nations will probably base their regulations and safety culture largely on the U.S. experience.

So I would like to make an offer to those nations: The Nuclear Energy Institute operates extensive technical and regulatory programs. Through our staff and our members we have the resources and the willingness to share insights gained from experience with those countries aspiring to produce electricity from the atom.

NEI, as you may know, has been in existence for only a year. It began when several Washington-based associations consolidated their efforts, and I must say the result has been remarkable. We are now doing more work together than we did separately, yet with a 25-percent reduction of resources—both people and dollars. We are now poised to reach out more effectively to other parts of the world through our international programs.

We already meet regularly with Washington representatives of Japanese electric companies. Every quarter, we get together at NEI for frank discussions of topics of mutual interest.

It is vitally important that companies and associations from our respective countries work together even more closely. While I'm here in Tokyo, I will be meeting with sister forums from Asia and Europe to explore new paths to friendly cooperation. I look forward to establishing even closer ties of cooperation to our mutual benefit.

Thank you. Please enjoy the cherry blossoms.

1. Background and historical perspective

1.1. Vietnam, lying on shore of the Pacific basin, is a country with great potential but facing important challenges in the past years. With about 330.000 km^2 and 72.5 million people[1], Vietnam is the 13th most populous country in the world and second one in South-East Asia. Vietnam at present is a largely rural society, with agriculture accounting for two-thirds of employment and nearly 28.7% of GDP (while industry accounts for only 29.6% and sevices for 41.7%). The physical infrastructure on which the economy depends is quite weak, though there have been some improvements in recent years.

The country is often described as rich in natural resources; however, on a per capita basis the country is not at all well endowed. One of the noteworthy features of Vietnam is that many social indicators have been rather good, despite the country's very low income and long history of war. Life expectancy is 63 years for men and 67.5 for women; literacy rate is estimated at 92%.

1.2. In the mid-1980s, Vietnam's economy encountered many difficulties. In the face of challenges of an under-developed country, Vietnam launched an ambitious reform programme. The renovation ("*doi moi*" in Vietnamese) programme began in 1986 and has accelerated since 1989. The results of the renovation have been very positive, although further reforms are necessary to ensure continued development of the economy. Inflation was halted in 1991 and brought under control in following years. Vietnam was transformed within a short time from a rice importer to a major rice exporter. Average annual GDP growth of the recent 4 years being 7.8%, agricultural output growth has been maintained over 5.3% per year, while growth rates of industry was 13.5%. Since 1990, export volume have grown rapidly, over 30% per year Direct foreign investment has been on the rise since Vietnam introduced a foreign investment law in 1987. By the end of 1994, more than US$ 11.2 billion in over 1.000 foreign investment projects had been approved. Although these progresses are promising, Vietnam has many serious problems that cannot be overlooked. One of those problems is that the level of investment in infrastructure in general and in energy sector in particular has been rather weak for years.

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[1] Data presented in this paper are those by the end of 1994, unless the context indicates otherwise.

SESSION 2
Asia's Economic Development and Nuclear Energy
Panel Discussion

Nguyen Dinh Tu
Chairman
Vietnam Atomic Energy Commission (VINATOM), Vietnam

2. Electric power development in Vietnam

2.1. In 1994, Vietnam generated 12,800 GWh of electricity, of which hydropower accounted for over 70% (see Figure 1) The country has installed electricity generating capacity of nearly 4,000 MW (see Table 1). In comparison with 1990 figures, total capacity was increased by 56% and hydropower capacity increased by 126.5%.

Table 1

Structure of Electricity Generation Capacity
(as of September 1994)

Section	MW	%
- Coal-fired thermal power	645	16.40
- Oil-fired thermal power	198	5.00
- Gas turbines	346	8.80
- Diesel sets	150	3.80
- Hydropower	2600	66.00
- *Total*	*3939*	*100.00*

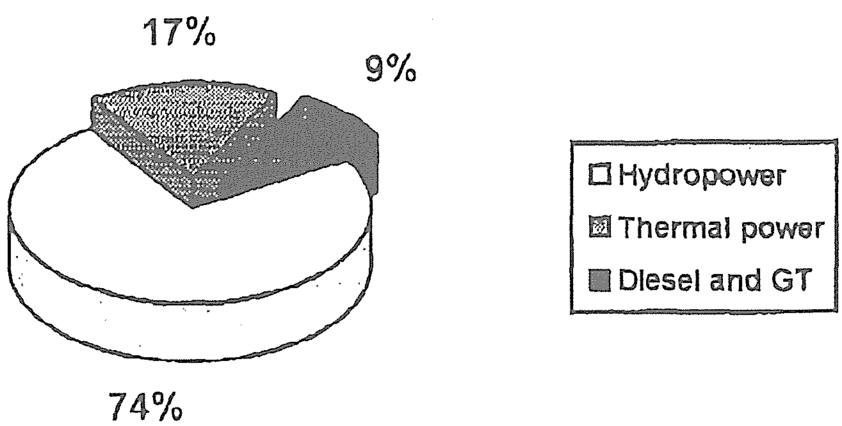

Figure 1

Structure of Electricity Generation Output

Along with the power sources development, transmission system has been im proved significantly during period 1986 - 1993. By December 1993, total 220 kV and 110 kV transmission lines had been 1790 km and 5257 km respectively, and total capacity of transforming substations had been 6426 MVA. Since June 1994, the newly commissioned 500 kV transmission line has paved the way for the integrated development of national power systems. Figure 2 shows the country's map with major transmission lines.

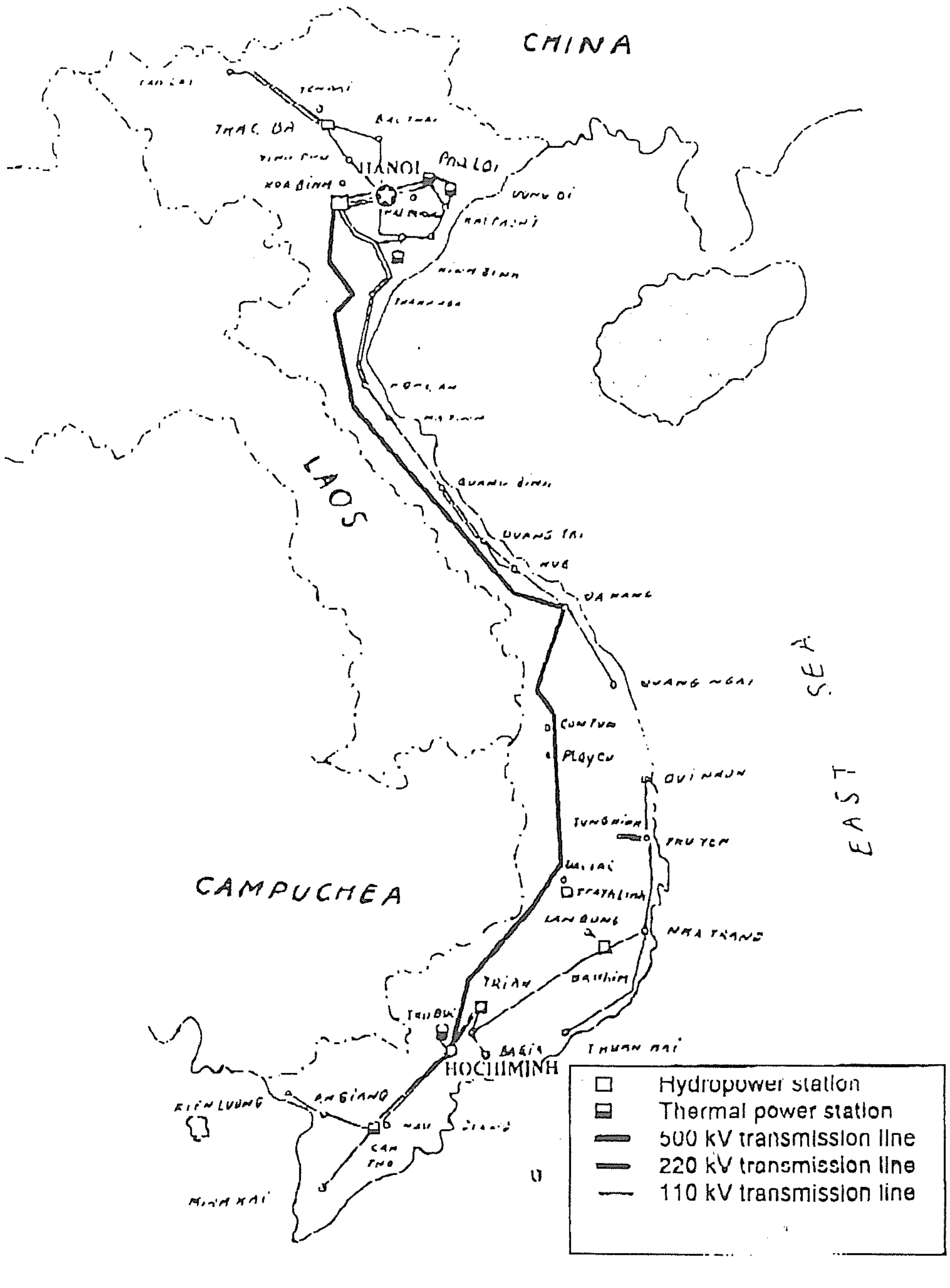

Figure 2

Vietnam's Power Grid (1993)

2.2 To address the energy demand for development. Vietnam can rely on natural resources such as coal, oil and natural gas, hydropower and other. However, thanks to low level of technology most of these resources have not been exploited effectively and in an economical fashion. According to recent studies, energy potentials of Vietnam can be estimated in terms of TOE (tons of oil equivalent) as follows:

- Coal reserve: more than 3 billion TOE;
- Oil and gas reserve: Different studies give different data, however all of them reveal figures higher than 3000 million TOE;
- Hydropower: 23.5 million TOE per year.

a) Forecast of coal production: Coal production is estimated at level of 10 - 12 million tons by the year 2010, half of which may go for electricity production.

b) Forecast of gas production: Estimated gas production by the year 2010 is 10 billion m^3/year, of which about 6 billion m^3/year are for electricity production.

c) Hydropower projection: According to the latest plan, 21 new hydroprojects with total generating capacity of 8760 MW have been undergoing feasibility study or pre-feasibility study. Though the economic hydropower potential of Vietnam is estimated at level of 82.000 GWh/year, optimal hydropower production should not exceed 70.000 GWh/year. with economical, social and environmental factors taken into account.

2.3. To ensure high GDP growth rate, the power sector should keep pace with the economy development. Table 2 indicates corresponding estimated growth rates of electricity output and GDP. Figure 3 illustrates forecast of electricity demand of Vietnam to the year of 2020.

Table 2

Estimated Annual GDP and Electricity Output Growth

Period	Electricity Output	GDP
1995 - 2000	12.3 - 14.0 %	11%
2000 - 2010	10.0 - 10.7 %	10 %
2010 - 2015	8.0 %	8 %

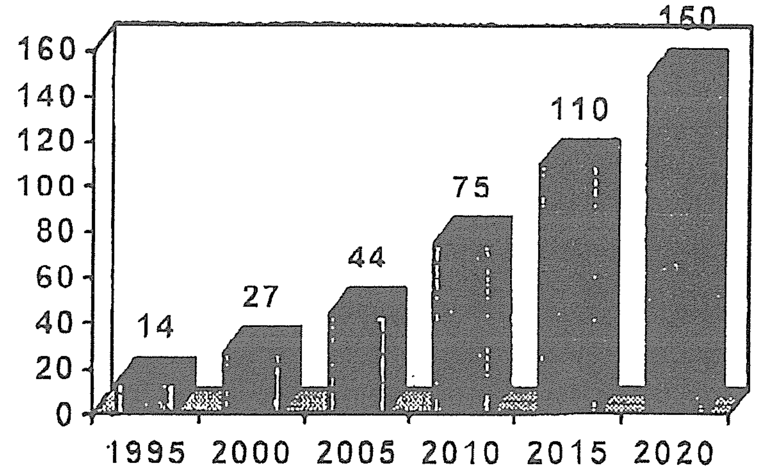

Figure 3

Forecast of Electricity Demand of Vietnam to the Year of 2020
(in TWh)

In order to meet the growing demand of electricity, an ambitious plan of power system expansion to the year of 2010 has been formulated. By the year 2010, total generating capacity of Vietnam's power system is projected at level of 14,400 MW, of which 8,000 MW will be from hydropower and the rest should be ensured by thermal power. Generation output can hopefully meet the then demand of 68,000 - 75,000 GWh/year. Table 3 lists hydropower projects to be completed during the period from now to the year of 2010. Apart from these projects, there are 11 more hydro projects of total capacity of 2364 MW in the list of power generation development programme to be considered and implemented in later periods. As far as thermal power is concerned, by the year 2010 a capacity of about 6,000 MWshould have been installed. Two coal-fired thermal power projects of 600 MW and 1,200 MW have already been approved for construction. The rest of thermal capacity should be secured by gas-fired power. Additional generating capacity of 1,000 - 1,500 MW is expectedly required for every following year. Nuclear power option is inevitable to be taken into account in oder to response to such a high growth.

From this plan and considering resource potentials, one can see that the orientation in general power balance of Vietnam to the year of 2010 is as following:

- High priority is given to an optimal and full use of potentials of hydropower, natural gas and coal for electricity production;
- Active study and preparation of alternative sources of energy, e.g. nuclear power.

Table 3

Planned hydropower projects to the year of 2010

Project	Capacity (MW)	Estimated Investment Capital (mil. US$)	Commissioning Year
1. Song Hinh HPS	66	110.0	1998
2. Yaly Hydropower station	720	524.6	1998-1999
3. Ham Thuan + Da Mi HPS	472	512.9	2000-2001
4 Pleikrong HPS	120	240.8	2001
5. Ban Mai HPS	350	377.0	2002
6. Dai Ninh HPS	300	373.6	2003
7. Sesan 3 HPS	200	180.9	2005
8. Son La HPS	3600	3380.0	2007-2013
9. Dong Nai 4 HPS	200	2484.0	2006
10. Upper Kontum HPS	260	2671.0	2006

In parallel with generation capacity development, a transmission and distribution development plan is being formulated and examining the nature of future development with a view to rationalising a basis for expansion in the urban and rural areas. The overall investment needs in the power sector are very large, therefore every effort should be made in order to mobilise adequate financial resources, both internally and externally.

2.4. Analysing the requirements of power development scenario of Vietnam as presented above, it is obvious that the first nuclear power station needs to be constructed during the period 2010 - 2015, though with keen making full use of all available primary energy resources. However, taking into account the strategy of energy sources diversification and of saving coal, oil and gas resources for long-term utilization purposes in other areas of the industry and economy, nuclear power may be introduced into Vietnam even earlier. Therefore, it is high time for our country to initiate preparation, formulation and implementation of a long-term nuclear power project.

A task research group comprised of scientists and experts of Ministry of Energy and the Vietnam Atomic Energy Commission has, in fact, been established and operated for several years to prepare arguments necessary for "*go nuclear*" decision taking. Using WASP power system computational package supplied by the IAEA, the group took part actively in determining energy demand of Vietnam in the decades to come. Preparation works regarding nuclear law and regulations, radiation protection and nuclear safety aspects, siting, etc. are being undertaken step by step.

3. Conclusion

It is obvious that by the year 2015 Vietnam shall have mobilised almost all her potential natural resources available for power generation at that time, i.e. 70,000 GWh by hydropower, 20,000 GWh by combined cycle gas turbines and 10,000 GWh by coal-fired thermal power stations. New alternative energy sources should have been found to meet requirements of diversification, optimal mix and security of power supply for sustainable development of national economy. Nuclear power at this stage may play significant role in the country's power balance. However, this option needs careful technical study, political support and public awareness as well as international cooperation in due course. We wish to develop and extend multilateral and bilateral relations with relevant international, regional organisations and interested nations in order to facilitate nuclear power to contribute its active part to prosperous development of our country.

Hanoi, March 1995

SUSTAINING IMPROVEMENTS THROUGH SAFETY CULTURE: PROBLEM IDENTIFICATION AND ORGANIZATIONAL LEARNING PROCESSES[1]

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Sustaining improvements in nuclear power plants demands more than identifying problems and designing corrective actions. Management expectations for initiatives such as empowerment and total quality management are frequently disappointed when short-term progress is interrupted by new problems and undermined by cynical detachment from the "program of the month." The problem of "sustaining" is experienced in many industries: for example, recent studies of companies using Total Quality Management demonstrate that the majority do not improve profitability [1]. In this paper I discuss the need for more comprehensive and systemic understanding of problems and the organizational learning process. Culture is how we act and <u>why</u> we act: I propose that an effective safety culture includes a broad set of conceptual "lenses" that provide many questions for plant staff to ask about their operating experiences and many actions to take to sustain improvements.

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Fixing Problems

The underlying culture of nuclear power plants, as in most technological organizations, emphasizes the importance of avoiding problems through engineering design and managerial controls and, when necessary, fixing problems. There is a presumption that organizations are like machines whose problems can be decomposed into parts, the causes identified, and fixes put in place. The "fixing" orientation looks for linear cause-effect relationships, simplifies problems by decomposing them into well-understood components, and applies specialized knowledge to create technical solutions. This is most clearly represented in Probabilistic Safety Analyses (PSA) which vividly reveal the expectation that events are enumerable, predictable, and additive, like a complex wiring diagram. Although extremely useful for some purposes, PSAs do not mirror the actual plant: for example, serious accidents nearly always involve being outside the design basis or modelling assumptions in PSA [2].

Rochlin and von Meier [3] associate these assumptions and ways of thinking with the engineering occupational subculture. Indeed, safety is most often conceptualized as an engineering specialty, and most of the literature on safety focuses on equipment and other technical concerns. In contrast, the operating subculture (of occupations that carry out hands-on, real-time functions) has a less formal, more organic, and more dynamic view of the plant. For example, Plant Managers may be more likely to write about safety from a social and organizational perspective (e.g., [4]).

The fixing orientation is consistent with American managers' desires for certainty and action. People are not encouraged to look at the linkages among problems and issues, because it creates a feeling of overwhelming complexity and hopelessness in the face of pressure to do something quickly. For example, one engineering executive at a U.S. nuclear power plant commented that, "it is against the culture to talk about problems unless you have a solution." The question is whether this approach works successfully with complex, organizational and cultural processes, or whether a different approach is needed.

Enacting the fixing approach can lead to myopic problem identification, overly-narrow solutions that fix the wrong thing and create unintended side effects, and continually disappointed expectations. Carroll [5] describes four common errors and biases in how plant staff learn from operating experience: (a) root cause seduction -- the desire to trace a problem back to one (or a very few) "root" causes. This false sense of certainty reduces the opportunity to learn about multiple causes that interact over time; (b) sharp end focus -- the tendency to identify causes at the place where trouble came to the surface, such as the equipment, procedures, and especially the people handling the hazardous process (usually in the control room); (c) solution-driven search -- seeking to analyze surprises and disappointments into problems with known solutions (e.g., "good practices"), which can turn out to be "band-aids" that address symptoms but not underlying causes; and (d) account acceptability -- guiding analysis by what an audience wants to hear, such as attributing problems to procedures rather than people because the Public Utilities Commission disallows recovery of costs due to human error, or blaming maintenance rather than engineering because engineering is higher status.

In any industry, well-intentioned, commonplace solutions can fail to help, have unintended side effects, or even exacerbate problems. "Fixes that fail" are an organizational pattern that emerges when systemic relationships are not understood [6]. Figure 1 gives a simplified representation of how solutions to problems in nuclear power plants may have unintended consequences: (a) blaming and disciplining particular individuals, intended to encourage accountability, can create an environment in which people do not report problems. For example, when the U.S. Federal Aviation Administration provided immunity from prosecution for pilots who reported near midair collisions, the number of reports tripled; when immunity was retracted, the number of reports dropped by a factor of six [7]. Under such conditions, problems cannot be addressed early, trending is incomplete, and the result can be more problems; (b) Increased procedural detail and monitoring of compliance, intended to ensure the quality of work, are often perceived by American and European workers as signals of mistrust and regimentation. This may result in loss of motivation, blind compliance to procedures that may still be incomplete, more workarounds, malicious compliance when workers know the right thing to do but also know that only rote compliance is safe from disciplinary action, and the departure of skilled workers who find more interesting work elsewhere; (c) equipment upgrades, intended to decrease system and component failures (but, perhaps, also to keep engineers excited about doing "real engineering", [8]), may drain resources away from activities such as preventive maintenance, create added complexity through layers of equipment and monitoring, and place demands on other departments that must upgrade procedures, retrain, and adjust to the new equipment; and (d) regulatory attention, intended to identify problems and force necessary corrective actions, also places tremendous stress on plants to write reports, attend meetings, shepherd regulators through the plant, and otherwise serve the regulator rather than the plant (this may also lead to increased staff size that may create cost pressures).

Because the fixing approach focuses on discrete categories of problems and solutions and specific expertise held by distinct groups, it tends to ignore issues that involve interdependencies and contributions to knowledge from unexpected sources. For example, at one plant, proposals from the mechanical crafts for design improvements were rejected because the craft were believed to lack expertise. Similarly, reports from other plants were considered irrelevant because they had different equipment. Experienced safety review staff may see a wide range of organizational conditions that have contributed to operations or maintenance staffs' mistakes, but they feel limited in their interpretations to the INPO "cause codes." Indeed, the value of incident reviews lies not only in identifying "the" cause of an incident so it can be addressed, but also in legitimating discussion and action on a wider set of issues and concerns among a diverse group of plant employees. As one U.S. plant employee said in an interview, "sustaining must involve everybody; the old management style of top down, pound away, is not enough."

Learning From Problems

An alternative approach focuses on learning from problems. Rather than trying to fix problems by returning the system to its perfect, designed status, the goal instead is to learn as much as possible from an occurrence. System behavior is dynamic and contextual; it cannot be entirely predicted from component parts, nor can human behavior be reduced to a mechanical performance. Indeed, no complex system can be perfectly designed, error-free, and static; the organizational and management systems of nuclear power plants change and grow with flexibility and resilience -- both the physical equipment and the human culture that shapes and works with the equipment. The nuclear power industry continues to discover important new information, for example, the importance of shutdown risk. This is why there are so many calls for enhanced safety culture, questioning attitude, intelligent compliance, and so forth. Complementing the fixing orientation with a learning orientation stimulates a wider range of analyses and actions.

I have found it useful to think about organizational learning as a set of four ordered activities that take place within and across individuals, groups, departments, organizations, and institutions. These four activities are:

1) Observing - noticing, attending, heeding, tracking .

2) Reflecting - analyzing, interpreting, diagnosing

3) Creating - imagining, designing, planning

4) Acting - implementing, doing, testing

This learning process cycle takes place at individual, group, organizational, and institutional levels as information and interpretations are shared across levels. They can be seen, for example, in self-verification, plan of the day meetings, incident reviews, outage critiques, peer visits among plants, exchanges of good practices, and so forth. Each activity requires resources -- such as time, information, tools, and procedures -- that are continually developed, depleted, renewed, and changed. Figure 2 is a graphical representation of this multilevel learning process.

One example of the value of a learning orientation comes from DuPont Chemicals [9]. Reminiscent of nuclear power plants, their chemical process plants were plagued with equipment failures. In the context of company-wide cost-reduction efforts, a benchmarking study showed that DuPont spent more than its competitors on maintenance, yet had worse equipment availability. A culture of reactive fire-fighting had developed, with workers regularly pulled off jobs to do corrective maintenance. Responding to the benchmarking study, a series of cost-cutting initiatives were undertaken that had no lasting impact. Finally, one team questioned the basic assumption that reducing maintenance costs could help reduce overall manufacturing costs; they thought that the effects of maintenance activities were tightly linked to so many aspects of plant performance that no one really understood the overall picture.

DuPont was able to improve maintenance only after a collaborative conceptual breakthrough. An internal team developed a dynamic model of the system of relationships around maintenance (a "modelling for learning" exercise [10]). The systemic lessons of this exercise could not be transmitted through ordinary means; instead, the team created an experiential game in which plant employees play the roles of function managers and discover new ways to think about plant activities, share their experiences and ideas, and test programs and policies. Having a broad range of employees with a system-wide understanding of the relationships between operations, maintenance, quality, and costs laid the groundwork for a successful pump maintenance pilot program.

New Questions and New Actions

The learning approach suggests new questions that can be asked about work practices and processes and new actions that can be considered. For example, we can look beyond particular individual actions and specific incidents to ask what organizational features underly them. It is not sufficient to blame an operator who misses a step in a procedure; there may be important concerns for which this is a symptom or outcropping. Are procedure steps being missed frequently but workers catch themselves before there are consequences? Are workers being asked to work faster, with more stress and overtime? Are procedures being changed so frequently that workers are losing skill? What happens when a worker tries to question a procedure or even stop the work? Are rewards being given to those who cause the least commotion, keep their heads down and workaround any problems, or to those who question everyday practice and make suggestions? Does a concern with error, blame, and status interfere with the flow of information and suggestions? Do workers feel free to act responsibly and even challenge authorities, or are they being discouraged from doing so by the same people who wonder why workers are not "accountable" and why the "safety culture" is not stronger?

Whenever an improvement is made, is attention focused only on how it will fix a prior problem, or do people imagine how it will create unintended side effects? For example, one U.S. utility is reorganizing its maintenance and engineering modification process to have multidisciplinary teams organized around major component types. The motor operated valve team will have planners, scaffolding, mechanical, electrical, and instrumentation skills in order to do many jobs from start to finish without clumsy handoffs from workgroup to workgroup. Although this reorganization would address the inefficiencies of the old system, it also has implications for information flows across the new groups, the nature of expertise and career paths, and the difficulties of having supervisors with enough training to manage such teams. As the VP-Nuclear for this plant said, we are "not just changing work control, but the whole company. We don't know what we're changing to."

This implies the need for a learning orientation involving all plant specialties, with consideration of different kinds of contacts among groups and different human resource practices along with the reorganization.

The shift from fixing to learning focuses attention on knowledge generation and sharing rather than knowledge ownership by distinct expert groups. The implicit meaning underlying these suggestions is that plant employees should not be perceived as machines doing work [11] or sources of error that interfere with the proper functioning of machines, who must be controlled by management. Instead, employees at all levels and in all specialties are the critical resource for identifying opportunities, understanding operations, and improving performance.

Thus, nuclear power plant staff could find a valuable complement to their existing strategies in a different approach to understanding problems, analyzing their sources, designing solutions, and implementing change. This approach emphasizes error recovery and learning from near misses, puts priority on making invisible cues and signals more visible, develops new kinds of conversations across specialties, keeps asking "why?" [cf. 12], and discusses the importance of investments in learning even without quantifiable improvements in performance outcomes. In this way, nuclear power plant staff not only complete tasks, but also enhance individual know-how and know-why, increase organizational competency, and learn how to sustain improvements.

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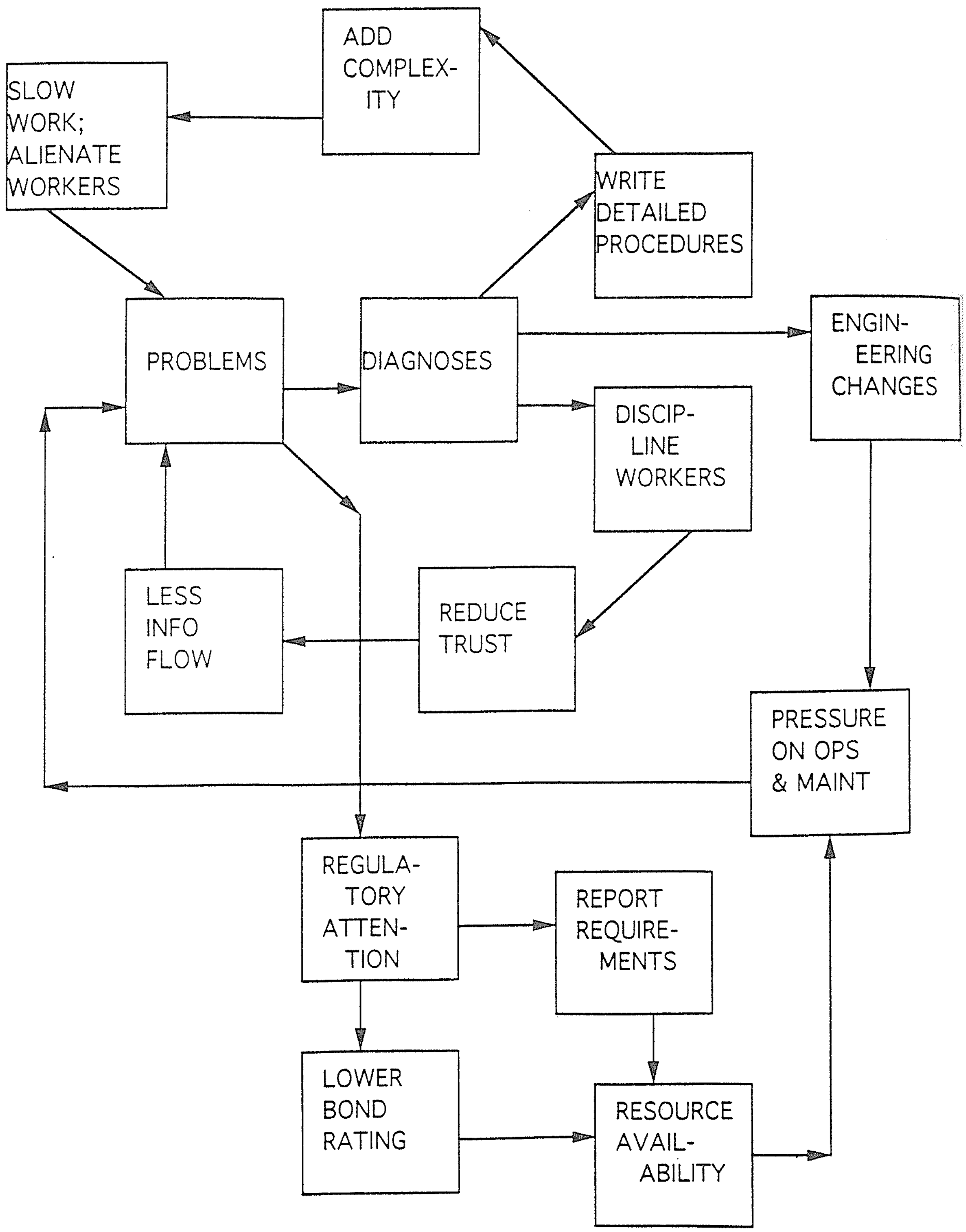
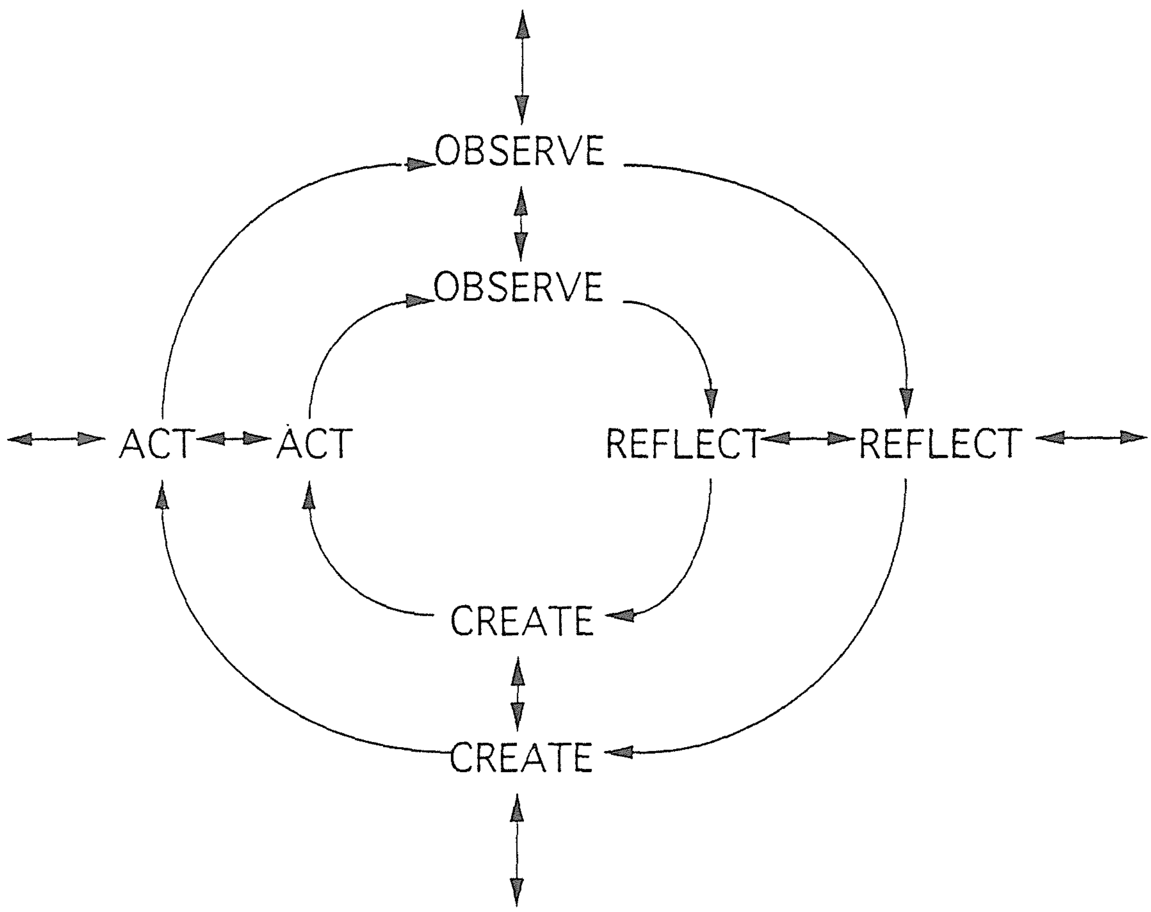
SOLUTION-DRIVEN CHANGES
CAN CREATE MORE PROBLEMS



The Process Cycle at Multiple Levels



DÉ 1 **Rémy Carle, Presentation to 28th JAIF Conference 12 April 1995**

Good morning, ladies and gentlemen.

I am delighted to be here today to have the opportunity to address this important meeting. Next year brings the tenth anniversary of the accident at Chernobyl NPP in Ukraine which was the event that finally persuaded all of the world's nuclear operators to work together and, by exchanging information, to maximise the safety and reliability of operation. Everyone here knows that the results of this determination to work together was the formation in May 1989 of the World Association of Nuclear Operators -
É 2 WANO. Because the model on which WANO is based, INPO, had already been operating for nearly ten years in the United States after the Three Mile Island accident and because INPO had already demonstrated the value of its international programme, we knew that information exchange could be effective in improving levels of operational safety. But we recognised that the combination of linguistic, cultural and regulatory differences together
É 3 with the voluntary nature of the cooperation would make our job more difficult than INPO's and we did not know how effective our efforts would be. But we knew that we had to try because of the total unacceptability of another serious accident. This fact was recognised all around the world, including in this so called Pacific basin area with your large commitment to nuclear energy. The support of all of the Asian nuclear operators for WANO Tokyo Centre have, in my opinion, been and continues to be essential to the maintenance of safe operation at all nuclear power plants.

Today, I would like to tell you what I think operators have achieved together working under the umbrella of WANO and I will focus particularly on the cultural aspects of our exchanges; how we have overcome difficulties and how, sometimes, we have used these differences to our advantage.

É 4 In practice, WANO's work is aimed at helping operators to communicate effectively with one another through several well defined programmes. We find that there are lessons to be learned not only among the operators of a single plant type or a single culture but across these boundaries. But of course we have to work hard to ensure that we are really communicating. Essentially, information is exchanged by face-to-face contact through exchanges and seminars, and electronically so that events can be shared and lessons learned and experience exchanged. The NUCLEAR NETWORK® electronic communication system made available to WANO from the start by INPO allows every WANO member to talk to each regional centre and to any other member and many members give their power plants direct access to this powerful system.

SLIDE 5

Operators also report to an agreed set of ten performance indicators as shown here which include parameters that generally represent a measure of safety and reliability factors. Operators can compare their own results with industry averages and upper quartiles for their plant type. The information is used as one of several management tools to achieve high performance in safety and reliability. The poor plants can use these indicators to identify experience to help them to improve. The strongest plants usually try to find colleagues who are performing even better than they are in selected areas and to ensure that they remain at the top.

SLIDE 6

More recently a "Peer" Review programme has been introduced which is another type of experience exchange. In a Peer Review, a WANO team is invited to spend two weeks at a member plant observing procedures and practices and discussing with their counterparts at the plant. The team brings a breadth of international experience from different cultural backgrounds and is able to make objective assessments against best international practice. The result is a confidential report to the Plant Manager identifying strengths and areas for improvement together with a wealth of good ideas that the team members take back to their own plants. I will say more about this programme a little later, but I want to stress that a Peer Review is not an inspection. It is more like a highly structured information exchange among experienced operators.

SLIDE 7

Where necessary, WANO embarks upon special projects at the request of members which may fall outside the scope of its main programmes. Recently WANO has sponsored the work of its Special Ambassador in chairing a newly formed USERS Group for Soviet Designed Reactors aimed at more efficient collaboration with western funding agencies and I will say more later about WANO's activities at the Kozloduy plant in Bulgaria.

IDE 8 The scale of WANO's activities is already considerable; about a 1000 event reports in the database, more than 250 exchange visits involving several thousands of engineers and 94 workshops/seminars have been completed. These communications have resulted in the production so far of about 95 good practices and 98% of operators report 7 or more indicators. Finally, 15 Peer Reviews have been completed up to the end of 1994.

Of course, the question that must be answered is whether all of this activity is effective in achieving the WANO goal of maximising the safety and reliability of operation.

As I told you earlier, WANO was modelled on INPO and has used the experience gathered by that organisations in establishing its own programmes. The principles developed by INPO in USA were adapted for use internationally across a wide range of cultures. It is natural therefore to consider first the effectiveness of US Industry in improving its performance.

IDE 9 It has to be said that the average performance of US plants as measured by the INPO equivalent of the 10 WANO Indicators in 1980 was generally below the international average. Spectacular improvements could be envisaged but it is nevertheless encouraging that these have been realised for every indicator. For example, collective radiation exposure has been halved, unplanned automatic scrums are 1/7th of the 1980 value and availability has improved from a unit capability factor of 63% in 1980 to about 78% today. *(Unit capability factor is defined as the percentage of maximum energy generation that a plant is capable of supplying to the electrical grid, limited only by factors within control of plant management.)*

As mentioned earlier, performance indicators must be used as just one of many tools to measure performance and there are other indications of the improvements made by the US utility industry. The number of significant events per plant has fallen steadily. Operating and Maintenance costs are now being better controlled and they are starting to decline.

There is ample evidence that the process works in the US but how well can it be adapted to a world-wide scale?

It appears that the most important result so far is one that is not measurable at all. No member, no nuclear power plant is now isolated from this large family. All operators can now compare their own performance with the industry best. Weaker performers can set their own realistic performance targets for improvement. The strongest must continually look over their shoulder in case they are overtaken. Staff at all plants now have the opportunity to visit their colleagues in other parts of the world and to communicate directly with them by electronic mail.

These intangible results are being translated into measurable results. It is
SLIDE 10 too early to identify clear trends which cannot, in any event, be as
spectacular as those seen in the USA. But these slides show that already
11 there is evidence of movement in the right direction. Many individual
12 companies now publish their own trends and these also confirm the progress
that has been made. The number and significance of events is also going
13 down thereby reducing the potential for incidents to escalate into more
serious events.

BLANK SLIDE Everything I have said so far is generally applicable to all operators. I now want to make a few remarks about the special case of those plants designed under the soviet system; operators that participate in WANO through our Moscow Centre. WANO has been of particular value to them because it has allowed them to break out of their isolationism. Before WANO was formed, it was unheard of for a soviet operator to visit a plant in another country, or for a western operator to make anything other than a superficial visit to a soviet plant.

Soviet operators were not, and are not, bad engineers. They were simply locked into a political system that rewarded the maintenance of watertight information compartments. The concept of public opinion about a satisfactory level of safety was unknown in the USSR; to the general public, the plants may as well not have existed and of course, the operators had no opportunity to find out what their colleagues abroad were doing and how safety requirements and criteria had developed since the first reactors were put into service in the 1950s. WANO gave them that opportunity for the first time to accept teams of colleagues for meaningful visits to their plants and to send their own engineers out to see for themselves how safe and reliable operation was secured in the orient and in the west. They have

DE 14 taken full advantage of this opportunity and more than 1000 engineers have now visited other plants throughout the world. There are many examples where they have liked what they saw, taken it home and implemented the idea in their own plants, often with the help of their new found colleagues. I have no doubt that, inspite of the continuing economic difficulties, particularly in Russia and Ukraine, there has been a significant improvement in safety culture that has resulted in a reduction of the number of significant events and their severity. I am sure that a large part of this improvement has come from the improved training centres and particularly the introduction to many plants of full scope simulators. Of course, WANO has not been the only means of promoting improvements in operational safety - I would mention particularly the initiative of the Japanese Government to receive about 100 engineers each year for training - but it has provided the only communication link among the operators themselves and with the outside world that has remained unbroken throughout the traumatic political and economic changes occasioned by the freeing of eastern Europe and the break-up of the Soviet Union.

DE 15 Improvements in operational safety provide significant benefits to safety that can be implemented fairly quickly, but the designs of many of these reactors, particularly the RBMKs and the earliest models of VVER reactors fell far short of the standards that we require at plants operating today in the west. and of course here in Japan. It is in this area that there has been the most controversy. For a variety of reasons, government aid made available by the G7 countries has only led to contracts for the provision of hardware in a few special cases and this has created the impression that little has been done to make improvements. In fact, many important hardware improvements have been made by the operators themselves as a direct result of their observations of western practices, but much more still needs to be done and, in some of these countries will only be realised with outside help. The main argument remains with those plants that cannot be backfitted to standards that we would accept for long term operation and, in my opinion, these plants should be closed as soon as practicable alternative energy supplies can be provided. But please note that informed western experts do not say that these plants are so unsafe that they must be closed immediately. The issue is that the possibility of a major pressure failure is very low but, if it did occur, the consequences could be very significant.

SLIDE 16 I want now to come to some specific examples of how operators have worked together to improve safety and reliability. It is important to distinguish between societal culture which varies from country to country, even sometimes between countries speaking the same language and safety culture which can be good or bad in two countries having the same societal culture. Our aim in WANO of course is to help nuclear operators to achieve and maintain a good safety culture by learning from one another.

SLIDE 17 Before WANO was formed, I have often heard people say after visiting a foreign plant "that plant was very good but I cannot learn anything from them because their culture is different" or "that plant is in very bad condition and they have nothing to teach me". In both of these examples, the speakers were focusing on their differences. But, through WANO, operators have learned to focus on the things they have in common which often leads them to very different conclusions.

SLIDE 18 My first example relates to the WANO assistance at Kozloduy in Bulgaria. When the IAEA carried out an OSART inspection in 1989, they were appalled by what they saw. The contract for supply of the reactors from the then Soviet Union did not include maintenance support or for the provision of full documentation. The Bulgarian operators were quite satisfied with this situation because the availability of the units was actually very good (4th in the world at the time I believe). The traditional fossil fuel mentality "If it is not broken, don't touch it" suited them very well and the poor standard of housekeeping was no different to their experience of everyday life under the regime imposed from Moscow. I am sure that the IAEA report came as a big shock to them because they had not seen any alternative; and initially they accepted the need to improve only as a means to an end and not from any conviction that changes were really needed. But five years later, after many visits of Bulgarian engineers to the Bugey plant in France and with the help of overseas operators who have worked at Kozloduy throughout this time, the situation has been transformed. The Bulgarian operators have a new sense of pride in what they have achieved with their western colleagues and the staff at Bugey have benefited also through having to think of the reasons why they operate as they do. Kozloduy used to be the plant people visited to see the worst example of housekeeping; now they visit it to see how much improvement it is possible to make.

DE 19 For my next example, I have chosen the WANO Peer Review programme in which a multinational, and multicultural, team of engineers visits a plant at the invitation of the host utility and carries out an in-depth review of its operations against best international practice. This example is of a completely different type to the Kozloduy experience. It demonstrates how very good operators can turn cultural differences to their advantage. The term "Peer Review" does not easily translate into the Japanese culture and the WANO Tokyo Centre took a naturally cautious approach when the idea was first introduced in 1991. But the Japanese operating companies did not dismiss the idea as irrelevant to them. They carefully studied the idea looking for the elements that were valuable to them. They sent engineers as team members on Peer Reviews at other plants around the world and they accepted the challenge issued by Taiwan Power Company to conduct a Peer Review at Chinshan focused on a reduction in the number of scrams.

Taipower had been trying to reduce their scram rates for some time with only limited success and the performance of Japanese plants in this area is legendary. The Japanese engineers therefore asked themselves the question "If this was a Japanese plant, what would I do to improve it?" It was clearly understood that it would not be appropriate to implement all the recommendations; the most important result was that it provided an understanding of the problem which helped Taipower to develop an implementation plan appropriate to its culture. The Japanese led Peer Review team benefited too. They found that they had not really understood how they achieved such a good performance and of course they can now use this improved understanding to make sure that they do not step back from the exemplary results achieved.

After this first trial, Japanese operators decided that they were ready to accept Peer Reviews in Japan and so far these have been conducted at Hokaido Electric's Tomari station and JAPCO's Tokai 2 station. I have the impression that both of these reviews are considered useful; and certainly they have been valuable to all of the team members who have observed many strengths and taken this knowledge back to their own plants.

DE 20 My final example is not international at all; it is a US affair which illustrates the importance of insisting on a good safety culture at the highest level in a company. I have chosen it because the lessons are international and can be applied whatever the societal culture might be. - and of course the story is in the public domain so I am not breaking any confidentiality. It is well known that in the 1980s operators at the Peach Bottom plant were caught sleeping while on duty and that this was symptomatic of a generally poor safety culture at the plant. This was during a period when INPO was well established in the US and you could ask whether this case represented a failure of the American self regulation introduced after the Three Mile Island accident. In fact the reverse is true as I will explain. The INPO evaluation process had identified a fundamental problem at Peach Bottom in the early 1980s and reports to the company CEO had reflected these serious concerns. Of course it is the responsibility of the operating company to take corrective actions, but when the next INPO evaluation took place, it was evident that no effective measures had been taken to correct the problem. Meetings progressively between the head of INPO and the company CEO and the chairman of the INPO Board and the Board of the operating company failed to resolve the issue. Eventually, the INPO Board had no option but to advise the operating company board that the problem was unlikely to be resolved whilst the CEO remained in charge and that board belatedly took appropriate action. This CEO was brought up under a culture not appropriate to nuclear power generation and could not change his approach. The case was a landmark in the history of INPO's development. It showed the whole of the US industry that INPO had teeth and that they could, and would, take strong action where it was needed and it demonstrated the fundamental importance of establishing an appropriate safety culture right from the top of every company. Of course WANO does not seek to develop teeth as sharp as INPO's - that is simply not possible on a world-wide scale. But that fact places an even greater responsibility on every company volunteering for a WANO Peer Review to take the findings very seriously and it places a great responsibility on every company not volunteering for a Peer Review to ensure that it has appropriate means in place to know that it has an effective safety culture throughout the company.

SLIDE 21 In Japan, and in France, we insist upon maintaining a very strong safety culture and that commitment is clearly evident right through our companies. But that does not mean that we can afford to be complacent. It is possible for the very best companies to develop a "mind set" that eventually leads to a reduction in performance without us realising it. Information exchange on an international basis is the only way of avoiding this and where the differences in our national cultures can help us in ensuring that we think about the way we do things. In this way, culture differences can be no more an obstacle, but on the contrary a beneficial factor to increase safety of our nuclear plants. We all know that nuclear energy remains the safest and most environmentally friendly means of electricity generation. I am sure that you will continue to play your part in ensuring that the highest possible levels of operational safety continue to be achieved here and in all of the other countries in this part of Asia that use, or aspire to use, nuclear power for electricity generation; and I am confident that the world-wide community of operators will play its part in securing this option for our children and our grandchildren by ensuring that no-one ever again breaks any link in the chain that holds us all together.

Thank you very much.

JAIF Conference
12 April 1995

Rémy Carle

Chairman of WANO Governing Board

Slide 2

Background to WANO Creation

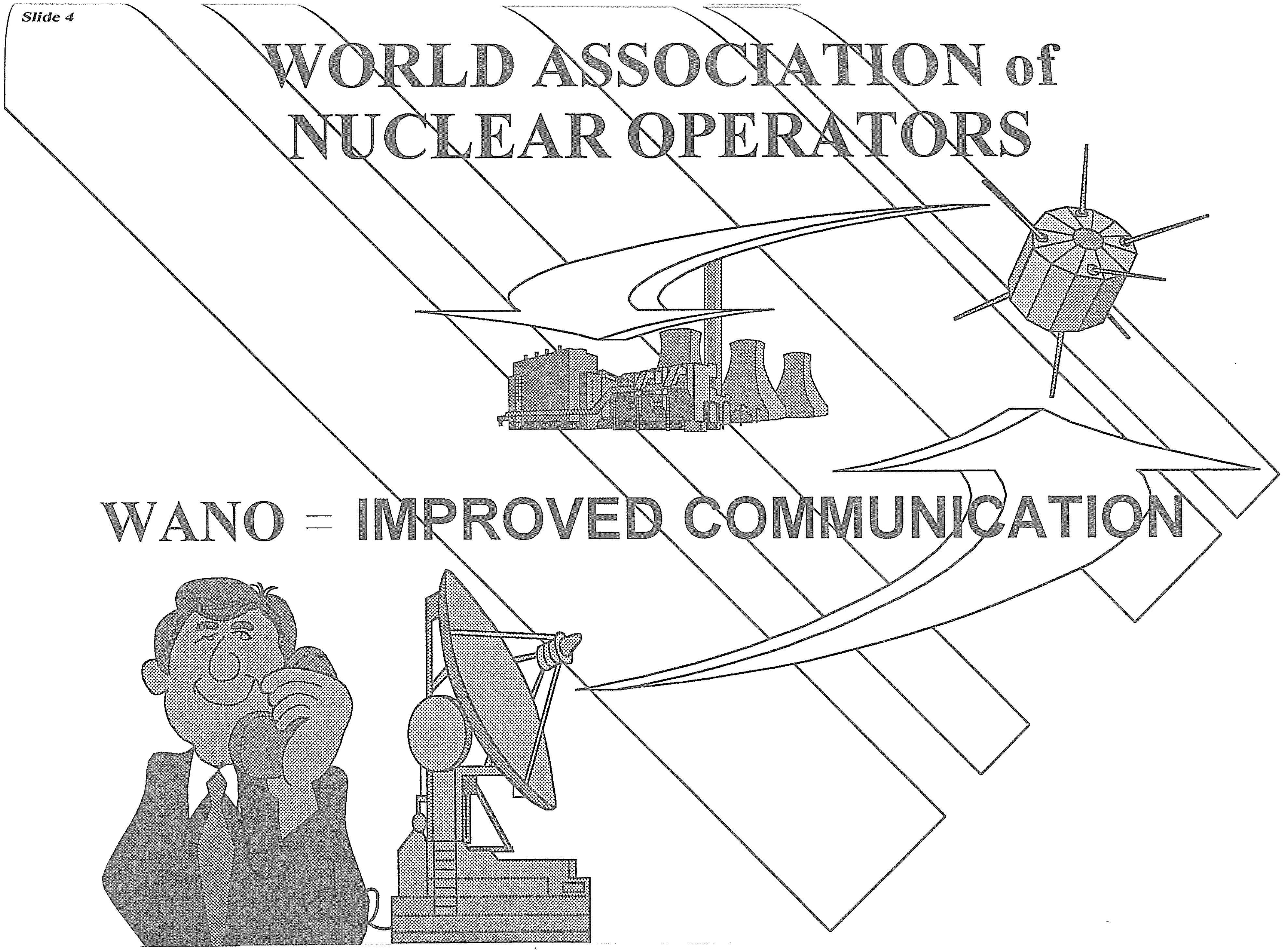
- 1979 Three Mile Island Accident
  - several precursors
  - necessity of information exchange
- 1980 Institute of Nuclear Power Operations (INPO) established

WANO

Slide 3

Background to WANO Creation

- 1986 Chernobyl accident
  - necessity of world-wide exchange
- 1989 WANO established

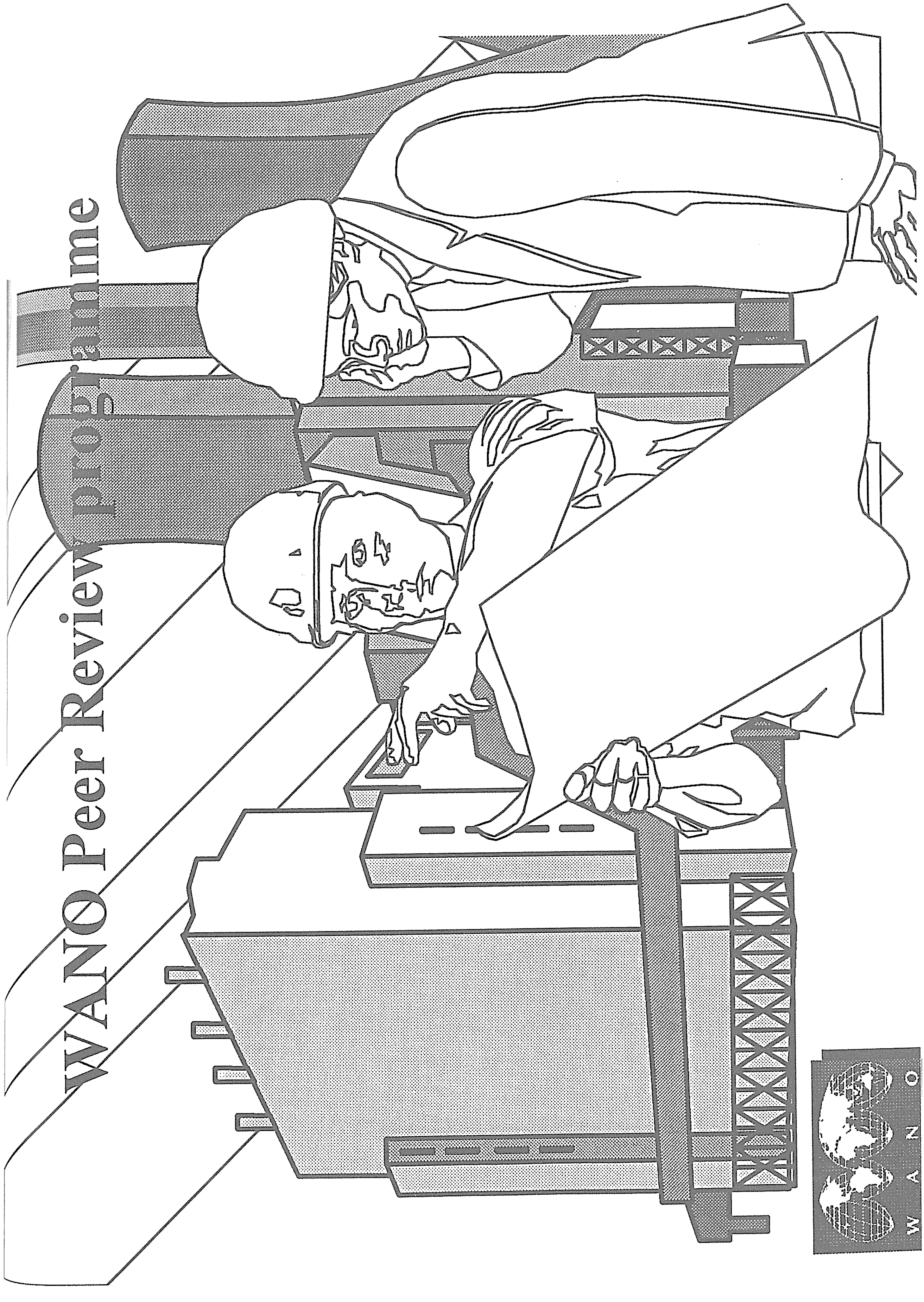

Slide 4
WORLD ASSOCIATION of
NUCLEAR OPERATORS
WANO = IMPROVED COMMUNICATION

Slide 5

WORLD ASSOCIATION of NUCLEAR OPERATORS

Performance Indicator Programme

- Unit Capability Factor
- Unplanned Capability Loss Factor
- Unplanned Automatic Scrams per 7000 Hours Critical
- Thermal Performance
- Fuel Reliability
- Chemistry Index
- Collective Radiation Exposure
- Volume of Low-Level Solid Radioactive Waste
- **Industrial Safety Accident Rate**

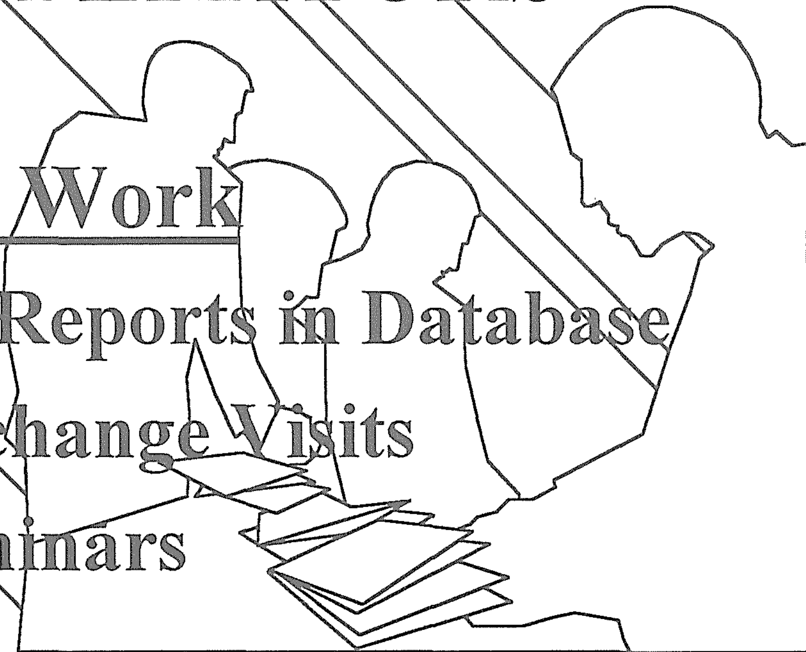

WANO Peer Review programme
W A N O

WANO Special Projects

- Assistance to Kozloduy Plant in Bulgaria
- MC-PC Advisory Group
- *Support for the Users Group of Soviet Designed Reactors*

Slide 8

WORLD ASSOCIATION of NUCLEAR OPERATORS



Members Hard at Work

- About 1000 Event Reports in Database
- More than 250 Exchange Visits
- 94 Workshops/Seminars
- 95 Good Practices
- 98%of Operators report more than 7 indicators
- 15 Peer Reviews up to the end of 1995

Slide 9

INSTITUTE of NUCLEAR POWER OPERATIONS

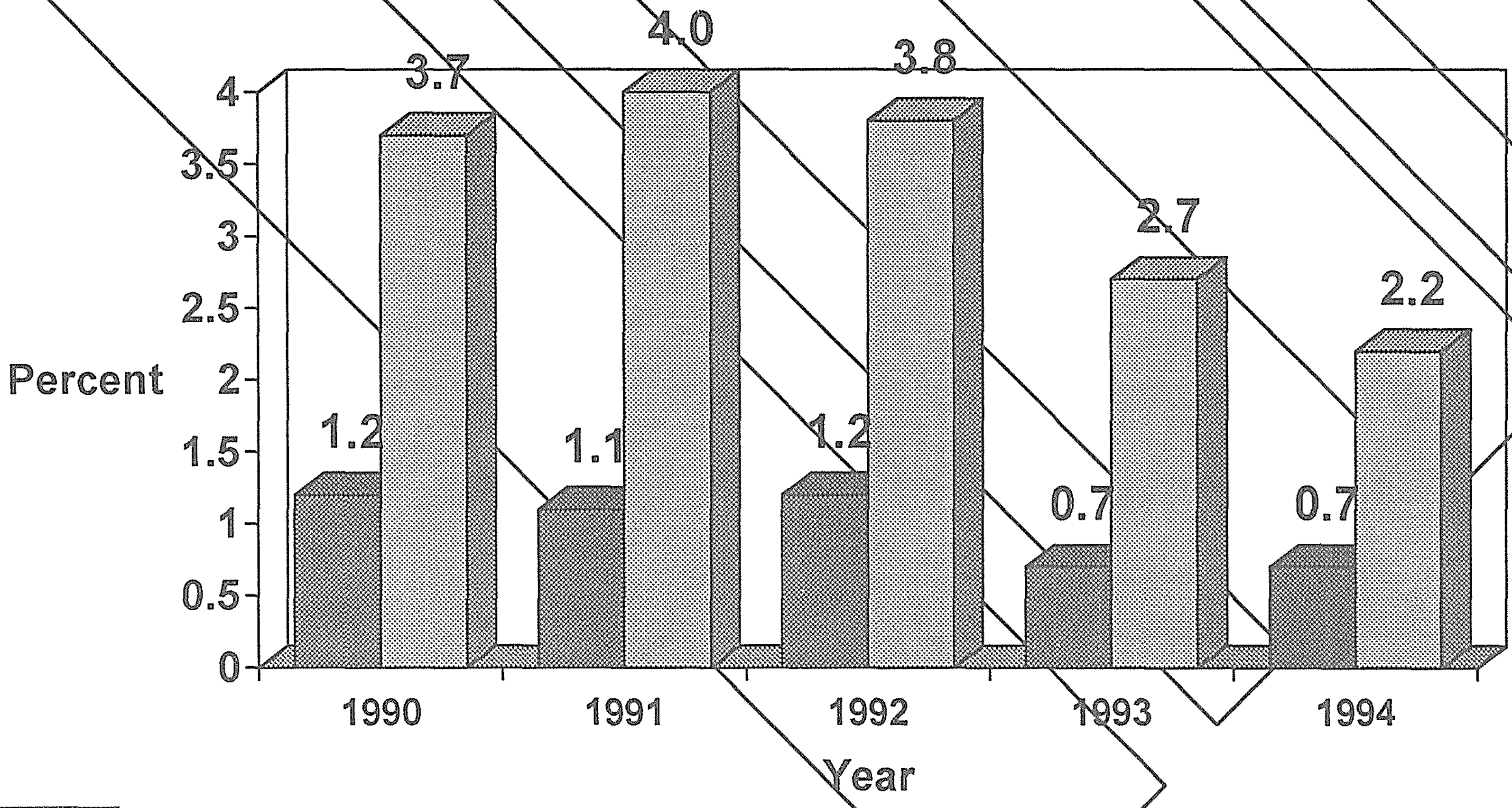
USA Experience

Unit Capability	⇧	up 15% from 1980
Automatic Scrams	⇩	1/7 of 1980 Value
Radiation Exposure	⇩	< 1/2 of 1980 Value
Operating Costs	⇨	Stabilized

Slide 10

WORLD ASSOCIATION of NUCLEAR OPERATORS

Unplanned Capability Loss Factor

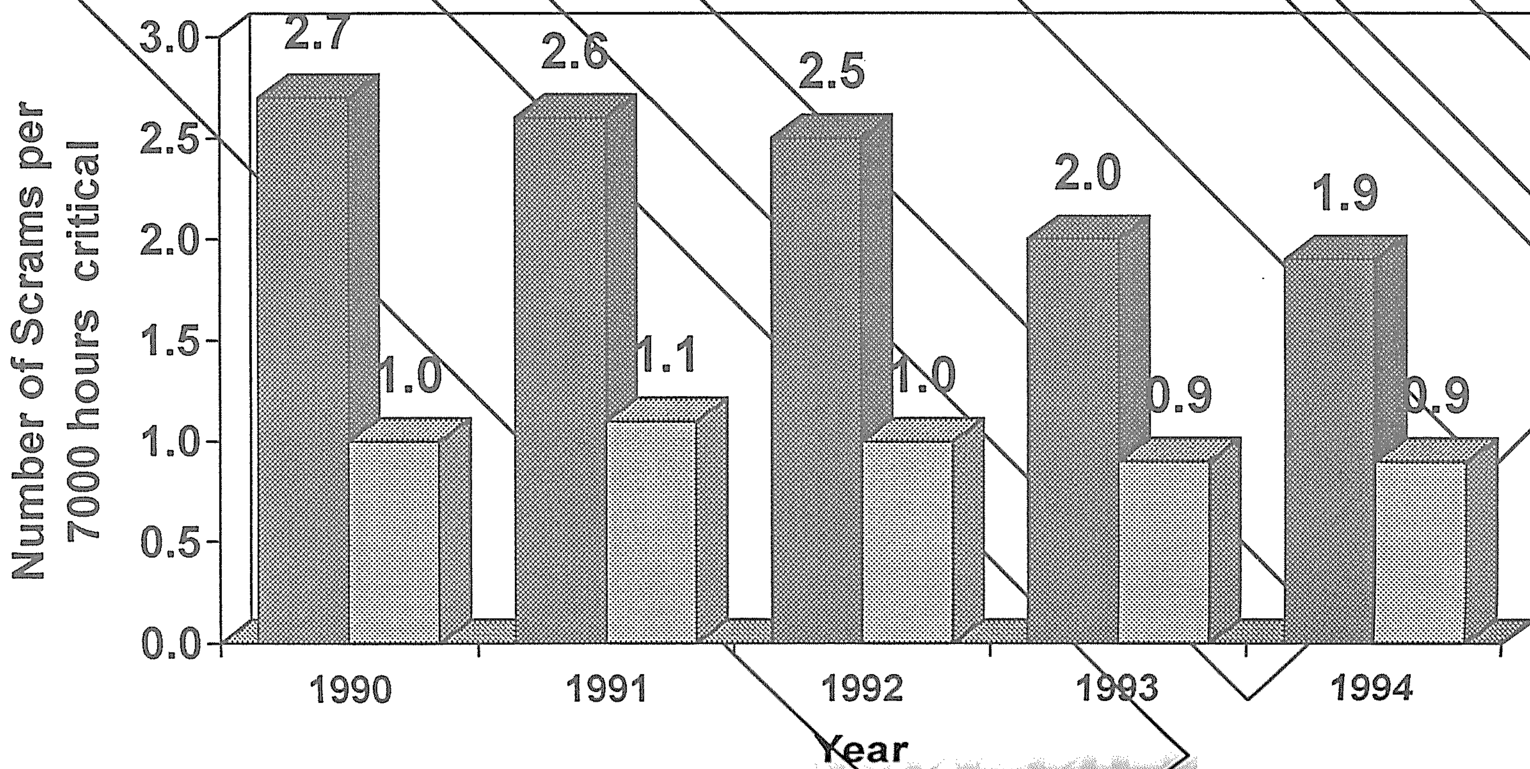


W A N O

Slide 11

WORLD ASSOCIATION of NUCLEAR OPERATORS

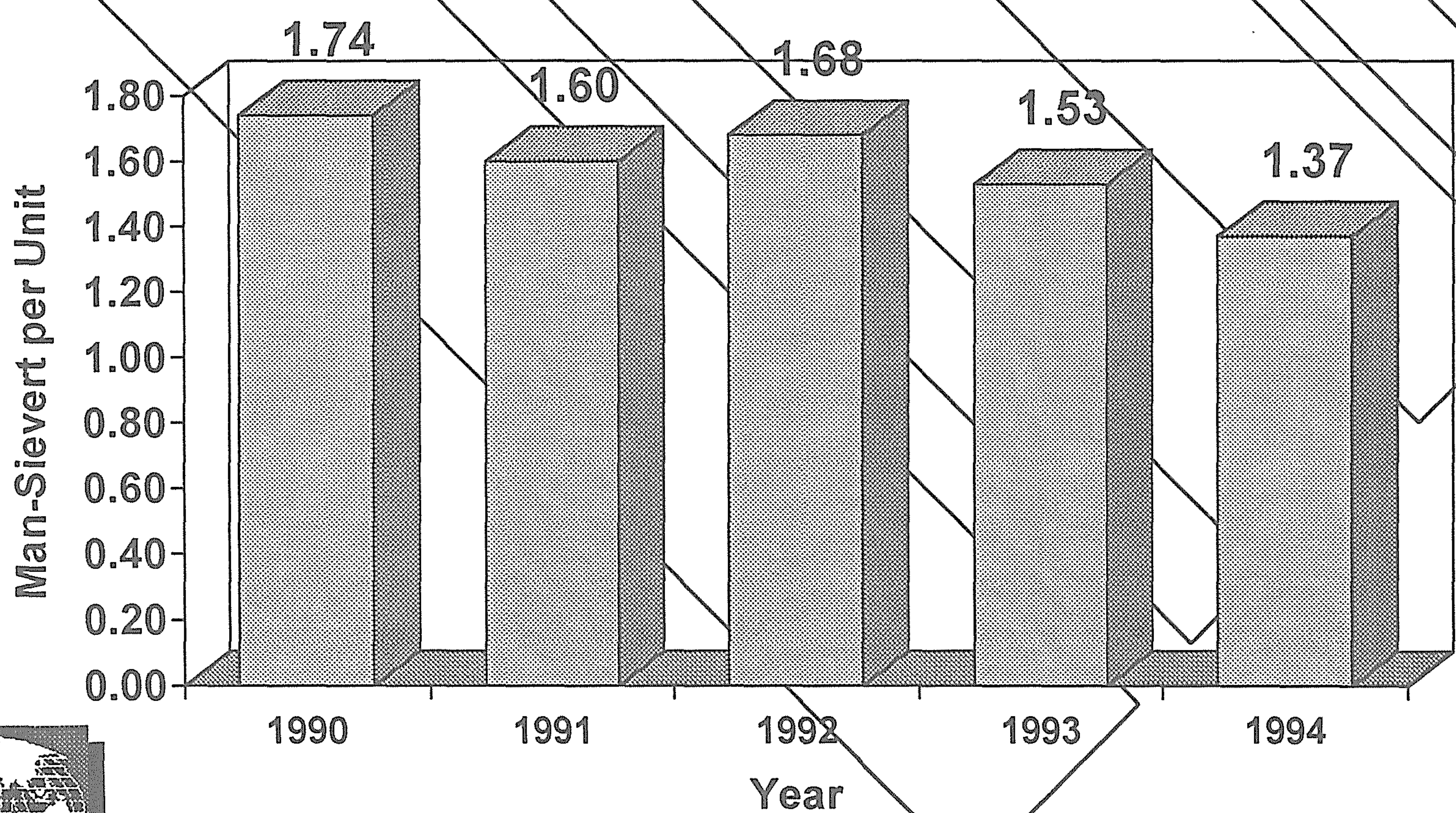
Unplanned Automatic Scrams



Slide ~~13~~ 12

WORLD ASSOCIATION of NUCLEAR OPERATORS

PWR Collective Radiation Exposure (Median Value)

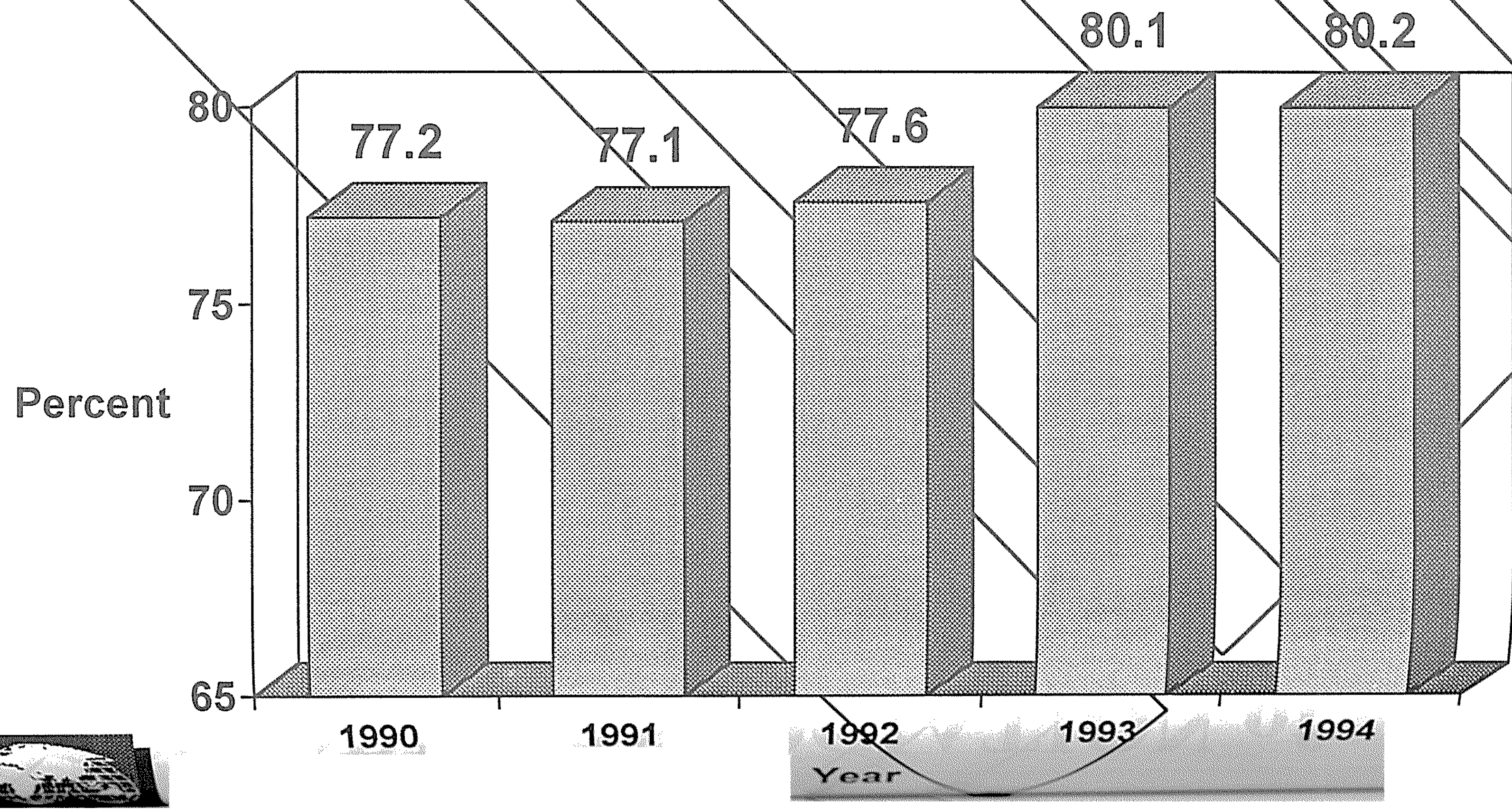


WANO

Slide ~~14~~ 13

WORLD ASSOCIATION of NUCLEAR OPERATORS

Unit Capability Factor (Median Value)



Slide ~~15~~ 14

Worldwide Improvement in Nuclear Operational Safety

More than 1000 Operators Learnt First Hand From Colleagues Abroad

Japanese Government to support training of about 100 engineers [illegible]

W A N O

WORLD ASSOCIATION of NUCLEAR OPERATORS

RBMK and VVER Reactors

- Virtually all Plants equipped with simulators 6 of them are full scope
- Many hardware improvements already carried out by the Operators
- Design changes need to be implemented too

WORLD ASSOCIATION of NUCLEAR OPERATORS

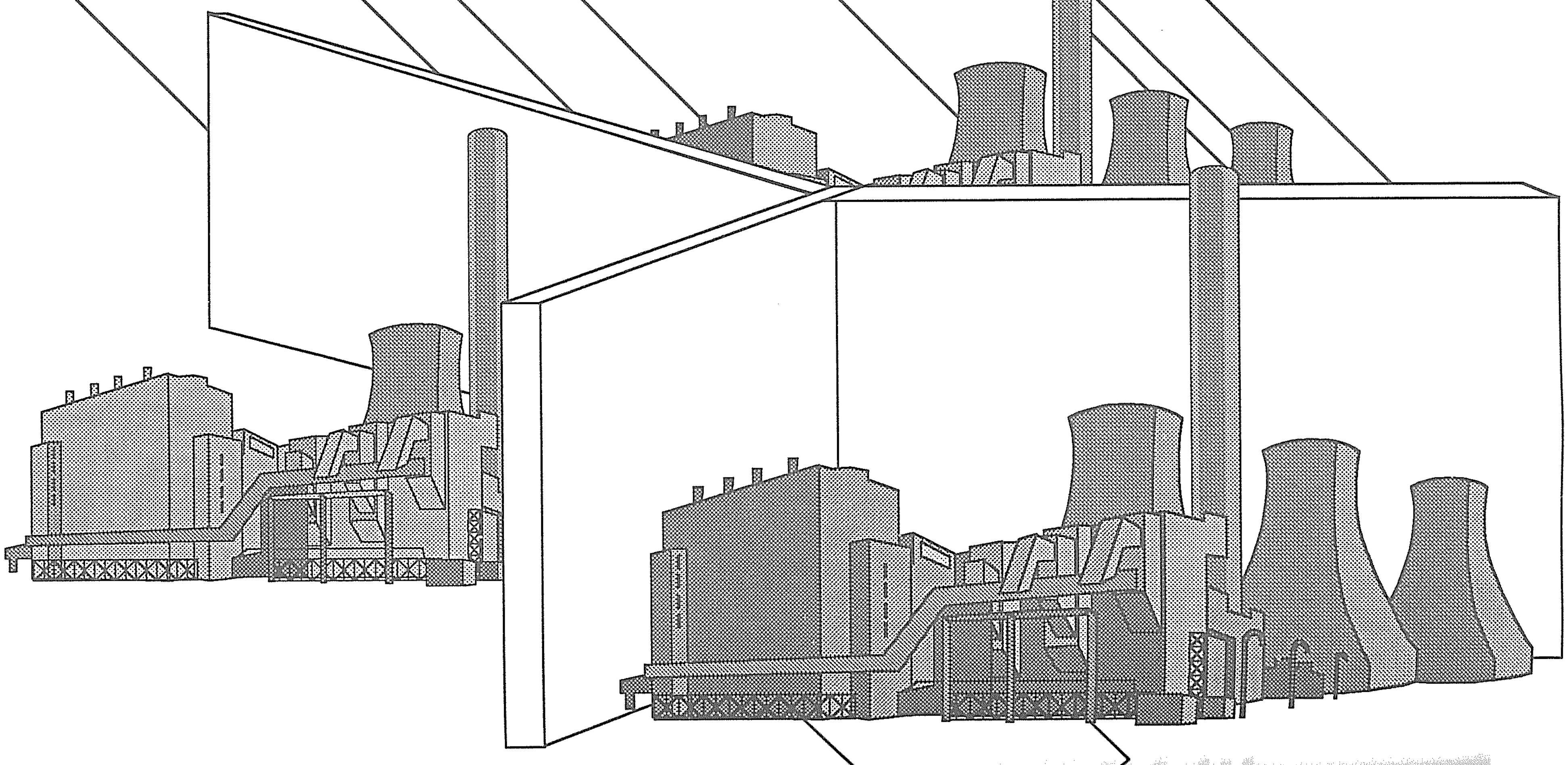
Improving safety and reliability may imply cultural change:

- Societal culture is important
- Safety culture may need improving

WANO

Slide ~~18~~ 17

WORLD ASSOCIATION of NUCLEAR OPERATORS



Barriers can be removed focusing on what we *have in common*

WORLD ASSOCIATION of NUCLEAR OPERATORS

Examples of Operators working together:

- Industrial and safety culture vastly changed at Kozloduy NPP after interactions with other Operators

WANO

WORLD ASSOCIATION of NUCLEAR OPERATORS

Examples of Operators working together

- After careful consideration, Japanese Operators have seen benefit and merit of "Peer Reviews"

WORLD ASSOCIATION of NUCLEAR OPERATORS

Examples of Operators working together:

- Peach Bottom: an example of importance of safety culture at the top

WANO

Slide ~~20~~ 1

WORLD ASSOCIATION of NUCLEAR OPERATORS

Even the best-run companies
cannot afford
to became complacent

Establishment of Safety Culture in Korea

Choi, Chang-Tong
Director
Ulchin Nuclear Power Division
Korea Electric Power Corporation

1. Introduction

Korea has endeavored to assure nuclear plant safety as an utmost priority from the early stages of nuclear projects. The codes and standards of the supplier's nation are thoroughly applied to the whole process of plant construction. Technical specifications and procedures are strictly observed during operation.

In 1985, a period of extensive expansion in the Korean nuclear industry, Atomic Energy Laws were entirely revised by the government to reinforce safety regulation and to enhance nuclear safety. At that time, the Yonggwang Unit 3&4 project, the first localized project, was underway. Therefore, the revised laws were applied to Yonggwang Unit 3&4. This application contributed considerably to enhancement of safety of Yonggwang unit 3&4, sweeping away the potential degradation of quality and safety, through development of self-reliance.

In addition to these government efforts, Korea Electric Power Corporation (KEPCO), the sole owner of nuclear power plants in Korea, has strived to promote safety. These safety promotion activities included implementation of post TMI actions, comprehensive training using a nuclear training center equipped with simulators and modern facilities, and international cooperation with IAEA, WANO, INPO, and various reactor owner's groups.

Though this sequence of efforts is consistent with the enhancement of safety, and with Safety Culture published in 1991 by IAEA, recently the government called for even more efforts. They encouraged the nuclear industries to establish comprehensive and systematic measures for safety culture and the nuclear industry is challanging to achieve the highest level of nuclear safety.

Now, I will briefly introduce various safety activities implemented up to now and the future plan for the establishment of safety culture in Korea.

2. Major Activities

Government Policy

In July 1994, the Atomic Energy Commission established a nuclear policy titled "Long-Term Nuclear Policy Direction Toward 2030." This policy states that atomic energy should be used safely, for peaceful purposes to promote the national welfare. On the ground of this principle, assurance of nuclear safety is emphasized as an overriding prerequisite for nuclear development.

In September 1994, the Ministry of Science and Technology issued the "Nuclear Safety Policy Statement," based on the Safety Culture of IAEA, declaring the government's commitment to ensure safety of the public. They also recommended KEPCO to establish a safety culture. This statement was the initiative for the implementaton of "Safety Culture" in Korea.

KEPCO System and Policy

In accordance with the government policy, KEPCO has made efforts to promote a safety culture and pursue safety awareness by all employees. KEPCO's management evaluation system, which compares and evaluates the management results of each nuclear plant every year, puts more emphasis on the evaluation of nuclear safety activities.

Plant managers meeting is held on periodical basis to exchange technical information and the experience acquired at each plant in the promotion of nuclear safety and to spread out good practices to the other plants.

Education and Training

KEPCO's nuclear training center has established a curriculum on nuclear safety culture and Human Performance Enhancement System (HPES). This course promote employees' attitudes to lead a life in observance of the safety culture tradition. Besides these courses, safety culture is an essential subject of operator refreshment courses. Education is conveyed by managers to engineers about safety culture.

Reinforcement of Safety Awareness

KEPCO has established "Nuclear Safety Day", on December 10th of each year since 1990, to promote employees' safety awareness and to emphasize the observance of regulatory guides. On every nuclear safety day, a meeting attended by all employees dedicated to safe operation is held at head office and at each nuclear site, respectively. Safety activities during the previous year are reviewed, the pledge to safety is renewed, and special spiritual education is conducted.

Improvement of the Administrative Organization

Operating shifts were changed from five shifts to six and a shift operation manager system was introduced. These changes help improve the work environment and provide the operators with more time for reviewing the safety related documents and activities.

Improvement of Human Performance

We have implemented out the K-HPES since October 1994, based on the HPES of INPO, but modified and developed to correspond to Korean eigen culture. Furthermore, managers play a leading role in safety efforts to reduce human errors by witnessing impotant surveillance inspections and by holding a safe-operation meeting everyday.

Safety Evaluation through International Cooperation

Nuclear power plant safety has been enhanced through exchange of technical information and techniques with IAEA, INPO, various reactor owner's groups, and some overseas nuclear plants. We have greatly enhanced the propagation of safety culture through application of technical documents published by these organizations. The results of our efforts up to now reveal the recogniton by the nuclear plant employee of the importance of safety culture.

3. Future Plan of KEPCO

"Safety Culture Compliance" will continue to receive the highest priority and attention of KEPCO management.

On basis of the ASCOT (Assessment of Safety Culture in Organization Team) guideline of IAEA, KEPCO is planning to establish evaluation indicators suitable for the realistic circumstances. As a trial case these indicators will be applied to one selected plant within this year, and extended to all nuclear power plants in the future.

For the purpose of early establishment of safety culture, KEPCO will continue to cultivate instructors, develop training materials, increase courses associated with safety, and try to participate in education programs related to the IAEA safety culture.

Also international sense of safety culture will be persued through assessment by international organizations such as IAEA/OSART, INPO Technical Exchange Visit and WANO Peer Review.

To reduce plant safety risk, potential vulnerabilities to nuclear safety will be identified by probablistic safety assessment (PSA).

4. Conclusion

The assurance of nuclear safety is a top priority goal. This goal can only be achieved in societies and countries with sound safety culture. Willingness of the nuclear plant owner to comply with nuclear safety is the most important factor contributing to the nuclear safety culture. Therefore, each nation's nuclear industries must create an environment to inspire voluntary efforts by the owners of nuclear facilities.

It is difficult to establish safety culture within a nuclear organization, because it may easily become a superficial program. To overcome this difficulty and to achieve a reliable safety culture, it is prudent to establish a concrete plan to be followed by positive implementation on the part of respective organizations and individuals involved.

Finally, I think that the exchange on each nation's experience of safety culture, like this conference, is very helpful to upgrade the level of safety culture on global basis as well as regional or national basis.

NUCLEAR POWER CORPORATION

(A GOVERNMENT OF INDIA ENTERPRISE)

Y. S. R. PRASAD
Managing Director

a:sk11/14/3/95

NUCLEAR POWER CORPORATION

A

GOVERNMENT OF INDIA ENTERPRISE

UNDER

DEPARTMENT OF ATOMIC ENERGY

a:sk!2/14/3

NPCIL

MISSION

TO DEVELOP NUCLEAR TECHONOLOGY

TO PRODUCE NUCLEAR POWER

IN

SAFE, ENVIRONMENTALLY BENIGN & ECONOMICAL

MANNER

PROVIDE EXPERT ASSISTANCE TO THE POWER &

ALLIED SECTOR

a:skj9.dp

NPCIL
OBJECTIVES

- MAXIMISING GENERATION FROM NUCLEAR POWER STATION SAFELY

- TO INCREASE NUCLEAR GENERATION CAPACITY IN THE COUNTRY CONSISTENT WITH AVAILABLE RESOURCES IN A SAFE, ECONOMICAL AND SELF RELIANT MANNER

- TO PRODUCE SURPLUSES FOR THE FURTHER GROWTH.

- TO CONTINUE AND STRENGTHEN Q.A. ACTIVITIES RELATING TO NUCLEAR POWER PROGRAMME WITHIN THE ORGANISATION AND THOSE ASSOCIATED WITH IT

- TO DEVELOP TECHNICAL PERSONNEL AT ALL LEVELS THROUGH AN APPROPRIATE HUMAN RESOURCES DEVELOPMENT (HRD) PROGRAMME IN THE ORGANISATION WITH A VIEW TO FURTHER IMPROVING THE SKILLS AND PERFORMANCES CONSISTENT WITH THE HIGH TECHNOLOGY FIELDS.

- TO CONTINUE AND STRENGTHEN ENVIRONMENTAL PROTECTION AND PUBLIC AWARENESS ACTIVITIES RELATING TO NUCLEAR POWER GENERATION.

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NUCLEAR SAFETY

THE ACHIEVEMENT OF PROPER OPERATING
CONDITIONS PREVENTION OF ACCIDENTS
OR MITIGATION OF ACCIDENTS CONSEQUENCES
RESULTING IN PROTECTION OF SITE PERSONNEL
THE PUBLIC AND THE ENVIRONMENT
FROM UNDUE RADIATION HAZARDS

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SAFETY CULTURE

ATTITUDINAL AND STRUCTURAL CHARACTERISTICS OF ORGANISATIONS AND INDIVIDUALS WHICH ESTABLISHES AN OVERRIDING FOR NUCLEAR SAFETY

- PERSONNEL ATTITUDES
- HABITS OF THOUGHT
- STYLE OF ORGANISATION

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COMMON ATTRIBUTES OF SEVEN MAJOR ACCIDENTS

ATTRIBUTE	BHOPAL	CHER– NOBYL	PETRO– CHEM Tx	PIPER ALPHA	ROCKET FUEL NV	SHUTTLE	THREE MILE IS.
ANALYSIS	X	X	X	X	X	X	X
COMPLIANCE	O	O	O	O	O	X	X
DESIGN	X	X	X	X	X	X	X
DISSENT	X	X	X	X	X	X	X
EMERGENCY	X	X	X	X	X	X	X
LEARNING	X	X	X	X	X	X	X
MINDSET	X	X	X	X	X	X	X
ORGANIZATION	X	X	X	X	X	X	X
PRECAUTIONS	X	X	X	X	X	X	(X)
RESPONSIBILITY	X	X	X	X	X	X	X
RISK MNGMNT	X	X	X	X	X	X	X

BHOPAL, 1984; CHERNOBYL, 1985; PETROCHEMICAL PLANT TEXAS,1989; PIPER ALPHA OIL PLATFORM,1988; AMMONIUM PERCHLORATE PLANT, NEVADA 1988; SHUTTLE CHALLENGER,1986; THREE MILE ISLAND,1979.

ask111 dt 23.3.95

ORGANISATION COMMITTMENT
ON NUCLER SAFTY

" SAFETY FIRST – PRODUCTION NEXT "

SYSTEMATIC EFFORTS IN IMPROVING THE HUMAN PERFORMANCE BY EXTENSIVE INDUCTION TRAINING AND PERIODIC RETRAINING

MANAGEMENT INSISTANCE ON "ROOT– CAUSE ANALYSIS" OF ALL THE EVENTS WITH CLEAR MISSION OF "NON RECURRENCE OF EVENT"

a:ekj8,dt.14.3.95

SCENARIO IN INDIAN CONTEXT

INDUSTRIAL FRONT

- ENTERED MODERN INDUSTRIA- LISATION ONLY RECENTLY
- TRADITIONALLY ORIENTED TOWARDS AGRICULTURE AND ANIMAL HUSBANDRY
- LIMITATION OF PRESENT INDUSTRIAL SET- UP IN PROVIDING POST SALE MAINTENANCE SERVICES TO NPPS
- ACCESS TO NUCLEAR TECHNOLOGY FROM DEVELOPED COUNTRIES RESTRICTED DUE TO PRINCIPLED STAND ON NPT

HUMAN FRONT

- HIGHLY POPULOUS COUNTRY WITH LARGE UNEMPLOYMENT RATE
- LABOUR INTENSIVE TECHNOLOGY / PROCEDURES ADOPTED
- ABUNDANT QUALIFIED TECHNICAL MANPOWER
- INDIANS BEING CONSERVATIVE BY NATURE, WILL AVOID TAKING UNDUE RISK

ALL THE ABOVE FACTORS REFLECT IN SAFETY CULTURE

skj6.dp

INDIVIDUALS CHARACTERISTICS FOR SAFETY CULTURE

TO PERFORM ASSIGNED JOB / TASK

- CORRECTLY (STICKING TO PROCEDURES)
- WITH ALERTNESS (NO COMPLACANCY)
- WITH DUE THOUGHTS (SAFETY THINKING)
- WITH FULL KNOWLEDGE (QUESTIONING ATTITUDE)
- WITH SOUND JUDGEMENT (COMMITTMENT TO EXCELLENCE)
- PROPER SCOPE OF ACCOUNTABILITY (SELF REGULATION IN SAFETY MATTER)

HUMAN PERFORMANCE IMPROVEMENT

- DEPLOYMENT OF PERSONNEL WITH HIGHER EDUCATIONAL QUALIFICATION.
- EXTENSIVE INDUCTION TRAINING BOTH CLASS ROOM ON THE JOB & SPECIFIC TASK.
- DETAILED O & M PROCEDURES WITH ELABORATE CHECK LISTS.
- DETAILED PROCEDURES FOR HANDLING EMERGENCY CONDITION
- PERIODIC RETRAINING THROUGH WORKSHOPS, BRAINSTORMING SESSIONS
- TRAINING PACKAGES BEING REGULARLY UPGRADED TO INCLUDE LATEST" INFORMATION " AND "GOOD PRACTICES" RECEIVED THROUGH WANO, COG, NMAC, AND IAEA

[illegible].14.3.98

INDIA'S TRACK RECORD

- INDIA HAS 10 OPERATING UNITS OF NUCLEAR POWER STATIONS

- 100 REACTOR YEARS OF OPERATING EXPERIENCE

- NOT A SINGLE CASE OF FATALITIES DURING OPERATION

- NOT A SINGLE CASE OF RELEASE OF RADIOACTIVITY BEYOND PERMISSIBLE LIMIT

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SAFETY CULTURE: A PAKISTANI PERSPECTIVE

Iqbal H. Qureshi and A. Talat Fatimi
Pakistan Atomic Energy Commission Islamabad, Pakistan

INTRODUCTION

The Nuclear power industry, since its very inception, has accorded very high importance to safety concerns as compared to any other industry. In fact the rapid growth of nuclear power during the 1960s and 1970s owes a great deal to its safe operation. The experience over the last four decades have led to a continuous evolution of standards, concepts methodologies, and processes to ensure safety of nuclear power plants. The process has been further intensified by the tremendous pressure of public opinion in the aftermath of the TMI and Chernobyl accidents, and it is now clear that any further occurrences of this nature anywhere could seriously jeopardise the future of nuclear power throughout the world.

There is now a growing worldwide recognition that the Man-Machine interaction in nuclear power is a critical issue that warrants particular attention by the international community. It was in this environment that in 1986, the International Nuclear Safety Advisory Group (INSAG) formed by IAEA, introduced the term "Safety Culture" as one of the essentials for the nuclear industry. A lot of effort has since been devoted to the elaboration of this concept and its effective implementation. The primary ingredient of this concept is a reiteration of the need for an unambiguous recognition by organisations and individuals involved in nuclear power of the over-riding priority of safety issues. It also involves active efforts to clearly identify and analyse all safety related problems, and to learn from past experience not only in specific cases but also in a wider perspective.

The nuclear power enterprise in Pakistan has been fully cognizant of its responsibilities as part of the nuclear community to ensure and enhance safety in its establishments. Our efforts in this direction have been multi-faceted. One important aspect has been the strengthening of the nuclear regulatory process in the country and a steady movement towards the goal of complete separation of the regulatory body and the operating organisation.

Paper to be presented at Japan Atomic Industrial Forum, 28th Annual Conference Tokyo, April 10-12, 1995.

NUCLEAR ENERGY PROGRAMME IN PAKISTAN

Pakistan is an energy resource-deficient developing country which is passing through an energy-intensive phase of socio-economic development and is confronted with rapid growth in energy and electricity demand. The per capita consumption of commercial energy and electricity in Pakistan are only 0.28 TOE and 400 KWH, which correspond to about one-fifth of the world average, one-half of the average level of consumption in the developing countries and one-twentieth of that in the industrialised countries. Inspite of its very low level of per capita consumption of commercial energy as well as electricity, the country is unable to cope with the demand through indigenous sources and has to import large quantities of oil, resulting in serious balance of payment difficulties. It has, therefore, long been recognised that nuclear power has an important role to play in the national energy scenario to reduce dependence on imported energy and provide greater diversity in the energy supply resources. By reducing the consumption of fossil fuel, it also offers the attractive feature of lowering atmospheric pollution in the local area as well as contributing to the reduction in the evolution of greenhouse gases from the global point of view.

Pakistan has a 137 MWe PHWR type nuclear power plant, KANUPP, which has been in operation for the last 23 years. A second nuclear power plant, CHASHNUPP, a 300 MWe PWR, is now under construction and is scheduled to be completed by 1998. In addition, we have two research reactors at the Pakistan Institute of Nuclear Science and Technology (PINSTECH). One of these is a swimming pool type reactor in operation since 1965; following a redesign of its core in 1992, the enrichment of its fuel has been reduced from 93% to 20% while the power has been raised from 5 MWth to 10 MWth. The other is a 27 KWth Miniature Neutron Source Reactor (MNSR) that was commissioned in 1989. The research activities at PINSTECH are concentrated in the fields of physical sciences and engineering. Besides PINSTECH, Pakistan Atomic Energy Commission operates three agricultural research centres and nine medical centres where radioisotopes and radiation techniques are being applied in the field of agriculture and medicine.

EVOLUTION OF NUCLEAR SAFETY IN PAKISTAN

All nuclear facilities in Pakistan are owned, operated and regulated by Federal Government through Pakistan Atomic Energy Commission (PAEC). It has so far not been found practicable in Pakistan that utilities and private companies may also own and operate nuclear power plants in view of the large capital costs of such plants and their requirements for highly skilled technical manpower.

In order to deal with nuclear safety issues, two organisations namely, the Pakistan Nuclear Safety Committee (PNSC) and the Nuclear Safety and Licensing Division (NSLD) were created by PAEC in 1964 and 1970 respectively. Of these the former (PNSC) was primarily a policy and decision making body, while the latter (NSLD) dealt with routine and general safety issues. A reorganisation was affected in 1985 following the promulgation of the Pakistan Nuclear Safety and Radiation Protection (PNSRP) Ordinance by the Government of Pakistan in 1984. The functions of NSLD were enhanced and it was reorganised as the Directorate of Nuclear Safety and Radiation Protection (DNSRP) with the responsibility to execute, enforce and supervise various nuclear safety and radiation protection measures. The DNSRP is now staffed by more than 50 scientists and engineers. In order to provide relatively independent inputs to the safety assessment process, the PNSC was also replaced by three Advisory Committees dealing respectively with issues concerning (i) nuclear reactor safety (ii) nuclear fuel cycle safety and (iii) use of radiation in agriculture, medicine and industry. Recently DNSRP has been provided more functional independence from the reactor operating establishments through the creation of the Pakistan Nuclear Regulatory Board (PNRB) in February 1995. The majority of the members of this Board are from non-PAEC organisations. The functions of the PNRB include over-seeing and reviewing the performance of DNSRP, approval of the regulations, guides and codes of practice, approval of the constitution of Advisory Committee, etc. The DNSRP will continue to be responsible for execution of statutory requirements of the PNSRP Ordinance-1984 and the PNSRP Regulations thereunder. For the future we have an evolutionary plan to continue moving towards the goal of total separation of the regulatory body from the operating agency.

SAFETY CONSIDERATIONS AT CASHNUPP

Procedure for Licensing of Nuclear Power Plants and Research Reactors in Pakistan have been issued by DNSRP. The main objective of these procedures is to provide guidance to the licencees to protect the site personnel, the public and environment from adverse effects arising from construction and operation of these nuclear facilities. The licensing procedures for nuclear power plants in Pakistan comprise of (i) Registration of Site (ii) Issuance of Construction License (iii) Issuance of Operating License.

Under these procedures the site for CHASNUPP was approved after thorough safety review of the Site Evaluation Report (SER). The construction license was issued in July 1993 after the review and approval of the Preliminary Safety Analysis Report by DNSRP.

During the construction, commissioning and operation of CHASHNUPP, the regulatory body will continue to conduct periodic inspections to review the license conditions. For QA inspection of CHASHNUPP, 68 control points have been identified, out of which 6 will be carried out at the plant site and the rest at factories that are manufacturing plant components.

SAFETY CULTURE AT KANUPP

The Karachi Nuclear Power Plant (KANUPP) has been in operation since 1972. Here, facilities for intensive training of personnel at different levels and job requirements are fully functional and are kept under review for incorporating improvements, whenever needed. These include the KANUPP Institute of Nuclear Power Engineering (KINPOE) which has undergone a major upgradation recently so as to be able to provide training in nuclear power engineering in a much broader perspective. There is also an In-Plant Training Centre that caters to the very specific training needs of the plant. Operating licenses for personnel are now required to be renewed every year by DNSRP through a procedure in which the performance and retraining of the individuals is thoroughly reviewed.

An important part of safety culture is the ability to learn from past experience and an elaborate system for ensuring this has been established at

KANUPP. All unusual events, particularly those with safety significance, are thoroughly analysed and documented in a process that involves plant personnel, management, regulators, and other experts. Within 48 hours of an incident, an Unusual Occurrence Report (UOR) is prepared by the person incharge of the section where the incident has occurred. The report is then forwarded by the Division Manager to the KANUPP Safety Committee for review and after approval by the General Manager, it is sent to DNSRP for review and comments. Besides, review and analysis by its own experts, DNSRP also sends the UORs to members of the ACRS for their comments. For a safety significant event, a detailed report is prepared that includes a thorough root cause analysis. The results of the analysis are documented in the form of a Special Technical Report (STR). The plant management has the responsibility for implementing the recommendations evolved in this process, and the implementation is carefully monitored by DNSRP.

In order to more thoroughly familiarise personnel with all the imperatives of safety culture, a week long seminar was arranged at the plant in collaboration with IAEA's Assessment of Safety Culture in Organisations Team (ASCOT) in November 1994. This format provided an opportunity for an exchange of ideas and sharing of experiences between plant personnel and IAEA experts. It has been useful in raising the general consciousness level regarding the demands of safety culture in nuclear establishments.

INTERNATIONAL COLLABORATION

In recent years there has been very extensive activity at KANUPP to further enhance the safety of the plant. International collaboration has been actively sought in this work and many of the safety upgradation projects have been conducted under the aegis of various IAEA programmes. Pakistan was one of the first countries to invite an IAEA Operational Safety and Review Team (OSART). The first visit to KANUPP took place in 1984, followed by another in 1989.

In 1989, KANUPP was also visited by IAEA's Assessment of Safety Significant Event Team (ASSET). As follow-up to the recommendations of this mission, a very comprehensive IAEA sponsored project entitled "Safe Operation of KANUPP" (SOK) was evolved. For the systematic execution of this ambitious project, a detailed plan titled "Integrated Safety Review Master Plan" (ISARMAP) was formulated and submitted to IAEA in 1992. It includes a large number of individual projects, which can be broadly categorised as follows:

1. Fuel channel integrity assessment and replacement.
2. Assessment and rehabilitation of many plant components and sub-systems, particularly those critical to safety.
3. Upgradation and replacement of computers, control and instrumentation throughout the plant.
4. Improved analysis of safety related systems to ensure their adequate functioning.
5. Development of Level-1 PSA for the plant.
6. Updating of KANUPP FSAR.

It is evident from this description that the project involves a very broad spectrum of activities whose completion will result in significantly enhancing plant safety. Efforts are being made to achieve the specified targets according to schedule. However, since KANUPP is a Canadian origin system, the execution of many of the elements of this programme depends heavily on the degree of cooperation and collaboration by the Canadian Government and various agencies. We hope that in view of the nature and objectives of this programme, and its importance not only for Pakistan, but for the global nuclear enterprise, obstacles in the way of its full implementation will be speedily removed.

PAEC actively participates in IAEA's Incident Reporting System (IRS). There is also on-going collaboration with World Association of Nuclear Plant Operators (WANO) and Candu Owners Group (COG) on matters related to plant safety. This collaboration has been further enhanced recently through WANO-TC and in 1994 WANO carried out a full-scale peer review for KANUPP. The support that WANO is providing, particularly in the fields of exchange visits, seminars and working staff level meetings are very useful to the member countries. The success of WANO has been achieved by the goodwill and willingness of its members to share the information, as well as, by the dedication and enthusiasm of its Directors and staff members.

Pakistan is a signatory to most international conventions in the area of nuclear safety and has actively participated in their formulation. These includes the Convention on Nuclear Safety; the Convention on Early Notification of Nuclear Accidents; and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. We are also participating in IAEA's project related to the Strengthening of Regulatory Bodies.

CONCLUSION & RECOMMENDATIONS

From our experience in Pakistan, we find that despite our very active engagement in international activities related to nuclear safety, there are many impediments in our efforts to obtain materials, equipment, spare parts and information related to construction and safe operation of nuclear power plants from the industrialised countries. We strongly feel that there is a need for general lowering of barriers to the flow of safety-related inputs so that the difficulties being faced by the energy resource-poor developing countries, particularly those of the Asia-Pacific region may be rectified. In particular we recommend that:

1. The international community should agreed to some definite arrrangement for cooperation and close collaboration between the supplier and recipient countries under the guidelines set by the International Atomic Energy Agency. In particular, it should be ensured that comprehensive documentation and all safety related information together with analytical tools are made available not only at the time of the establishment of a nuclear facility but also with appropriate updates, throughout its operational life.

2. There should also be close collaboration between the regulatory bodies of the supplier and recipient countries.

3. The developing countries should be associated with the design, development and demonstration efforts on the new advanced type of reactors with enhanced safety features.

4. The countries of the Asia-Pacific region should establish a regional regime of close collaboration for exchange of information and cooperation in the field of nuclear power.

5. Joint concerted efforts should be made by the countries of the Asia-Pacific region to inform the planners and decision makers as well as the general public about the economic merit, safety and environmental compatibility of nuclear power in relation to other alternatives.

6. A suitable framework should be established within the Asia-Pacific region to facilitate the financing of nuclear power plant construction in developing countries of the region that are deficient in energy resources.

ACKNOWLEDGEMENT

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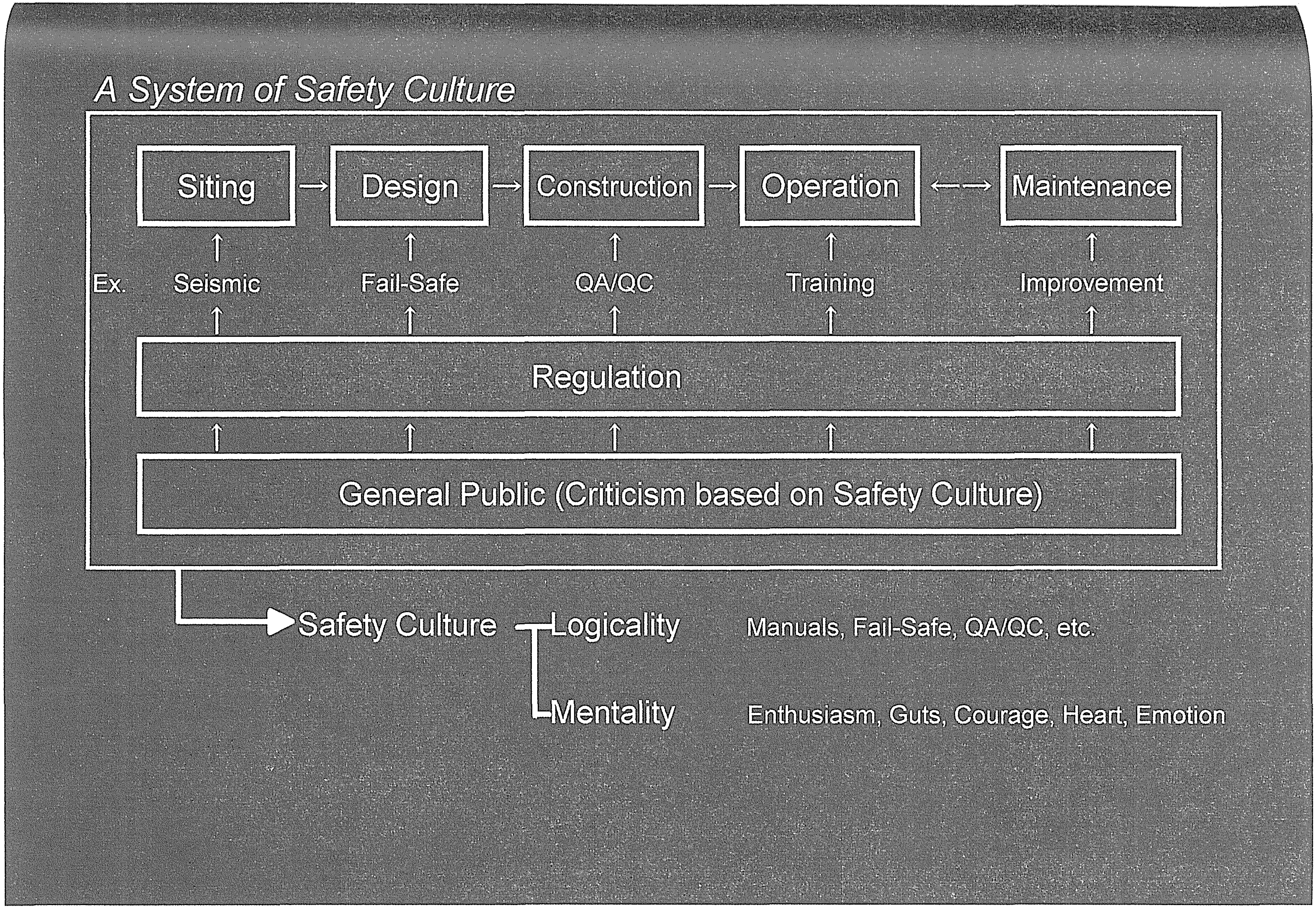
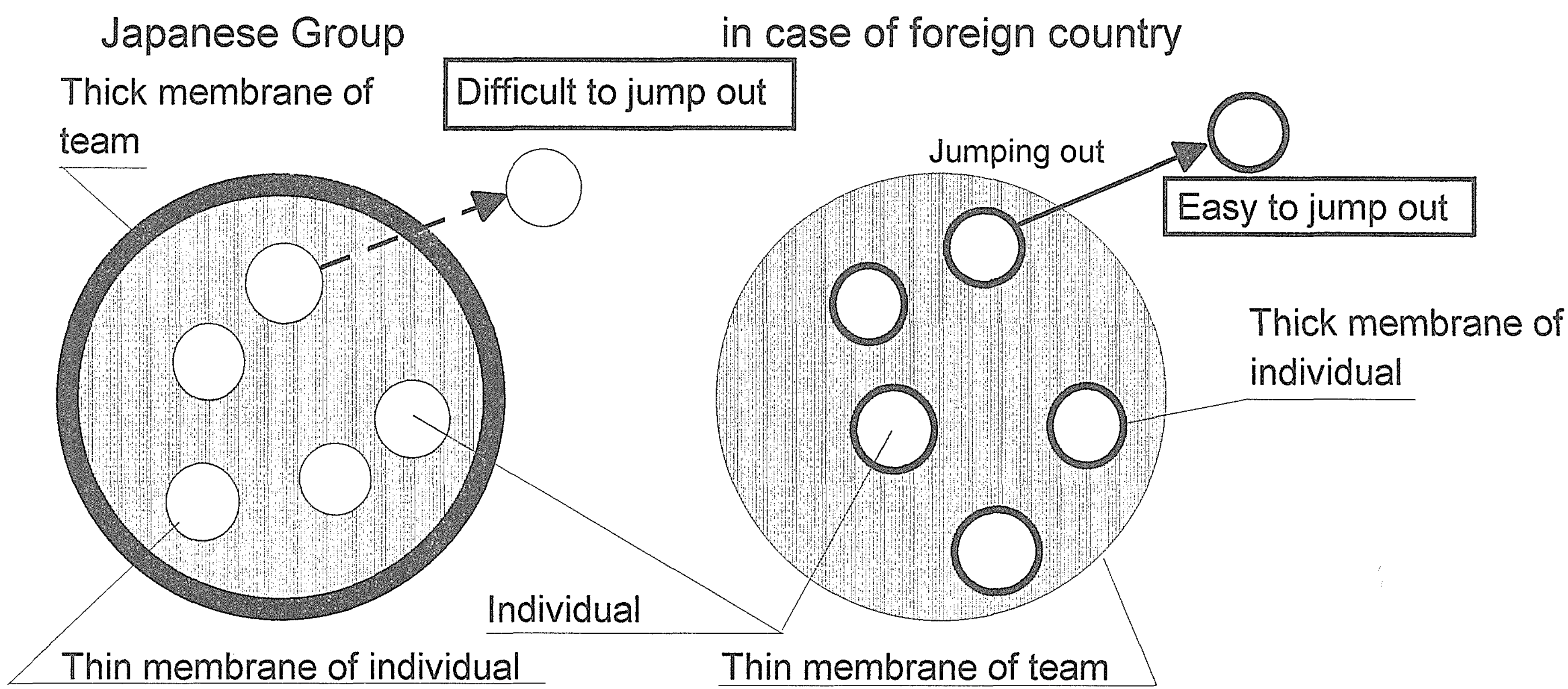

A System of Safety Culture
Siting
Design
Construction
Operation
Maintenance
Ex.
Seismic
Fail-Safe
QA/QC
Training
Improvement
Regulation
General Public (Criticism based on Safety Culture)
Safety Culture
Logicality
Manuals, Fail-Safe, QA/QC, etc.
Mentality
Enthusiasm, Guts, Courage, Heart, Emotion

Japanese Culture of Teamwork



平成７年４月１２日

「核燃料サイクル・バックエンド～日本の選択、その意義と計画～」

東京電力（株）　池　亀　　亮

１.はじめに

昨年6月、原子力委員会は、約1年10カ月を費やして検討した新しい「原子力開発利用長期計画」（原子力長計）を発表しました。また、ほぼ同時期に通産大臣の諮問機関である総合エネルギー調査会の原子力部会でも今後の原子力開発について、特に、エネルギー政策上の観点からの検討を行い、中間報告を発表しています。
この新原子力長計及び原子力部会報告に述べられている核燃料サイクル計画の骨子とその意義、また計画の背景にある基本的考え方についてご説明し、私なりの意見を申し上げてみたいと思います。

２．２１世紀に向けた原子力開発計画（新原子力長計）

(OHP 1)
今回原子力長計の見直しが行われた背景には、わが国の原子力開発をとりまく、近年の情勢の変化があります。具体的には、戦後続いていた冷戦構造の崩壊に伴う国際情勢の激変や流動化、地球環境問題に対しての意識の高まり、長期的な世界のエネルギー需要増大の見通し、核燃料サイクル事業を始めとするわが国の原子力開発利用の進展、核燃料サイクルの主要課題であるプルトニウム利用をめぐる国内外の関心の高まり、原子力施設の新規立地の停滞などが挙げられます。

これらの情勢変化を見極めつつ、原子力を構成する軽水炉関連技術、廃棄物

対策、プルトニウム利用等の各分野の計画に整合性をもたせながら、長期的視点にたった今後の開発のあり方について多面的な検討がなされました。
その結果、細部においては幾つかの調整はあったものの、プルトニウムの本格的な利用を目標とした原子力開発の基本路線が再確認され、従来から進めてきている核燃料サイクル諸施設を着実に推進していく方針が示されたことが、最も重要な点ではないかと思います。

そこで、新原子力長計の中から、核燃料サイクルに関連の深い、再処理、軽水炉でのプルトニウム利用、高速増殖炉開発、プルトニウム利用に係わる透明性の向上策についての具体的な計画を紹介したいと思います。

（OHP 2）
核燃料サイクルはいくつかの技術から構成される訳ですが、中でも、再処理はプルトニウム利用の要となる技術です。既に建設中の六カ所再処理工場については２０００年過ぎの操業開始を目指して建設を進めることとしています。しかしながら、従来、２０１０年頃の操業開始を目途に技術開発を推進することとしていた第二再処理工場の建設計画については、プルトニウムの需給動向、高速増殖炉実用化の見通し、高速増殖炉使用済み燃料再処理技術を含む今後の技術開発の進展等を総合的に勘案して、２０１０年頃に方針を決定することとしています。
この第二再処理工場の方針変更に関連して、発生する六カ所再処理工場の処理能力を上回る使用済み燃料については、第二再処理工場建設までの間、エネルギー資源の備蓄として、再処理されるまでの間、適切に貯蔵・管理することとなります。
なお、高レベル廃棄物の処分については、その実施主体を２０００年頃に設立することとし、高レベル事業推進準備会において、そのための諸準備を行うこととしています。処分場については、２０３０年代から遅くとも２０４０年代の半ば頃までの操業開始を目途とすることとしています。

この六カ所再処理工場や海外再処理からのプルトニウムは、高速増殖炉などの研究開発用に使用される他、MOX燃料に加工し、軽水炉にて利用する計画です。このプルサーマルの実施は、将来の高速増殖炉による本格的なプルトニウム利用に備え、再処理、MOX燃料加工技術などのプルトニウム利用に関連する広範な取り扱い技術の習得、体制等の基盤整備を進めていく上で欠かせないものであります。このため、六カ所再処理工場の操業開始を踏まえ、２０００年過ぎには、年間１００トン弱程度規模の国内MOX燃料加工の事業化を図ることとしております。
海外再処理からのプルトニウムを海外でMOX加工したものも含め、わが国では、１９９０年代後半からプルサーマルの実施を少数基で開始し、２０００年頃に１０基程度、２０００年から２０１０年までの間に１０数基程度の規模にまで拡大して行くこととしております。

高速増殖炉開発については、種々の不確定性のある中で、ウラン資源の動向、軽水炉と競合できる経済性の見通しなどを勘案し、２０３０年頃までにその技術体系を確立することを目標として進めることとしています。将来の実用炉を軽水炉と競合できるものとするためには、特に経済性の向上が必要です。経済性を向上させるには、機器・構造物の削減、簡素化、合体化が不可欠であり、これらを実現するため幾つかの革新技術の開発に取り組んでいくこととしています。しかしながら、これらの革新技術は現状技術との差が大きく、プラントの大出力化と同時に、すべてを一度に実プラントに適用することは、リスクが大きいと考えられます。このため、技術の進捗に合わせ、段階的に導入し、着実に運転経験を積み重ね、実用化につなげることが妥当とされました。

わが国は、原子力平和利用国家として、NPTの無期限延長を支持するとともに、核燃料サイクルの開発にあたっては、米・ロ両国の核兵器解体の流れの中で、核拡散への懸念が高まっている内外の情勢に的確に対応するため、余剰のプルトニウムは持たないとの原則を堅持することとしておりますが、以

上のプルトニウム利用計画を進めていくためには、わが国の政策について国内外からの理解を得ることが必要です。
この考えに基づき、核兵器を保有する意図があるとの疑念をもたれないよう、我が国のプルトニウム利用計画を積極的に明らかにし、計画の透明性をより一層向上させるため、２０１０年までの我が国のプルトニウム・バランスの試算が公表されています。
また、今後の核燃料サイクル事業の推進に当たっては核不拡散性への対応が重要であることから、核不拡散性に優れた核燃料サイクル技術についての研究を推進することとされ、今後、先進的リサイクル技術の研究に着手することとしています。

今後、この新原子力長計をガイドラインとして、原子力開発を着実に進めていくことが、２１世紀に世界のエネルギー需要が大幅に増大すると見通されている中にあって、極めて重要であると考えております。

３.エネルギー問題のゆくえ

以上、原子力長計と総合エネルギー調査会原子力部会報告の骨子を説明いたしましたが、ここで、その意義や、背景にある基本的考え方について私見を含めて述べたいと思います。

今ご説明いたしました、現在私どもが取り組んでいる課題は、２１世紀の人類のエネルギーをどうするかということと深く関連しております。
人類、とりわけ先進諸国は、ここ100年余りの間に、石炭、石油、天然ガスといった化石資源を利用することによって、著しい生活の向上を図ってきました。今日、私たちは、ギリシャ、ローマ時代以降産業革命が起こるまでのエネルギー消費に匹敵するエネルギーをわずか１年のうちに消費するといわれる社会に生きており、今後の人口増加等によりエネルギー需要はさらに増

大すると見込まれている状況にあります。

(OHP 3)

世界の人口は加速度的に増加の一途をたどり、１９６０年には約３０億人であったものが、現在では約５３億人であり、このまま推移すれば、２０２０年には約８１億人となり、２１世紀中葉には１００億人を越えるとも予想されているところです。

(OHP 4)

一方、一次エネルギーの年間需要量を見ますと、２０２０年の時点では現在に比べ石油換算で約４６億トン増加し、約１３４億トンに達すると見通されております。そして、この増加分の約８０％は発展途上国の需要の増加によるものです。

(OHP 5)

１９９０年における発展途上国での一人当たりのエネルギー使用量は、北米の１０％に過ぎません。それでも、発展途上国の人口は、２０２０年の世界の人口の８０％以上を占めているため、このようなエネルギー消費率のわずかな増加で発展途上国全体のエネルギー需要量が北米の３倍に大きく増加することが分かります。

(OHP 6)

今後の人口やエネルギー消費率の増加、発展途上国の飛躍的な成長等について、世界エネルギー会議が１９９３年に行った予測をもとに、21世紀中葉を展望すれば、石炭を除く、石油、天然ガスといった化石燃料資源がかなり逼迫してくることが危惧されます。

このため、我々は21世紀のエネルギー資源に関して、考えられるあらゆる可能性に前向きに取り組んで行かねばならないと考えます。原子力エネルギー、太陽エネルギー等全てのものについて、量や質の問題、利用形態の問題を考慮しつつ、それぞれの特徴を活かす形で技術開発を進めていく必要があります。

４.計算できる原子力エネルギーの未来

原子力エネルギーについては、1994年12月末現在で、全世界で425基、約3億5600万kWに相当する原子力発電所が運転中であり、1993年には、世界全体で中東諸国における1992年の石油生産量の半分以上にも相当する約4億7000万㌧の石油を節減したことになります。

わが国では、昨年、新たに３基の原子力発電所が運転を開始し、併せて４９基が運転中であります。原子力エネルギーは、１９９３年では、わが国の全発電電力量の３０．９％を占めております。
(OHP 7)
一方、昨年改定された電事審需給部会報告の中の長期需給見通しによると、２０１０年では、電力供給の約４２％を原子力発電が賄う計画になっております。原子力発電所について、今なかなか新しい立地点が見つからないという事情がある中でこれほど大きな期待がかけられているのは、２０００年以降における国民一人あたりのCO2排出量を１９９０年並に抑制しようとする政策目標があるからです。つまり、増加するエネルギー需要を満たしながら、CO2排出量を抑えて地球温暖化を防止するための唯一の実際的手段として、原子力エネルギーの果たす役割が明確に認識されたと考えております。

化石燃料に対する代替エネルギーの極めて不透明な中で、量としてのポテンシャル、環境との調和などを考えても原子力エネルギーが21世紀のエネルギーの重要なオプションであることは疑う余地がないと考えられます。

５．21世紀のエネルギーの確保に向けて（再処理・リサイクル路線の意義）

しかしながら、原子力エネルギーも天然ウランの中に0.7％しか存在しないウラン235に頼っている限り、その寿命は化石燃料と大差はありません。

(OHP 8)
軽水炉ではこのウラン235の割合を3%位にまで高めた燃料を使っていますが、この燃料を使い終わった時点で、燃料には燃え残ったウラン235と、燃えないウラン238がプルトニウムに変わったものと合わせて、2%弱の核分裂性物質が残っています。

(OHP 9)
これを再処理によって回収し有効利用するならば、我々は、使い残しているウラン235を再利用するだけでなく、直接には核分裂しにくいウラン238をもプルトニウムという形態にして、利用することになります。
軽水炉でなく高速増殖炉であれば、ウラン238をもっと効率よくプルトニウムに転換できます。高速増殖炉が実用化されれば、全ウラン資源の60%をエネルギー源として利用することができると期待されています。

(OHP 10)
このような再処理という方法によって、プルトニウムを利用していくかどうかが今後の原子力エネルギー開発利用のあり方の大きな別れ道になっています。再処理しなければ、いずれは使用済燃料をそのまま、たとえば、地層の中に処分してしまう路線をとることになります。確かに、これも技術的には可能であり、そのような選択をしようとしている国もあります。
しかし、再処理によってプルトニウムなど環境に有害な核種を回収し、廃棄物を環境になじみやすい形に加工するならば、はるかにその方が、望ましい処分方法だと言えると思います。

6.再処理・リサイクル路線の高度化を目指して

今、説明しましたように、再処理・リサイクル路線は、そもそも、将来の長期的なエネルギーの確保、廃棄物の環境との調和といった課題への取組みを内包したものであります。これを、化石燃料の消費と同列にあるとも言える使用済燃料の直接処分、いわゆるワンス・スルー路線と単純に比較するべき

ものではないにも拘わらず、ワンス・スルー路線と比べて、経済性や安全性を問題視する議論が多くなっております。

(OHP 11)

ワンス・スルーと比較した再処理・リサイクルの経済性については、国際的にも種々の議論が展開されていることはご存じの通りであります。例えば、図に見られるように、OECD-NEAの検討では両者に大差はないとしています。こうしたコスト計算にはいくつかの前提がつきものですが、さらにリサイクル路線かワンス・スルー路線かという選択に当たっては、資源の状況、政治、文化的背景等、各国それぞれ事情が異なることから、一律に論ずることはできません。特に、両者の比較を行うに当たっては、それぞれの技術の今後の発展性を考慮に入れることが大切です。

(OHP 12)

再処理路線については、今後さらなる技術革新や技術の改良・改善が期待でき、それにより、経済性のより一層の向上が可能と考えられます。

昨年とりまとめられた新原子力長計、総合エネルギー調査会原子力部会報告の中でも、リサイクル技術については、今後、経済性の向上を目指して多様な取り組みをする必要があることが述べられています。我々はプルトニウム利用の緒についたところでありますが、プルトニウムの利用にかかる、考えられる幾つかの利用体系の中から、未来の夢を託すに足る具体的な技術像を常に描きながら進んで行くことが必要であると思っている訳です。

将来、プルトニウム利用が本格化する時期までには、まさに、先に述べた経済性、安全性の懸念を払拭するような技術の確立を図っておく必要があります。プルトニウム利用の経済性向上のためには、プルトニウムを利用する原子炉とプルトニウムを使用済み燃料から分離し、新しい燃料を生成する再処理・燃料成型加工、いわゆる燃料サイクル全体をトータルシステムとして捉え、検討していくことが重要です。ご存知の通り、高速増殖炉の燃料としてプルトニウムを使う場合には、連鎖反応は高速中性子で維持され、燃料中の不純物はあまり問題になりません。このため、燃料として使用するプルトニ

ウムの純度を高める必要はなく、再処理・燃料成型加工工程が簡略化できる可能性があることから、結果として、燃料サイクルコストの大幅な低減が期待できます。また、かっては困難だった技術も将来は容易になることだってあるでしょう。今の軽水炉でもそうであったし、他の技術についても言えることですが、ある技術の経済性というものは、それを利用しながら改良・改善に向けての不断の努力を積み重ねることによって、向上してくるものなのです。

(OHP 13)
次にプルトニウムの安全性、とりわけ核拡散の問題について考えてみたいと思います。そもそも、発電用原子炉から出る使用済燃料中のプルトニウム,いわゆる原子炉級のプルトニウムで有効な核兵器が作れるかどうかについても議論のあるところですが、少なくとも原子炉級プルトニウムで核兵器を作っている国がないことは事実です。
にもかかわらず、民生用プルトニウムの取扱いについては、用心深く十分な保障措置を講ずべきだと考えられており、事実、例えば、動燃の再処理工場では、IAEAの査察員が１日平均４～５人の割で厳重な査察を続けております。
核保有国以外で唯一プルトニウム利用を進める日本としては、このような厳重な保障措置を講ずることに止まらず、進んでプルトニウム利用の政策，計画，プルトニウム在庫量について公開し、全体像の透明性を高める対応も重要であります。
現在核保有５ヶ国に、ドイツ，スイス，ベルギー，日本を加えた９ヶ国が民生用及び解体核兵器からのプルトニウムに関して透明性向上策を検討中でありますが、これは透明性に関する国際的な協調への努力として評価されるものであります。
さらに言えば、プルトニウムを平和的目的に利用するか、軍事目的に利用するかは最終的には当事国の意図の問題に他ならず、従ってＮＰＴ体制を含む国際的な平和維持の枠組みの強化が何よりも必要であります。

勿論、技術的観点からは、核拡散抵抗性の高い再処理技術の開発は重要であります。特に高速炉燃料の再処理では不純物の除去性能（ＤＦ）を上げる必要がないので、現行Purex法に比してはるかに核拡散抵抗性の高い技術体系が構築できることに注目する必要があります。

(OHP 14)

そもそもプルトニウムは、原子炉を運転すれば発生するものであって、これを核分裂などによって消滅させない限り、存在し続けます。ワンス・スルー路線をとって使用済燃料を地中に埋めたとしても、現在の技術で何時でも取り出しプルトニウムを分離することができます。つまりこれはプルトニウムの鉱山に他ならないわけです。しかも、放射能レベルは年とともに低下しますから、年とともに掘り出しやすくなる鉱山です。核拡散の懸念は決して解消されず、年とともに増大して行きます。リサイクル路線をとり、プルトニウムを積極的に燃焼し、消滅させることが核不拡散をより確実にする実際的な方法であると言うことができます。

(OHP 15)

最後に再処理に関連する環境問題に触れてみたいと思います。

図は、出力100万kWの石炭火力，石油火力および原子力発電所を１年間運転した場合の廃棄物量を比較したもので、原子力発電所の廃棄物は、原子力発電所及び再処理工場で発生する廃棄物を含んだものです。これから明らかなように、原子力発電による廃棄物の発生量は他のシステムに比して、圧倒的に少ないことがわかります。

(OHP 16)

次の図はフランスのコジェマ社の試算によるものですが、使用済燃料を再処理した場合の廃棄物量を、直接処分した場合と比較して示してあります。すでに現状でも、再処理による廃棄物量は直接処分した場合よりも少なくなっております。さらに、将来は、再処理の方が直接処分よりもはるかに少なくなる見通しも示されております。

(OHP 17)

ワンス・スルー路線をとって使用済燃料に含まれる全プルトニウムを直接処

分する場合、再処理した場合の100倍以上のプルトニウムが最終的に環境への負荷となります。

(OHP 18)

以上の考察から、再処理・リサイクル路線によるプルトニウムの利用は、直接処分ワンス・スルー路線と比較して、エネルギー利用，核不拡散，環境負荷の低減の全ての面から見ても好ましい方法であり、経済性についても短期的に見ても大差なく、将来ははるかに有利になる可能性を秘めていると言えましょう。

エネルギー資源を持たない日本にとって、21世紀に向かって長期的観点からエネルギー問題の解決に取り組む必要があり、このために核不拡散に最大限留意しつつ再処理・リサイク路線を選択する。これが、今回の新原子力長計のメッセージであります。

7.おわりに

東京電力が最初の軽水炉の運転を開始したのは、いまから約４半世紀前の１９７１年であります。その後、種々の改良、改善を加え、BWRの集大成とも言えるABWRが来年の運転開始を目指しているところです。この軽水炉技術の開発に携わってきて、一つの炉型をものにするにも長い期間が必要であることを身を持って体験してきました。将来のエネルギー源の確保の問題も遠くに見えて実は現在の課題であるということだと思います。

将来のエネルギー源確保への取り組みとして、我が国の原子力開発利用計画を円滑に推進していくためには、新原子力長計にも唱われているように、広く国際社会の理解を得ることが必要です。

そのためには政策の一貫性が重要なことは言うまでもありませんが、計画が硬直化しないよう、社会情勢や経済情勢などの変化に柔軟に対応していくことも重要であると考えます。

最近、核燃料リサイクルに関する国際円卓会議に参加する機会があり、各国

の方々のご意見を聞きながらエネルギー問題、特に環太平洋・アジア地域でのエネルギー問題の重要性を痛感した次第です。

原子力エネルギーを核燃料サイクルの輪を閉じた形で使用することができるようになると、エネルギー源は主として技術力から得られることになります。従って、世界の中で資源を持てる国と持たざる国との間の差が縮小し、エネルギー資源をめぐる国際間の紛争の種を減少することに寄与してゆくものと考えられます。

このことから、我が国の再処理・リサイクル路線の確立に向けてのこのような地道な努力は、21世紀における世界のエネルギー問題の解決に必ずや貢献し、ひいては世界の平和と安定のために寄与するものと確信するものであります。

以　上

(OHP 1)

Background behind The Long-Term Program revision

- Drastic change of the international situation as a result of collapse of the Cold War structure

- Increase of awareness of global environmental problems

- Growing global demand for energy

- Progress of nuclear fuel cycle programs in Rokkasho-mura ,etc.

- Increase of interest at home and abroad in use of plutonium

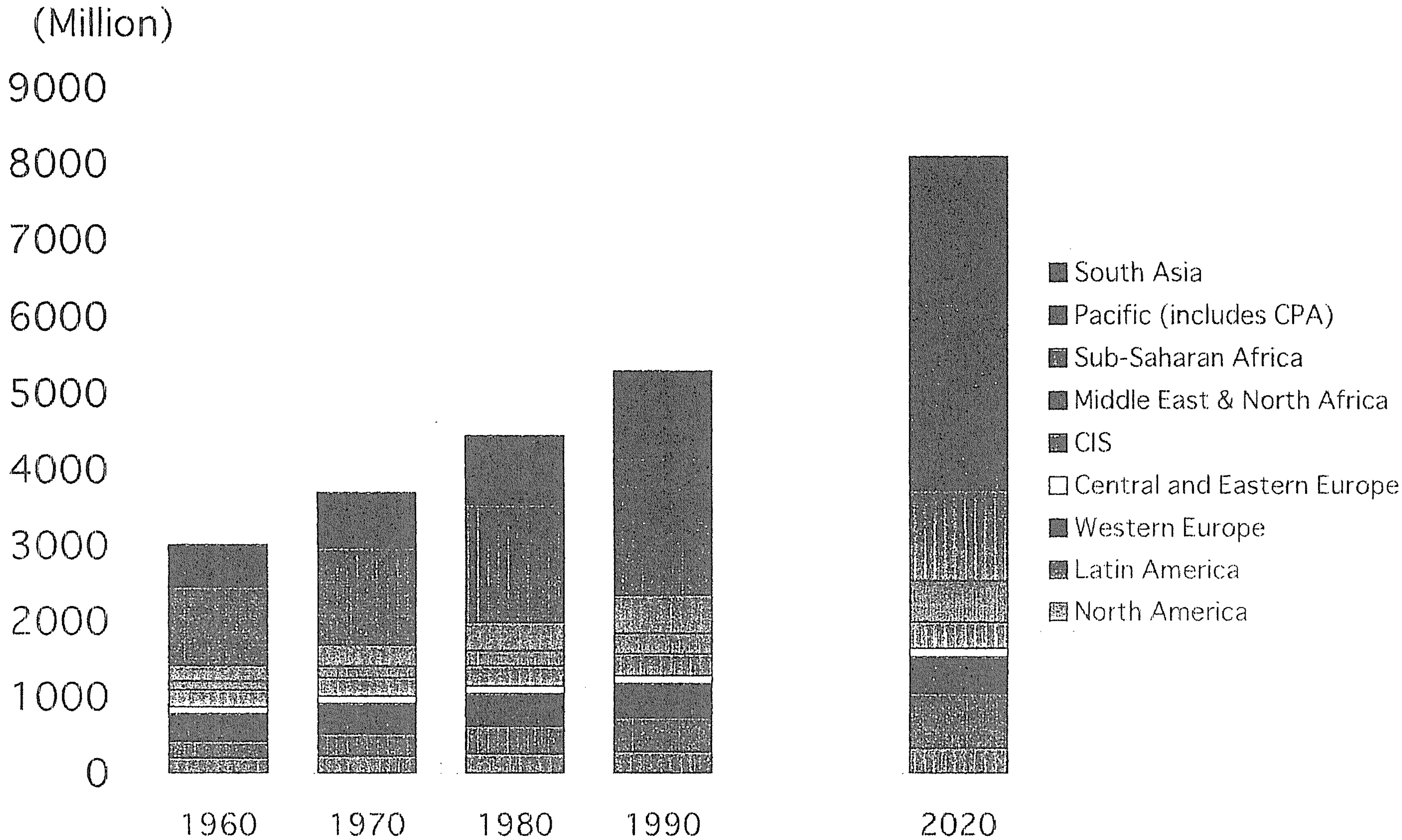
- Difficulty of new siting for nuclear facilities

(OHP 2)

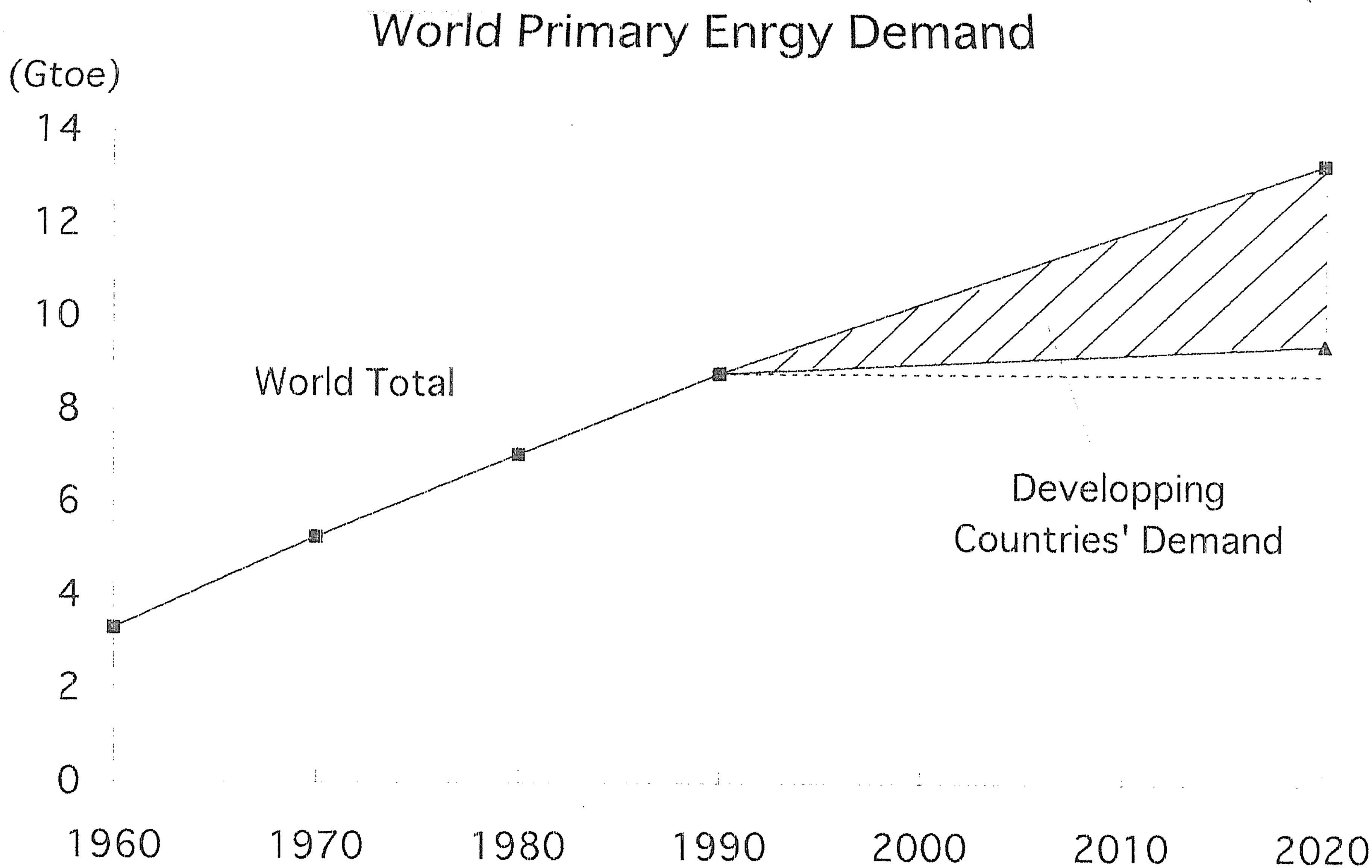
Summary of program for major Pu-recycle related projects

Project	New Long-Term Program (1994)	Previous Long-Term Program (1987)
-Rokkasho reprocessing plant -Second commercial reprocessing plant	-to start operation sometime after 2000 -construction plan is to be decided at around 2010	-to start operation in the middle of 1990's -to start operation at around 2010
-Pu thermal (Pu-utilization in LWRs)	-to start Pu-thermal with a few PWRs & BWRs in the second half of 1990's -to increase the number of Pu-thermal plants to about 10 at around 2000 and to ten several by 2010	-to start Pu-thermal with a PWR and a BWR in the first half of 1990's -to increase the number of Pu-thermal plants to about ten in the second half of 1990's
-FBR prototype reactor(Monju) -Demonstration reactor(FDR)	-to start full power operation in 1995 -two FDRs are to be constructed -construction for the first FDR is to start shortly after 2000	-to achieve criticality in 1992 -more than one FDRs is to be constructed -construction for the first FDR is to start in the second half of 1990's
-Advanced recycle technology	-to promote systematic R&D	-no description

World Population



("Energy for Tomorrow's World" WEC, 1993)

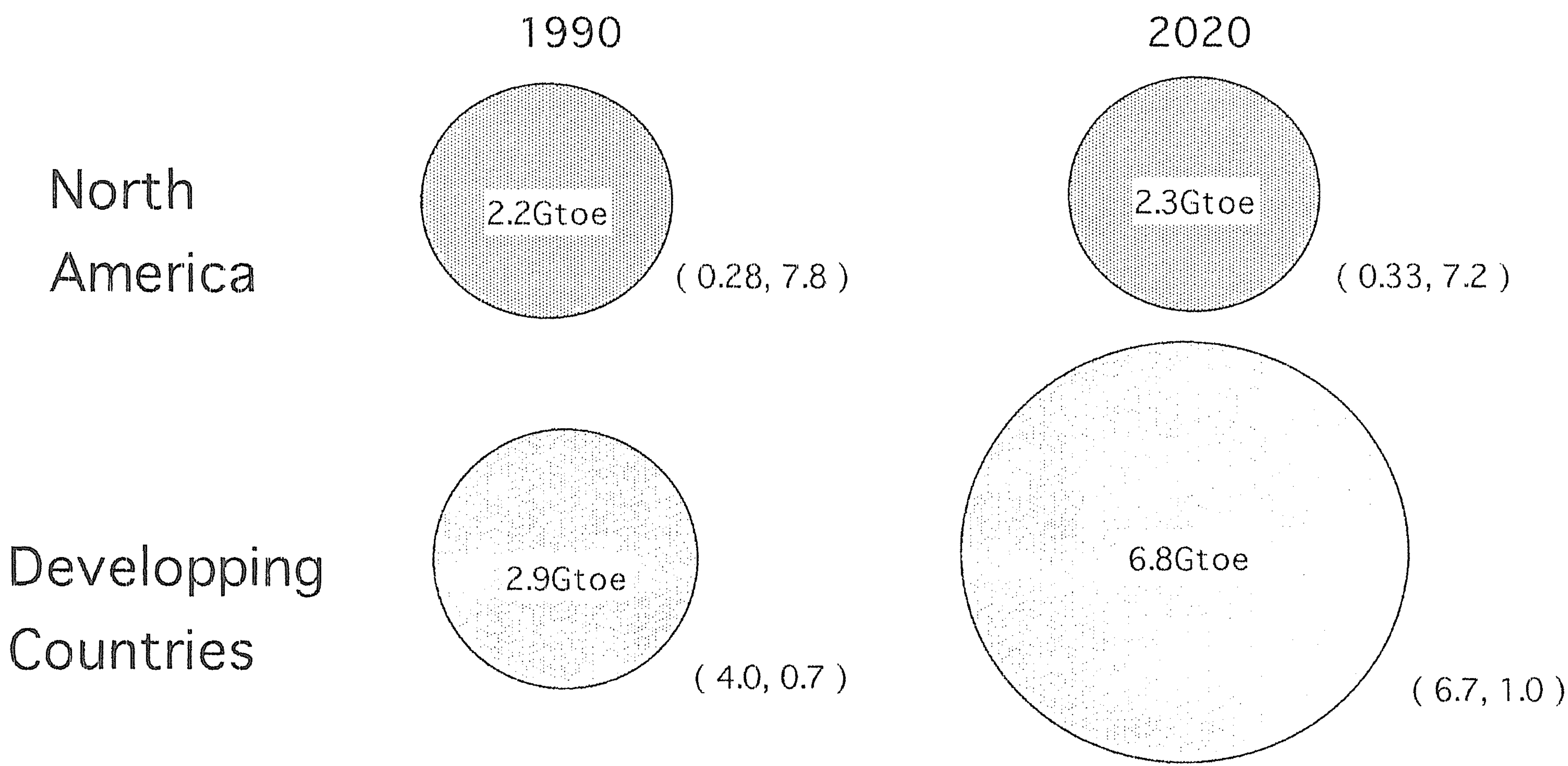


("Energy for Tomorrow's World" WEC,1993)

(OHP 5)

Energy demand in 1990 & 2020

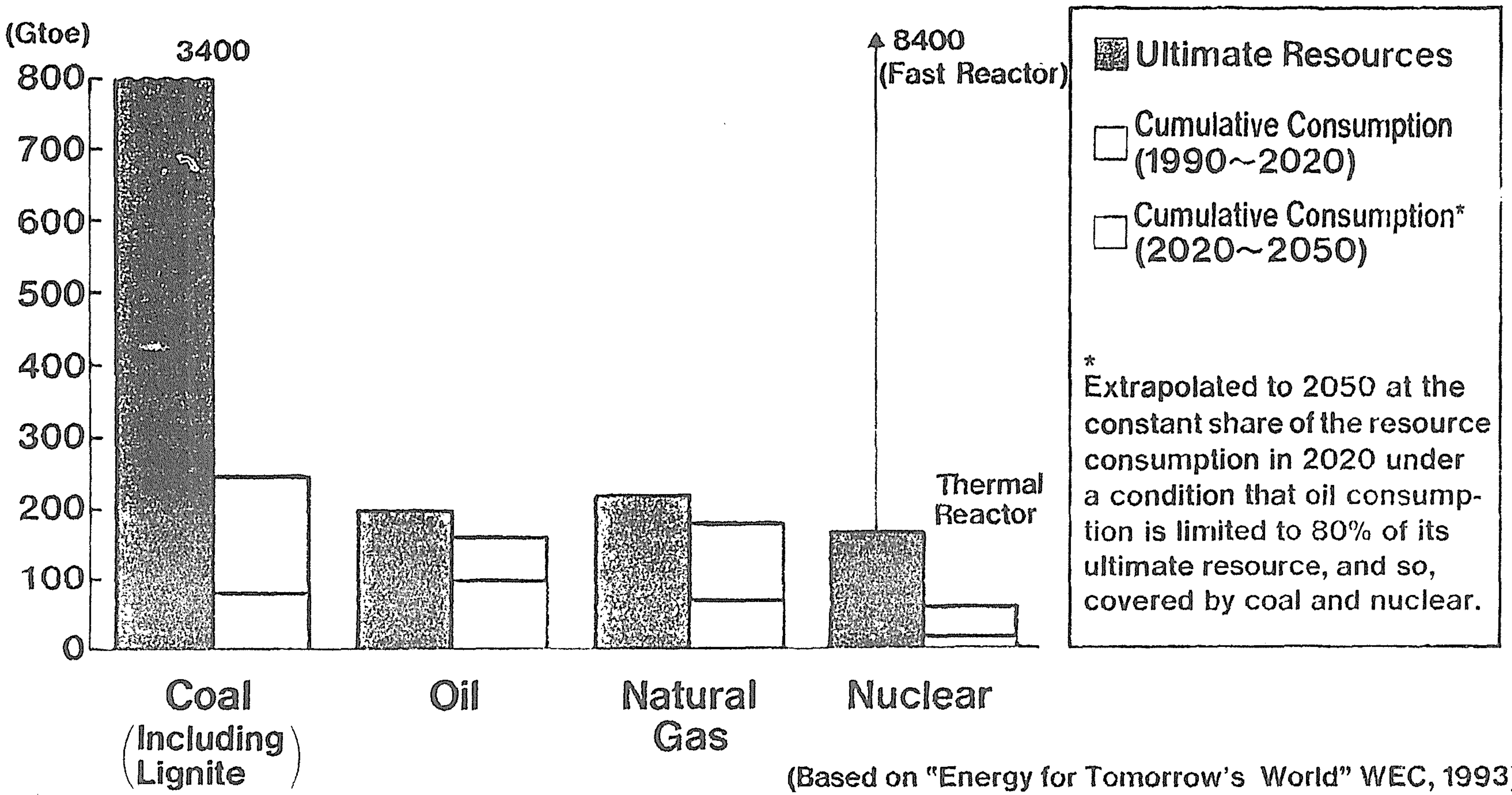
(Population (Billions), Energy consumuption per Capita (toe))



("Energy for Tomorrow's" WEC. 1993)

Ultimate Resources and Cumulative Consumption to 2050

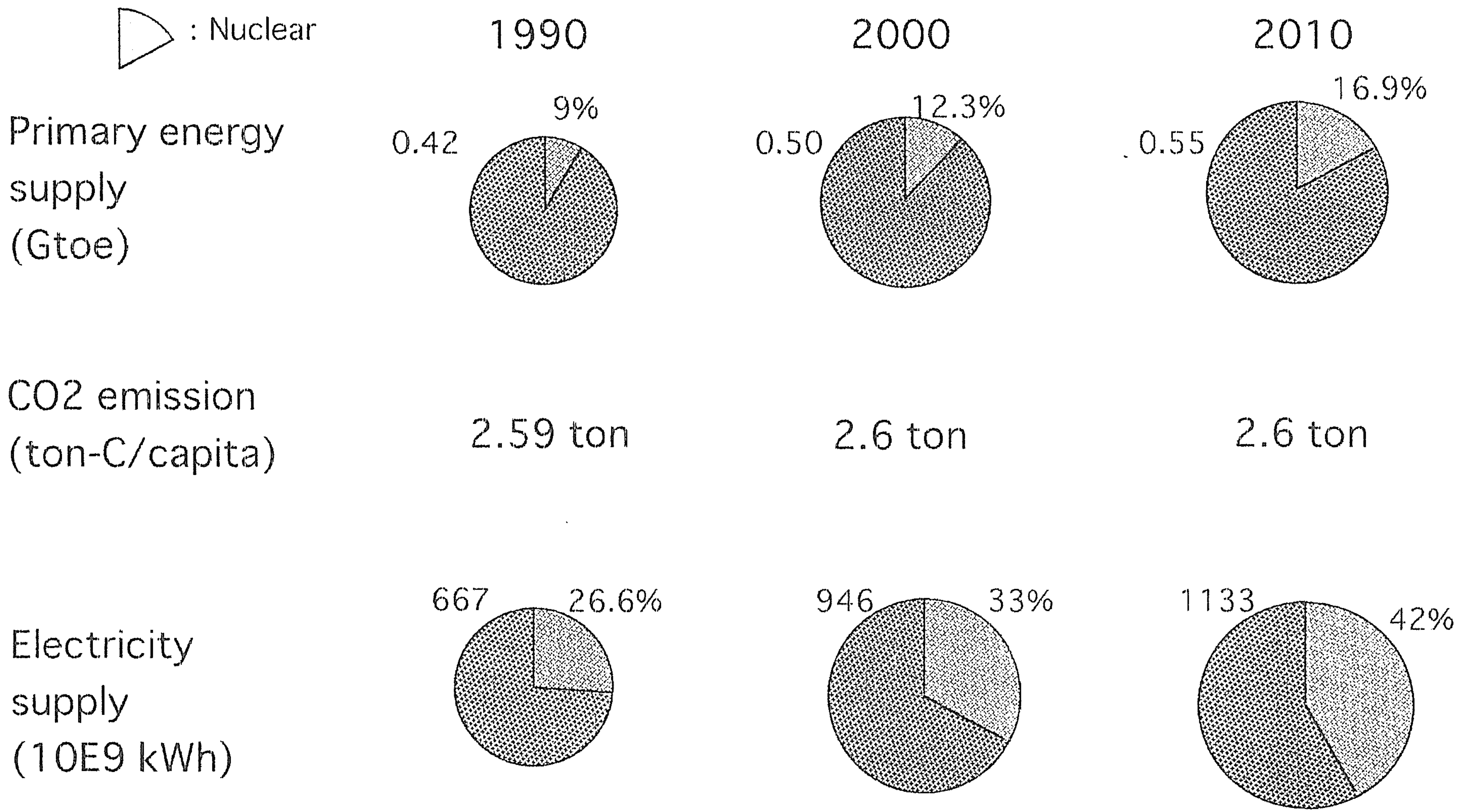
(Based on Reference Case of WEC)



(Based on "Energy for Tomorrow's World" WEC, 1993)

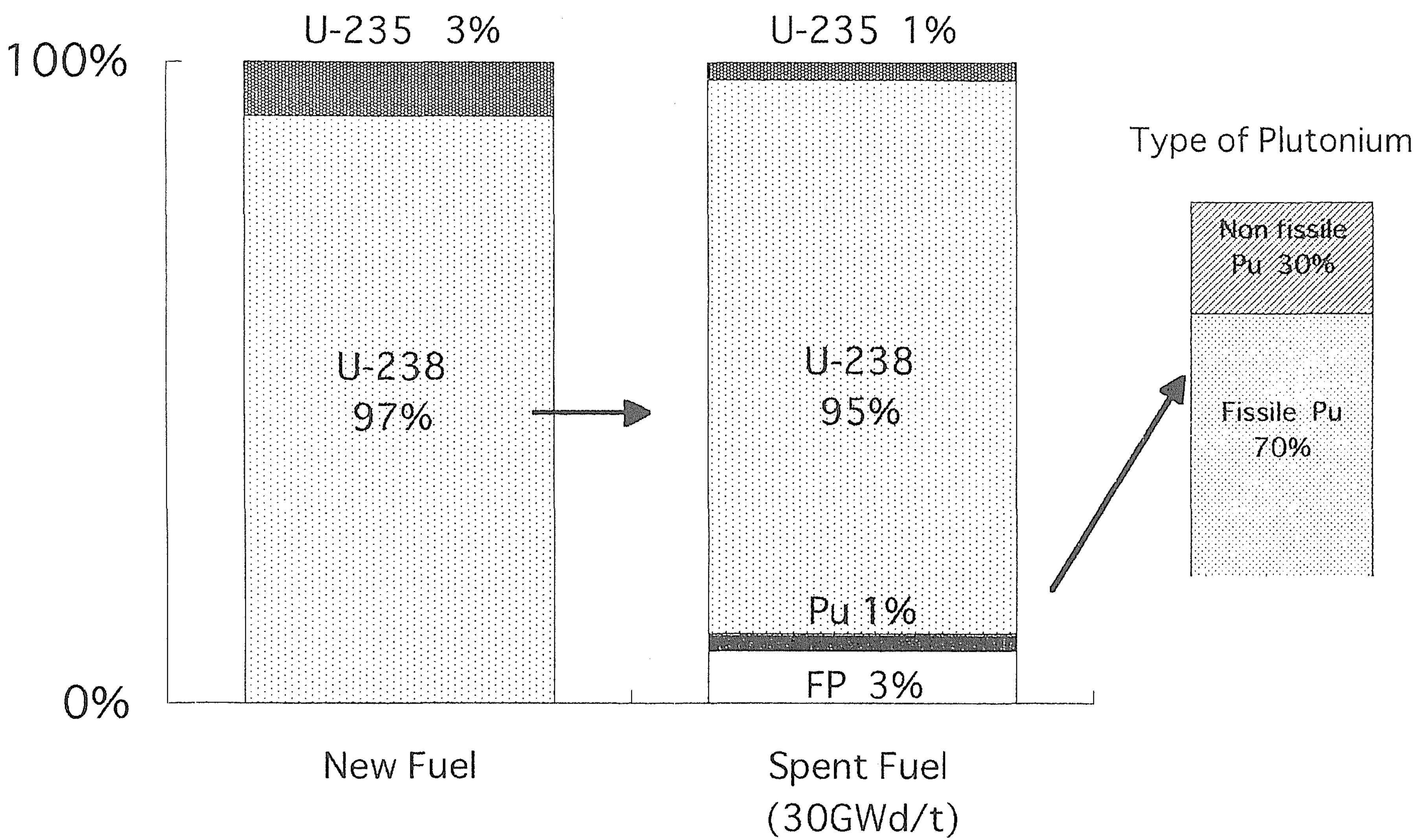
(OHP 7)

Primary energy demand ,electricity supply , CO2 emission in 1990, 2000 and 2010 (Japan)

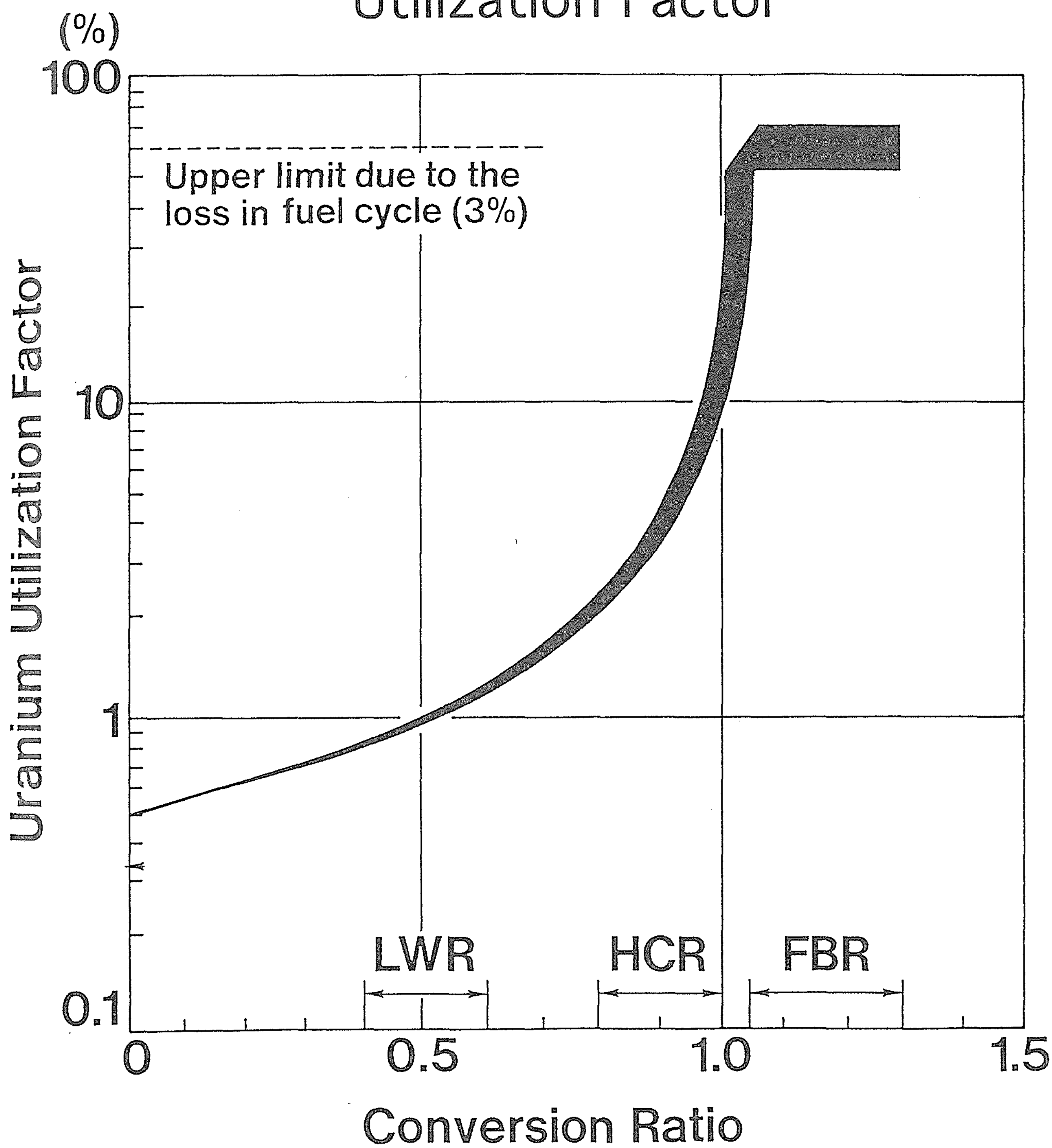


(Source MITI report)

Plutonium Generated in LWR



Conversion Ratio and Uranium Utilization Factor



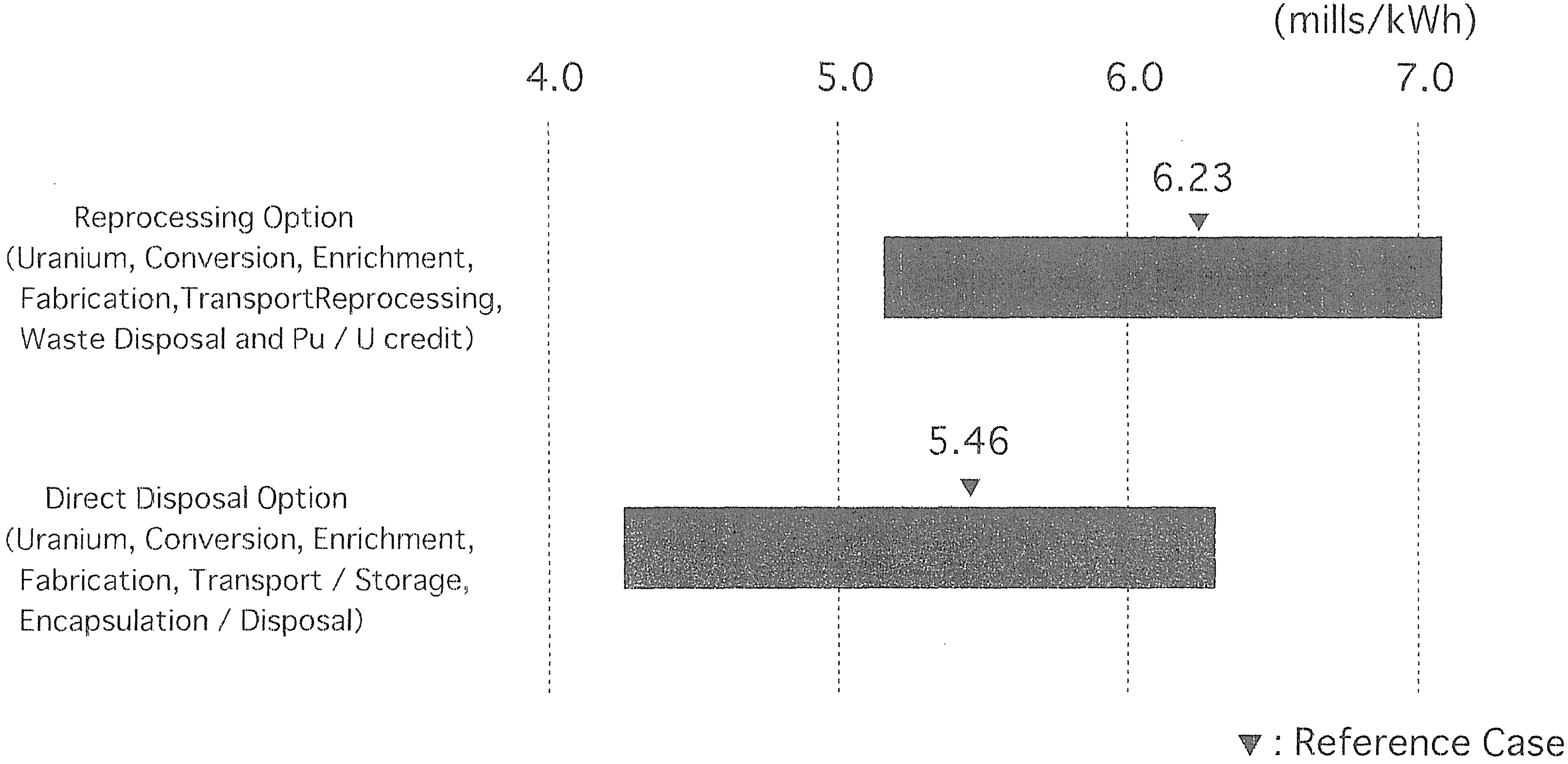
Back-End Policy (As of 1993)

Nation	Interim Storage	Direct Disposal	Repro-cessing	Pu Use in LWR
Argentina	○		○	
Belgium			○	○
Brazil	○			
Bulgaria	○		△	
Canada		○		
China			○	
Czech/ Slovakia	○		△	
Finland	○	○		
France			○	○
Germany	○	(○)	○	○
Hungary	○		△	
India			○	
Japan			○	○
South Korea	○			
Mexico	○			
Netherlands			○	
Pakistan	○			
South Africa	○			
Spain	○		○	
Sweden		○		
Switzerland			○	○
Ex USSR			○	
Great Britain	(○)		○	
U.S.		○		
Ex Yugoslavia	○			

Original Source : "Nuclear Power, Nuclear Fuel Cycle and Waste Management: Status and Trends 1990" IAEA,1990

Estimate of Fuel Cycle Cost for Reprocessing and Direct Disposal Option by OECD / NEA

(OHP 11)



(Source: The Economics of the Nuclear Fuel Cycle, OECD/NEA, 1994)

Cost reduction of Recycle Option in the future

- Achieved by continuous technological improvement

- Expected by optimizing whole fuel cycle system with inovative technology

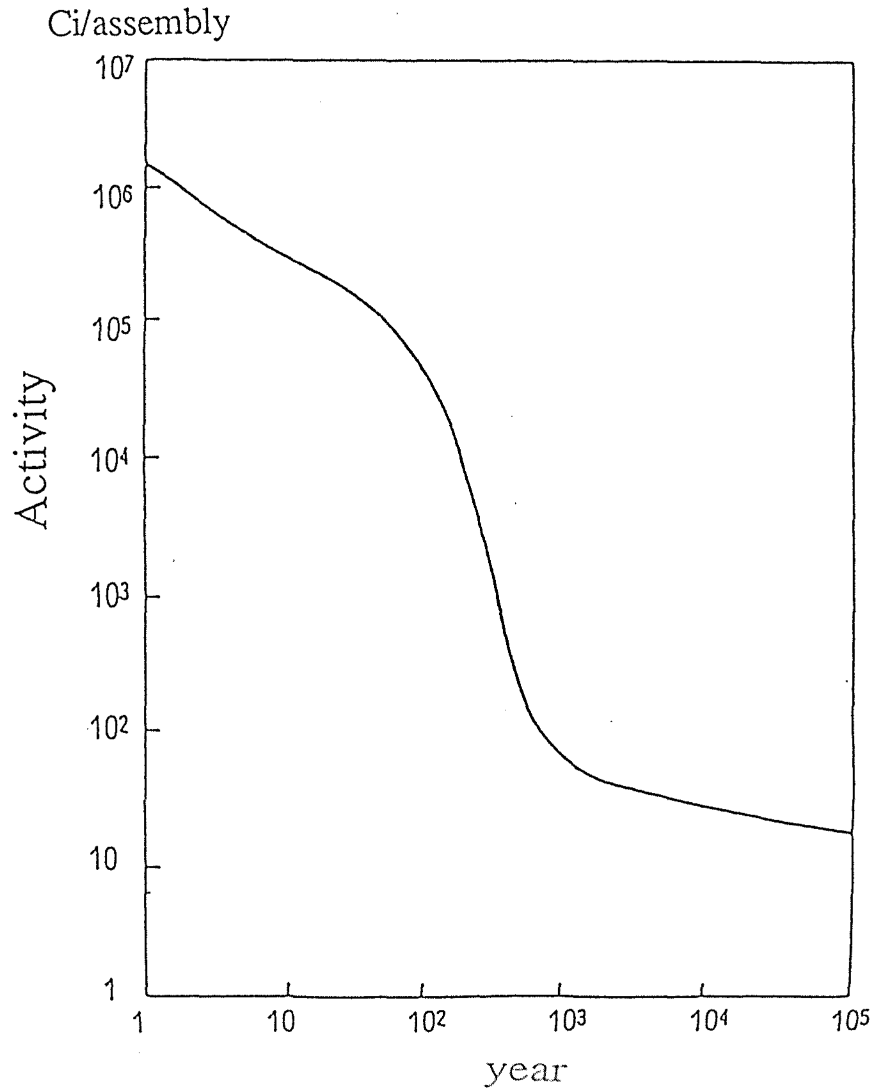
Nonproliferation aspect of Recycle Option

- Principle
  - IAEA Safeguards
  - Transparency of Pu utilization program
  - International regime
  - Proliferation-resistant technology

(OHP 14)

FP decay of discharged LWR spent fuel

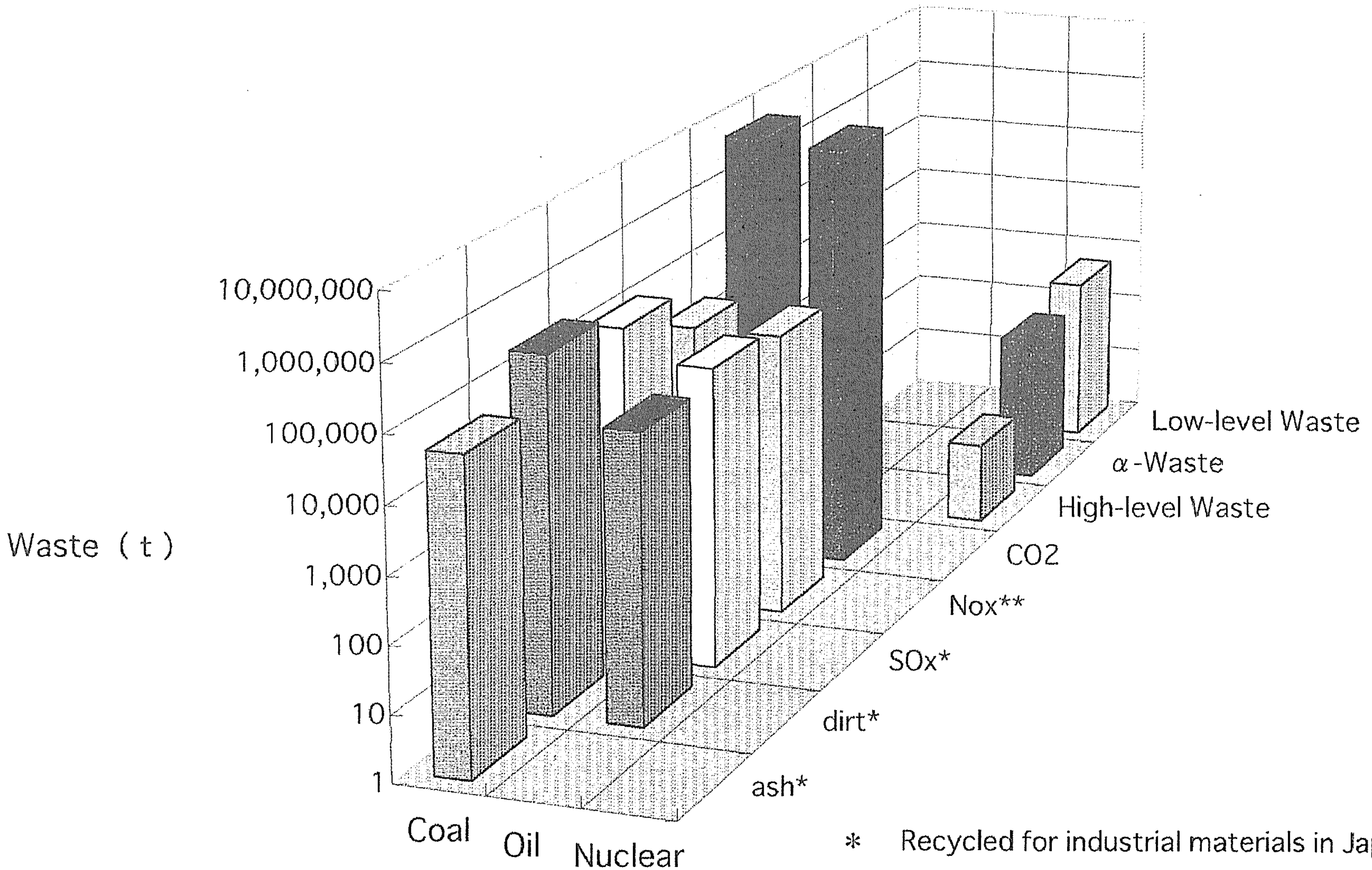
(burnup : 28,000MWD/t)



(OHP 15)

Waste production from 1GW power plant

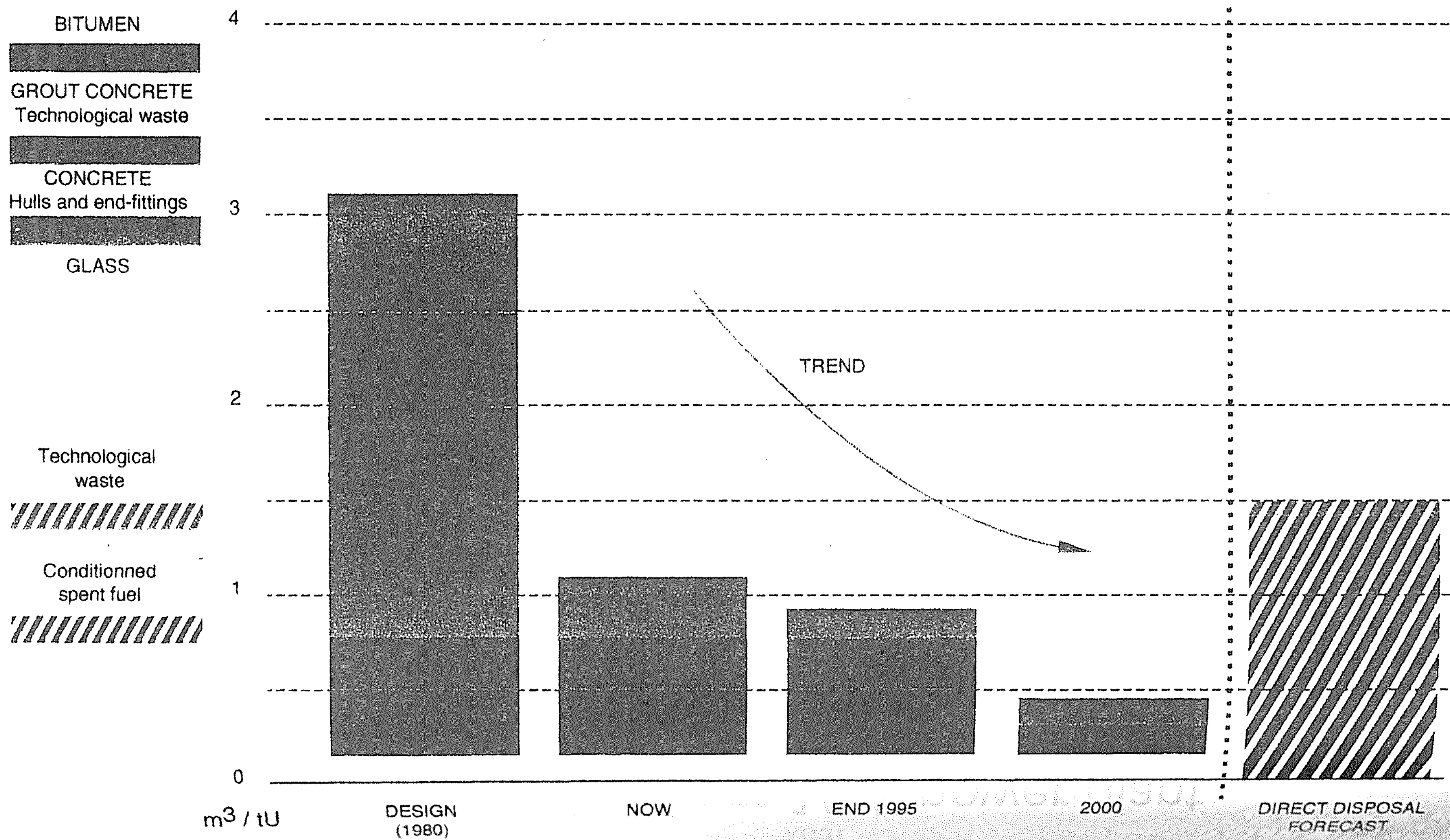
(/year ; Capacity factor 75%)

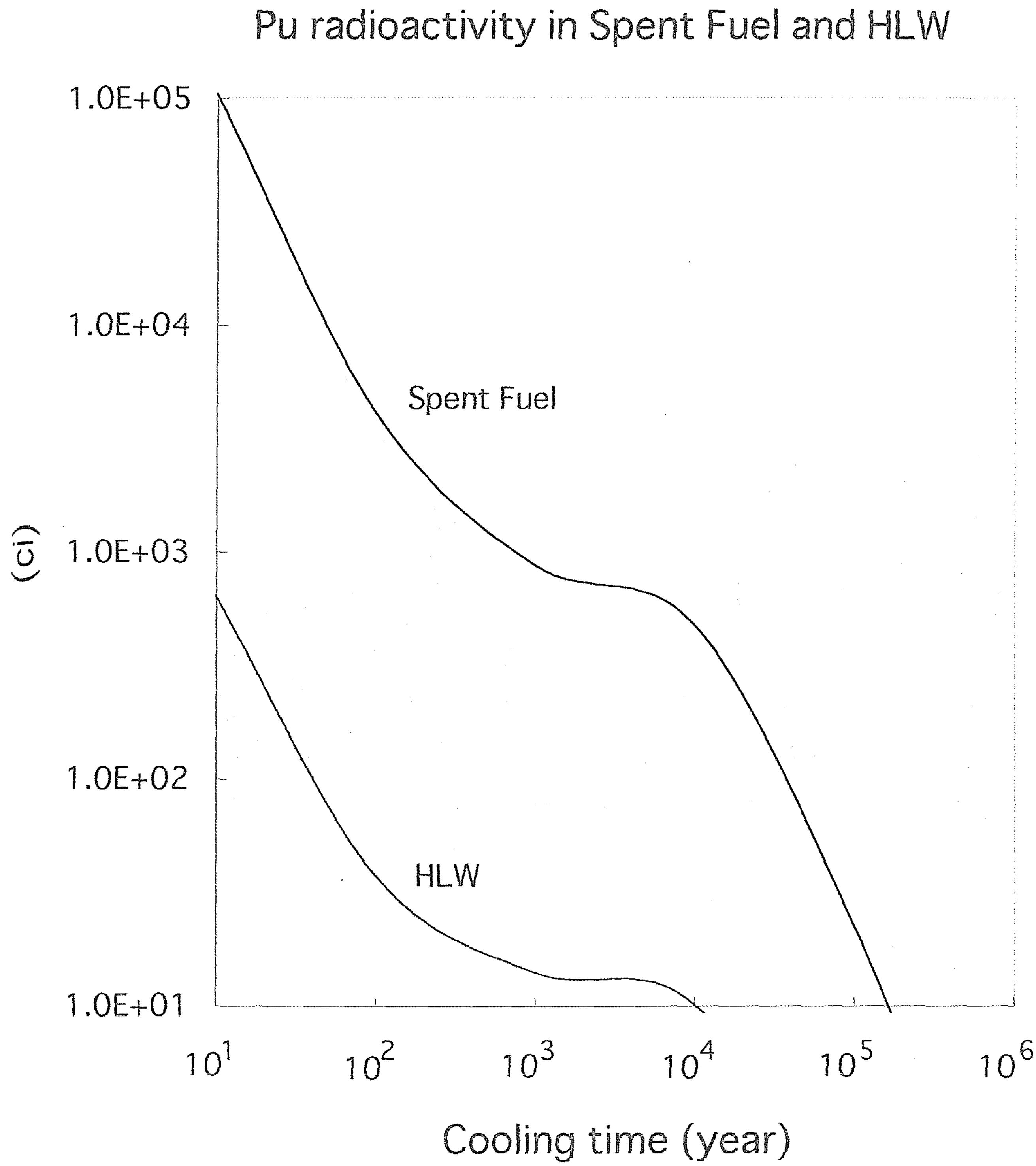


* Recycled for industrial materials in Japan

** Converted to N2 then discharged in Japan

VOLUMES OF FINAL RESIDUES GENERATED IN UP3 (m^3/tU) (LONG LIVED WASTE AFTER CONDITIONING)





note:
-Per 1t-HM Spent Fuel (Burnup 45,000MWd/t)
-HLW produced by 1t-HM Spent Fuel (Purex technology)

Summary of Recycle Option

- Advantages

  -Energy source for 21 st century

  -Nonproliferation preparedness

  -Environmental friendliness

- Cost perspective

  -Current Equivalent to direct disposal (OECD / NEA)

  -Future Much more improved by technical improvement and inovation

THE FRENCH EXPERIENCE IN THE BACK-END OF THE FUEL CYCLE

J.P. ROUGEAU
Chairman, French Nuclear Society
Senior Vice President, COGEMA

Introduction

Nuclear power, one of the greatest human adventures of this century offers some of the most exciting challenges to our imagination, competence and responsibility.

- First, the vastness and variety of branches and competences required to face the complexity of the activity : nuclear physics, chemistry, thermohydraulics, mechanics, material sciences, chemical engineering, health physics, data processing, modelling, quality control, environmental sciences, communication, sociology, philosophy, politics, strategy, diplomacy, to name only a few...

- Second, the absolute necessity of globalization, in order to embrace and manage properly the whole system in charge of producing nuclear electricity : nuclear reactors, the whole fuel cycle, the waste disposition.

- Third, the unprecedented requirement to address an uncommon time scale ranging from the nanoseconds of a nuclear fission process to the hundreds thousand years of long-lived elements management.

Today I will present a few remarks regarding a key part of the whole system : namely the back-end of the fuel cycle in its relation both with the reactor and the waste disposition.
The French experience in this sector has some value for all the countries engaged in an ongoing development of nuclear power, as spent fuel and waste management appear more and more as a focal point to overlook the global questions. I intend in particular to illustrate the "timing" issue.

1 – The back-end of the fuel cycle in France

Reprocessing of spent fuel, Conditioning of waste, Recycling of uranium and plutonium or as the French name it : RCR, represents an overall industrial policy for "closing" or completing the nuclear fuel cycle. Such policy requires a broad scientific knowledge and a large technological deployment.

a) In France since the 60's reprocessing activities have been developed, improved and optimized, and result today in the twin COGEMA–La Hague facility, now operating smoothly and ensuring, with a capacity of 1,600 tons of HM in spent fuel per year, the service of some 80 LWR reactors, both from the French utility EDF and European and Japanese utilities. Continuous R & D and return of operational experience have been combined to obtain an excellent capability with better than designed results in terms of quality of products, health physics, effluents and waste management.

b) Part of the La Hague facility is devoted to conditioning waste into residues, meeting strict safety specifications for their return to the bodies responsible of their further storage and disposal, either in France or abroad. Vitrification of high level waste is the most important conditioning process as 99 % of the activity of reprocessing waste is included in glass, the only internationally recognized medium for safe long–term immobilization.

c) Uranium recycling, through conversion to UF6, reenrichment and fabrication of new fuel, has been demonstrated since several years and represents an available fuel inventory for the utilities, that they will use whenever they decide so.

d) Plutonium recycling in LWRs with MOX fuel, (and later in fast reactors), is also a mature technology, both as regards fuel fabrication, with the Cadarache facility, and the large MELOX plant at Marcoule, and in–core operation, demonstrated by the smooth operation of 7 "Moxed" reactors in France.

   At the European level, by the end of this year a total of 19 reactors will have been moxed, this number climbing up to 40 reactors by the year 2000 (with more than half in France).

It is by building upon such strong technological and operational experience with long term views that we are legitimate to participate in the political debate, which covers safety, impact on environment, international commerce, energy strategy, nuclear acceptance, non-proliferation policy,...

And there is some irony to realize that the most vocal people and bodies in such debates are also the less informed of the technical practical realities. In particular, antinuclear opponents plague our community with questions as if we had not devoted the best of our efforts in several decades to master and control the various sides of the subject... We must indeed certainly pursue a large, open, communication policy to show how careful we are in mastering every impact of nuclear power in the future.

In fact I believe nuclear power has to address a basic psychological constraint in order to obtain a more complete acceptance of the public :

If we realise that everybody is naturally anxious of the unknown, that nuclear power is a relatively young industry, still not familiar in the public technical culture, and that nuclear power releases a powerful energy which is perceived to remain "mysteriously" active over very long periods, then we may draw some remarks for action :

- The above factors combine to create in the public a feeling of impotence for now, and the fear that this will remain so in the future.

- Antinuclear militants build their tactics on this feeling when they deny the on-going technological progress, demonstrating their basic regressive attitude.

- Accordingly, we have to communicate broadly on the progressive mastering of our technologies, for instance, the progress in the quality of protection of nuclear workers and the reduction of waste in our facilities.

2 – The time scales of the back–end of the fuel cycle

Nuclear physics phenomena span over fabulous time scales : by reference to one day, a basic human activity unit, the mean lifetime of a neutron between emission and further fission in a reactor core is 10^{10} less (ten billion times less), and the half–life of Np^{237}, an important actinide, is 10^{9} more (one billion times more).

Nuclear technology, industry and institutions must face more modest time scales, but still uncommon with most other human and industrial activities.

I would like now to share with you some observations on this important characteristic of our industry : the need for anticipation, in particular, in these three areas :

- industrial deployment times,
- economic horizons,
- strategic programs and long–term management.

a) Industrial deployment times : from reprocessing to recycling.

When some people say that reprocessing creates growing stockpiles of separated plutonium, endangering the environment and the political arena, they seem to ignore the very logic of the RCR system : by definition, the system will be balanced. This means that its constituent elements will have capacities consistent with each other: the plutonium separated by reprocessing feeds the MOX fabrication plants, the latter being sized to correctly supply nuclear reactors. It must be recalled on this subject that a LWR reactor loaded to 30% with MOX fuel gives a zero net production of plutonium. Reactors loaded up to 100% with MOX fuel or fast reactors can act as plutonium–burners.

European and Japanese industries are in the process of progressively setting up all these elements, which requires the development of advanced technologies and significant investment. In Europe, and in Japan as well, the MOX fabrication plants are built downstream from the reprocessing plants and the utilities are getting their reactors ready and having them licensed to accept the MOX fuel in due time.

It is generally recognized that the commercial plutonium inventory will be stabilized around the year 2000, and will start decrease a few years after.

Such major industrial development requires some lead time for both technical and economical reasons. That the actors of this vast program be reproached for not achieving it instantaneously may be called naivety ... or perhaps duplicity.

b) Economic horizons :

Reprocessing and recycling are sometimes qualified as "non-economical", in particular in the USA. Such declarations are based on instant cost analyses, using today's market situation for natural uranium and enrichment services, where low spot prices reflect a temporary glut. They also use today's situation in the back-end of the fuel cycle, where the commercial offer in MOX fuel fabrication is just starting producing competitive prices and covered, sofar, limited series of manufacturing.

The instant cost assessment is a short-sighted attitude which might only make sense for a small utility with no forward vision, wishing to take advantage of an opportunity, but exposing itself to the risks of future changes.

The discounted cost analysis over a period of time corresponding more or less to the industrial life of a nuclear reactor is much more pertinent to our world.

This is the method used by OECD/NEA in its updated report "The economics of the nuclear fuel cycle".

It may be useful to recall here that such economical approach puts the cost of the two back-end options : reprocessing/recycling and direct disposal inside a 10-15 % difference. We believe that this difference is not significant when one considers the cost uncertainties associated with the direct disposal technology deployment, whose present status is basically paper work.

But the discounted cost method has its own time limits, and is well adapted to current industrial ventures planned up to 30-40 years. When one speaks of 60 to 100 years, which may be a figure describing the duration of interim spent fuel storage before actual geological disposal, the application of a constant discount rate will systematically favor scenarios like "do nothing now, everything as later as possible (ALAP)".

Imagine that according to the DCF method with a discount rate of 8 % one action performed today at a cost of $ 1000 is perceived as "more expensive" that one action performed in 100 years at a cost of. $ 2 millions ... (in constant money) !

c) Strategic programs and long–term management

In the fields of economic development, environment, energy, and in our case nuclear power, the world is learning to cope with strategic visions over several decades, up to more than one century. As shown above, the usual economical tools must then be relayed by long–term visions. France had to cope with these difficult policy–making processes, using at the same time bold prospective analyses, voluntary proactive attitudes, and adaptative answers to the future changes.

And in turn, such strategic visions and policies require a timely stable background. Precisely, we know that the smooth nuclear power development in a country requires a stable political commitment and permanent administrative and regulations structures, in order to let the whole nuclear system to develop over several decades.

In my country for instance, four successive Presidents (and very likely the fifth one) coming from different political horizons, and a dozen Governments since 25 years, have consistently backed nuclear power development.

It is only with such confidence in their institutions that the industrial actors can engage in long–term R & D, long lead–time deployments and long–term return of their investments.

In the field of the back–end of the fuel cycle, the French strategic vision involves successively, over the next decades :

- reprocessing and plutonium recycling through MOX fuel in LWRs, as currently deployed ;
- progressive coming on line of the new generations of reactors, including plutonium devoted reactors (100 % MOX and fast reactors) ;
- continuous improvement in the management of final residues both in terms of volume and radiotoxicity ;
- choice and implementation of the most efficient residue disposal (December 1991 Law).

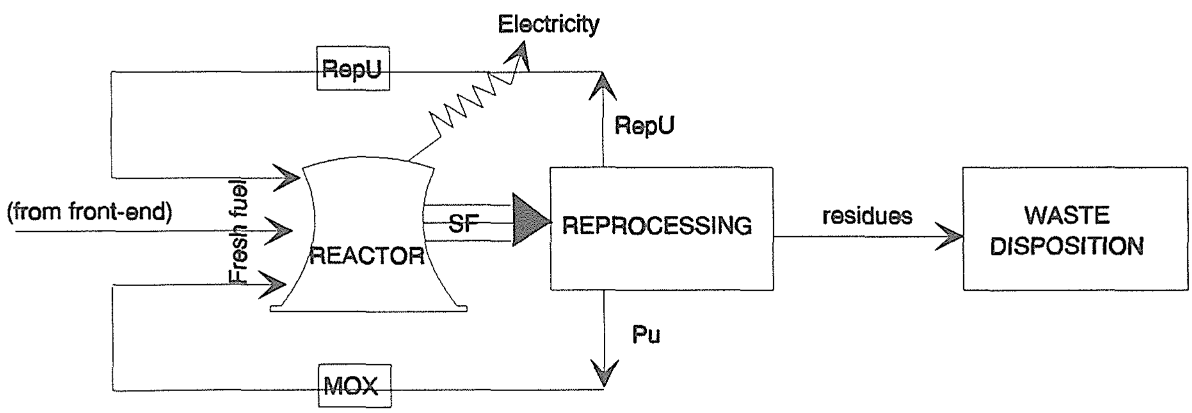
This last step clearly encompasses political responsibilities regarding the future generations. This is why a decision of the Parliament is requested on the related basic policy.

3 - Conclusion

To conclude I would like to suggest a systemic approach to the back–end of the fuel cycle :

In the case of the closed fuel cycle, as chosen by Japan, France and a number of European countries, one can describe the complementary aspects of the nuclear reactor and the back–end facilities as follows :

- the reactor receives fresh fuel, and produces electricity and spent fuel ;
- the reprocessing plant receives spent fuel and produces uranium, plutonium and residues ;
- the recycling facilities (transport, reprocessing uranium treatment, MOX fabrication) receive U and Pu and produce fresh fuel ;
- the waste disposition bodies receive residues and dispose of it.



In other words reprocessing acts as a filtering mirror for the reactors, sending back (recycling) most of the material (96 % of the spent fuel) but the useless part of it (waste).

This representation of the fuel cycle insists on the dual roles of the reactors and the back–end facilities, it strongly suggests that nuclear fuel composition and management must be optimized both for its in–core use as the energy source, and for its treatment in the back–end facilities and, conversely, future reactors will have to accomodate every category of recycled materials.

This presentation shows clearly the global long term view that drives the nuclear power development. I am convinced that both our countries, Japan and France, did make a rewarding choice in committing in nuclear power.

Backend of Nuclear Fuel Cycle in China

Sun Donghui

Chief Engineer

Bureau of Nuclear Fuel, CNNC

1. Introduction

During passed 40 years, a complete nuclear industry system has been established, in which the back end of the nuclear fuel cycle is certainly included. China National Nuclear Corp. (CNNC) posseses and manages the whole nuclear fuel cycle facilities, incl. uranium resource exploration, ore mining and processing, isotope enrichment, fuel fabrication, spent fuel reprocessing, waste management and decommissioning of the nuclear facilities. Since 1979, China's nuclear industry has changed its emphasis to serving the national economy.

2. Strategy of Nuclear Fuel Cycle and Waste Management

Since the early 1980's, a strategy for backend of nuclear fuel cycle has set up:

· Utilizing nuclear resources in full;

· Reducing the costs of uranium mining, processing and enrichment;

· Reprocessing the spent fuel from NPP;

· Developing fast neutron reactor ;

· Minimizing the radwaste generated;

· Vitrifying high level liquid waste;

· Regional disposing low and intermediate level waste in near surface, and centralized disposing high level waste in geological repository.

3. Storage of Spent Fuel

In the later of last year, the spent fuel of the first core loading was discharged from Qingshan phase 1 and Daya Bay unit one, amounting to 12 and 25 t HM respectively, They are being stored in pools at reactor sites.

Due to one third core loading shall be discharged annually, two storage pools have built for 15 years' fuel discharge in Qingshan Plant, and in Daya Bay Plant only one pool for 10 years, each unit even adopting a compact storage pattern.

A wet Centralized Storage Facility (CSF) placed in Lanzhou Nuclear Fuel Complex (LNFC) has been constructed to provide receipt and buffer storage of spent fuel before reprocessing. The capacity of CSF is 550 t HM, among which 500 t HM for NPP fuel and 50 t HM for the others from reseach and test reactors. CSF was such designed, that it could be expanded modulary and interlinked with a industrial scale reprocessing plant in the future, if necessary. According to the time schedule, it will be put into operation in 1998.

4. Reprocessing

A multi-purpose Reprocessing Pilot Plant (RPP) has been decided to build, which consists of a Main Radiochemical Facility (MRF), a Hot cell Lab. (HCL), a Machinery Testing Workshop (MTW) and other auxiliary facilies.

Different testing racks in MTW are designated for simulated tests of some key equipments, instruments and remote operation. MRF and HCLbuildings will be started to construct within 3 years, and the commissioning of the whole RPP is scheduled in the beginning of next century.

After gaining considerable experience from RPP and accumulating sufficient amount of spent fuel at CSF, a large scale plant, may be with capacity of 400 or 800 t HM/a, would be built, and it is estimated to put into operation in 2010's.

5. FBR Program and Civil Pu Recycle

China has been paying more attention to R&D on FBR. A number of experimental facilities, incl. critical assembly and metal sodium loop test rig, had been set up until 1987. Since then, FBR project has been involved in the high-tech. R&D program and made a marked progress.A tentative development program has been drawn up. It is planed that an experimental fast neutron reactor with a capacity of 65 MWt (25MWe) will be completed at beginning of next century.

In view of the approximately simultaneous development in both of civil reprocessing and FBR, civil plutonium would be mainly applied to of FBR fuel as MOX. Furthermore, MOX fuel could be used for PWR as well, therefore, China is currently considering to build a MOX fuel demonstration facility at appropriate time.

6. The Principles of Waste Manegement

The fundamental principles of radioactive waste management establishedby IAEA are adopted, and the embodied principles are set up as follows:

- Minimization of generation;
- Segregation and collection in accordance with criteria;
- Purification and concentration;
- Volume reduction and conditioning;
- Packing with care;
- Safe transportation;
- Temporary storage;
- Centralized disposal;
- Discharge under strick control;
- Enhanced monitoring.

7. High Level Waste Management

Currently vitrification has been selected for solidification of HLLW, and Liquid-Fed Ceramic Melter (LFCM) technology will be used. Now a full scale mock up facility with capacity of 55 l/h HLLW and 30kg/h glass is under construction in Sichang Nuclear Fuel Plant. It will be put into operation in 1996. It is planning that the active vitrification plant will be put into operation in first decade after 2000.

China has decided to dispose HLW in geological repository. At present the research, which started in 1985, is focused on the site selection for repository and underground research lab. (URL), basic technology and methodology for final disposal of the HLW. The URL's R&D is been planning to divided into 2 stages. During the first stage, the URL will be locatedin Beijing area, the methodological studies and cold tests will be conducted there, the demonstration of models and active tests will be carried out at the HLW repository's area during the second stage.

The construction of the HLW repository is scheduled in 2050, and its site will be decided before 2030.

8. The status of the disposal of L/I LW

According to the regional disposal policy of L/I LW, which has been approved by Chinese goverment, 2 disposal sites have been selected.

North-West Repository of L/I LW is located at Lanzhou Nuclear Fuel Complex. After the preliminary design is proved,the detailed design will be finished in June this year. The repository will be built in 1996, and the waste could be received in 1997.

The capacity of the North-West Repositry to be built is 60,000 m^3 , and the radioactivity to be disposed of is 1.2×10^{16} Bq. Later on, the capacity could be expanded to 200,000m^3 and 4.1×10^{16} Bq respectively.

South Repository of L/I LW is located at Changwan near DayaBay NPP. Now the feasibility study is waiting for approval. The construction will be started in this year. It is scheduled that the repository will be put into operation in 1997.

The capacity of the first plase of South Repository is 80,000m^3 and the radioactivity to be disposed is 2.5×10^{15} Bq. The second plase will be 160,000 m3.

9. International Cooperation

Combine with Chinese opening policy, we are actively seeking for the international cooperation based on the equality and benefit for both sides. Now CNNC has good relationship with many organisations. Some of them are dealing with backend of nuclear fuel cycle, such as vitrification mock up facility. German side (DWK and KfK) has transfered their vitrification technology to CNNC, a joint design was performed by BINE and KKN+KfK in 1991, some systems and equipments were supplied by Germany. Technicaland personnel exchanges between China and Japen, France, Germary, U.K, USA, Russia, Belgium, Italy, Swedem have been carried out for many years.

Along with the development of nuclear power, the demand for reprocessing and waste management will increase accordingly. On one hand, the internal funds and technology must be utilized, on the other hand, the foreign enterprises and funds are welcomed for cooperation. We hope that more and more friends would join us.

28th JAIF Annual Conference
Session 4: "Back end of nuclear fuel cycle options"

Paper by Graham L Watts
Director, International Group
BNFL

Good morning. It is an honour and a privilege to address this conference at a very important time for the nuclear industry worldwide. The potential for expansion of nuclear power, particularly in the Pacific area, is immense and the tremendous investment in nuclear power here in Japan has demonstrated to the rest of the world the symbiotic relationship between energy security and economic prosperity. I hope our discussions this week will set an equally favourable example.

The back end of the fuel cycle plays a crucial part in securing the essential diversity of nuclear power. There are two options for the final management of used nuclear fuel: reprocessing or direct disposal - essentially recycle or once-through. We believe that the choice of option should be kept open and be up to individual utilities to decide. UK national policy on reprocessing reflects the importance of keeping this choice.

I think it is important at the outset to state that there is plenty of room in the nuclear industry for both technologies to co-exist well into the foreseeable future. It is estimated that there will be some 200,000 tonnes of spent fuel in existence by the year 2000.

IAEA figures suggest that reprocessing capacity worldwide is unlikely to be more than 5,000 tonnes per year.

Clearly, the choice is open and up to the reactor and utility operators, as owners of the fuel, to decide which is option best suits their particular circumstance. Indeed, the utility owners of two German power stations recently decided to cancel their fuel reprocessing commitments for the period 2005-2015 in our Thermal Oxide Reprocessing Plant - THORP - after 2005, due partly to political pressures from anti-nuclear groups. For the next 10 years, they will continue to reprocess.

But this does not mean that THORP cannot attract further business. On the contrary, I am pleased to announce that we have recently concluded agreements with both of our UK customers, Scottish Nuclear and Nuclear Electric.

Scottish Nuclear were considering the dry storage route but they have now reconsidered their spent fuel management strategy and have further embraced reprocessing. We were able to offer them a competitive package providing a complete fuel service to their Advanced Gas-cooled Reactors (AGRs) until well into the next century.

The agreement includes an additional 550 tonnes of post-baseload reprocessing business for THORP, a further 200 tonnes taken up from an earlier option and a new option to reprocess more than 1,000 tonnes of future used fuel which will be sent for storage at Sellafield, again reflecting our commitment to customer choice.

The agreement with Nuclear Electric completed one of the biggest commercial deals negotiated between two companies anywhere in the world.

The £14 billion package includes the reprocessing of all AGR fuel arisings up to 2004 in THORP and the reprocessing of all scheduled lifetime arisings from NE's six remaining Magnox stations.

In this short paper today, I want to highlight the advantages of the recycle option, the current status of high level waste conditioning, the challenge of public acceptance and the specific benefits of re-use of uranium and plutonium.

When considering final management options, one of the deciding factors will clearly be cost.

We have always maintained that the costs of reprocessing and direct disposal are broadly similar and it is refreshing that some of our customers are now coming to the same conclusion. I am pleased to say that this assertion was also backed up last year by a report from the OECD's Nuclear Energy Agency, entitled 'The Economics of the Nuclear Fuel Cycle'.

The report concluded that 'in light of the underlying cost uncertainties, the small cost difference between prompt reprocessing and the direct disposal option was considered to be "insignificant, and in any event represents a negligible difference in overall generating cost term".

The total cost difference is less than 1mill per kWh, representing less than 2 per cent of the estimated total cost of generation.

Reprocessing is a proven, mature technology which clearly remains very competitive. Direct disposal is currently an untried option with uncertain costs.

But cost is not the only consideration. There are several entirely practical and strategic benefits to reprocessing, one of which is the simplification of waste management.

Critics of reprocessing often maintain that it produces excessive amounts of waste. This is quite simply not the case. In fact, compared with the volume estimates for direct disposal, total volumes of waste are some 25 per cent lower for reprocessing.

In particular, High level waste (HLW) volumes under reprocessing are one-eighth of the volume under direct disposal.

However, the actual volume of waste is only half the story. The treatment, conditioning and final disposal arrangements for the waste are just as important. All waste arising from reprocessing at Sellafield is dealt with under comprehensive management strategies.

HLW accounts for only a tiny fraction of the total volume but contains 99 per cent of the radioactivity.

Liquid HLW from reprocessing has been stored in complete safety in cooled double-walled stainless steel tanks at Sellafield for more than 40 years. In context, this is the volume equivalent of 12 London buses. To convert this liquid into a solid more suitable for long-term storage and eventual disposal, BNFL researched different immobilisation technologies and adopted vitrification.

The process converts the liquid into a concentrated glassified block, using a calciner furnace and adding borosilicate glass. The vitrified waste is cast into specially engineered containers and placed in an adjacent product store. The store, which is monitored and cooled by a unique natural air convection process, is large enough to accommodate all vitrified arisings until well into the next century. Current policy for UK HLW is that it will be stored for at least 50 years until a final repository is available.

Vitrification reduces the total volume of the HLW by up to two-thirds. In other words, the total amount of vitrified HLW from 40 years of reprocessing at Sellafield will be the volume equivalent of 4 London buses. To put this analogy further into context, a person's lifetime electricity needs, if generated by nuclear power, would produce an amount of glass little larger than a compact disc.

The vitrification plant at Sellafield was opened in 1990 to begin this process, with two production lines. The plant has exceeded its production targets for both 1993/94 and 1994/95, 260 and 330 containers respectively.

A new, third vitrification line is now being constructed and is scheduled to come into operation in 1999, with an initial throughput of 100 containers in its first year, building to an annual target of 250 containers.

The third line is being built with the benefit our operating experience and a significant continuing investment in R+D. Indeed, we are committed to continuing research in the area of waste immobilisation and development work aimed at future waste treatment processes.

In particular, we are working towards waste forms which further the pursuit of cost reduction and volume minimisation, for both current and future arisings, including those from advanced reprocessing.

Waste from our overseas customers under post 1976 contracts is covered by a return of waste option and it is UK government policy that all HLW should be returned to customers as soon as practicable after vitrification.

To this end, we have completed construction of an export facility attached to the vitrification store which will facilitate prompt return of the vitrified product to customers in shielded transport flasks. As you will be aware, the first return of vitrified product from France to Japan began earlier this year.

BNFL will begin to return residues towards the end of this decade, no doubt further raising the issue of public acceptance towards return and disposal of HLW.

The first return shipment has already been a success, thanks to dedicated public acceptance support providing balance information in those countries adjacent to our transport routes, and despite the deliberate scaremongering tactics employed by Greenpeace.

There is a lesson to be learnt here and a message that we ignore at our peril as we consider a further expansion of nuclear power and approach the issue of final disposal of HLW.

That message is that we must not let anti-nuclear groups set the media and political agenda. Public acceptance is earned - not bought or acquired by accident. We must press on with the proactive briefing of media and government to strengthen the communication work undertaken by utilities and fuel cycle companies in our respective countries.

This is particularly relevant where there is a weak link in our communication chain. HLW disposal and in particular its return transport, has already proved to be worthy of extra attention.

The tactics of the anti-nuclear groups with regard to our transportation routes are transparent. They will seek to alarm the governments of those countries adjacent to the routes and close off our options so that transportation becomes ever more difficult - and ever more expensive.

The industry's response *must* be proactive.

We must ensure that the government and the media of these third party nations are aware of the facts - not the anti-nuclear fiction - concerning the transportation of nuclear materials. This is imperative in preparation for future MOX shipments from Europe to Japan. In 1996 we have the opportunity to seize the initiative in this respect and ensure that we get our message across. If we do not, then we will remain reactive and Greenpeace and their allies will continue to box our industry into a corner.

But back to waste management. In respect of other less radioactive wastes, BNFL has proposed that a system of waste substitution, whereby an additional quantity of HLW is returned, could be implemented.

Our proposals for substitution are based upon Integrated Toxic Potential (ITP) which takes account of all relevant factors over time, ensuring a fair return of total radioactivity to the customer. This would reduce the number of transport movements by a factor of 17 and greatly simplify final disposal arrangements, as only one specification of waste needs to be considered.

It would also enable us to offer a more attractive total package to our reprocessing customers. These proposals are currently being considered by the UK Department of the Environment.

Waste management considerations aside, there are other strategic reasons which favour the recycle option. Because reprocessing recycles uranium for re-use, less fresh ore is needed for the production of new fuel.

Not only does this conserve finite resources, waste volumes from front-end mining and milling activities are reduced. This results in a lower overall global radiation dose from fuel cycle activities under reprocessing, compared with direct disposal.

I have no need to tell a Japanese audience the strategic value of securing a supply of uranium which is not under the control of a third party, through reprocessing. I am very pleased to say that the first dissolved Japanese BWR fuel was introduced into the Chemical Separation area of THORP recently and will soon emerge as finished separated product.

Although a truism, a nuclear reactor is no use without uranium. Supply crises resulting from physical shortage or as we have seen too many times in recent years, political unrest in other parts of the world, can drastically affect the 'energy mix'.

A supply of uranium under the control of the customer is a partial buffer against uncertainties which can ultimately damage the long-term economics of the reactor, but more importantly, severely constrict the national energy supply in the short-term.

Uranium re-use is not the only strategic advantage of reprocessing. I believe plutonium recycle is definitely the key to the future of nuclear power, and possibly the answer to the long-term energy security of the world.

Just 1 kilogram of this element will produce the same energy as more than 2,000 tonnes of coal, when fabricated as Mixed Oxide - or MOX - fuel and burnt in a conventional nuclear reactor.

Current technology allows MOX loading up to one-third of the core, but development work is underway to increase this to half. The technology to build a 100 per cent MOX-fuelled reactor already exists.

Burning MOX fuel actually helps to manage civil stocks of plutonium which have been slowly increasing since the advent of nuclear power, and would otherwise continue to increase as more conventional uranium is burnt. BNFL entered the MOX market in 1993 with the completion of a pilot scale fabrication facility which produced its first MOX fuel assemblies to order last year. That fuel is now generating electricity in a nuclear reactor in Switzerland.

Construction of a larger facility - the Sellafield MOX plant - is now well underway, on a site adjacent to THORP. The new plant will have a capacity of 120 tonnes per year, enough to utilise all of the plutonium to be separated out in THORP, as it arises.

The immense energy potential of MOX fuel is not its only advantage. Because the electricity will be generated in a nuclear reactor, it will not produce any carbon dioxide, sulphur dioxide or nitrous oxide to add to the effects of global warming or acid rain. In other words, 1 tonne of plutonium will save the emission of more than 5 million tonnes of CO_2, compared with the same amount of electricity generated from burning coal.

Considering that fossil fuels still account for over three-quarters of global energy production, the potential to generate vast amounts of clean electricity must not be ignored. Clearly, the value of plutonium as a clean energy source means that it is just *too important* to throw away.

I think we all agree that nuclear power is set to contribute to the future maintenance and development of the quality of life that we enjoy today, and can greatly assist in the extension of that affluence to the developing nations of the world.

The back end of the nuclear fuel cycle will determine how effective this contribution will be. Reprocessing as a final management route recycles uranium for re-use in new fuel, separates plutonium for utilisation in MOX fuel, effectively simplifies the waste streams to be dealt with and puts High level waste into a solid form which has been designed to withstand the potential problems and longevity of deep underground disposal. The development of this particular disposal route will be greatly assisted by international co-operation, proactive communication and by discussion forums such as these.

Thank you.

Nuclear Non-Proliferation: Asian Dangers in a Global Context

by
Alton Frye
Council on Foreign Relations

Address to 28th Annual Conference, Japan Atomic Industrial Forum, Inc.
Tokyo, April 12, 1995

Mr. Chairman, ladies and gentlemen, it is a great honor for me to participate in this 28th annual conference of the Japan Atomic Industrial Forum. For some time now I have had the privilege of working with a number of colleagues from JAIF in a joint energy security project at the Council on Foreign Relations. I want especially to note the contribution of Professor Shuzaburo Takeda who has played such a central role in building bridges between Japanese and American leaders, and specifically between the Council on Foreign Relations and this Forum. The energy security working groups of the Council and JAIF, and the sessions of this important conference have offered invaluable opportunities to learn from each other about vitall issues affecting not only our two countries, but the wider international community.

More than three centuries ago the poet John Donne spoke a universal truth: "No man is an island." Today, in an age of mass destruction weaponry, that insight applies to nations no less than to individuals. No country is sanctuary from the reach of nuclear or chemical or biological devastation. No nation, whether island or continent, can be secure in itself, by itself. That fact, no matter how familiar, must be the starting point for any serious discussion of the security dilemmas confronting every state.

We meet on the eve of the Nonproliferation Treaty Review Conference, at a moment when contradictory tendencies are evident. The fact that nuclear weapons capabilities have spread more slowly than expected by many commentators forty years ago is no basis for confidence that the present reality of only five declared nuclear weapons states will endure. Indeed, the end of the Cold War has bred perverse incentives for some countries to consider a nuclear option, since the tightly bound geopolitics and alliance systems of that era are no longer either so controlling or so reassuring. The impending NPT conference is a crucial event in our search for safe passage to a stable international system, but its outcome remains uncertain.

Preparations for the conference moved slowly through several preliminary meetings over the last two years, and only in the Fourth Preparatory Committee meeting in January did a positive atmosphere begin to develop. The selection of Sri Lankan Ambassador Jayantha Dhanapala to chair the conference ensures that it will be led with skill and knowledge. The agenda has taken shape and the conference structure is in place. Yet disagreement persists over the specific rules governing how votes will be taken regarding the Treaty's extension. An additional preparatory meeting will take place in the next few days to address that question; the way it is resolved will bear heavily on the success or failure of the conference.

The delay in setting agreed procedures for voting on the NPT extension reflects deep-seated differences in the perceptions of conference participants. There is substantial -- and I believe, misguided -- sentiment among some states for the view that the Treaty is a favor done by the nuclear have-not nations for the five declared nuclear powers. The notion that the Treaty is a bargain that mainly serves the interests of the nuclear weapons states ignores both sides of a fundamental reality: First, it is a central security interest of states without nuclear weapons to make sure that their neighbors do not acquire them and, second, it is essential that proliferation be prevented if the states **with** nuclear weapons are to control and reduce the arsenals which already exist.

There are valid concerns on the part of non-nuclear weapons states about how to maintain pressure on the nuclear weapons states to pursue nuclear disarmament, but they should not obscure the stake all countries have in holding the line against proliferation. It was awareness of shared peril that prompted the United Nations in 1946 to dedicate the first General Assembly resolution in to the nuclear problem. The complexity of that problem, compounded by the superpower competition that defined the Cold war, defeated efforts to mold an international consensus for a quarter century, when the Non-Proliferation Treaty finally emerged.

It would be a tragic irony of historically unprecedented scale if now, at the very time meaningful progress toward superpower arms reductions is being made, a feeble endorsement of the NPT undermined the international norm of nuclear restraint to which the Treaty has contributed. Persuading non-nuclear weapon states that the indefinite extension of the NPT is in their own interests should not require either bribery or blackmail on the part of nuclear weapon states striving to restrain and reverse the dangerous competition in which they have been trapped. It **should** require, however, clear and convincing demonstration of their commitment to implement existing strategic arms reduction agreements and to undertake more far-reaching restraints that will affect all nuclear weapon powers, not only the United States and Russia.

The menace of nuclear weapons proliferation is multi-faceted and must be addressed on many levels -- technological, political, economic, military and strategic. In Asia security and stability depend on far more than the question of nuclear proliferation, but they cannot be assured without addressing the critical nuclear factor. The question of possible proliferation in Asia arises in more than one country, but the nuclear activities of North Korea pose the gravest immediate danger to the nonproliferation regime in the region and elsewhere. At the same time, nuclear stability in East Asia is vulnerable to unravelling of restraints against nuclear weapons in other regions, especially the Indian subcontinent and the Middle East.

An independent task force recently convened by the Council on Foreign Relations highlighted several aspects of the proliferation problem in East Asia. The interests and activities of three of the five nuclear powers intersect here. Several other countries in the region, including Japan, South Korea and Taiwan, have foresworn nuclear weapons despite ample technical capacity to mount such a program. Presumably, it would be difficult for those governments to sustain their policies of self-restraint if a nuclear China became belligerent or took a cavalier attitude toward transfer of its own nuclear technology to other states. Similarly, a decision by North Korea to leave the NPT, terminate International Atomic Energy Agency safeguards and resume its provocative nuclear programs would place the non-proliferation regime under grave strain in Asia and beyond. The impact of such nuclear trends would be all the greater if China and North Korea persisted in the sale of ballistic missiles and related technology to would-be proliferators.

For these reasons the Council task force urged firm support for the continuation of U.S. security commitments in the region, including substantial military deployments. Given the absence of strong multilateral security institutions in Asia, the task force emphasized the importance of existing bilateral security arrangements as the foundation for stability in this period. Beyond these arrangements, however, a priority objective must be to enlist China in an effective regime to control exports that could contribute to proliferation. Preferably, China should become a committed, reliable member of both the so-called Nuclear Suppliers Group and the

Missile Technology Control Regime.

The situation in North Korea poses particularly difficult challenges, all of them amplified by the character of the regime in Pyongyang. We need to be clear that the protracted negotiations with North Korea have produced not a final agreement removing the threat of proliferation, but an agreed framework within which to seek a series of agreements for that purpose. It outlines a plan to substitute technology that is less prone to weapons proliferation than the earlier reactors on which the North had embarked. More importantly, it opens the way for North Korea to move toward beneficial political and economic relations with other nations. At this writing the framework remains in jeopardy, as North Korea resists the idea of accepting light water reactors built in South Korea -- even though the Republic of Korea's participation is necessary to fund a substantial portion of the $4 billion plan. There are reports that the North has even threatened to restart a reactor that it had ceased operating as part of the understanding.

A process so vulnerable to bad faith or overt disruption must be monitored with supreme diligence. Yet even good faith implementation of the agreed framework will not suffice unless the North Korean government is prepared to proceed in earnest toward a degree of mutual tolerance, if not reconciliation, on the Korean peninsula. That larger strategic requirement implies not only a resumption of the movement toward constructive engagement between North and South Korea, but early adjustments in the forward deployment of massive conventional forces north of the 38th parallel. With the miraculous transformation of the military balance in Central Europe, the Koreas, more than any other nations on earth, desperately need a pullback of forces and other confidence-building measures to reduce the danger of war. While pressing the North Koreans to go forward with the generous alternative proposed to meet their energy needs, it is also urgent to do everything possible to revive the December 1991 North-South reconciliation accord. Political and economic engagement along the lines contemplated in that understanding is indispensable to an eventual transition on the peninsula that can provide enduring prosperity and security.

The bubbling anxiety over nuclear developments in East Asia is not unrelated to destabilizing tendencies in South Asia and the Middle East. The missiles supplied by China and North Korea to various countries in those areas feed long-term trends that could eventually reverberate in

East Asia as well. China's reported nuclear and missile assistance to Pakistan, for example, is bound to reinforce the pro-nuclear weapons advocates in India, already disposed to pursue the option as a response to China's nuclear capability. Furthermore, whatever prospects may exist for India to hold the line short of deploying nuclear weapons would surely shrink if Iran were someday able to marry a missile capability with nuclear payloads. And, needless to say, Iran's and Iraq's nuclear ambitions are unlikely to die so long as rumors abound of a nuclear weapons capability in Israel. Thus, the nuclear and missile linkages at work across Asia and the Middle East have high potential for pernicious, interlocking outcomes that could spell the death of the non-proliferation regime. Since both South Asia and the Middle East have shown a repeated propensity for war, the risks of adding weapons of mass destruction to the cauldrons of hostility already present there are acute.

In these circumstances it is imperative to engage China in responsible efforts to avert a cascade of proliferation. In logic it ought to be apparent to China's leaders that, under a worst-case scenario, they could find themselves with nuclear-armed neighbors in both Korea and India. If that happened they could not expect other advanced states in the region to refrain from joining the nuclear club. With those possibilities in view, China has an obvious need to forge improved, mutually reassuring security relations with India, while collaborating more vigorously in discouraging nuclear inclinations in both North Korea and Pakistan. A stern test may lie ahead for China. If a breakdown in the plan described in the agreed framework forces the issue of sanctions against North Korea back on the agenda, Beijing will face a particularly difficult choice.

Fortunately, these gloomy contingencies are not the whole story. Proliferation trends are decidedly mixed. On the one hand,

-- the major nuclear powers have embarked on unprecedented reductions in their arsenals;

-- over 170 adherents have made the Nonproliferation Treaty the most broadly supported arms control agreement in history;

-- an unacknowledged nuclear power, South Africa, has rolled back its program and destroyed its small number of weapons;

-- Argentina, another state with advanced nuclear technology, has also entered the NPT and, in bilateral arrangements with Brazil, has warded off the danger of a nuclear weapons competition in South

America;

-- Ukraine, Kazakhstan and Belarus, which inherited on their territories portions of the Soviet nuclear capabilities, have shown statecraft of a high order in moving to become non-nuclear participants in the non-proliferation regime.

On the other hand,

-- the understandable demand for safe and efficient nuclear energy has prompted many countries to acquire the technological mobilization base on which weapons could be built;

-- furthermore, under the stressful conditions prevailing in the nuclear facilities of the former Soviet Union, there is evidence of nuclear materials entering the black market, with worrisome amounts recovered in Germany and the Czech Republic;

-- the potential movement of Soviet-trained nuclear scientists and engineers to countries of proliferation concern poses unique dangers;

-- clandestine activities of Iraq and other countries reveal glaring inadequacies in international safeguards;

-- and at the same time, growing international trade in ballistic missiles tends to heighten instability, especially if missiles were mated to nuclear warheads.

In this troubling context effective policy requires accelerated efforts to complete several longstanding nonproliferation goals. Foremost among them is a comprehensive test ban; on that score the outlook has brightened with strong affirmation of that goal from most of the nuclear weapons powers, although the timetable for completing a CTB may run into next year. With vast accumulations of fissile materials already on hand, large quantities are becoming surplus as the United States and Russia dismantle thousands of warheads. A cutoff in production of such material for weapons now seems within reach.

President Clinton has spurred the campaign for these agreements by dropping a dubious U.S. proposal for a special right to withdraw from the CTB after ten years and by ordering that 200 tons of special nuclear material be permanently removed from the U.S. weapons stockpile. In addition the President extended the moratorium on testing U.S. weapons, pressing for intensified negotiations to bring a CTB into force no later than 1996. Despite complex arguments over so-called hydro-nuclear experiments, that deadline should be met. Achievement of those two goals -- demanded by non-nuclear weapon states for decades -- would mark a true turning point in the erection of barricades to proliferation. To serve their purpose, however, the CTB and fissile material production cutoff will have to become universal at an early date. Verification arrangements will have to win the general confidence of the world community.

Beyond the specifics of these two agreements, experience has shown the urgency of strengthening international safeguards and export controls. There have been useful improvements in safeguards practices after the unsettling discoveries of Iraqi nuclear activities, especially with respect to so-called special inspections and to closer involvement of the United Nations Security Council in these matters. Yet without additional resources it is questionable whether the International Atomic Energy Agency can perform this mission satisfactorily. The challenge is perpetual and surveillance must be unrelenting.

The same is true of the need for export controls. The Cold War-based mechanism known as COCOM must be succeeded by a more focussed but also more determined attempt to prevent dangerous equipment, components and technologies from reaching states likely to employ them for covert nuclear purposes. The starting point must be greater transparency in transactions which involve items clearly relevant to the proliferation problem. From the mixed record of COCOM the lesson is clear that export controls must be carefully designed and as precisely targeted as possible. In establishing such controls, we have to recognize that there is no entirely workable solution to the problem of dual-use technologies. However, that is an argument not for abandoning export controls but for creating a system of vigilant consultation among countries capable of supplying critical products. The maxim "higher fences around fewer items" is the sound principle for a new system of export controls, but it should be applied sooner rather than later. Too much time has already elapsed without such a system in operation.

The dilemmas posed by safeguards and export controls become especially difficult when dealing with the possibility of bad faith on the part of NPT adherents. Iraq has already shown how far a rogue state can proceed in maintaining the fiction of NPT compliance while working steadily to acquire a nuclear weapons capability. As is well known, there are reasons to worry that Iran is pursuing a similar course. For that reason the United States has urged Russia not to go forward with its sale of reactors and supporting technology to Tehran. For its part, Iran demands to know why it, as an NPT party in good standing, should not have ready access to such reactors when North Korea, a state not in compliance with its Treaty obligations, is to receive comparable technology on favorable terms. The answer is, of course, a pragmatic one: the North Korean arrangement is designed to cope with a government already well advanced on the road to an indigenous capacity to produce nuclear weapons; the Iranian situation is quite different and there remains a chance to curb a potential movement toward nuclear weapons at an earlier stage. That is not a satisfactory answer, however, to those who stress the obligation under the NPT of nuclear-haves to assist nuclear have-nots in reaping the benefits of peaceful nuclear technology.

If, as it now appears, Russia and Iran complete this transaction, Moscow will have a special responsibility to remain alert to any activity that could transform its legitimate deal with Iran into an instrument that subverts NPT safeguards. Russia's economic imperatives in this sale are obvious, but, so, too, are the security imperatives that the Russian government must respect in preventing the appearance of another nuclear weapons state in its neghborhood.

The need to bolster safeguards and export controls underscores one of the most vital requirements of coming months. The historic concentration on bilateral arms control between Moscow and Washington must now give way to concerted negotiation among all the declared nuclear weapons states. That applies not only to the obvious requirement for their participation in the CTB and fissile material cutoff. They also bear the burden of framing credible security assurances that their nuclear weapons will not be used to threaten or attack states which have refrained from acquiring such weapons. We do not know how far it is possible to go in removing the shadow or reality of nuclear weapons from world politics. To some strategists, it is not desirable to move in that direction, for nuclear weapons have undoubtedly induced a degree of wholesome caution in the behavior of states. But the logic of nuclear deterrence that served bipolar stability is a dubious basis for a dependable order in the fractured system that follows the Cold War. In searching for other strategic foundations appropriate to new circumstances, the time has come to establish a five-power forum dedicated to mapping a collective path toward restraining all deployed nuclear arsenals. While France, Britain and China have sometimes resisted such proposals, it is reasonable to expect them to exercise restraint commensurate with the drastic reductions now accepted by the two larger nuclear powers.

The altered international situation also argues for bold new initiatives to energize the nonproliferation regime as part of a more general approach to a stable and just world order. Responsibility for framing such proposals rests primarily on the major nuclear states. The seeds of such initiatives have already been planted in ideas introduced but not fully developed in negotiations between Moscow and Washington. Two concepts in particular commend themselves as major contributors to strategic stability and non-proliferation:

-- first, a program to separate nuclear weapons from their delivery vehicles and place them in secure storage under international supervision;

-- and second, a global ban on the testing, production and deployment of ballistic missiles.

Not long ago such concepts appeared too radical for serious consideration. With the dissolution of East-West ideological barriers and breakthroughs in strategic arms control, they are now candidates for active diplomacy. Few initiatives could do so much to lengthen the fuse on possible nuclear attack as separating nuclear weapons from their delivery systems. Nothing would lend more credibility to the positive and negative security assurances the nuclear weapons states are offering to other countries. Precedents are already coming into existence in the agreements between the United States and Russia. Last September, Presidents Yeltsin and Clinton agreed to accelerate removal of warheads from missiles scheduled to be dismantled under the START accords. The two countries had gained experience in similar procedures under the Intermediate Nuclear Forces Treaty of 1987 and in the removal of nuclear weapons from surface navies. While such arrangements are most readily applied to long-range ballistic missiles, it should be possible to extend them to aircraft as well.

Placing weapons in secure storage under international monitoring arrangements would obviously not satisfy those who demand elimination of all nuclear weapons. But "strategic escrow", as this concept is called, would reap many benefits by impeding ready access to the ultimate devices of war. And by offering an intermediate, reversible course of action it would enable states to embark on meaningful reductions in their nuclear arsenals in the knowledge that, if their supreme interests were at some time imperilled, they would retain the option to retrieve their nuclear payloads. At this juncture in the history of arms control, the next leap forward may only occur if nations know they have a fall-back option. The theme should be "Store the nucs and lock the door -- but don't yet throw away the key."

A comparable opportunity relates to long-range ballistic missiles. When President Reagan introduced the proposal to prohibit ballistic missiles in the Reykjavik summit of 1986, the notion was farfetched and untimely. But what was infeasible in an era of fierce strategic competition and mutual hostility has become practical in a transformed world of Russian-American cooperation to manage the nuclear menace. There are now coming into place under the Strategic Arms Reduction Treaties detailed verification arrangements, including procedures to monitor missile production facilities on each other's territory, that make a ballistic missile ban workable.

Clearly, both Russia and the United States have a profound interest in protecting themselves against the emergence of additional missile capabilities that could threaten their homelands. Without a fresh approach to the problem of missile proliferation, they will face -- indeed, they already face in the American Congress -- intense pressure to deploy costly, but predictably imperfect, missile defenses.

Technically, a ban on ballistic missiles would be far more feasible than many of the controls being imposed on nuclear technologies. That is true in large measure because missiles require highly visible flight tests and missile crews need elaborate training without which the maintenance of a credible force is implausible. And it hardly needs to be said that a strict, verified ban on such systems would be far more reliable than any defense yet contrived against them.

To be sure, a scheme for "zero ballistic missiles" or ZBM would not resolve the dangers of nuclear proliferation. There are too many other means of delivering nuclear weapons. By slowing the tempo of possible operations, however, it would diminish the risk of hair-trigger strikes and greatly enhance stability in crises. It would fundamentally shift the controversies over missile defenses away from ambitious fantasies of comprehensive global systems and toward more modest defenses to protect forces in the field against short-range battlefield rockets and to hedge against violations of the ban.

Nor need such a plan constrain the numerous space launches on which nations have come to depend. To be compatible with ZBM, space activities would have to become more transparent, with thorough inventory controls over rocket production, pre-launch inspections and launch monitoring to confirm the booster's flight characteristics. With Japan's own vigorous space program, it could play a leading role in defining and demonstrating procedures to ensure that space operations can continue without disrupting an agreed ban on ballistic missiles for weapons delivery.

Few things could impart greater momentum to the overall effort to eliminate weapons of mass destruction than a campaign led by the two major nuclear powers to ban ballistic missiles. After all, to induce other states to consider such a plan they would be placing on the table an offer to eliminate massive strategic investments in intercontinental missiles more numerous and more advanced than those any other countries could hope to match in the foreseeable future. A proposal of this nature would pose for all countries a cardinal question: Would they be better off seeking ballistic missiles of their own -- or supporting a program that would deny such threatening devices to their neighbors? Forcing that question into national debates throughout the world could help enormously in concentrating the attention of governments and peoples on the multiple tasks they must address in fending off the threat of mass destruction weaponry.

No one has yet devised a wholly persuasive way to abolish nuclear weapons. But one can describe a precise, verifiable approach to banning ballistic missiles that supports the long-term goal of curbing the nuclear danger.

To advance these proposals is not to predict their easy acceptance by all the states whose involvement would be necessary. To begin with one must confront the fact that severe budget pressures are inclining Russia to rely primarily on ballistic missiles, rather than more costly aircraft, for its strategic forces. If ZBM is to have any promise as a global regime, it must begin with a plan that maintains reasonable parity between the capabilities of the two major nuclear powers. Such a plan will face real, but not necessarily insurmountable, obstacles in seeking adequate balance over time in the two sides' strategic aviation capabilities. That balance need not be defined as strict equality, and achieving such a balance should be facilitated by the kind of strategic escrow of warheads already described.

We have reached a stage where we must simultaneously complete work on the old agenda of arms control and invent a new agenda that will enlist wide support in the international community. This is a time to lift our sights if we are to sustain the non-proliferation regime.

Such far-reaching measures can only be contemplated if there is confidence in other security mechanisms, especially the regional alliances that have been instrumental in Asia and Europe. The durable alliances between Japan and the United States, and between the Republic of Korea and the United States can be the bedrock in an evolving security system for the region. In areas which are unsettled by local antagonisms but not protected by strong alliances, building reliable security arrangements is a first priority for nonproliferation policy. Conversely, would-be proliferators should understand that acquiring nuclear weapons will diminish the likelihood that they can obtain dependable alliance partners. Where possible, the message should be that "to go nuclear is to go alone."

Finally, one must highlight the interdependence between the nonproliferation regime and further reductions in the nuclear forces of the United States and Russia. Those reductions are not likely to continue if new states enter the nuclear weapons club or existing nuclear-weapons states decline to restrain the growth in their forces.

These and other factors converge in the NPT Review Conference. Reinforcing the Treaty is the urgent preliminary to a predictable order in which the "nuclear haves" can work with each other toward radical reductions in their nuclear deployments and with the "nuclear have-nots" toward dependable non-nuclear security arrangements where they are needed.

Forty five years ago Dag Hammarskjold wrote that "like the bee, we distill poison from honey for our self-defense -- what happens to the bee if it uses its sting is well known." Those words resonate in our nuclear predicament. Harvesting the fruits of peaceful nuclear technology remains a worthy goal, but it will avail mankind nothing if the poison of nuclear weaponry spreads through the world. Those who hold the vision of safe nuclear energy must never lose sight of the poison that lurks within it.

The Geneva Framework Agreement and its Implications for Inter Korean relations*

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It is certain that the US-North Korea Agreed Framework adopted on october 21 1994 in Geneva is a significant step toward the nuclear-free Korean peninsula. The primary importance of the Geneva agreement is that it has provided a framework for the ultimate resolution of North Korea's nuclear issue, which has seriously threatened the future of the NPT regime, as well as peace and stability on the Korean peninsula and in Northeast Asia. The centerpiece of the agreement is a deal under which North Korea promised to freeze and eventually give up its capability to produce plutonium and to comply with the fullscope safeguards under the NPT, in return for political and economic rewards such as light water reactors, heavy oil, and diplomatic normalization with the US. The Geneva agreement provides that North Korea will gradually abandon its plutonium producing capability in accordance with the progress of the light water reactor construction over around 10 years.

Among other things, one of the significant achievements of the Geneva agreement is to keep North Korea at the critical point of time from producing large quantities of nuclear weapons grade plutonium through the operation of the 50 and 200 megawatt graphite-moderated reactors and the plutonium reprocessing plant. The Geneva agreement commits North Korea to freeze the construction of its 50 and 200 megawatt reactors and ultimately dismantle them. Absent this agreement, North Korea, within short period of time, could have completed the construction of two reactors, capable of producing weapon-grade plutonium enough for about 30 bombs each year.

It is expected that the Agreed Framework, if fully implemented, will successfully prevent North Korea from going nuclear. However, complete transparency over North Korea's nuclear activities, in particular its past activities, will not be secured until some time in the future, which is believed to be as late as five years from now. The freeze may not prevent North Korea from producing a few nuclear weapons. One of the serious problems of the Geneva agreement is that it cannot drive a wedge in 'qualitative proliferation'

* The views expressed in the paper are the author's own, and do not necessarily reflect those of the IFANS and the Government of the Republic of Korea.

(improvement in nuclear weapon production capability), albeit prohibiting 'quantitative proliferation' (increase in number of nuclear weapons). According to most credible intelligence estimates, it is already in 1989 that North Korea extracted about 12Kg plutonium enough for a couple of atomic bombs. Moreover, as a result of the Geneva agreement, the special inspection, that is crucial to searching North Korea's past nuclear activities, has been postponed until key components of light water reactors are delivered at least 5 years later. This means North Korea was given 10 years enough to develop and even sophisticate its nuclear weapon technology with the plutonium already extracted.

North Korea's continued ambiguity concerning a small nuclear stockpile appears to be the major weakness of the Geneva agreement. A small nuclear stockpile would present a dangerous element to the military situation on the Korean Peninsula. The Republic of Korea is facing the situation in which it has to live with North Korea which may possess a few nuclear weapons. Japan also faces the same dilemma. As far as the security of Northeast Asia is concerned, it must be not a small burden.

Despite such weaknesses, the reason why South Korea has willingly accepted the Geneva agreement is that South Korea is supposed to supply the Korean standard model of light water reactor(LWR) to the North. The LWR project furnishes a key to the implementation of the agreement. According to the Agreed Framework, North Korea's nuclear problem is to be gradually resolved in accordance with the progress of the LWR project. Therefore, considering that North Korea does not need to implement the framework when the project stagnates, the supply of Korean standard LWRs to North Korea, of which South Korea is expected to bear most part of astronomical expenses, must be a heavy burden.

Nervertheless, South Korea is willing to take charge of a 'central role in financing and constructing the LWR project because the supply of South Koran reactors to the North would bring about momentous opportunities for substantial improvement in the relation between South and North Korea. Because the supply would inevitably promote large-scale direct exchanges of people, as well as goods and technology. It may also result in the inevitable openning of roads, railways and ports between the South and the North, closed for almost fifty years. Moreover, in the light of military senstivities, an exchange of nuclear related goods and technology is usually made between the most credible nations. It is certain that the supply of the Korean standard LWRs to North Korea would have a symbolic meaning to the future South-North relaton.

In order to finance and supply the Korean standard LWRs, the Korea Energy Development Organization(KEDO), an international consortium, was formally established in late March through active consultations among South Korea, Japan and the United States. The KEDO will play a key role in implementing the Geneva agreement. The agreement has set a target date of April 21 for the reactor contract to be completed.

As a matter of fact, North Korea, in the Geneva high level talks last year, had accepted the South Korean models by saying "North Korea does not care the type of reactor if the United States gurantees the supply." The Agreed Framework thus had been adopted with such an understanding that Seoul would build the reactors. However, North Korea was renegating on the understanding by turning its position to refuse to accept a major South Korean role in the LWR project, hence rejecting the Korean standard LWR. Recently, Pyongyang is threatenning to reactivate its nuclear program if forced to accept South Korean reactors.

As far as the LWR project is concerned, the position of South Korea is very firm and steady. It will not finance any expenses of the LWR project unless the South Korean reator is cleary accepted. This is a strong national concensus. And the international community, as well as South Korea, could not help but impose sanctions against North Korea if it restarts its 5 megawatt reactor and its program to seperate plutonium.

It is somewhat understandable that North Korea finds it politically difficult to have South Korea build reactors on its territory. North Korea appears to be worried about the domestic impact of a display of the technological and economic superiority of its capitalist southern brethren. But North Korea needs to change such perception. The Korean standard reator is not 'a poisoned carrot', but an opportunity for the South-North reconciliation and cooperation. Pyongyang should realize the fact that Seoul has not intended to undermine the North's political system or to absorb it, as already made clear by signing with the North the historic Basic Agreement on reconciliation, non-aggression and cooperation in late 1991.

Since 1988, the Republic of Korea has pursued a policy of coexitence and cooperation with its northern half through recognizing the existence of two different systems and promoting exchanges and cooperation between them. Seoul has tried to accommodate and engage North Korea by providing various economic cooperations and improving its relations with Pyongyang. Such policy was obviously designed to steer the North into a more constructive and moderate direction including undertaking extensive reform and open-door policy. However, due to North Korea's nuclear issue, South Korea was almost forced to suspend it.

With the adoption of the framework agreement, therefore, it is not surprising the South Korean government is now prepared to resume its interrupted policy of engagement toward the North. South Korea already responded to the Agreed Framework by lifting some restrictions on contacts between South Korean companies and North Korea.

The Agreed Framework states that North Korea will take steps to implement the South-North denuclearization agreement and that North Korea will engage in dialogue with the South. However, North Korea is refusing to negotiate with South Korea. Since signing the Geneva agreement, North Korea has acted as if it revived its longstanding strategy of 'ultimate liberation of South Korea.' North Korea has engaged in a multifaceted strategy aimed at isolating South Korea from diplomacy on Korean issues and creating the image of an isolated, ineffective South Korean government. In doing so, North Korea continues to refuse a dialogue with the South Korean government while on the other proposing talks with non-government South Korean groups and to apply stepped-up pressure on the United States to agree to direct bilateral military talks exculding the South.

It is unlikey that North Korea will easily renounce that strategy of isolating the South Korean government and damaging its authority. Furthemore, the recent situation has encouraged North Korea to continue to think that it can have the important economic benefits from good relations with the United States and Japan without any change in its persistent refusal to recognize and deal with South Korea.

Fortunately, however, the strong political, economic and diplomatic position of South Korea vis-a-vis North Korea provides a great deal of leverage on the situation. Contrary to the North Korea's wishes, the society of South Korea cannot be easily collapsed or spilt. In a sense, South Korea is the only neighbor to provide substantial assistance that North Korea desperately needs. It is no longer a secret that the North Korean regime has faced the kind of immediate economic crisis. South Korea is willing to help North Korea overcome it. South Korea has also expressed its willingness to help Pyongyang to become a responsible member of the international community sharing the benefits of international stability and prosperity.

In conclusion, South Korea's basic positions on the North Korea's nuclear issues need to be made clear.

Firstly, despite some important flaws, South Korea believes the Geneva agreement represents a significant step to eliminate the threat of North Korea's acquiring nuclear weapons. South Korea supports the agreement and wishes that all concerned parties should make every effort to implement them faithfully.

secondly, South Korea cannot afford any expense unless North Korea cleary accepts South Korean reactors. As a matter of fact, South Korea had endrosed the agreed framework with such an understanding that South Korea would build the reactors.

Thirdly, as North Korea agreed in the Geneva agreement, the Joint Declaration of the Denuclearization of the Korean peninsula must be implemented. To do so, the South-North dialogue is indispensable. As long as North Korea refuses to deal with South Korea, it is difficult to see any confidence in the solution to the nuclear problem.

Given the North Korean record of ignoring its past obiligations, there is every reason to suspect whether the Agreed Framework will actually be implemented. Moreover, the Agreed Framework itself is fraught with possible pitfalls that, over 10 years, could emanate from technical, financial or political consideration at each step along the way. In order to reliably implement each part of the fragile agreement, one cannot overestimate the importance of the continued close cooperation of international community, in particular among Japan, the United States and South Korea. The international community must develop a coherent strategy to enforce the agreement. It is also important to remain prepared for North Korea's possible stalling tatics, or even a breakdown in the implementation phase that could lead to renewed tension and confrontation.

SESSION 5

NUCLEAR NON-PROLIFERATION REGIME

- PROSPECT IN ASIA

NOTES FOR PANEL PRESENTATION

by

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[MALAYSIA]

The threat of nuclear proliferation is a symptom of an arms race fuelled by ambition or fear in an environment of rising international tension and uncertainty. On the other hand, a slowing down of the arms race, a lessening of tension, and an improvement in the world security situation will contribute immensely to the lessening of the threat of nuclear proliferation. Because of this linkage this presentation will address the question of nuclear proliferation as an integral part of the global efforts to enhance international peace and security in which nuclear disarmament and the prevention of nuclear proliferation play critical roles.

2. Secondly, the presentation will examine the security scenario of the Asia Pacific region from the Southeast Asian viewpoint centered on the region's strategic interest as seen from the Malaysian perspective. By that is not meant that the views here are those of the Malaysian government but rather the Panelist's own personal perception. Though nuclear disarmament is a global issue requiring multilateral efforts to stem the proliferation of nuclear weapons, the UN has recognized the need for simultaneous <u>REGIONAL</u> and <u>GLOBAL</u> approaches to promote regional and international peace and security. Thus, any initiatives taken by regional countries such as ASEAN, in this regard are very relevant to the global efforts to prevent the proliferation of nuclear weapons.

<u>Southeast Asia Overview</u>

3. The present political and security situation in Southeast Asia offers a real prospect of durable peace built on a strong foundation of economic prosperity and friendly relations among the countries in the region. The end of the Cold War has diminished, if not totally eliminated, the threat of global war or the spectre of Southeast Asia becoming a battle ground of a global war. This

optimism is balanced, however, by some uncertainty and apprehension over possible new sources of danger and instability emerging in the post-Cold War period.

4. On the positive side, for the first time in half a century there is no armed conflict between states in Southeast Asia. The settlement of the Cambodian problem has removed an obstacle for full regional cooperation involving all countries in the region, socialists and market economy countries. Now ASEAN which hitherto was confined to the market economy countries of the region is poised to achieve universality with the participation of Socialist Vietnam, Laos and Cambodia, and eventually Myanmar. The picture is one of ASEAN and Southeast Asia looking forward with confidence.

Ethnic conflicts which elsewhere in the world have ignited a series of local but devastating wars, have not surfaced in the region. Southeast Asian states with multiracial population (Malaysia and Singapore) have been successful in building national unity.

The biggest plus factor in the region is the impressive economic success story of the market economy countries of ASEAN. Now the Socialist countries in the region, especially Vietnam, are fast catching up.

5 There are however still some unresolved issues between ASEAN countries, e.g. the Philippines' claim on Sabah; territorial disputes over Sipadan and Ligitan Islands between Malaysia and Indonesia and over Batu Putih island between Malaysia and Singapore. These issues although viewed with grave concern by the countries involved have not become obstacles to the strengthening of relations and

cooperation between and among ASEAN countries. In the ASEAN spirit and in accordance with the Treaty of Amity and Cooperation to which all ASEAN countries are signatories, the Parties concerned in these disputes are committed to a peaceful settlement through negotiations.

Cambodia of course is struggling to consolidate its stability. The country is still threatened by internal insurgency of the Khmer Rouge. But a legitimate duly elected Government is in place and is receiving international support.

Rival territorial claims in the Spratlys in the South China Sea gives rise to the most serious concern, not only because of the area's strategic character and its estimated wealth in terms of oil and gas deposits but also because of the number of countries involved which include apart from ASEAN countries (Brunei, Malaysia and Philippines), also non-ASEAN countries like China, Taiwan and Vietnam all of whom have considerable military muscle while Vietnam and China have been engaged in actual fighting in pursuit of their claims. Conscious that any adverse developments in the South China Sea directly affect the peace and stability in the region, ASEAN Foreign Ministers issued the Manila Declaration on the South China Sea of 22 November 1992 urging restraint and peaceful resolution of the problem and maritime cooperation without prejudice to sovereignty and jurisdiction. There are ongoing efforts to diffuse the potentially explosive situation.

6. As mentioned earlier, there is apprehension and uncertainty over possible new sources of danger and instability emerging in the larger Asian scene - outside Southeast Asia - but which directly affects the region's security. The

Korean Peninsular is still a source of tension although diplomatic efforts are underway to diffuse the crisis. But of greater relevance in the longer term is the emergence of regional powers in Asia with large economic and manpower resources and with potential to become world superpowers. At present, these regional powers are pursuing policies conducive to peaceful cooperation and it is of the utmost importance to keep this momentum going for mutual good, and for the long term peace and stability of the Asia Pacific region.

7. The scenario as described above, despite some negative factors, still offers a good prospect for peace and stability in the region in the short and medium term. The challenge facing the countries of Southeast Asia is how to maintain the momentum of peace and to build and consolidate a regime of regional peace and stability.

ASEAN

8. A plus factor in this regard is that a regional organization i.e. ASEAN is already in place with a proven track record of versatility, flexibility and dynamism in coping with regional, political and security issues in the past two decades. Although primarily concerned with economic and social issues, ASEAN has taken some notable initiatives in the area of confidence building and preventive diplomacy for peace and security. In 1970, it issued the KL Declaration on A Zone of Peace, Freedom and Neutrality (ZOPFAN) designed to keep the Southeast Asian region free from great power rivalries. In 1977, during its first summit meeting in Bali, ASEAN countries signed the Treaty of Amity and Cooperation laying down a code of conduct for peaceful relations among signatory countries and providing a mechanism for the peaceful settlement of disputes. Following the Bali Summit, ASEAN started the annual Post-Ministerial Conference i.e. a meeting between ASEAN ministers and the ministers of the Dialogue partners (Australia, Canada,

European Community, Japan, New Zealand, USA and more recently South Korea). The PMC has proven to be a useful forum for high-level dialogue not only on economic cooperation but also on political and security issues, for example, the Cambodian question and the problem of Vietnamese refugees. The PMC can be credited with having made substantial contribution to the success of UN diplomatic efforts in the solution of the Cambodian problem.

<u>ASEAN Regional Forum</u>

9. As an extension of the PMC, ASEAN has initiated the ASEAN Regional Forum (ARF) as a vehicle for the multilateral dialogue to take stock of the evolving post-Cold War security situation as well as promote confidence and trust. The Chairman's Statement, which was issued at the end of the first ARF in Bangkok in July 1994, pointed out that the ARF, as a high level consultative forum meeting annually, would enable countries in the Asia Pacific region to foster the habit of constructive dialogue and consultation for political and security issues of common concern and thus contribute to efforts towards confidence building and preventive diplomacy in the region.

10. The ARF has strong potential to be an effective forum for dialogue to deal with the uncertainties of the post-Cold War security situation in Southeast Asia. The spread of its membership is unique for a regional forum. It includes not only the ASEAN 6, plus Cambodia, Laos, Papua New Guinea and Vietnam (All Southeast Asian countries) but also non-regional countries who are dialogue partners of ASEAN (Australia, Canada, European Community, Japan, New Zealand Republic of Korea and USA), and consultative partners (China and Russia), representing almost the entire Asia Pacific region with European participation as well. Equally significant is the fact that ARF membership includes all the Permanent Members of the UN Security Council. Already a number of other non-regional countries have expressed an interest to participate in the ARF.

11. Despite the wide geographical spread of its membership, ARF is ASEAN-centred and intended primarily to enhance security in Southeast Asia and continued stability and economic development. Given the strategic character of Southeast Asia (in military, political and economic terms), the participation of the world's major powers and regional powers will help to harmonise interests and ensure the freedom of Southeast Asia from big power rivalries and conflicts.

Nuclear Non-Proliferation

12. In the context of the Asia Pacific region, the ARF can effectively contribute towards creating conditions of peace and confidence that could help reduce the threat of nuclear proliferation. Any measure that diffuses crisis, and reduces tension, at local or regional level, is a contribution towards de-escalating the arms race. The endorsement by the ARF of the purposes and principles of the Treaty of Amity and Cooperation in Southeast Asia is a recognition of the Treaty as a unique diplomatic instrument for confidence building, preventive diplomacy and security cooperation. Furthermore, this endorsement can encourage ASEAN to push forward with its own design of Zone of Peace and Nuclear Weapons Free Zone.

13. The Nuclear Non-Proliferation Treaty (NPT) has been in force for 25 years but has not succeeded in eliminating the threat of nuclear proliferation. A number of threshold countries have not acceded to the Treaty while some who have are suspected of not fully observing their obligations under the Treaty. The dissolution of the Soviet Union had left some states in the former Soviet Union in possession of nuclear arsenals and expertise in the development of nuclear weapons. Efforts to achieve universality of accession to the Treaty must assume urgency in the agenda of the international community. A number of countries have recently acceded to the Treaty (Algeria, Moldova, South Africa,

Turkmenistan, Tajikistan and Ukraine) and it is vitally important that this momentum is maintained towards complete universality.

NPT

14. A major weakness in the NPT is its discrimination between nuclear weapon states and non-nuclear weapon states. As long as the nuclear weapon states continue to base their security on the development of large nuclear arsenals, other states will also seek to acquire nuclear weapons. This is especially true if such states feel threatened by adversary states - such mutual fears inevitably leads to an arms race and, in the case of threshold countries to nuclear armament.

15. The nuclear powers therefore have a clear responsibility for the success or otherwise of the NPT, as they have the power and obligation to ensure an end to the nuclear arms race and the phasing out of nuclear weapons. The reaffirmation of their commitment to the complete elimination of nuclear weapons with time-bound framework and target dates will create a strong political thrust towards international efforts to prevent the spread of nuclear weapons.

16. In the same context, the nuclear powers should agree to a Comprehensive Nuclear Test Ban Treaty (CTBT), the conclusion of which remains one of the highest priority objectives of the international community and is a fundamental pillar of an effective and comprehensive non-proliferation regime.

17. The establishment of Zones of Peace and Nuclear Weapons Free Zones (NWFZ) in various parts of the world have assisted in deterring the spread of nuclear weapons and in promoting nuclear disarmament. Two formal nuclear non-proliferation regimes at the regional level i.e. the Treaty for the Prohibition of

Nuclear Weapons in Latin America (Treaty of Tlateloco) and the South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga) have helped to foster confidence and security. In the case of Southeast Asia, ASEAN has declared its intention to establish a Zone of Peace, Freedom and Neutrality (ZOPFAN) and a Nuclear Weapons Free Zone. The establishment of such zones should be encouraged as they would help create conditions conducive to peace and stability as well as to promote regional confidence building.

18. The nuclear powers should abide by and adhere to those international instruments that have established the NWFZ and to support initiatives taken by a State or States Parties with a view to establishing NWFZ. Deployment of nuclear weapons on foreign territories should be prohibited as it negates the objectives of the NWFZ. All States that have deployed nuclear weapons outside their boundaries should withdraw all those weapons back to their own territories.

<u>The Review Conference</u>

19. The forthcoming Review Conference of the NPT provides an opportunity to strengthen the NPT into a truly universal instrument to eliminate nuclear weapons as well as ensure non-proliferation while encouraging cooperation in the peaceful use of nuclear energy. The experience of the present Treaty has demonstrated that extension alone is not enough. The Review Conference has to address the evident weakness of the present Treaty and come out with a new Treaty that provides clear undertakings and measures to build confidence and security assurances which more than anything else can ensure complete adherence and universality. Among these undertakings and measures, in which the nuclear powers must show courage, leadership and responsibility, are comprehensive test ban, reduction of their nuclear arsenals and commitment to general and complete disarmament. These undertakings, to be built into the new Treaty must include specific time tables and monitoring mechanisms. A Comprehensive Test Ban is the

most important factor in the areas of confidence building measures because of its tremendous psychological impact.

20. Treaties and legal instruments alone are not enough to build confidence. The international community, especially the major powers, must match treaty obligations with a responsible approach to the world security problems. Especially in the area of nuclear disarmament, the major nuclear powers have not only a heavy obligation but the power to make the NPT a success.

Kuala Lumpur
8 April 1995