RUSSIAN FEDERATION *

MEMORANDUM OF UNDERSTANDING BETWEEN THE INSTITUTE OF NUCLEAR ENERGY RESEARCH AND KURCHATOV INSTITUTE

Signed on April 28, 1995
Entered into force on April 28, 1995

The Institute of Nuclear Energy Research (hereafter called INER), of the Atomic Energy Council, in Lung-Tan, Tao-Yuan, Taiwan is a major nuclear science and technology research institute in the Republic of China.

The Russian Research Center (RRC, Kurchatov Institute) in Moscow, Russia is the oldest and largest research institute in the area of fundamental and applied research for nuclear science and technology.

Follow discussions and visits to facilities in INER by President and Academician E. P. Velikhov, it is recognized that INER and Kurchatov Institute have compatible and complementary areas of interest and expertise. Areas preliminarily indentified as being of possible cooperation and complementarity include the following:

- Artificial diamond coating technology.
- Treatment of radioactive and hazardous/wastes by plasma technology.
- CdZnTe crystal growth technology.
- TRR Ⅱ research reactor engineering design supporting.
- Stable isotopes (Xe-124, Tl-203, Cd-112, Zn-68, etc.) and radioisotope, (W-188, Sm-153, Cu-67, Ir-192) supplies.

俄羅斯聯邦 *

〔核能研究所與科柴多夫研究所瞭解備忘錄〕（中譯本）

八十四年四月二十八日簽署
八十四年四月二十八日生效

位於中華民國臺灣省桃園龍潭之原子能委員會核能研究所（以下簡稱核研所），係中華民國一主要核子科技研究機構，而位於俄羅斯莫斯科之俄羅斯研究中心（RRC，科柴多夫研究所），係俄羅斯在核子科技之基礎與應用研究方面，成立最久及最大之研究機構。

經由E.P. Velikhov總裁兼院士來核研所訪問並討論後，核研所與科柴多夫研究所雙方均認為在專長與興趣方面具有相容與互補性。初步確認之可能合作與互補領域，包括有下列各項：

- 人工鑽石被覆技術
- 放射性與有害廢棄物之電漿處理技術
- 鎘鋅碲晶體成長技術
- TRR Ⅱ研究反應器工程設計支援
- 穩定同位素（氙-124、鉈-203、鎘-112、鋅-68等）與放射性同位素（鎢-188、釤-153、銅-67、銥-192）之供應

- Cyclotron produced radioisotope technology development.
- Nuclear power reactor fuel examination technology.
- Nuclear power reactor risk assessment technology.
- Controlled fusion technology.

some of the technical information see the attachments.

In recognition of the spirit in which the discussions between the two parties were conducted, the intention is hereby stated of negotiating formal agreements. The provisions of this Memorandum of Understanding between INER and the Kurchatov Institute, which must be prepared for review and approval by the Boards of Management of both INER and RRC.

It is the objective of this Memorandum of Understanding that effort will be made to identify the specific area of technical cooperation and to prepare a formal agreement for the necessary reviews, approvals and signatures.

Done at Taipei, in duplicate, in the English language on this April day 28, 1995.

for INER
[Signed]
Der-Yu Hsia
Director

for Kurchatov Institute
[Signed]
Evgenii P. Velikhov
President

- 迴旋加速器生產同位素技術發展
- 核燃料檢驗技術
- 核能反應器安全度評估技術
- 核融合控制技術

至於相關之技術資料，請參閱附件。

雙方經討論均承認有意願談判一正式之協議書。核研所與科柴多夫研究所之協議備忘錄內的所有條文，均需經由雙方主管機關之審查與核准。

本協議備忘錄之目的，即為確認特定之技術合作領域，以及準備一正式之協議書，以進行必要之審查、核准與簽署。

本協議書在台北簽署，以英文繕打兩份，1995年四月二十八日。

核研所
所長
夏德鈺〔簽字〕

科柴多夫研究所
總　裁
Evgenii P. Velikhov〔簽字〕

ATTACHMENT
TECHNICAL INFORMATION

附件、技術資料

I .Physics Related Technology

一、物理相關技術

1. Artificial Diamond Coating

1. 人工鑽石被覆

(1) Description about the present accomplishment at Kurchatov

(1) 目前科柴多夫研究所已有產品或技術之說明。

(2) Any technical help offered for its equipment and processes

(2) 對於其設備與流程所需之任何技術性協助。

(3) The person and the address to contact for this item.

(3) 本項之連絡人員與通訊地址。

2. Simultaneous Treatment of Radioactive and Hazardous Wastes by Plasma Processing

2. 利用電漿流程對放射性與有害廢棄物之同時處理

(1) Design, fabrication and operation of high-average power plasma torch (greater than 500 kw)

(1) 高平均能電漿炬（大於500仟瓦）之設計、製造與操作。

(2) Design, fabrication and operation of plasma furnace (greater than 1600℃ and 200 kg/hr) and its associated off-gas treatment

(2) 電漿爐（大於1600℃及200公斤／小時）與其相關廢氣處理設施之設計、製造與運轉。

(3) The present accomplishment at Kurchatov for the radioactive, hazardous, toxic wastes.

(3) 目前在科柴多夫研究所已完成之放射性、有害及有毒廢棄物處理的相關說明。

3. A high-frequency gyrotron system for industrial application, like ceramic sintering

3. 高頻率gyrotron系統之工業應用如陶瓷燒結（Sintering）。

4. Ion Implantation Technique and the Plasma-Chemical Reactor

4. 離子種植技術與電漿——化學反應器

(1) The accomplishment in more details

(1) 已完成技術之詳細說明

II. Supply of Stable-Isotopes and Radioisotopes

二、穩定同位素與放射性同位素之

1. Supply of radioisotopes from Russia for R/D of therapeutic radiopharmaceutical

   (1) W-188 isotope in hundred mCi order

   (2) Cu-67 isotope in hundred mCi order

   (3) Sm-153 isotope in hundred mCi order

   (4) Ir-192 isotope in ten thousand Ci order

2. Quotation and supply of stable enriched isotopes from Russia for cyclotron target material.

   (1) Xe-124 gas in liter order (enriched Xe-124>99.8%)

   (2) Tl-203 in 10 grams order (enriched Tl-203>99%)

   (3) Cd-112 in 10 grams order (enriched Cd-112>99%)

   (4) Zn-68 in 10 grams order (enriched Zn-68>99%)

   (5) O-18-H_2O in 100 ml order (enriched O-18>99%)

Ⅲ. Cd_{1-x} Zn_x Te Crystal Growth for Nuclear Radiation Detectors

Features of Cd_{1-x} Zn_x Te radiation detectors include: energy resolutions at 122 KeV<7%, resistivity approximately 10^11 Ω-cm, no polarization effect, and

供應

1. 來自俄羅斯對於治療用放射性藥物研發之放射性同位素的供應

   (1) 鎢-188同位素（百毫居里量級）

   (2) 銅-67同位素（百毫居里量級）

   (3) 釤-153同位素（百毫居里量級）

   (4) 銥-192同位素（萬居里量級）

2. 由俄羅斯訂購與供應做為迴旋加速器靶材之濃縮穩定同位素

   (1) 氙-124氣體以公升量級（濃縮氙-124大於99.8%）

   (2) 鉈-203以10公克量級（濃縮鉈-203大於99%）

   (3) 鎘-112以10公克量級（濃縮鎘-112大於99%）

   (4) 鋅-68以10公克量級（濃縮鋅-68大於99%）

   (5) O-18-H_2O以100毫升量級（濃縮氧-18大於99%）

三、輻射偵檢器之Cd_{1-x}ZnxTe晶體成長

Cd_{1-x}ZnxTe輻射偵檢器特徵包括：在122仟電子伏之能量鑑別力小於7%，電阻大約在10^{11}歐姆一厘

temperature for useful operation up to 100℃. Therefore, Cd_{1-x} Zn_x Te radiation detectors can be widely used for various monitor systems, particularly, in the detection of high-temperature radiation fields. The goal of this program is to develop radiation detectors for high-temperature applications

米，無偏極化效應（polarization effect），以及達100℃仍勘使用。所以，Cd_{1-x}ZnxTe輻射偵檢器能被廣泛使用在各種偵檢系統中，特別在高溫輻射場中之偵測。本計畫之目標即為發展一應用在高溫之輻射偵檢器。

Program targets:

(1) to develop the growth technology of high-resistivity Cd_{1-x} Zn_x Te crystals.

(2) to develop the fabrication processes of Cd_{1-x} Zn_x Te radiation detectors.

(3) to construct the radiation detection instruments applied to the high-temperature radiation fields.

計畫目標：

1. 發展高電阻Cd_{1-x}ZnxTe晶體之成長技術

2. 發展Cd_{1-x}ZnxTe輻射偵檢器之製造流程

3. 製造應用在高溫輻射場之輻射偵檢儀器

Needed Technologies:

(1) high-pressure crystal growth system for Cd_{1-x} Zn_x Te material.

(2) crystal growth conditions of Cd_{1-x} Zn_x Te with high-resistivity 10^{10}~10^{11} Ω-cm.

(3) fabrication of Cd_{1-x} Zn_x Te nuclear radiation detectors.

所需技術：

1. Cd_{1-x}ZnxTe材之高壓晶體成長系統

2. 高電阻10^{10}－10^{11}歐姆一厘米Cd_{1-x}ZnxTe之晶體成長條件

3. Cd_{1-x}ZnxTe輻射偵檢器之製造

IV. Advanced Research Reactor Technology.

四、進步型研究反應器技術

1. General Information for Advanced Research Reactor.

1. 進步型研究反應器之一般資料

(1) Operation, Maintenance Experience of Research Reactor in Russia.

(2) The strategy of the future development for Research Reactor in Russia.

(1) 俄羅斯在研究反應器之運轉與維護經驗

(2) 俄羅斯未來在研究反應器之發展策略

2. Design and Construction of an Advanced Research Reactor.

   (1) Selection Criteria for Advanced Research Reactor.

   (2) Advanced Design and State-of-the-art Technology for Advanced Research Reactor.

   (3) Code standard and Safety Regulation to be followed for Advanced Research Reactor in Russia.

3. Utilization Program of an Advanced Research Reactor.

   (1) National R/D Program supported by Research Reactor.

   (2) Cost-benefit Evaluation for Utilization Program of an Advanced Research Reactor.

4. Design and Construction of Experimental Facilities and Utilization Technics for Advanced Research Reactor.

   (1) Fuel and Material Test.

   (2) Neutron Transmutation Dopping.

   (3) Boron Neutron Capture Therapy.

   (4) Water Radiochemistry.

   (5) Cold Neutron Source and Neutron Beam Experiment.

   (6) Neutron Activation Analysis.

2 進步型研究反應器之設計與建造

   (1) 進步型研究反應器之篩選原則

   (2) 進步型研究反應器之進步型設計與相關技術

   (3) 俄羅斯進步型反應器所採用之相關標準與安全法規

3. 進步型研究反應器之應用計畫

   (1) 研究反應器支援之國家級研發計畫

   (2) 進步型研究反應器之應用計畫的成本——效益評估

4. 進步型研究反應器之實驗設施設計與建造及應用技術

   (1) 核燃料與材料試驗

   (2) 中子轉化技術（Neutron transmutation dopping）

   (3) 硼中子捕獲治療

   (4) 反應器水化學

   (5) 冷中子源與中子射束實驗

   (6) 中子活化分析