INDUSTRIAL STERILIZATION OF MEDICAL SUPPLIES

TURKEY

TERMINAL REPORT
PROJECT FINDINGS AND RECOMMENDATIONS

Report prepared for
the Government of Turkey

by

the International Atomic Energy Agency
acting as Executing Agency for
the United Nations Development Programme

UNITED NATIONS DEVELOPMENT PROGRAMME
INTERNATIONAL ATOMIC ENERGY AGENCY

30 - 47
REPORT SUMMARY SHEET

a) Country: Turkey

Project title: Industrial Sterilization of Medical Supplies

UNDP Number: TUR/88/040/A01/18

b) Total contributions:

Government (in kind): T.L. 800,000,000
Government (in cash):
UNDP: $400,056 ; Government Cost Sharing $300,418
IAEA:

c) Executing Agency:
International Atomic Energy Agency (IAEA)

d) Name of the report: Terminal Report, Project Findings and Recommendations

e) Technical Officer: Vitomir Markovic, Industrial Applications and Chemistry Section, Department of Research and Isotopes, IAEA.

f) (i) Objectives

To create the capability to use modern industrial sterilization techniques in the manufacture of health care products and to upgrade the quality of health care products indigenously manufactured. The immediate objective has been achieved by setting up a Radiation Sterilization Service Center in Ankara. The long term objective, the improvement of standards of health care and the competitiveness of the Turkish health care industry on the world market, is expected to be achieved very soon.

(ii) Achievements

1. The Radiation Sterilization Service Center has been constructed and put into operation.
2. Basic infrastructure (personnel, laboratories, management) for operation, further development and for transfer of the technology to private industry has been established.
(iii) **Findings and recommendations.**

The Turkish Atomic Energy Authority (TAEK) was an excellent counterpart for implementation of the project. It is recommended further support by the Government (particularly for regulations), by the IAEA and UNDP for similar projects in other countries.

Well designed projects with relatively modest inputs can produce benefits to the country on a large scale in several sectors at the same time, like in this case, industry and health care.

(iv) **Place and date of Publication.**

Vienna, August 1995

(v) **Date transmitted to recipients.**

August 1995

(vi) **Restriction.**

Derestriction is requested.
REPORT
1. Development and immediate problems tackled.

1.1. Development problems.

In Turkey the importance of using disposable (single use) medical products in health care has been recognized some time ago. Quite substantial indigenous industry has been developed to manufacture health care products for single use in main industrial centers: Istanbul, Ankara and some other locations. These products are supposed to be marketed as "sterile" and sterilization is the final and the most important part of the manufacturing process. The aseptic production, often used by the pharmaceutical industry, that provides sterile products without sterilization is neither practical nor economically viable. Sterilization of the end-product in its final and hermetic packaging is the only alternative. Heat sterilization is applicable to only about 5% of all products as most of them are heat sensitive. There are only two alternatives to heat, "cold" processes: exposure to radiation, and exposure to toxic gas, usually ethylene oxide (EO), in pure form or in a mixture with Argon or Nitrogen. EO has been in use since the early 1950s and radiation since the early 1960s. The competitive edge of the two technologies has gradually changed in the favour of radiation. Presently, in North America, Western Europe and Japan more than 50% of all medical products are sterilized by radiation and the number is very likely to grow to about 80% in a few years. The reason for industry’s preference to use radiation instead of EO is because of several inherent advantages: environmental safety, occupational safety, no residues of any kind in the product (the type of radiation used does not produce radioactivity in the irradiated products), and economic competitiveness.

The medical products industry in Turkey is currently using only the EO technology, making Turkey one of the few countries in Europe that does not have a capability to use radiation sterilization technology.

There is a big demand for industrial sterilization in Turkey (Annex 1). It was necessary to develop a capability to use the most modern technique, radiation sterilization, which is particularly important in the view of new forthcoming European and international (ISO) regulations.

1.2. Immediate problems.

In spite of well developed medical products industry, there was no possibility to use the most modern and most reliable industrial sterilization radiation technique.
2. Objectives.

2.1. Immediate objectives.

The immediate objectives were to establish and start operating a radiation sterilization service center and build the infrastructure for management, process and quality control, including drafting of regulations and standards harmonized with international trends (ISO).

2.2. Long term objectives.

Long term objectives are the improvement of standards of health care by providing a more reliable manufacturing process, especially in the sterilization of health care products. The existence of the center in Ankara will significantly facilitate establishing a similar center in Istanbul, since even before the project's completion a private investor decided upon its foundation. This project will enable the Turkish medical products industry to be competitive on a world market scale (estimated to be US $60 billion annually) and will provide high quality medical products for domestic use.

3. Achievements.

3.1. Radiation Sterilization Service Center.

A new radiation center has been established at the Saraykoy Nuclear Research Center, near Ankara, comprising the Co-60 gamma radiation facility including all required premises and installations for continuous operation and provision of radiation sterilization services to the local industry with initial capacity of 2,240 m$^3$/y and design capacity of up to about 22,400 m$^3$/y. The present capacity can be increased to the maximum with only the addition of more Co-60 isotope, without any need for further investment in the engineering part. Radiation safety is also designed to the maximum capacity.

Technical details and specifications of Radiation Sterilization Service Center are given in the Annex 2.

3.2. Regulations.

The basis for establishing national regulations for industrial sterilization of health care products (including radiation sterilization) has been created in accordance with requirements of the European Community and recommendations and guidelines from the International Standards Organization (ISO).

The draft of national regulations for industrial sterilization is given in Annex 3.

3.3. Infrastructure.

A capability to implement the new technology, to control the process of industrial sterilization, and to provide quality assurance in accordance with international standards has been established. It comprises laboratories with adequate equipment and trained personnel for process control, control of compatibility of materials with irradiation procedure, quality control (sterilization assurance), management and safe operation of the irradiation facility.
The personnel involved and laboratories established provide also a capability for further development of technology and new applications.

3.4. Long term impact.

Availability of radiation sterilization services on an industrial scale, particularly in the Ankara region, provides an incentive to industry to use this modern sterilization technology and benefit from its ecological and economical advantages.

3.5. Problems encountered.

No major problems were encountered during the implementation of the project.

4. Findings and lessons learned.

This project has demonstrated, like other similar UNDP/IAEA projects, that the transfer of radiation technology can be effectively carried out through international cooperation and that the National Atomic Energy Authority is an excellent counterpart for the project. That is because the Atomic Energy Authority possesses the basic infrastructure for such a project which many industries and private companies do not have.

This project has demonstrated that once the technology has been introduced it is quickly transferred further to the private sector, as has happened in many other countries.

5. Recommendations

5.1. To the Government.
- To continue supporting the operation of the radiation facility at the Saraykoy Center as a model facility and training center for private industry and as a service to local manufacturers of health care products.
- To provide support to TAEK for further strengthening of infrastructure in radiation processing and technology.
- To develop as a highest priority regulations and standards for industrial sterilization of health care products including the three main technologies (Radiation, Heat, EO) in accordance with standards developed by the ISO.

5.2. To the executing agency.
- To provide continuous support in the field of industrial applications of radiation technology.
- To consider in due time, using the establishment and facilities at the Saraykoy center as the training ground, individual or group training, and as a means for transfer of new technologies to the countries of the Middle East and North Africa.

5.3. To the UNDP.
- To consider providing similar assistance to other developing countries in the field of industrial sterilization of medical supplies.
LIST OF ANNEXES.

1. Industrial sterilization in Turkey.
2. Technical details, description and specification of radiation sterilization service center.
3. List of major pieces of equipment provided (besides the irradiator).
4. List of fellowships and scientific visits.
5. List of expert missions.
6. List of national training courses and seminars.
ANNEXES
INDUSTRIAL STERILIZATION

IN TURKEY

A. YILMAZ ERKOL
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEYBI</td>
<td>Istanbul</td>
</tr>
<tr>
<td>ELSAN</td>
<td>Istanbul</td>
</tr>
<tr>
<td>MEDEKS</td>
<td>Istanbul</td>
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<tr>
<td>TIP FEN</td>
<td>Istanbul</td>
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<tr>
<td>KANSUK</td>
<td>Istanbul</td>
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<td>TIP TETNIK</td>
<td>Istanbul</td>
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<tr>
<td>BIMED</td>
<td>Istanbul</td>
</tr>
<tr>
<td>AKIN.</td>
<td>Istanbul</td>
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<tr>
<td>IPEK</td>
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<tr>
<td>IBRAHIM ETM</td>
<td>Istanbul</td>
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<tr>
<td>MERKEZ LAB.</td>
<td>Istanbul</td>
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<td>KOC</td>
<td>Istanbul</td>
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<td>TOPRAK</td>
<td>Istanbul</td>
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<td>IPEK</td>
<td>Istanbul</td>
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<tr>
<td>SOPER MEDIKAL</td>
<td>Istanbul</td>
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<td>DISPOMED</td>
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<td>FEGET</td>
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<td>BIRG</td>
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<td>TIBAS</td>
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<td>DETAS</td>
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<td>HAVER</td>
<td>Istanbul</td>
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<td>KANSUK</td>
<td>Ankara</td>
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<td>DOGSAN</td>
<td>Trabzon</td>
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<td>ORFEN</td>
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<td>KUTEKS</td>
<td>Nazilli</td>
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<tr>
<td>KATSAN</td>
<td>izmir</td>
</tr>
<tr>
<td>ADIL BOZ</td>
<td>USak</td>
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<tr>
<td>AGAOGLU</td>
<td>USak</td>
</tr>
<tr>
<td>GERCEK</td>
<td>Iskenderun</td>
</tr>
<tr>
<td>FILSAN</td>
<td>Gaziantep</td>
</tr>
<tr>
<td>SEMTEKS</td>
<td>Adana</td>
</tr>
<tr>
<td>SAHINLER</td>
<td>Adana</td>
</tr>
</tbody>
</table>

- **Products**
  - Surgical Gloves
  - Sutures
  - Syringes
  - Syringes
  - Syringes
  - Cotton Wool
  - Infusion Sets
  - Bandages
  - Bandages
  - Sanitary Pads
  - Sanitary Pads
  - Sanitary Pads
  - Petri Dishes
  - Sample Vessels
  - Reactive Tubes
  - Blood Bags
  - Sutures
  - Sutures
  - Gauze Dressing
  - Gauze Dressing
  - Gauze Dressing
  - Bandages
  - Sutures
  - Cotton Wool
  - Gauze Dressing
  - Cotton Wool
  - Gauze Dressing
  - Cotton Wool
TECHNICAL DETAILS, DESCRIPTION AND SPECIFICATIONS

OF

RADIATION STERILIZATION SERVICE CENTER
TIBSET

* Location: ISTANBUL

* Commissioning Year: 1977
* Capacity: 60 million syringes year
* Product Range: 1, 2, 2.5, 5, 10, 20, 50 ml syringe
* Sterilization:
  - 3.5 ms EtO Chamber
  - EtO + Freon
* Other Products:
  - Butterfly Sets - Urine Sonda
  - Surgical Gloves - Stomach Sonda
  - Catheters - Masks
  - Needles - Condoms
* Applied Tests:
  - Sterility - Pyrogen Test (LAL)
  - Rabbit Test - Residue Determination
* Raw Materials:
  - Polyethylene
  - Polypropylene
  - Rubber
ECZACIBASI

* Location: ISTANBUL

* Capacity:  - 15 million infusion sets
             - 17 million infusion fluids

* Sterilization:
  - 3 x 3.5 m³ Chamber
  - Formaldehyde or EtO

* Production Technology: Mc Graw - USA

* Other Products:
  - Surgical Tubes
  - Catheters
  - Catheters for Dialysis - Blood Giving Sets

* Raw Materials:
  - PVC
  - ABS
  - Low Density PE
  - Latex
USTAY

* Location: ISTANBUL
* Commissioning Year: 1987
* Capacity: 150 million syringes/year
* Production Technology: German know-how
* Product Range: 2, 5, 10 ml, Insuline 80 Syringes

* Sterilization:
  - 15 ms EtO Chamber
  - 4 cycles/day
  - EtO (pure)

* Applied Tests:
  - Sterility Test
  - Residue Determination
  - Pyrogen Test
  - Toxicity Test

* Raw Materials:
  - Polypropylene
  - Polyethylene

* Packaging Materials: Polyamide - Polyethylene

* Other Products:
  - Urine Bags (non-sterile)
  - Catheter (planned to be produced)

* Sterilized Products (for other manufacturers):
  - Surgical Gloves
  - Sutures
* Location: QORUM
* Capacity: 75 million syringes / year
* Production Technology: Italian/German know-how
* Commissioning Year: 1988
* Product Range: 2 ml, 5 ml, 10 ml, 20 ml syringes
* Sterilization:
  - 16 m$^3$ EtO Chamber
  - EtO : CO$_2$ = 10 : 90
* Ventillation Rate: 4 times / hr
* Quarantine Time: 2 weeks
* Raw Materials:
  - Polypropylene (Medical Grade)
BICAKCILAR

* Location: ISTANBUL

* Products:
  - Medical Tubing
  - Tube Set
  - Drainage Set
  - 3 - Way Stopcock for CVP
  - Urine Bag (5 million)
  - Butterfly Set (3.5 million)

* Sterilization:
  - 5 ms EtO Chamber
  - EtO : CO₂ = 3 : 27
  - 150 cycles year 750 m³/year
  - Ventilation Rate: 12 times/hr

* Raw Materials:
  - PVC
  - Polyethylene
  - Polycarbonate

* Other Products:
  - Surgical Aspirator
  - Vacuum Extractor / Curettage Aspirator
  - Oxygen Therapy Devices
  - Drainage Jar Systems
* Location: Cubuk - ANKARA
* Capacity: 100 million syringes/year
* Commissioning Date: 1990
* Sterilization
  - 16 m³ EtO Chamber
  - Cycle: 7 hr
  - EtO : CO₂ = 10 : 90
* Product Range: 2 ml, 5 ml, 10 ml syringes
* Ventilation Rate: 7 times/hr
* Products plan to be produced:
  - Needles
  - Condoms
  - Gloves
  - Other medical devices
* Raw Materials:
  - Polyethylene
  - Polypropylene
  - Natural Rubber
* Owners:
  - 51% : Ministry of Health
  - 39% : Red.Crescent
  - 10% : Foundation of Woman
LIST OF MAJOR PIECES OF EQUIPMENT PROVIDED
List of major pieces of equipment provided:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instron Model 1011</td>
<td>$ 29,517.45</td>
</tr>
<tr>
<td>Universal Testing Instrument &amp; Accessories</td>
<td>$ 29,517.45</td>
</tr>
<tr>
<td>Laboratory Equipment &amp; Supplies</td>
<td>$ 1,155.64</td>
</tr>
<tr>
<td>Laboratory Equipment</td>
<td>$ 8,502.43</td>
</tr>
<tr>
<td>Plastic Laboratory (Melt Flow)</td>
<td>$ 4,850.69</td>
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</tbody>
</table>
LIST OF FELLOWSHIPS AND SCIENTIFIC VISITS
**TUR/7/005 (UNDP) FELLOWSHIP & SCIENTIFIC VISIT**

<table>
<thead>
<tr>
<th>NAME</th>
<th>PERIOD</th>
<th>PLACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Galip Siyakus (Fellowship)</td>
<td>07/02/92 to 06/08/92 (5 mm/29DD)</td>
<td>Hungary: Frederic Joliot Curie National Research Institute for Radiobiology Radiohygiene</td>
</tr>
<tr>
<td>Mr. Umit Demirezen (Fellowship)</td>
<td>15/11/92 to 15/02/93 (3 Months)</td>
<td>Hungary: Institute of Isotopes of the Hungarian Academy of Sciences</td>
</tr>
<tr>
<td>Mr. Galip Arl (Fellowship)</td>
<td>02/09/92 to 02/12/92 (3 Months)</td>
<td>Hungary: Research Institute for Plastic Industry</td>
</tr>
<tr>
<td>Mr. Dogan Tarakli (Fellowship)</td>
<td>30/06/92 to 29/09/92 (3 Months)</td>
<td>Hungary: Institute of Isotopes of the Hungarian Academy of Sciences</td>
</tr>
<tr>
<td>Ms. Seniha Akin (Scientific Visit)</td>
<td>07/04/92 to 06/05/92 (1 Month)</td>
<td>Hungary: Frederic Joliot Curie National Research Institute For Radiobiology Radiohygiene</td>
</tr>
<tr>
<td>Mr. A. Canguzel Taner (Scientific Visit)</td>
<td>Nov.'91 to Dec.'91 (3 weeks)</td>
<td>USA: Isomedix</td>
</tr>
<tr>
<td>a)</td>
<td></td>
<td>USA: Isomedix</td>
</tr>
<tr>
<td>b)</td>
<td>05/11/90 to 16/11/90 (12 days)</td>
<td>Italy: ILO, Trq Center Turin</td>
</tr>
<tr>
<td>Mr. Afsar T. Taner (Scientific Visit)</td>
<td>25/06/90 to 29/06/90 (7 Days)</td>
<td>Hungary: Institute of Isotopes</td>
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<tr>
<td>Mr. Erkol Ali Yilmaz (Scientific Visit)</td>
<td>25/6/90 to 29/6/90 (7 Days)</td>
<td>Hungary: Institute of Isotopes</td>
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<tr>
<td>Ms. Meral Basgul (Fellowship)</td>
<td></td>
<td>U.K Fellowship awarded and application being processed</td>
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Total Budgeted: $57,013
* Total Utilized: $37,000 (approx.)
Balance Available: $20,000 (approx.)

* Estimate only, including commitments and revised periods for items 2 & 9
LIST OF EXPERT MISSIONS
# EXPERTS SERVICES (IAEA) TUR/7/004

<table>
<thead>
<tr>
<th>Subject / Name / Country</th>
<th>Period</th>
<th>mm/DD</th>
</tr>
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<tbody>
<tr>
<td>1. Feasibility Study of Industrial Radiation Sterilization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IYA Vasudeva Kilara (India)</td>
<td>30/01/90 to 11/03/90</td>
<td>1/13</td>
</tr>
<tr>
<td>2. Project Implementation; Civil Engineering Design</td>
<td></td>
<td></td>
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<tr>
<td>Markovic Vitomir M. (Yugoslavia-IAEA)</td>
<td>10/06/90 to 13/06/90</td>
<td>0/4</td>
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<tr>
<td>rows with dates are repeated to fill column</td>
<td></td>
<td></td>
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<tr>
<td>3. National Training Course on Radiation Sterilization</td>
<td></td>
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<tr>
<td>Markovic Vitomir M. (Yugoslavia-IAEA)</td>
<td>23/09/90 to 28/09/90</td>
<td>0/6</td>
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<tr>
<td>4. a- Radiation Safety System</td>
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<tr>
<td>b-Safety Report and Safety system-Evaluation</td>
<td></td>
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<tr>
<td>Mrs. Milton Marion Isabel (UK)</td>
<td>21/06/92 to 27/06/92</td>
<td>0/7</td>
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<td></td>
<td>March/April '93</td>
<td>0/12</td>
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<tr>
<td>5. Consultants</td>
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<td></td>
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<tr>
<td>Mukkerjee Ramendra (India-IAEA)</td>
<td>01/11/92 to 07/11/92</td>
<td>0/7</td>
</tr>
<tr>
<td>Markovic Vitomir (Yugoslavia-IAEA)</td>
<td>08/11/92 to 14/11/92</td>
<td>0/7</td>
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**Total Expert Service Used and Committed**: 3 mm / 3 d

**Total Budgeted**: 3 mm / 23 DD

**Balance Available**: 20 DD
### Experts Services (UNDP) TUR/7/005

**NAME / COUNTRY** | **PERIOD** | **mm/DD**
---|---|---
1. **Industrial Radiation Sterilization** (Training Course)  
Gopal Srimivasa Nuggehally Gunda (India)  
22/09/90 to 30/09/90  | 0/9  
Stenger Vilmos (Hungary)  
23/09/90 to 29/09/90  | 0/7  
Gazso Lajos Gaspar (Hungary)  
22/09/90 to 30/09/90  | 0/9  
**Subtotal**  | 0/25  
2. **Radiation Microbiology**  
Gazso Lajos Gaspar (Hungary)  
01/10/90 to 20/10/90  | 0/20  
3. **Radiation Sterilization** (Training Course)  
Stenger Vilmos (Hungary)  
09/06/91 to 15/06/91  | 0/7  
Mukkerjee Ramendra (India/IAEA)  
09/06/91 to 15/06/91  | 0/7  
Jacops Geoffrey Pelir (U.K)  
09/06/91 to 17/06/91  | 0/9  
**Subtotal**  | 0/23  
4. **Civil Engineering**  
Ertemur Ismail (Turkey)  
09/03/91 to 16/03/91  | 0/8  
Selcuk Atif (Turkey)  
09/03/91 to 16/03/91  | 0/8  
**Subtotal**  | 0/16  
5. **Irradiation Technology**  
Giddings George Gosselin (USA)  
09/06/91 to 15/06/91  | 0/7  
6. **Feasibility Study On Industrial Radiation Sterilization**  
Iya Vasudeva Kilara (India)  
16/05/91 to 05/06/91  | 0/21
7. **Radiation Effect On Materials**

Gopal Srivasu Nuggehally Gunda (India) 25/04/92 to 09/05/92 0/15

8. **Training Course On Process And Quality Control**

Stenger Vilmos (Hungary) 24/10/92 to 07/11/92 0/15
Gazso Lajos Gaspar (Hungary) 31/10/92 to 14/11/92 0/15

Subtotal 1/00

9. **Promotion of Technology And Applications (National Exec. Mgmt. Seminar)**

Phillips Glyn Owen (U.K) 11/11/92 to 14/11/92 0/4
Tallentire Alan (U.K) 11/11/92 to 14/11/92 0/4
Iya Vasudeva Kilara (India) 08/11/92 to 23/11/92 0/16

Subtotal 0/24

Total Budgeted: $91,141
Total Expert Services: 8 mm / 24 DD
Total Used: 6 m / 1D
Balance: 2 mm / 23 D
LIST OF NATIONAL TRAINING COURSES AND SEMINARS
# NATIONAL TRAINING COURSES AND SEMINARS

<table>
<thead>
<tr>
<th>Name</th>
<th>Duration &amp; Place</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Industrial Radiation Sterilization</td>
<td>1 week, Ankara</td>
<td>Sept.'90</td>
</tr>
<tr>
<td>2. Industrial Radiation Sterilization-Quality Assurance</td>
<td>1 week, Ankara</td>
<td>June '91</td>
</tr>
<tr>
<td>3. Radiation Compability of Materials</td>
<td>2 weeks, Ankara</td>
<td>April'92</td>
</tr>
<tr>
<td>4. Process And Quality Control-Sterility Assurance</td>
<td>1 week, Ankara</td>
<td>Oct. '92</td>
</tr>
<tr>
<td>5. National Executive Management Seminar on Industrial Radiation of Health Care Products</td>
<td>2 days, Istanbul</td>
<td>Nov. '92</td>
</tr>
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