ARMENIAN CENTRE OF EXCELLENCE IN ONCOLOGY
RADIATION TREATMENT CENTER
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT

AND

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

RADIOISOTOPE PRODUCTION CENTER
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Yerevan,
September, 2016
List of Acronyms

ACEO – Armenian Centre of Excellence in Oncology
CJSC – Closed Joint Stock Company
EIAE – Environmental Impact Assessment and Expertise
ESIA – Environmental and Social Impact Assessment
ESMP – Environmental and Social Management Plan
HPIU – Health Project Implementation Unit
MAC – Maximum Acceptable Concentration
MH – Ministry of Health
MNP – Ministry of Nature Protection
PET – Positron Emission Tomography
RA – Republic of Armenia
RPC – Radioisotope Production Center
RTC – Radiation Treatment Center
SNCO – State Non Commercial Organization
WB – World Bank
WHO – World Health Organization
YPI – Yerevan Physics Institute
Table of Contents

EXECUTIVE SUMMARY ................................................................. 5
1. INTRODUCTION ........................................................................ 12
2. METHODOLOGY ..................................................................... 14
3. LEGAL AND ADMINISTRATIVE FRAMEWORK ...................... 15
   3.1. National Legislation ......................................................... 15
   3.2. Licenses and permits to be obtained for construction and for operation of ACEO premises ................................................................................................................. 17
   Construction Phase ................................................................. 17
3.3. World Bank Safeguard Policies ........................................... 18
3.4. International Agreements ..................................................... 18
   According to the requirements of the Aarhus Convention before making a decision of ACEO construction it is necessary to notify the public, local authorities and interested bodies on the proposed project and to carry out public consultations. ................................................................. 18
3.5. Technical Standards and Regulations .................................. 18
3.6. Administrative Framework .................................................. 19
4. ENVIRONMENTAL AND SOCIAL SCREENING .................... 21
5. PHYSICAL AND NATURAL ENVIRONMENT ......................... 22
   5.1. Geographic location ......................................................... 22
   5.2. Seismic condition and tectonics ....................................... 22
   5.3. Climate .......................................................................... 22
   5.4. Water resources ............................................................. 23
   5.5. Ambient Air .................................................................... 23
   5.6. Landscape and soils ....................................................... 24
   5.7. Biodiversity .................................................................... 24
6. Project Description ................................................................. 25
   6.1. Construction of ACEO Premises ...................................... 25
   6.2. Operation of ACEO ......................................................... 26
   6.3. Operation of RPC ........................................................... 28
7. SENSITIVE RECEPTORS .......................................................... 29
   7.1. Ambient Air ..................................................................... 29
   7.2. Water Resources ........................................................... 29
   7.3. Land Resources ............................................................. 29
   7.4. Social Environment ...................................................... 29
   7.5. Cultural Resources ......................................................... 29
8. SOCIAL AND ECONOMIC ENVIRONMENT .......................... 30
9. EXPECTED ENVIRONMENTAL AND SOCIAL IMPACTS ........ 31
   9.1. Construction of the premises of RTC .............................. 31
   9.2. Operation of RTC .......................................................... 32
   9.3. Operation of RPC .......................................................... 33
EXECUTIVE SUMMARY

Introduction

Taking into consideration the increasing number of the oncological disease in Armenia, the incidence of which almost doubled during recent decade the Government of Armenia decided to create an integrated cancer centre in Armenia, which will cover increasing demand of contemporary treatment among Armenian population.

Government Decree from the November 15, 2012 #1447 approved master plan of the establishment of the Armenian Centre of Excellence in Oncology (ACEO). The ACEO is intended to provide state of the art diagnostics including molecular imaging, radiation oncology, chemotherapy and medical oncology services.

Initially it was planned that ACEO will be established as Public-Private Partnership project and would consist of the following parts:

- **First phase - Radioisotope Production Center:** positron emission tomography (PET) diagnostic facility supported by Cyclotron to produce the radioisotopes necessary for PET. Creation financed by the Government of Armenia, directly through state budget (for civil works and furniture) and by the export loan provided by Belgian KBC NV bank, as well as a contract with the ABA Molecular company (for equipment).

- **Second phase - Radiation treatment center:** equipped with contemporary linear accelerators, brachitherapy machine and sufficient diagnostic equipment. Creation financed by the World Bank, within the scope of the 5222-AM Disease Prevention and Control project. In particular World Bank would finance: the entire design for the ACEO Radiation therapy facility, civil works for the Radiation therapy facility, provision of diagnostic and treatment equipment for Radiation therapy facility, and development of clinical protocols and treatment standards.

- **Third phase - A 100-150 bed oncology clinic:** should be financed by the private investor.

Later on, due to the lack of the private investor the Government decided to limit ACEO only with Radioisotope Production Center and Radiation treatment center. According to the above mentioned Government Decree, it is stipulated that the new centre should be located in the Yerevan, 38/7, Halabyanst. (2, Alikhanyan Brothers street). According to the Amendment to the Government Decree N 388-N from the April 14, 2011, the total area of 13,500 m² were allocated for that reasons.

The Ministry of Economy of the republic of Armenia (RA) in cooperation with the Ministry of Health (MH) and the National Competitiveness Foundation of Armenia worked out the Project for the establishment of the Armenian Centre of Excellence in Oncology (ACEO).

In the framework of the Project the following steps have been undertaken:

- On 7 October, 2010, RA Government adopted the decree N 1424-N on the establishment of the ACEO Project and establishment of the Radioisotope Production Center.

- In 2010, RA Government signed a loan agreement with the Belgian KBC NV Bank, as well as a contract with the company ABA Molecular. These contracts would finance procurement and provision of the Cyclotron 18/18, Positron Emission Tomograph and SPECT camera.
• A Closed Joint Stock Company (CJSC) Radioisotope Production Center was established under the Ministry of Economy of RA (later the Company was transferred under jurisdiction of the Ministry of Health (MH)).

• On 14 April, 2011, the RA Government issued Decree N 388-N on the allocation of land for organizing radioisotope production.¹

• On 24 March, 2016, the RA Government issued Decree #302 on the establishment of the Radiation Treatment Center CJSC under the MH.

• Later, in April 2015, the Government decided that the ACEO will consist of only Radiation Treatment Center and Radioisotope Production Center, while construction of the clinic was considered inexpedient.

At present, constraining, equipping and furnishing of the first phase of project - creation of the Radioisotope Production Center - is almost completed and now testing and commissioning of the equipment is in process. The facility will be put into operation during upcoming months. Implementation of the second phase creation of the Radiation treatment center is also on the way. Particularly development of the architectural design documentation of the Center is almost completed.

**Legal and Administrative Framework**

The Law on Environmental Impact Assessment and Expertise (EIAE) of 2014 is the key national law safeguarding environment from anthropogenic impact and contains the standard steps of the environmental assessment and permitting process for various types of projects and activities in Armenia.

According to the list of activities provided in the Article 14 of this Law, the construction activities exceeding 1500 m² construction area are subject to expertise with simplified procedure. In 2012, when the previous iteration (1995) of the EIAE law had been in force, the environmental impact assessment of the project for construction of the Radioisotope Production Center (RPC) was carried out and a positive conclusion of the expert review was issued. The new EIAE law requires the same procedures in regard to the construction of a building designed for the RPC. Hence the conclusion issued back in 2012 is currently in force. However, according to the national legislation, environmental documentation prepared for the RPC covers the construction phase only, while the World Bank policy requires coverage of the operational phase too. Because construction and operation of the RPC is an activity associated with the World Bank-financed operation covering Radiation Treatment Center (RTC), the Bank required development of the Environmental and Social Management Plan (ESMP) for the operation of the RTC.

The construction of the RTC building, which is part of the ACEO Project and subject for the World Bank financing from the DPCP, is a Category B activity. Based on the environmental and social screening of this activity and according to the World Bank policy, construction and operation of the RTC requires conduct of the Environmental and Social Impact Assessment (ESIA) and preparation of an ESMP. According to the national EIAE law, obtaining conclusion from the expert examination of the environmental and social aspects of the construction of Treatment Center will also be required as the total construction area exceeds 1500m².

During the construction works all permits and agreements are obtained by the General contractor, and HPIU controls these processes. In ACEO operation phase, ACEO administration is responsible for the implementation of the requirements of environmental legislation. External control is exercised by the State Environmental Inspection of the Ministry of Nature Protection.

¹ [http://mineconomy.am/eng/41/text.html](http://mineconomy.am/eng/41/text.html)
Public Participation

According to the national legislation, the obligation taken up to the RA upon joining the Aarhus Convention, as well as the World Bank requirements on the disclosure of information, the present draft ESIA report will be disclosed in-country in Armenian and English languages by posting it on the web page of the Ministry of Health. A public consultation meeting will be held in Yerevan to discuss the draft ESIA report with project-affected people and all other stakeholders. The ESIA report will be re-disclosed after incorporation of the received feedback, and attachment of minutes of the consultation meeting.

Sensitive Environmental Receptors and Potential Impacts

The ACEO will be located in Yerevan, in 5-6 km distance from the city center. The closest streets are those named after Halabyan, Marqaryan and Alikhanyan brothers. Residential blocks and buildings of a medical compound are situated nearby. River Hrazdan gorge is located in 600 to 800m distance from the ACEO area. The total area of the buildings of the ACEO consisting of the RPC and RTC is 5467 square meters, from which 1948 square meters are under the single-level RPC and 3519 square meters area under the three-storied RTC. Subsidiary buildings of the YPI are located in the immediate proximity to the construction site.

The expected main environmental and social impacts of the construction of the RTC are the nuisance from the noise, dust and vibration, and pollution with the construction waste. Poorly managed construction process may disrupt operation of the YPI and affect daily life in the district due to excessive noise and dust, irregular movement of construction vehicles delivering construction materials and removing construction waste, accumulation of waste on-site and its vicinity. Pollution of River Hrazdan is also possible as a result of solid and liquid waste mismanagement. Because the construction site is in a separate, fenced and guarded territory of YPI (see Annex V) which had been owned and operated by the Government for many years, no land use or property issues involving population of nearby residential district of Yerevan are expected.

During the operation of RPC and RTC the impact is mostly connected with the probable increase of radiation level, as well as with the occurrence of clinical and daily waste.

Project Alternatives

The “no-project”, or in other words, “zero-alternative” has not been considered for the construction of Radiation Treatment Center, because it is an integral part of the ACEO concept justified and approved through the Government of the RA rulings. This concept was acknowledged by the World Bank too and the decision was made to co-finance it.

Three options of modernization of oncological services

Three options for modernization of oncological services in Armenia were suggested. In particular,

1. Modernization of existing National Oncology Center.
2. Using the site of existing hospital to build a new radiotherapy unit.
3. Construction of the new center.

(a) Modernization of current National Oncology Center (NOC)

Taking into consideration that several departments of NOC are duplicated, the number of beds does not correspond to the contemporary approaches of the treatment of cancers, the significant maintenance costs, thus it is suggested to optimize the hospital service. In particular, the working group suggested to reduce the number of beds to 200, concentrate all the hospital services except
radiotherapy in the wing B and C of main sub-building (with conservation or demolition of other wings of existing sub-building), merge the existing (more than 20) departments in 10-12 services, strengthen the outpatient service, modernize the radiotherapy department, as well as establish contemporary and sufficient “day hospital” service which will significantly reduce the number of unnecessary hospitalizations.

*The possible advantages of modernization of current Oncology hospital are:*

- Existence of 4 bunkers
- Requires less time for renovation

*The possible disadvantages of modernization of current Oncology hospital are:*

- The current location of NOC does not correspond to contemporary medical standards
- The renovation of NOC is temporary solution and after the several years need of re-renovation might occur
- The demolition of Wing A might result in disturbance of equilibrium of the existing building
- The conservation of Wing A will increase of maintains cost of the building
- The renovation might break the center’s regular activities
- Before the start of renovation activities the seismic study should be done, after which the renovation cost might significantly increase

**(b) Using the site of existing Hospital to build a new radiotherapy unit.**
The modernization activities will include construction of new Cancer Treatment Center and provision with modern radiological equipment. The medical staff will undergo required training. The envisaged site location of the Center is in the territory of current Hospital 8. Location near multifunctional hospital will be key element of the long-term plan and will include the creation of a "hospitable multi-field zone" to facilitate medical exchanges, mobility of patients between facilities and multidisciplinary consultation on therapeutic decisions in association with the existing medical teams, particularly surgical and other teams.

The project will be flexible in its design to allow a further increase of the accommodation facilities. The services to be offered will require 3000-3500 m² facility, with 4-6 bunkers. The structure will accommodate a Center of hospitalizations in cancer treatment to which the beds of ambulatory hospitalization (medical oncology) will be attached, consultation areas for specialists, training facilities for the medical and ancillary staff, laboratories for immunohematology and pathology, as well as radiotherapy therapy facilities. The center will not provide surgical, chemotherapeutic and long-term hospitalization services; it will have 20-25 hospital beds only for radiotherapy.

The basic core will include the administration, reception, consultation rooms and laboratories.

*The possible advantages of construction of new Radiotherapy center near the 8 Hospital are:*

- Location near multifunctional hospital, with probability of integration of medical services
- Requires less investments
- Ability to provide high-quality radiotherapy to population of Armenia, as well as reduce the number of people in “waiting lists” to receive radiotherapy

*The possible disadvantages of construction of new Radiotherapy center near the 8 Hospital are:*
• The construction of new Radiotherapy center will be partial solution of the given issues
• Duplication of several services

(c) **Construction of the new oncology center.**
According to situational analysis of current oncology service, as one of the possible options for modernization, it was suggested to establish a new multifunctional oncology center, in a location accessible to population. The new center might be located near the site of the Institute of Physics where it is planned to establish the PET scan and concentrate the services in one place.
In accordance with preliminary estimations of MoH, as well as international experts, the new hospital should have a capacity of 200 beds, with following services (the structure of the new oncology clinic is issue to discuss by the responsible authorities of MoH based on contemporary standards and recommendations of international experts):
• Strong outpatient service with “day hospital”
• Diagnostic service including the pathologic laboratory
• Surgical service with surgical unit (4 operation theaters – 1 theater for 1000 operations)
• Chemotherapeutic service
• Pediatric oncology
• Mammology
• Radiotherapy
• Intensive Care Unit

The possible advantages of construction of new Oncology center are:
• The long-term solution of the given issues
• Ability to provide high-quality complex oncology service to population of Armenia

**Environmental Impact Assessment Methodology**
The present ESIA covers construction and operation phases of the RTC and the operation phase of the RPC. The ESIA process included the desk top work to review project documents and scientific literature, as well as the field work required for verification of the available baseline data, collection of missing information, and meetings with the local stakeholders. The background information was compiled on the biophysical environment around the project site, on the land tenure and land use of the allocated plot and its adjacent area. Based on the background material, sensitive environmental receptors were identified and potential environmental and social impacts were defined for the construction and operation phases. A detailed ESMP was developed by listing specific activities that carry various environmental and social risks, and measures prescribed for their mitigation. Indicators for quantitative or qualitative measurement of the effectiveness of mitigation measures were selected and used for the development of an Environmental Monitoring Plan.

**Environmental and Social Baseline**
Yerevan is the capital and the largest city of Armenia. It is located in the north-eastern part of the Ararat valley, in the central part of the Armenian highlands. The relief of Yerevan stands out by its variety; fluctuations in the heights of its boundaries reach 400 meters. Hrazdan River flows through the city.
The climate is dry, with hot summers and cold winters. North-eastern and south-western winds are dominating here.
The project site is located in Ajapnyak administrative district of Yerevan. Population of Yerevan at the end of the year 2014 made 1,071,500.

**Expected Impacts and Mitigation**

The expected environmental and social risks associated with the construction and operation of the ACEO is moderate and can be effectively mitigated.

**Possible negative impacts of the construction phase:**

- Air pollution from the operation of the construction vehicles and machinery;
- Nuisance to local population from the dust, noise and vibration generated at the construction site;
- Disruption of local traffic due to movement of construction vehicles and machinery;
- Land degradation and erosion as a result of damaged vegetative cover and borrowing;
- Land and water pollution with runoff and spillages from the construction site;
- Landscape degradation and pollution due to improper disposal of access material and construction waste;
- Traumatism and long term health damage among construction workers due to poor application of health and safety standards.

**Mitigation measures for the construction phase:**

- Keep construction vehicles and machinery in adequate technical condition;
- Organize fueling, washing, and other servicing construction vehicles and machinery at service centers or in the designated locations of the construction site which can contain operational and accidental spillages of oils and lubricants, and do not allow direct water discharge to the natural water bodies;
- Operate vehicles and machinery within working hours and shutting engines when idle;
- Keep subsoil and topsoil separately and using them for backfilling and reinstatement of the construction site;
- Pile construction materials and waste within the construction site and periodically disposing them into formally designated locations;
- Avoid opening of new quarries to the extent possible. Disallow unlicensed extraction of material.
- Instruct contractor’s personnel on the course of action if potentially hazardous substances are encountered in the course of demolition and excavation works;
- Provide workers with adequate personal safety gear and insure its proper use; ensure that personnel operating complex construction machinery is trained and licensed.

**Possible negative impacts of the operation phase:**

- Accumulation of excessive amounts of waste on-site due to failure of its timely removal;
- Open air burning or illegal dumping of waste resulting in the pollution of soil and water as well as in risks of spreading disease to local communities.
- Public health and environmental damage caused by improper handling of medical waste;
- Malfunctioning of boiler’s burners resulting in excessive emissions of nitrogen and carbon oxides.
- Water damage to the buildings of ACEO and deterioration of area around it due to leaking water/sewer pipes, and/or dis-functional drainage of storm water.
- Exposure of medical and support staff to radiation due to lack or protective arrangements and gear as well as violation of staff rules of handling hazardous substances.
- Increase of radiation level due improper handling and transportation of radioactive materials.
- Rise of radiation level within RTC building (external impact excluded due to non-permeable insulation).

**Mitigation measures of the operation phase:**

- Collect household waste in regular plastic binds and regularly dispose of at the municipal landfill. Make and maintain proper arrangements for out-transportation of waste with specialized covered scavenger trucks.
- Strictly disallow burning of any type of waste in open air at or around the site.
- Collect medical waste separately in special containers and regularly hand it over for disposal to a specially licensed entity.
- Accumulate chemically active liquids separately from other liquid waste and hand it over for deactivation and disposal to a specially licensed entity.
- Undertake regular checking of communications inside and around the ACEO premises to timely identify and fix any leakages that may occur. Arrange and maintain effective drainage system for the collection and discharge of storm water to avoid water damage to the buildings and waterlogging of the ACEO and RPC area.
- Implement automatic measurements of radiation levels and in case of the signal of increased level to stop immediately the operation of the RPC, and bring out the personnel.

**Institutional Arrangements for Managing Environmental Impacts**

Overall responsibility for managing environmental and social impacts of construction works at ACEO rests with the Project implementing entity, which is the MH of the RA. The Ministry will exercise environmental and social monitoring of works through the Health Projects Implementation Unit (HPIU) under it. HPIU is mandated to monitor implementation of the ESMP by works contractor and to report on the outcomes of monitoring to the MH and to the WB. Once operational, the ACEO premises will be managed by the Directorates of entities comprising it. Environmental compliance of the ACEO operation will be enforced by the Yerevan regional unit of the RA State Environmental Inspectorate.
1. INTRODUCTION

The cancer disease morbidity in the population of the Armenia increased in 2002-2012 by nearly 36.9%; in almost the same period the number of cancer cases among women (breast, uterus, ovaries) and men (trachea, bronchi, lungs) grew up by almost the same level.

According to the official statistics, in Armenia the cancer morbidity and mortality rates among the male population are mostly related to neoplasms of trachea, bronchi and lungs, and such rates are mostly related to neoplasms of breast, cervical and uterine bodies among the female population.

In the period of 2002-2012, the number of patients under a dispensary observation by the end of the year grew up, reaching 32,580 people, and the cancer-caused mortality rate increased by nearly 35.0%.

According to international experts, the cancer morbidity rate does not seem realistic: it is higher because studies conducted in countries with such demographic characteristics as Armenia, showed that yearly the number of new cancer cases among approximately 1 million population is around 6,000. Taking it into account, the supposed number of new cases in Armenia should have been twice as much higher: 12,000-13,000 annually.

Taking into cosideration of the above-mentioned circumstances, Government of Armenia approved a number of programs aimed at creating a contemporary system for prevention and treatment of oncological diseases.

With this vision in mind, the Ministry of Health (MH) is focusing on the diagnosis and treatment of oncological diseases in Armenia in order to address the increase in the rates of these ailments. The establishment of the Armenian Center of Excellence in Oncology (ACEO) will be instrumental in this process through the production of nuclear isotopes for the diagnosis and treatment of cancers.

Development of the scientific technologies of the recent years has enabled to use radio-nuclides for diagnostic and medical purposes, which led to invention of a new medical direction: the nuclear medicine. Fundamental knowledge on the biological impact of the ionizing radiation laid a basis for development of new technologies, permitting to shift from radiation of the entire tumor to a selective radiation of the tumor cells.

Currently more than 350 nuclides of nearly eighty chemical elements are reproduced in the World, and most of them are used for development and industrial manufacturing of radio-medical preparations. Radio-nuclides are successfully used for therapeutic radio-therapy of tumors and non-tumour diseases. The advantage of radio-nuclide therapy is based on the absorption of radiation in the pathological centers, minimally damaging the healthy tissues, which allow to healthy distant metastases. The radio-nuclide treatment has no alternative when surgery is highly risky, as well as in the case of expressed pain syndrome of bone metastases.

According to the World Health Organization (WHO), cancer diseases have significant increasing trends in developing states. Relevant studies forecast that the number of patients will double in 2015.

In cooperation with Alikhanyan National Science Laboratory as well as by utilizing Armenian scientific potential and traditions, the health sector modernization will be implemented through international accreditation and establishment of contemporary standards and protocols. The
ACEO will foster the inception of a nuclear medicine program in Armenia to provide exemplary educational and training programs for professionals and to enable local capacity-building in the provision of high-quality medical services.

Government of the Republic of Armenia (RA) by its Decision No 310-N of February 19, 2009 on the Approval of Placing Cyclone 18/18 Isotope Production Complex at the A. I. Alkhanyan National Scientific Laboratory State Non-Commercial Organization (SNCO) and Program in Support to Creation of a Nuclear Medicine Center in the Republic of Armenia approved a relevant program under the same name. By Decision No 1424-N of October 7, 2010, the Government of RA made amendments and supplements in the mentioned program. The program objective is to establish Radioisotope Production Center (RPC) in the capacity of a Closed Joint Stock Company (CJSC) that will operate the Belgian IBA Cyclone-30 (IBA-Ion Beam Application) which will lay basis for the development of the nuclear medicine in the RA.

Radiochemical system of nuclear medicine center will consist of 18MeV energy cyclotron, corresponding radio- laboratories, and afterwards will be replenished with positron emission tomography.

By Decision No 388-N of the RA Government (April 14, 2011), a 13,500 m² area of the land plot registered with the State-owned non-commercial organization A.I. Alkhanyan National Scientific Laboratory with the right of permanent use was allocated for the creation of the ACEO. It will have buildings and premises where its functional divisions will be located.

ACEO will perform the following functions:
1) Prevention and early detection of oncological diseases;
2) Instrumentaldiagnosticsofoncologicaldiseases;
3) Diagnosticsofoncologicaldiseasesusingradiologicdevices: X-ray, computertomography (CT), magnetoresonancetomography (MRT), positron-emissiontomography (PET), Spectrum (SPECT) camera, etc.
4) Chemotherapeutical treatment of oncological diseases, including high dose, radiation, immuno-therapeutical,hormonal, radio-isotopic, proton therapy and other methods; and
5) Radioisotope production.

The envisaged structure of the ACEO is as follows:
1) radiological diagnostic division;
2) radioisotope diagnostics and treatment section (nuclear medicine);
3) chemotherapeutical division;
4) RPC; and
5) RTC.

The 100% State-owned RPC was founded through the Government decree N 1424, dated October 7, 2010. On 24 March, 2016 Government Decree #302, the RTC CJSC 100% state owned company was established under the jurisdiction of the MH. In accordance with the Government’s vision, after completion of works, both RPC and RTC will be merged under the ACEO.

Beyond the fenced area of the National Scientific Laboratory, there are some residential buildings to the south and a couple of operating medical institutions to the west. Hrazdan River Canyon is 0.5km away to the south-east.

The territory of the National Scientific Laboratory is supplied with water, power and gas, and is connected to the municipal sewage system.
2. METHODOLOGY

The present ESIA was carried out according to the Terms of Reference agreed upon with its main financier - WB, and covered the entire scope of the Project, including construction phase and operation of the RTC and operation of the RPC. The ESIA process included desk work to review project documents and scientific literature, as well as field work aimed at verification of the available data, collection of missing information, and meetings with the Project stakeholders. General overview of biophysical environment was conducted through the desktop study. A field survey was conducted in July 2016 which implied visiting the YFI territory and the Hrazdan Canyon with the purpose to identifying occurring plant species and checking presence of any rare, endangered, endemic, or other species of concern.

For the purpose of a transparent presentation and evaluation, a tabulated evaluation matrix was applied. On the basis of a point scale, the severity of the particular environmental impact together with its general trend - that is negative or positive - was described. The evaluation scale applied is as follows:

Extent of impact:

- = high
- = medium
= low
= no impact
+ = locally positive
++ = regionally positive

For judgments international standards like standards from the EU Directives, World Bank, WHO, IFC, were used along the national Armenian standards. According to these standards, the evaluation of impacts is done as follows:

**Table 2.1. Evaluation of impacts using International and National Standards**

<table>
<thead>
<tr>
<th>Extent of impact</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>International and national standards are exceeded</td>
</tr>
<tr>
<td>Medium</td>
<td>Between international and national standards, international and national standards are barely met</td>
</tr>
<tr>
<td>Low</td>
<td>International and national standards are met</td>
</tr>
</tbody>
</table>

This method allowed to clarify which environmental impacts are most important and for which impacts mitigation measures must be applied in order to reduce negative effects on the environment.
3. LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1. National Legislation

The 10th Article of the Constitution of the Republic of Armenia (adopted in 1995 and amended in 2005 and 2015) states the State responsibility for environmental protection, reproduction, and wise use of natural resources. Since 1991 more than 25 codes and laws as well as numerous by-laws and regulations have been adopted to protect the environment.

Land Code (2001)

The Land Code defines the main directives for management use of the state lands, included those allocated for various purposes, such as agriculture, urban construction, industry and mining, energy production, transmission and communication lines, transport and other purposes. The Code defines the lands under the specially protected areas as well as other reserved lands. It also establishes the measures aimed to the lands protection, as well as the rights of state bodies, local authorities and citizens towards the land.

Land allocations needed for the project are done according to the Land Code.


The main purpose of the Water Code is to provide the legal basis for the protection of the country’s water resources, the satisfaction of water needs of citizens and economic sectors through effective management of water resources, and safeguarding the protection of water resources for future generations. The Water Code addresses the following key issues: responsibilities of state/local authorities and public, development of the National Water Policy (2005) and National Water Program (2006), water cadaster and monitoring system, public access to the relevant information, water use and water system use permitting systems, trans-boundary water resources use, water quality standards, hydraulic structures operation safety issues, protection of water resources and state supervision.

The formulations of applications for the water used during the construction works, water supply and water drainage during operation of ACEO should be implemented in accordance with the requirements of the Water Code.

Law on Environmental Impact Assessment and Expertise (2014)

A law on environmental impact assessment and expertise was adopted recently (July 2014). The Law provides legal basis undertaking state environmental expertise of planned activities and concepts and presents standard steps of EIA process. The Law establishes general legal, economic, and organizational principles for conducting mandatory State EIA of various types of projects and concepts of sectoral development.

According to this law, activities are classified into 3 categories: A, B, C.

The categories are defined on the basis of the volume of the activity, characteristics and the level of impact on environment. “A” category includes such large-scale processes which have a significant impact on the environment based on practice, particularly they are: the mining industry, chemical industries, hazardous waste transportation, recycling or landfilling, metals’, construction materials’ and other products’ high-output plants, thermal energy production large installations etc. "B" category includes practically the same types of activities, but on a smaller scale or productivity. “C” category includes the types of activities that have a certain, not significant impact on environment but does not require assessment of this impact.
The state expertise procedure consists of 2 stages. During the first stage lasting 1 month the Ministry of Nature Protection (MNP) and the public are notified about the project (short summary), and the first round of public consultation is held. The MNP undertakes classification of a project and recommends TOR for the EIA, if the EIA is required according to the classification outcome. EIA is not required for “C” category, just a notification and public hearings of initial stage.

At the second stage, an EIA report is submitted to the MNP and the Ministry undertakes its review during 60 days for a category “A” project or 40 days for a category “B” project. Two public consultation meetings are required at this stage. The Ministry may extend the review deadline for up to 30 days after which it issues a positive (permitting) or a negative conclusion of the expert review.

According to this Law, the healthcare activity is not subject to environmental expertise, but the construction works are, as the construction site exceeds 1500m².

**Law on Atmospheric Air Protection (1994)**

The objective of the Law is to provide the cleanness of the atmospheric air, elimination and prevention of the negative impact on the atmospheric air, as well as regulation of public relations in this field. The Law defines norms of permissible amount of concentrations and physical negative impact as well as norms of permissible pollution from movable and unmovable sources.

The limitation of emissions resulting from fuel combustion in the boiler is done by this Law.

**Law on Medical Care and Services to the Population (1996)**

The Law on Medical Care and Services to the Population establishes the legal, economic and financial guidelines for medical care and service delivery, which ensures the realization of people’s constitutional right to preserve their health.


The Law “On Ensuring Sanitary-Epidemiological Security of the RA Population” was adopted in 1992, which sets legal, economic and institutional bases for ensured sanitary and epidemiological safety of the population, as well as other guaranties provided for by the State to exclude influence of adverse and hazardous factors on human organism and ensure favorable conditions for vital capacity of the present and future generations.

Sanitary-epidemiological conditions of ACEO must comply with the terms of this law.

**Law on the Protection and Use of Fixed Cultural and Historic Monuments and Historic Environment (1998)**

This Law provides the legal and policy basis for the protection and use of such monuments in Armenia and regulates the relations between protection and use activities. Article 15 of the Law describes procedures for, among other things, the discovery and state registration of monuments, the assessment of protection zones around them, and the creation of historic-cultural reserves. Article 22 requires the approval of the authorized body (Department of Historic and Cultural Monuments Preservation) before land can be allocated for construction, agricultural and other types of activities in areas containing monuments.

According to this Law, any case of a chance find must be communicated to the Department of Historic and Cultural Monuments Preservation.
**Law on Wastes (2004)**

The law regulates legal and economic relations connected to the collection, transfer, maintenance, development, reduction of volumes, prevention of negative impact on human health and environment. The law defines objects of waste usage, the main principles and directions of state policy, the principles of state standardization, inventory, and introduction of statistical data, the implementation of their requirements and mechanisms, the principles of wastes processing, the requirements for presenting wastes for the state monitoring, activities to decrease the amount of the wastes, including nature utilization payments, as well as the compensation for the damages caused to the human health and environment by the legal entities and individuals, using the wastes, as well as requirements for state monitoring and legal violations.

*Constructional, clinical and daily waste management occurred during the central construction and operation must comply with this Law.*

**Law on Environmental Oversight (2005)**

This Law regulates the issues of organization and enforcement of oversight over the implementation of environmental legislation of the Republic of Armenia, and defines the legal and economic bases underlying the specifics of oversight, the relevant procedures, conditions and relations, as well as environmental oversight in the Republic of Armenia.

*The State Environmental Inspection of RA Ministry of Nature Protection will have authority to exercise State control on the environmental aspects of the construction and operation of the ACEO according to this Law.*

### 3.2. Licenses and permits to be obtained for construction and for operation of ACEO premises

**Construction Phase**

- Civil license in the area of the capital construction, including development of documents for urban development, engineering research and expertise to be held by the design company.
- Civil license in the area of capital construction to be held by the construction company providing works.
- Positive conclusions for construction of RTC issued by State Environmental Expertise SNCO of the MNP to be obtained by the constructor prior to commencement of works.
- Agreements from the Yerevan municipality for the disposal of excavated materials and construction wastes in the formal disposal sites to be obtained by construction contractors prior to transportation and disposal of construction waste and spoil.

**Operation Phase**

- Technical passports for medical wastes to be developed by ACEO and approved by the MNP;
- Agreement between ACEO and especially licensed company for the hand-over and disposal of medical waste;
- Agreement between ACEO and especially licensed company for the hand-over, deactivation and disposal of chemically active liquids.
3.3. **World Bank Safeguard Policies**

Construction of the RTC will be supported by the World Bank-financed DPCP. This project triggers the World Bank OP/BP 4.01 *Environmental Assessment* and is classified as environmental Category B. The HPIU carried out screening of ACEO project and confirmed that it indeed falls under Category B. Construction of RTC requires ESIA and development of the ESMP. World Bank does not support construction and operation of the RPC, however because both RPC and RTC are parts of the ACEO, the Government-financed construction and operation of RPC is an activity associated with the World Bank-financed construction of the RTC. As long as the national environmental legislation does not require environmental and social due diligence at the operation phase, and ESMP for the operation phase of RPC was developed by the HPIU upon request of the World Bank, so that operation of ACEO in general meets basic safeguard requirements of the World Bank.

Construction of ACEO is subject to EIA procedure according to the national legislation too, that does not cover the operation phase.

The main differences between the OP/BP 4.01 and the RA Legislation (Law on Environmental Impact Assessment and Expertise) are that: (i) by the mentioned law, the activities of health organizations (hospitals, clinics, etc.) are not subject to EIA expertise, only for the construction of 1,500 m² area EIA is required for construction works, and (ii) the national legislation does not call for the preparation of an ESMP, while OP/BP 4.01 clearly sets forth such requirement.

Activities supported from the World Bank-financed DPCP will be carried out in compliance with the World Bank/IFC General Environmental, Health and Safety (EHS) Guidelines.

3.4. **International Agreements**

Out of the international agreements signed by the RA, those most important for the purposes of ACEO Project are the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (RA being a party since 1999), and the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (RA being a party since 2001).

*According to the requirements of the Aarhus Convention before making a decision of ACEO construction it is necessary to notify the public, local authorities and interested bodies on the proposed project and to carry out public consultations.*

3.5. **Technical Standards and Regulations**

The national technical standards and regulations applicable to the construction of ACEO are as follows:

- The RA Health Minister’s N 138 order as of May 6, 2002 on approving N2 – III – 11.3 sanitary norms on *Noise at Workplaces, Public and Residential Buildings, and Residential Construction Areas*.

- The RA Health Minister’s N 01-N order as of January 25, 2010, on *Approving Sanitary Rules and Norms of Soil Quality Hygiene Requirements* N 2.1.7.003-10.
- The RA Health Minister’s N 533-N order as of May 17, 2006, on Approving HN N 2.2.4-009-06 Vibration Hygiene Norms at Workplaces, Residential and Public Buildings.

- The RA Government Decision N 750-N as of May 29, 2006 on Establishment of Technical Regulations for Requirements on Re-cultivation and for Classification of Disturbed Lands Which Are Subject to Re-cultivation.

3.6. **Administrative Framework**

This section reviews the roles of government agencies that may have involvement in the ACEO project, primarily, but not exclusively, from an environment perspective.

**Ministry of Nature Protection**
The MNP is responsible for the protection, sustainable use, and regeneration of natural resources as well as the improvement of the environment in the Republic of Armenia. In those areas, the MNP’s authority includes overseeing national policy development, developing environmental standards and guidelines, and enforcement. The MNP also undertakes several functions through the following key detached divisions and subordinate bodies:

- **Environmental Impact Expertise Center SNCO** conducts environmental assessments and issues conclusions. In 2012 RPC construction project was submitted to environmental expertise and received a positive opinion.

- **State Environmental Inspectorate** includes 11 Regional Environmental Inspectorates and oversees the implementation of legislative and regulatory standards in natural resources protection, use and regeneration. It also conducts environmental inspections at worksites for control of environmental measures and valid permits.

  During the RPC construction, State Environmental Inspectorate has implemented a control of the measures represented in EIA. **Environmental Impact Monitoring Center** collects water quality data from 131 sampling points.

  Monitoring areas carried out by this center also include Ajapnyak district, where ACEO is situated.

- **Water Resources Management Agency**

  WRMA is the key institution responsible for the water resources management: development of National Water Policy and National Water Plan; classification of water resources by their purpose usage; participation in water standards development and supervise their application, issue water use permits, etc.

  Water Resources Management Agency sets water use and discharge limits for all organizations.

**Ministry of Health**
The Ministry of Health (MH) is a state body of executive authority, which elaborates and implements the policies of the Republic of Armenia Government in the healthcare sector. The MH implements the functions related to development and organization of implementation of healthcare management policy and state projects, development and approval and sanitary norms and rules, drafting as well as oversight over implementation of laws and regulations related to healthcare sector.
The MH is designated by the Government as the implementing entity for the WB-financed projects. The Ministry is supported by the Health Projects Implementation Unit (HPIU). The HPIU will be responsible for managing ACEO project, including its environmental compliance.

**Yerevan Municipality**
Within the Yerevan municipality, there is a nature protection department, which performs monitoring of implementation of nature protection legal norms for the general use lands under the municipal authority.

*Location and conditions of landfilling of ACEO waste was set by the municipality of Yerevan.*
4. ENVIRONMENTAL AND SOCIAL SCREENING

ACEO Project carries investment components in support to provision of premises for medical facilities and therefore triggers OP/BP 4.01 Environmental Assessment. Construction of ACEO carries medium environmental and social risks which can be effectively mitigated. Due to the above, ACEO project falls under environmental Category B.

Land plot selected for the construction of the ACEO is located within the city of Yerevan. It is owned by the State and has been in use by the National Scientific Laboratory for many years, fenced and guarded. There is no known physical cultural property within this land plot. For the same reasons described above, construction and operation of ACEO is not related to any type of land ownership/land use or other property issues.

In summary, the ACEO project falls under the same environmental category as the DPCP, and does not trigger any additional safeguard policy not triggered by the Project.
5. PHYSICAL AND NATURAL ENVIRONMENT

5.1. Geographic location

According to the approved General Plan of Yerevan of 2005-2020, the territory of Yerevan is divided into 4 vertical landscape zones or landscape types:
- dry steppe: with semi-desert elements,
- semi-desert: with desert elements,
- desert: with semi-desert elements,
- lowland meadow.

In a geological structure of the area participate consolidate sediments from the upper Pliocene to the modern age, which are mostly represented by volcanic, volcanic-sedimentary fractions. Rock layers such as dolerite basalt, andesite-basalt and semirock sediments placed on them in some places: tuffs are characterized by great strength, but have different deployment scenarios and splitting feature associated with it. Fragile soils mainly are modern slope sediments. Hrazdan valley slopes are composed of basalt and andesite-basalt lavas, and are steep. Modern relief history begins with the formation of upper Pliocene when on the weathered and erosion-denudation surface of Miocene sediments started to appear volcanic rocks of upper Pliocene ages, as well as quaternary and modern formations. Modern relief partly inherited the forms of old relief. In the study area the following main geomorphological elements had been conventionally separated:
- A - Flat areas.
- B - Hills.
- C - Steep weathering slopes.
- D - Riverbeds, floodplains, gorges.

5.2. Seismic condition and tectonics

From a tectonic point of view the region of Yerevan has rather complex geological structure which is explained by its positioning: situated in the north-west of Small Caucasus meganticlinorium, Sevan-Amasia tectonic zones, i.e. in Cimerel foliation zone of Kapan-Gogaran. Sevan-Amasia tectonic zone is described by intensive foliation, which, in some areas, is equally steep and semicircle with complex ascents and descents.

In the above mentioned region, the likelihood of severe earthquake is at 8-9 magnitude scale. (according to the information of the National Seismic Protection Service). In the territory the expected values of maximum horizontal acceleration are:
- 0.25g - 0.30g
- 0.30g - 0.35g
- 0.35g - 0.40g
- 0.40g - 0.45g

5.3. Climate

Overall the climate in Yerevan has a continental character: hot and dry summers followed by moderately cold winters with unstable snow cover. Climate peculiarities are: invasion of hot, dry air masses from the south in summer, and cold air masses from the north in winter. Not frosty period lasts 213 days, with a ranging period from 163 to 234 days. The average air temperature varies in height 11.5-1200°C. The lowest temperature in Yerevan was 30°C measured in January and the highest recorded maximum temperature was + 42°C, measured in July and August. The area's climate is dry. During spring months (March - May) the precipitation amounts up to 150
mm, while June and September are extremely dry: up to 64 mm. Annual precipitation ranges from 286 to 353 mm.

In summer, the relative humidity is 49% to 53%, in winter 73% - 76%, in spring, 57% - 61% and in fall 51% - 70%. Wind direction typical for the area is north-east. During the winter months the weather features with frequently and calm winds, which due to the concavity relief contributes to the stagnation of cold air. In January, the number of calm days may be 45% - 75%.

5.4. Water resources

The main water artery of the Yerevan region is the Hrazdan River, the left tributary of the Arax River, the gorge of which is in 0.5-0.7 km from the ACEO area.

Hrazdan originates from the Sevan Lake, flows from the north-east to the south-west. The length is 141 km, water collection basin is 2560 sq. km (without the Sevan Lake). It falls into Arax at 820 m above the sea level. In the upper reaches of the river there are curls, the valley is 10-11 km wide. In its middle reaches the river flows through a narrow and deep (120-150 meters) gorge, then by V-shape canyons and hollows. There are terraces (3-4), landslides, steep slopes of the gorge, basalt column-like exposures (Arzni, Yerevan); in the valley, near the settlements of Hrazdan and Arzni, there are springs, which are used for Yerevan water supply, and mineral waters. In the lower flow the valley gradually widens, entering the Ararat valley. The overall fall of the river is 1100 meters. The system has 340 watercourses, 25 of which have more than 10-km longitude, 3 ones are up to 50 km long. Large tributaries are Marmarik, Tsakhkadzor, Dalar, Arayi river, Getar. Feeding is mainly underground (51%) and thawing (37%), flooding in spring, freshets in summer and autumn.

In Armenia, the background pollution of water resources is monitored by the Environmental Impact Monitoring Center SNCO of the MNP (Ecomonitoring): its 2015 data are presented below. According to GoA Decree No 75-N on Establishment of Norms to Ensure the Water Quality of Each Water Basin Management Area, Depending on the Terrain Characteristics (January 27, 2011), the surface water assessment system in Armenia specifies five classes for evaluating chemical quality of each parameter: “excellent” (1st class), “good” (2nd class), “moderate” (3rd class), “poor” (4th class) and “bad” (5th class). The integral status of water quality is formed by a quality parameter, which shows the worst quality class.

On the territory of the Republic of Armenia the waters management is conducted by means of 14 river basin managements areas. The Hrazdan river shapes the Hrazdan basin management area. According to the nearest Ecomonitoring observation point, water in the Yerevan section is “bad” quality (5th class) due to ammonium and phosphate ions.

5.5. Ambient Air

The pollution of air basin of Yerevan is also under the monitoring by the Environmental Impact Monitoring Center SNCO of the MNP (Ecomonitoring). On the territory of Yerevan there are five stationary observation posts, providing data for calculation of the background level of air pollution in the town. The data on air basin pollution of the town of Yerevan in 2015, according to the reference, provided by Ecomonitoring, are given below.

The air basin monitoring was conducted by observation posts located in Yerevan via active (24-hour) sampling to determine the content of dust, sulfur dioxide, nitrogen dioxide and ground-level ozone in the atmosphere.

Table 5.1. Results of monitoring via active sampling in Yerevan
Air basin monitoring was carried out by passive sampling in 48 observation posts of the town. 4715 samples were taken, and their sulfurdioxide and nitrogendioxide average annual concentrations did not exceed MACs.

<table>
<thead>
<tr>
<th>Determined substances (monitoring points)</th>
<th>Maximum concentration fixed in monitoring, mg/m$^3$ (for a monitoring point)</th>
<th>Number of MAC exceedences</th>
<th>Average annual concentration (mg/m$^3$)</th>
<th>Average daily TLV (mg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur dioxide (7)</td>
<td>0.067 (mon. N18)</td>
<td>18</td>
<td>0.020</td>
<td>0.05</td>
</tr>
<tr>
<td>Nitrogen dioxide (7)</td>
<td>0.088 (mon. N18)</td>
<td>175</td>
<td>0.018</td>
<td>0.04</td>
</tr>
<tr>
<td>Dust (7)</td>
<td>2.387 (mon. N18)</td>
<td>694</td>
<td>0.126</td>
<td>0.15</td>
</tr>
<tr>
<td>Ground-level ozone (7)</td>
<td>0.257 (mon. N19)</td>
<td>53</td>
<td>0.010</td>
<td>0.03</td>
</tr>
</tbody>
</table>

5.6. Landscape and soils

The territory of Yerevan from the geo-morphological view is located in the Trans-Yerevan region, the central area of the plain, which is a part of the Ararat valley. The Ararat valley is a bottom of the Ararat concavity, filled with lake, river and torrencial sediments and lavas. The edging of the Ararat Valley is formed by contemporary rivers' output and proluvialfan-shaped cones, transformed into table-shaped terraces. The relief of the entire area has a flat, in some places wavy surface.

Semi-desert and mountain-steppe landscapes are prevailing. The ground cover consists of semi-desert soils, which were formed on alluvial, alluvial-proluvial gravel-fragmentary carbonate basic types (the map of natural types of soils is given in Picture 2). These soils have mainly a sandy-clay mechanical structure with quite a skeletal mass contents. The structure is dusty-granule, the quantity of water resistant aggregates does not exceed 30-35%. In some places, the in the deep strata of soil, water-saluble salts are accumulated in substantial ammounts (up to 1-1.5%), mainly containing CaSO$_4$, MgSO$_4$ and other salts. For such soils insignificant contents of humus (1-1.5%) is typical. Soils are stony: superficial, buried and semi-buried stones are present. Due to uneven terrain, poor vegetation cover, and unfavoriable physical characteristics, these soils are exposed to water and partly wind erosion.

5.7. Biodiversity

The flora and fauna of the Yerevan area are incorporated in the Yerevan floristic region. Mainly the petrophil variants of the semi-desert flora are prevailing here with ephemeral and halophyte, psammophyte desert plant species. The fauna in the region is represented mostly by species, typical for desert and semi-desert landscapes. Amphibians (such as lakefrogs, Syriaspadefoots, greentoads), lizards (round-headed, snake-headed ones and long-legged skinks) and snakes (blindsnakes, rhinosnakes) are common for the area. Birds and insects are diverse. Satyrs and big swallowtails are typical butterflies.

The monitoring area lies within the urban environment and no wild plants or animals inhabit it. In the surroundings, there are no specially protected nature areas, endangered and vanishing ecosystems.

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2 As the monitoring is carried out day and night the comparison is made with the daily average MAC.
6. Project Description

6.1. Construction of ACEO Premises

All design work and specifications for RPC and RTC premises are developed by POLITECNIKA ENGEGENERIA E ARCHITETTURA (Modena, Italy) in accordance with construction norms enacted by the Government of the Republic of Armenia. In particular, design and specifications meets international nuclear and radiation safety regulations adopted in the Republic of Armenia.

Structure

The premises of ACEO comprise of two structural blocks. One is very massive and rigid, and is made by four bunkers; the other is a three-storied building. The 4 bunkers are dedicated for the radiotherapy, beneath the brachytherapy with their own ancillary areas and technical rooms.

- The four bunker plan is almost a rectangle located at ground floor only.
- The ancillary building is in direct communication with the diagnostic center. Its geometry is rectangular.
- The mechanical and electrical equipment are located in the roof and in the immediate surroundings of the building in order to guarantee a proper functioning of the new intervention.
- The external area directly serving the new building is organized with visitors and staff parking areas.

The dimensioning of the new extension has been carried out on the basis of the Clients’ requirements, according to European Norms for Sanitary Structures, and most updated Standards in the Construction of Cancer Centers. The position of each facility has been defined according to required and/or preferred proximity to complementary or supporting facilities. The interventions included in the design of the new Department of Radiotherapy and a Diagnostic center complies with the following objectives:

- Particular care is to be given to the design of circulation routes, separating “clean” from “dirty” flow, in-patient access areas from out-patients’, maintenance flows, etc.
- The project must meet the needs of the public health, clearly spelled out by the Client.
- Spatial reorganization of activities and paths must to maintain the connection between the clinical diagnostic functions and the support and hospitality to patients.
- Flexible use of space
- Optimization of external arrangements
- Integration of the project with the existing building, interpreting it, and fitting into the landscape.
- Overcoming architectural barriers
- Hygiene health care and environmental sites in the workplace

The main access from the urban road system allows the entrance of the out patients, ambulances and social services cars in order to provide the entrance of outpatients even when arriving in stretchers or wheelchairs. A secondary access allows the entrance to the suppliers, goods deliveries and maintenance services. The internal road system guarantee the access all around the new building for the fire fighting vehicles. The complex is organized in three levels above ground. The ground floor is dedicated to the diagnostic and therapeutically functions and it is positioned next to the actual cyclotron. The three floors are connected by a lift and stair...
dedicated to visitors. A secondary stair is located in the back front of the building as well as the service elevator.

**Dimensions**

The 3 floors building has the following internal surfaces:
- Ground floor: 2122.45m²
- First floor: 832.36 m²
- Second floor: 564.39 m²

Leading to a total amount of 3519.15 m², as net walkable surfaces. For what regards the amount of gross surface we have 4267 m² that is an amount of approx. 4000 m², if excluding the technical room/area located at first floor roof.

**Technical Connections**

The supplies to the public networks will be made according local authority prescriptions.

The demand of energy, water, sewage and gas is reported in the following table.

Table 10.1. Technical Connections, Dem and/Supplies

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Power Demand</td>
<td>600KW</td>
</tr>
<tr>
<td>Potable Water Demand</td>
<td>6,000 litres/day</td>
</tr>
<tr>
<td></td>
<td>4 litres/second</td>
</tr>
<tr>
<td>Sewage</td>
<td>8 litres/second</td>
</tr>
<tr>
<td>Gas Thermal Power</td>
<td>800 KW</td>
</tr>
<tr>
<td>Fire Fighting Water Demand (Internal + External)</td>
<td>243mc/day</td>
</tr>
<tr>
<td></td>
<td>22.5litres/second</td>
</tr>
</tbody>
</table>

**6.2. Operation of ACEO**

ACEO is a Medical Center, where there are carried out diagnostic and treatment procedures. In ACEO for the implementation of the services like accepting the patients, diagnose, and treat, there are provided the following departments.

**Diagnostic area**

The diagnostic area is placed in a central surface between cyclotron building and radiotherapy services. A separate flow guarantees the entrance of technician in the control rooms. The diagnostic rooms are the following:

- Mammograph: it is near the main entrance with its own changing room and rest room.
- X-Ray: it has two changing room with in a proper rest room.
- Standard CT: it has an own preparation room with in a rest room.

Simulator CT: it has an own preparation room with in a rest room. This equipment is dedicated to the Radiotherapy service.

- MRI: this area is separate with one door from the rest of the diagnostics, in order to guarantee the safety protocols.
• There is a room for the interview with the patients; afterwards there is a changing room, a rest room, the preparation area, the technician control room and the MRI room. The dedicated plant room is accessible from the main entrance.

• Staff rest room
• Clean and dirty stores

Radiotherapy area

Opposite to the cyclotron and beside the diagnostic area are located the Radiotherapy services. Between these two areas there are the staff offices, staff services and meeting room. This area is easily reachable from both, diagnostic and radiotherapy staff.

Outpatients find desk information, a minor waiting area and the examination rooms as well as the simulator CT scan in order to schedule the therapy program.

In the next area there are four preparation rooms with an internal rest room divided in two groups, each one with two rooms. There are two secondary waiting areas and from there the patients can go inside the dedicated changing rooms, going through the patient reach the entrance to the radiotherapy bunkers. Privacy and dignity issues are guarantee by the changing room used as a filter area between the waiting area and the area before the entrance to the bunker.

The bunkers are four, large enough to allow easy access and movement for patients on beds, trolleys and wheelchairs. The linear accelerators will be placed inside the treatment room (bunker). The details of the protective radiation shielding used for the final design are available in the “Structural shielding design report”.

The control room is located beside the bunker organized in an open space. This organization offer flexibility and increase technicians control for the bunker access.

The treatment room is placed in a barycenter area. This important room has two accesses in order to facilitate the staff the communication with technicians, doctors and to be adjacent to the treatment area.

There are also general services rooms as stores, offices and rest room for the staff.

Brachytherapy area

There are two brachytherapy rooms. In this area, there are the following rooms:

• waiting areas
• two preparation rooms within the rest rooms,
• two treatment rooms,
• two control rooms.

The Radiotherapy building includes:

• 4 bunkers (treatment rooms) for installation of the linear accelerators, from which two are optional
• 1 Simulator room
• 1 Treatment planning room
• 1 Mould room
• 1 Examination room
• Rooms for medical physics and staff (included nurses and physicians)
• Waiting areas
- 2 bunkers (treatment rooms/operating rooms) for administration of HDR (high dose rate) brachytherapy
- Treatment planning room

**Diagnostic, consultation, in-patient and other parts:**
- 10 single bed wards
- Room for CT examinations
- Room for MRI
- Room for Mammography
- 2 Rooms for Ultrasound examination
- 1 Room for X-ray with auxiliary areas
- Laboratory room
- Admission
- Lounge
- Administration rooms
- Other areas

### 6.3. Operation of RPC

Positron emission tomography (PET) has advanced rapidly in recent years and is becoming an indispensable imaging modality for the evaluation and staging of cancer patients. The key component of the successful operation of a PET center is the on-demand availability of radiotracers (radiopharmaceuticals) labelled with suitable positron emitting radioisotopes.

PET is an imaging modality in nuclear medicine that uses the principle of coincidence detection of the two annihilation photons resulting from the decay of a positron emitting radionuclide to measure radiotracer distribution within tissues.

The idea of a radioisotope used in therapy is based on the desire to link a radionuclide that has a high linear energy transfer (LET) associated with its decay products, such as Auger electrons, beta particles or alpha particles, to a biologically active molecule that can be directed to a tumor site. Since the beta emitting radionuclides are neutron rich, they have, in general, been produced in reactors.

The service of the center will be carried out by specially trained personnel, and all functions will be carried out in accordance with Cyclotron Produced Radionuclides: Principles and Practice technical guidance.
7. SENSITIVE RECEPTORS

7.1. Ambient Air

In Soviet times Yerevan had a developed industry which was significantly polluting air. However, in the last few years the industrial production dropped dramatically and so has the level of emissions. At present, automobile exhausts are the only main contributor to the air pollution in Yerevan.

Air pollution is characterized by background concentrations level of various pollutants. The air pollution control of residential areas on the territory of the RA is implemented by Environmental Impact Monitoring Center SNPO of the MNP by the means of observation stations located in the settlements. Permanent observation stations are located only in Yerevan, Vanadzor, Ararat and Hrazdan cities.

Based on the data of 2015 obtained from observation stations of Impact Monitoring Center SNPO installed in Yerevan and local researches, the highest contamination of air is considered near the busy highways.

7.2. Water Resources

Hrazdan River is the largest hydrographic unit of Yerevan. While the river flows from Lake Sevan to Yerevan during the entire way it is filled with sewage from settlements and industrial plants. As it was mentioned in 6.4. water in the Yerevan section is “bad” quality (5th class).

7.3. Land Resources

Land plot allocated for the construction of ACEO is located in the highly transformed urban settings. Their vegetative cover is represented by grass, shrubs, and artificially planted trees. The land plot allocated for the construction of the ACEO was previously used by YPI.

7.4. Social Environment

Land plot allocated for the construction of ACEO is located within the residential area, in the existing YPI territory. The location and connectivity of the site are highly convenient for potential users of their services and will amplify social benefits of the provision of these new premises.

Staff of the existing YPI will be under immediate direct health impacts from the design of the buildings and from the materials used for their construction and finishing, as well as from the operation of some medical devices, and management of the medical waste.

7.5. Cultural Resources

There are no known and registered physical cultural resources located in the vicinity of the land plots allocated for the construction of the ACEO. Though due to the need of earth excavation works, encountering of change finds cannot be entirely excluded.
8. SOCIAL AND ECONOMIC ENVIRONMENT

The current area is located in Ajapnyak administrative district of Yerevan. Yerevan is the capital and largest city of Armenia. Yerevan is the administrative, cultural, and industrial center of the country.

Territory: 223 sq. km
Territory share of the city in the territory of RA: 0.7 %
Agricultural land: 3 352.1 ha, including - arable land: 915.9 ha
District communities: 12
Population number at the end of the year, 2014: 1,071,500 persons.
Share of city population size in RA population size, 2014: 35.6 %

Yerevan is the largest economical center of the republic. Manufacturing is the main, principal trend of multi-branch industry.

In 2014, the share of economy main branches of the capital in total volume of correspondent branches of the republic comprised:
- industry 42.1 %,
- agriculture 1.1 %,
- construction 53.9 %,
- retail trade 82.6 %,
- services 85.5 %.

The main trends of industry are manufacture of food products, including alcoholic beverages and chemical and metallurgy industry.

Table 8.1. Some social indicators of Yerevan City, 2014

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Total</th>
<th>including:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>women</td>
</tr>
<tr>
<td>Population, person</td>
<td>1071500</td>
<td>575500</td>
</tr>
<tr>
<td>Employed, person</td>
<td>309235</td>
<td>137152</td>
</tr>
<tr>
<td>Unemployed, person</td>
<td>113900</td>
<td>57540</td>
</tr>
<tr>
<td>Total pensioners/as of the end of the year/ person</td>
<td>167154</td>
<td>103400</td>
</tr>
<tr>
<td>Families that get poverty family benefit and one-time benefit</td>
<td>17040</td>
<td>-</td>
</tr>
</tbody>
</table>

Administrative district Ajapnyak
Territory: 2 582 ha
Number of total population in the end of the year: 108.900 persons.
9. EXPECTED ENVIRONMENTAL AND SOCIAL IMPACTS

The expected impact of the planned activities on the environment is presented in two stages: in the course of the implementation of construction works in RTC and operation/maintenance of the entire ACEO.

9.1. Construction of the premises of RTC

The main environmental and social risks are identified to be:

- Air pollution during earth works and loading operations, and exploitation of construction equipment engines;
- Land degradation and erosion as a result of damaging vegetative cover;
- Nuisance to local communities from dust and noise during construction equipment operation and motor vehicles works;
- Local traffic disruption due to movement of construction vehicles and machinery;
- Unsafe disposal of access material and construction waste;
- Soil and ground water pollution with operational spillages of fuel and the runoff;
- Unsafe extraction of construction materials.

Impact on the air

Emissions of hazardous materials originate during construction works when drilling of foundations, soil loading, unloading and transportation takes place, as well as a result of construction equipment diesel engines combustion of fuel, laying of asphalt, bitumen works and welding.

a) dust emissions during drilling-loading works

During the drilling-loading works inorganic dust emissions are generated, mainly during drilling with excavator, removal of the priming ground, and loading of dump trucks.

b) dust emissions during preparation of concrete mix;

c) VOC emissions during bitumen works and laying of asphalt;

d) Diesel fuel combustion products/results

During the combustion of diesel fuel nitrogen, carbon and sulfur oxides, as well as solid particles are being generated.

Emissions generated during construction are of localized and temporary nature and quickly disperse.

Impact of Water Resources

During construction works the water will mainly be used for watering the construction site, cleaning the pipes, preparation of concrete mix and household needs of the contractor’s staff and personnel.

Water use for watering of a construction site is classified as irredeemable water use and is counted as a loss. Water used for testing and disinfecting pipes is collected in a special tanker, and after neutralizing it with hypochlorite sodium, this water can be used for watering the construction site.

To meet household water consumption needs of personnel, the construction company will make accommodations equipped with bathroom and food court spaces in the construction site.
Surface water pollution is not expected from the construction works, as the closest surface water body – Hrazdan River is about 0.5-0.6 km away from the construction site and the position of the relief doesn’t allow water to reach the river canyon by gravity. Ground water pollution may result from regular operational spills or accidental spill of fuel and lubricants in case servicing of construction vehicles and machinery is undertaken on-site. Unregulated washing of vehicles at the construction site may also result in ground water pollution.

**Impact on Soil – waste pollution, borrowing**

It is planned to organize a construction site in the nearest free territory. The debris occurring in the process of construction works must be periodically transported to the dump. The location of a dump and transportation schedule is agreed with Yerevan municipality. In the course of construction works the top-soil in some parts of the site is withdrawn and it could cause phenomena of further erosion.

As a result of construction works construction waste is generated, which may result in accumulation of garbage and pollution of the outer layer of the soil. The total excavated soil will be used as backfilling. The surplus land mass, as well as the construction waste will be removed to the mentioned dump provided by Yerevan municipality.

**Noise generation**

The technical machines used in the process of construction works generate additional noise. The specific parameters of noise generated by the technical means are presented in Table 10.2.

<table>
<thead>
<tr>
<th>Name of technical means</th>
<th>Number of simultaneously operating machine</th>
<th>Absolute (tech. passport) parameter of noise, dBA</th>
<th>Permissible level of noise at the workplace, dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavator</td>
<td>1</td>
<td>90 - 102</td>
<td>85</td>
</tr>
<tr>
<td>Bulldozer</td>
<td>1</td>
<td>95 - 104</td>
<td>85</td>
</tr>
<tr>
<td>Hoisting crane</td>
<td>1</td>
<td>77 - 84</td>
<td>85</td>
</tr>
<tr>
<td>Dumper</td>
<td>1</td>
<td>82 - 87</td>
<td>85</td>
</tr>
</tbody>
</table>

Taking into account the distance of the residential districts from the construction site, the noise of the mentioned above technical means will not create an exceeding normative source for residential and public buildings.

**9.2. Operation of RTC**

The main environmental risks:
- improper operation of boiler house
- organic, chemical and household waste generation
Impact on the air quality

The ACEO heating system operation results in generation of hazardous substances from the combustion of fossil fuel that is being emitted into the atmosphere, thus impacting the environment.

The estimations of hazardous substances emitted and dispersed into the atmosphere realized during the boiler-house operation showed, that the expected surface based concentrations are in the range of permissible norms.

Water Resources

Water supply of the drinking water of the RTC will be carried out from the urban water supply network through the network of YPI. The water use volumes are not comparable with YPI water consumption and cannot break the water balance.

The water supply internal network is circuit-shaped. The hot water is supplied from the boiler-house, which will be located at the RTC area.

To ensure the fire safety of the area a ground fire-fighting hydrant is to be installed.

Water discharge

The sewage waters of the RTC arise as a result of household water usage and works of laboratories. All the sewage waters are accumulated in one sewage pipe and connected with YPI sewage system.

Waste

Clinical wastes, X-ray films development solutions and waste of domestic nature are generated at the RTC.

The surgical (clothes, bandages, paper containers and cardboard boxes) and organic wastes can be combined and send to thermal neutralization to the relevant organizations.

In particular, there are a few companies (Ecologia V.K.H, ECOPROTECT LLC, etc.) in the republic that possesses a waste processing license and positive environmental expertise assessment that carry out clinical waste collection and burning.

Neutralization of X-ray films developing solutions are also implemented by organizations that have received a positive assessment of environmental expertise and a waste processing license. Wastes of domestic nature will be transported to Yerevan municipal landfill on the basis of a contract with Yerevan city garbage Disposal Company.

<table>
<thead>
<tr>
<th>Impact of/ on</th>
<th>Sensitivity</th>
<th>Duration of Impact</th>
<th>Direct/ Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation of ACEO</td>
<td>■</td>
<td>Long term</td>
<td>Indirect</td>
</tr>
</tbody>
</table>

9.3. Operation of RPC

During the commissioning and operation of RPC the main impact on the environment and population is due to the exploitation of radioactive equipment and generation of hazardous waste.

<table>
<thead>
<tr>
<th>Impact of/ on</th>
<th>Sensitivity</th>
<th>Duration of Impact</th>
<th>Direct/ Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation of RPC</td>
<td>■■</td>
<td>Long term</td>
<td>Indirect</td>
</tr>
</tbody>
</table>
10. IMPACT MITIGATION

Below presented a generic set of mitigation measures, proposed for the construction and operation of RTC and operation of the RPC.

10.1. Construction Phase

Emissions, noise and vibration originate during construction works when drilling foundations, loading/unloading/transporting materials, operating construction equipment and vehicles, etc. For minimizing these negative impacts:

- keep construction equipment and machinery in an adequate technical condition;
- avoid idling of engines;
- do not use sub-standard fuel;
- do not use non-proper construction materials.

Excessive and unmanaged water use at the construction sites may result in waterlogging of the site, runoff from the site, pollution of the ground water with oil and lubricants. For minimizing these negative impacts:

- do not allow leakages from the construction sites;
- any vehicle washing done on-site should be in a designated location with mechanism to prevent oil from seeping into ground.

In case of encountering any unidentified objects and/or substances beneath the soil:

- immediately take all construction activities on hold and contact national authorities responsible of handling emergency situations(Ministry of Emergency Situations);
- do not resume works until having received formal permission from the above authorities.

To avoid health hazards of workers and environmental pollution with hazardous waste:

- ensure proper use of personal protective gear by all workers and personnel exposed to hazardous materials;
- keep dangerous waste in separate and especially isolated location of the work site and timely remove it to the formally designated disposal site (Nubarashen Landfill) using covered vehicles.

Non-toxic construction waste, including excess excavated material, may hinder works and pollute environment if mismanaged. In order to minimize negative impacts from generated construction waste:

- organize temporary on-site storage of waste in especially designated locations and timely remove it to the location of permanent disposal;
- use covered vehicles for waste transportation;
- timely obtain written permission from municipal authorities for permanent disposal of waste and ensure that all waste is disposed exclusively in such formally designated locations.

Accidents leading to health damage and even casualties may occur in the course of construction. To minimize risk of negative health impact and accidents:

- constructors should be properly insured (Insurance of construction workers);
- ensure that workers and any visitors are provided and use personal protective gear;
- insure that workers receive worksite safety training,
- insure that workers operating large equipment are properly trained and licensed.
- ensure that construction equipment are inspected and licensed
- ensure that construction equipment is used strictly following its operation instructions;
- keep first aid medical kits and fire-fighting equipment on site.

Construction works, especially operation of machinery, may cause nuisance to nearby residents caused with noise, dust, and vibration. Construction may cause nuisance to the personnel of the YPI. To minimize this impact:
- keep construction equipment and machinery in an adequate technical condition;
- avoid idling of engines;
- water work sites in the course of dusty works or in case of especially hot and dry weather conditions;
- disallow on-site activities beyond the working hours.

10.2. Operation of the RPC

Operation of hot water supply and heating systems, as well as running of emergency back-up systems of power generation, emit to the ambient air. In order to minimize negative impacts of emission:
- install and operate high quality and energy efficient cooling/heating units;
- provide adequate insulation of buildings to decrease energy consumption;
- keep boiler and other equipment in good working condition to avoid excessive fuel use and emissions.

Operation of the RPC will generate variety of wastes, including medical, household, liquid, and hazardous wastes. Waste management system must include (see Annex VII):
- waste separation (medical, household, hazardous);
- provision of adequate containers for separated collection of waste, provide safe on-site waste storage facilities, and convenient access to such facilities by waste transportation vehicles;
- contractual arrangements with specialized companies licensed for the removal, deactivation, and disposal of medical and hazardous waste (the list of specialized licensed companies is available at MNP);
- arrangement for the connection to the municipal waste water collection system and provide adequate maintenance to ensure flawless operation of internal sewerage;
- elaboration, formal adoption, and strict adherence to the operational rules for the units involved using the radionuclide, radio-diagnostics, and radiotherapy.

Smooth operation of the ACEO will require regular good maintenance of the internal communications and the yard area, including regular check-up of water and sewage pipes to avoid leakage; periodic cleaning of storm water drainage passages to avoid water damage to the building and waterlogging of the yard; timely clean-up of snow deposited on the roof and in the yard to avoid damage and leaking of the roof and nuisance to the staff and visitors of the RPC.

10.3. Operation of the RTC

Radiotherapy is a multidisciplinary specialty which uses complex equipment and radiation sources for the delivery of treatment. The operation, radiation safety and quality control of the Radiation Treatment Center will organized in accordance with the requirements of International Atomic Energy Agency’s (IAEA) (Setting Up a Radiotherapy Programme: Clinical, Medical Physics, Radiation Protection and Safety Aspects (IAEA. Vienna, 2008)). Collection of the medical waste have to be organized in accordance with the scheme developed by the designer.
The management of the “Radiation Treatment Center of the Ministry of Health” CJSC is directly responsible for the development of internal workflow protocols where direct responsibilities of each employee will be indicated. At present, the staff of the newly established center is not selected yet, the Ministry of Health will betake selection of staff closer to completion of creation works in years 2018.

**Staff training**

In accordance of the IAEA guidelines early in the process, a decision should be made about additional training required for some hospital staff. For that reason within the scope of the DPC project both international and local trainings of the specialist of the Radiation Treatment Center is planned. The HPIU will start training activities as soon as the staff of the newly established Center will be defined by the Ministry of Health. Within the scope of the trainings inter alia clinical topic the radiation safety and quality control topic will be covered as well. The international facility which will provide trainings will be selected in accordance with the WB procurement guidelines.

**Planning and construction of facilities**

Careful attention focused on the flow of patients in the treatment facility. For that reason, the special radiation safety report was developed by the Designer and set of documents including layout of the Center, bunkers shielding report with calculations have been presented for the approval of the appropriate organization - Nuclear and radiation safety center State Organization. During design phase careful attention was made to the compliance of the general safety rules, such as separation of the diagnostic and treatment parts of the Center, separation of the patient and staff pathways, exception of the patients pathways to the dangerous areas, assurance of the evacuation pathways, as well as fire alarm systems.

**Delivery of equipment**

A number of important steps must be taken before, during and immediately after the equipment arrives.

- Acceptance testing and commissioning
- Quality control and radiation safety procedures

As it was already mentioned, provisos of the equipment as well as dosimeter equipment will be provided by the HPIU within the scope of the DPC project. As usual, the supplier companies will perform testing and commissioning of the supplied equipment, which will be accepted by the management of the Center.

**Treatment policies**

Treatment policies serve to prevent a mismatch of treatment philosophies, and to allow any non-standard practice to be questioned. Once the treatment policies have been defined by the appropriate physician for the full range of radiotherapy (external and brachytherapy) techniques proposed, they should be implemented in conjunction with the medical physicist. The prescribed doses (or ranges of prescribed doses) and the overall treatment regimens should be defined for different disease sites, tumor stages and presentations.

The special treatment policies should be developed by the specialized organizations such as National Institute of Health. At present the National Institute of Health already started translation of the international guidelines on treatment of the oncology diseases. It is assumed, that new guidelines, translated and adopted to Armenian situation will be approved and adopted by the Ministry of Health before the completion of Center’s creation process.
**Radiation Protection and Safety of Sources**

It is important at the design stage to ensure that equipment meets IEC standards and that sealed sources meet ISO standards.

For this purpose, the recipient needs to prepare:
(a) A safety assessment of the equipment;
(b) A quality control test before the donor decommissions the machine, the results of which are to be submitted to the regulatory authority in the recipient country;
(c) A full, safe and workable maintenance strategy.

**Brachytherapy**

For reducing the dose rate brachytherapy can be performed by manually loading the sources into the applicators, which have been placed into the patient, or by using a remote after loading unit that stores the sources until they are needed and then drives them into position in the applicator. The remote after loader acts as its own storage safe and allows the sources to be retracted into the safe position whenever anyone, such as a nurse, needs to be near the patient. Therefore, staff exposures can be kept to a very low level.

**Occupational Protection**

The establishment of investigation levels is a tool used to provide a ‘warning’ on the need to review procedures and performance, to investigate what is not working as expected and to take timely corrective action. In radiotherapy, a suitable quantity for use as the investigation level is the monthly effective dose itself, but the dose to the hands can be used as a quantity to establish the investigation level for staff in manual brachytherapy.

The following are examples of levels and their related tasks that are rarely exceeded and, therefore, could be suitable as investigation levels:

(a) For persons working only with accelerators or remote control brachytherapy, a monthly investigation level of 0.4 mSv effective dose;
(b) For staff working with 60Co external beam therapy, brachytherapy nurses, and persons inserting and removing manual brachytherapy sources, a monthly investigation level of 0.5 mSv effective dose.

**Supervision**

Sufficient supervision needs to be exercised in order to avoid the degradation of safety that occurs if the impression forms that the management tolerates a situation in which procedures are not followed. When supervisors fail to make procedures and rules understood or take no actions when rules are violated, accidents will eventually occur. Effective management provides comprehensive safety training to supervisors and holds supervisors accountable for worker observance of rules and procedures.

**Prevention of Accidental Medical Exposures**

When developing a project for radiotherapy, the following issues have to be considered:
(a) The great dependence of radiotherapy on human performance;
(b) The large number of steps from prescription of a treatment to delivery of the radiation dose;
(c) The fact that interaction and communication between staff from different professions are necessary in most of the steps;
(d) The combination of sophisticated equipment with manual work.
Public Exposure

The licensee is responsible for controlling public exposures resulting from a radiotherapy practice. Public exposure is controlled by proper design of shielding and, in large part, by ensuring that radiation sources are shielded and secured (e.g. located in a locked area), and that keys to the control panel are secured to prevent unauthorized access or use. Presence of members of the public in and near the radiotherapy department should be taken into account when designing the shielding of storage and treatment facilities.

Emergency Plans

The greatest hazard to staff, public and patients occurs when events do not follow accepted procedures. For such situations, there need to be well prepared emergency plans that are concise and easily followed, and these should be developed before the startup of a radiation treatment programme.

Contamination

Contamination may occur if radioactive material has spread outside its container or encapsulation. It is very important that the area be closed to further entry and that all those persons who were in the area remain to be surveyed and decontaminated if necessary. If there are windows or ventilation shafts, these should be closed and the RPO should take control of the situation.

Emergency procedures should be posted at the control console in the event that the radiation unit does not turn off. These procedures should deal with the safe evacuation of the patient from the room and securing the room from further entry until the appropriate experts have arrived. There should also be information on how to contact the responsible radiation safety individual in the event of an emergency.

10.4. Operation of the RPC

General safety planning guidelines

Radiation protection aspects will have to be considered upfront while developing a cyclotron based radiopharmaceutical production facility. The design as well as the operational arrangements proposed will have to be provided to the regulatory body as part of the licensing process.

Below there are represented the requirements of International Atomic Energy Agency’s (IAEA) “Cyclotron Produced Radionuclides: Guidelines” (IAEA. Vienna, 2009) on the installation, maintenance and safe conditions’ insurance of cyclotron.

Protection of the public

The likelihood of unnecessary exposure of the general public to radioactive material will be reduced if certain features are incorporated into the design. These are:

— Areas where radioactive material is used or stored should have restricted access. Members of the general public should not be permitted access to areas where radiation levels are in excess of 2.5 mSv/h.
— All areas which require restricted access should be furnished with adequate security provisions to prevent unauthorized access to the radioactive material.
— Areas where radioactive material is used or stored should be well-shielded. Special attention should be given to radionuclides with high energy gamma rays.
—The movement of radioactive material should be minimized and contained. This can be achieved by keeping areas where radioactivity must be stored or handled in close proximity to each other.
—Waste contaminated with radioactive material should be stored and handled in a way that is in compliance with all appropriate regulations.

**Protection of workers**

The incorporation of several other general design principles will protect workers from unnecessary exposure to radioactive material. These are:
—Radioisotope laboratories must have sufficient floor space, counter space, and hood space to allow people to work safely. The space requirements will depend on the type of work, traffic patterns, and equipment needs. In a well-organized laboratory, at least 3 m² of free floor area per person should be provided.
—Shielding around radioactive sources should be provided to ensure that workers are not subjected to radiation levels in excess of 25 mSv/h. In most cases, it is advisable to shield radioactive material such that workers are exposed to radiation levels of less than 2.5 mSv/h.
—The facility should be equipped with a radiation alarm system in case of excessive radiation.
—All surfaces in the laboratory should be fabricated from materials that can be readily decontaminated,
—All radiation workers shall be appropriately trained in handling radioactive materials.

**Adequate space and movement of materials**

The most important consideration in facility planning is to be clear on the scope of the center. This requires input from the scientists, physicians, and administrators who will be using the center, as well as the scientists and engineers involved in setting up the center. It is imperative that everyone clearly understand what a particular facility can do and, more importantly, what it cannot do. It is common for radiochemistry facilities to gradually increase their scope of operations over time (scope creep). After a time, the facility will need to grow to accommodate these expanded operations.

**Work surfaces**

There should be some work surfaces, either inside the vault or in an area immediately adjacent to the vault, that are set up for carrying out radioactive work. These surfaces are essential for the routine maintenance and repair work on the cyclotron. The work surfaces should be resistant to chemicals and solvents, smooth, and easy to clean. They should not generate dust.

**Floor surface**

The floor surface should be hard, washable, and smooth. The concrete surface should be painted or covered with an epoxy coating, so that there will be a minimum of dust collected and contamination can be removed.

**Floor drains**

The floor of the vault must contain drains for water. There will be hoses that break and, during maintenance, it is often necessary to remove water from the water lines. These drains are normally connected to the sanitary sewer system. They may also be tied into a hold up system, for the water to be checked for radioactivity, before it is released into the sanitary sewer system.
The weight of a bare cyclotron is of the order of 15–25 t. The weight of the self-shielding system may be 85–100 t. The weight of the vault of a locally shielded cyclotron with 1.2 m thick concrete walls is approximately 300 t.

The total weight of a self-shielded cyclotron is much less than an unshielded or locally shielded cyclotron, which must be installed in a vault with thick walls. The floor underneath the cyclotron and vault must be strong and thick enough to bear these weights. A floor thickness of 40–50 cm is typical for the self-shielded version of the cyclotron. The floor loading of the path as the cyclotron is brought into the facility is also a concern, and structural engineers should be consulted before the move is made. Steel plates and other techniques can be used to spread the load if the floor on the path into the facility will not bear the weight of the magnet.

**Shielding thickness**

The thickness of the shielding around the cyclotron vault will depend on the type of cyclotron, the energy, types of particles, and the targets to be used. The main purpose of the shielding is to reduce the neutron flux during the operation of the machine. Any shielding that will reduce the neutron flux to an acceptable level will also reduce the gamma flux. Final testing should be done using a reaction which produces a lot of neutrons.

**Air conditioning and humidity control**

Much of the heat load of the cyclotron and associated equipment must be removed by the air conditioning system. The humidity in the room must be maintained low enough so that water will not condense on the cooling water lines. Typical requirements are for temperature control at $20^\circ \pm 2^\circ$C, with less than 2$^\circ$C change/hour and a relative humidity which must not exceed 65%. The air in the cyclotron vault must be clean and free of dust.

**Dust contamination**

Dust in the vault can be a means of transport of radioactive contamination out of the vault and into other areas and, therefore, should be kept to a minimum. Dust can be kept to a minimum by using epoxy or other sealant on the floors and walls of the vault. This will minimize the number of small particles which flake off the concrete. The other fixtures in the vault should be made of rust resistant materials, and the exposed metal surfaces should be oiled to prevent corrosion if possible.

**Magnetic fields**

There are magnetic fields associated with cyclotrons. In modern cyclotrons, the field is quite low, more than 30 cm away from the magnet yoke. Magnetic and RF field measurements should be taken in the vicinity of the machine during operation at the acceptance testing. In modern cyclotrons in which the magnet is of the contemporary ‘deep valley’ style, the external field is typically quite low, beyond several tens of centimeters from the surface of the yoke. However, if the cyclotron has the older, more traditional ‘H-style’ or ‘window frame’ yoke and pole construction, the external field can be high enough while the magnet is energized to pose a direct physical hazard if, during maintenance or trouble-shooting, one strays too close to the magnet with steel tools in hand. The intense magnetic field close to the magnet will also render many ion chamber and Geiger–Müller type radiation survey instruments inoperative, creating a potential radiation hazard near close mounted targets and beam-line components due to falsely-low or null instrument readings if one is not forewarned.

**Radiation monitoring**
Commercial area monitoring packages are readily available for radioisotope production facilities, but at a fairly significant cost. These systems measure activity levels in areas where radioactive material is handled, or where there is potential leakage of gaseous or volatile radioactive materials. Ideally, there should be a monitor inside the cyclotron vault to indicate the radiation levels before entry. There should also be radiation monitors inside each hot cell and in the general areas around the hot cells to detect any leakage. In addition, a monitoring device should be installed on all the exhaust ducts from the cyclotron and hot cells to warn of any emission escaping from the facility to the outside. These detectors can, when properly calibrated, give the integrated amount of activity being released from the facility, which is often a regulatory requirement. If the hot cell and the cyclotron exhaust ducts are bundled close together, detectors in the exhaust ducts should be placed carefully to avoid one detector reading activity from the adjacent duct.

**Distance to cyclotron**

The equipment room should be relatively close to the cyclotron, since water pipes and a substantial quantity of cabling will run from the various supporting units into the vault.

**Waste disposal**

There should also be an area for waste waiting to be removed from the facility. This process is usually referred to as decay in storage, and one should wait at least ten half-lives or until the radioactivity in the sample has decayed to levels authorized for clearance.
11. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The ESMP, attached to the present ESIA report as Annex II, was developed for the ACEO project to mitigate the negative environmental and social impacts at the construction and operation phases. ESMP includes information on the risks arising on different stages of the activities, the sectors affected by the risks, as well as the list of envisaged measures, implementers, responsible people and State or community control intended to reduce each effect of the impact.

11.1. Responsibilities and Institutional Arrangements

HPIU is responsible for the implementation of the ESMP including obligation of qualitative and timely implementation of all mitigation measures, supervision on implementation, documentation of the results of the supervision about cases such as environmental problems connected with implementation of environmental activities and manual principles for contractors.

11.2. Responsibilities of Construction Contractor

ESMP will be an integral part of the contract for the provision of civil works and adherence to ESMP will be contractually obligatory for the contractor.

HPIU will obtain Construction Permit associated to construction activities. Conclusion of the ecological expertise and possibly other licenses, permits, consents required (e.g. inert material etc.) construction company shall obtain within its capacity.

11.3. Monitoring and reporting

HPIU carries overall responsibility for the implementation of ESMP and for organizing environmental monitoring of works. Environmental monitoring of works will be undertaken according to the Environmental Monitoring Plan which is part of the ESMP and the outcomes of monitoring will be documented in monthly environmental monitoring reports, including photo documentation. A template of environmental monitoring checklist to be used during field work is provided in Annex IV to this ESIA report.

HPIU will include outcomes of environmental and social monitoring of works in the form of an analytical write-up into the general DPCP progress reporting to the Government of the RA and the World Bank. Such reports should contain information on the issues revealed during the reporting period, corrective actions prescribed to the construction contractor, and the results of the prescribed corrective actions. Any work-site accidents must be reported as well.
12. STAKEHOLDER CONSULTATION, GRIEVANCE AND REDRESS

According to the Aarhus Convention, the requirements of the World Bank and the RA Law on Environmental Impact Assessment and Expertise, the present draft ESIA report will be disclosed and consultations on it will be held with all stakeholders. Armenian and English versions of the draft ESIA report will be posted on the web page of the MH and an advertisement on the upcoming consultation meeting will be published through the media. The meeting will be held in Yerevan, after which the ESIA report will be finalized and the minutes of the consultation meeting will be attached to it.

HPIU will be responsible for establishing and retaining an efficient and convenient Grievance and Redress Mechanism (GRM) to ensure meaningful communication between the project-affected people (PAP) and the HPIU on the issues that may arise during works at the ACEO.

PAP are encouraged to proceed in the following way:

a. Contact the construction contractor’s designated grievance staff in the following way: in person via designated telephone number, via personal email, via regular mail. Alternatively, PAP can contact Yerevan Municipality official, who would convey their grievance to the contractor’s designated grievance staff.

b. Lodge complaint and provide information on the case. Each complaint will be registered by the contractor’s staff and a tracking number will be assigned to it. Responses to all complaints should be provided within 15 days (or 25 days in cases where complaint resolution requires special efforts).

c. Agree with the contractor on mitigation measure.

d. Sign if the mitigation measure has been implemented as agreed

e. Seek redress from HPIU if not satisfied with above mentioned procedure though designated telephone numbers, in person, or via email or regular mail. HPIU should register all grievances and provide response within 15 days. PIU should keep a table that shows when the grievance was received, by whom, summary of the issue, dates of any responses/communications, how the issue was responded to/resolved, whether there are pending actions

f. Seek redress from court if all else fails.

Nevertheless, the above mentioned grievance mechanism does not limit citizens’ right to submit the case straight to the court of law just in the first stage of grievance process. The grievance mechanism is designed to avoid lengthy court procedures. All costs will be provided from the Project budget.
ANNEX I. List of References

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3. Climate Change Information Centre of Armenia, http://www.nature.am/
4. Construction norms and regulations volume II-L.9-70 Hospitals & Polyclinics;
5. Construction norms and regulations 2.08.02-89 Public buildings;
10. RA Governmental Regulation on assessment of impact on atmosphere caused by economic activities, 25 January 2005, N91-N
12. SNIP 1.02.01-85: Instruction on content, order of development, agreement and approval of design-tender documentation for construction of enterprises, buildings and structures.
13. SNIP 2.04.02-84: Water supply, External pipelines and structures
17. EMEP/EEA Air PollutantEmissionInventoryGuidebook, 2009
18. IFC. Environmental, Health and Safety (EHS) Guidelines
20. STATISTICAL YEARBOOK OF ARMENIA. 2015. www.armstat.am
## ANNEX II. Environmental Management Plan (EMP).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential Impact</th>
<th>Mitigation Measure</th>
<th>Indicator of Mitigation</th>
<th>Cost of Mitigation</th>
<th>Responsibility for Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of construction materials</td>
<td>Delivery of substandard materials which may cause risks to the safety of structure and to health of people</td>
<td>Purchase of construction materials from the licensed providers</td>
<td>Delivery of standard quality construction materials carrying relevant certificates of origin</td>
<td>None</td>
<td>Construction contractor</td>
</tr>
</tbody>
</table>
| Transportation of construction materials and waste and Movement of construction machinery | - Pollution due to poor technical condition of vehicles and movement of uncovered truckloads  
  - Nuisance to local residents from noise and dust | - Adequate technical condition of vehicles and machinery  
  - Confine ment and protection of truck loads with lining  
  - Respect of the established hours and routes of transportation | - Vehicles and machinery found in decent technical condition during inspections  
  - No uncovered truck loads found during inspections  
  - No activity ongoing out of working hours which may be disturbing for nearby population  
  - No complaints from nearby residents | No specific extra cost: common responsibility of works contractor | Construction contractor |
| Operation of construction equipment on site   | - Pollution of environment with emissions and leakages  
  - Nuisance for nearby population and personnel of YPI | - Adequate technical condition of construction equipment  
  - no excessive exhaust  
  - no fuel and lubricant leakage  
  - Observation of working hours | - Vehicles and machinery found in decent technical condition during inspections  
  - No heavy vehicles and machinery found operational out of the established hours  
  - No complaints from nearby population | No specific extra cost: common responsibility of works contractor | Construction contractor |
| Maintenance of construction equipment         | - Pollution of ground water and soil with oil products due to operation of equipment  
  - Damage in case of fire | - Cars and construction equipment washed outside the construction site or on maximum distance from the Hrazdanriver  
  - Refueling or lubrication of construction equipment and outside the construction site or at the predetermined point  
  - Technical order at the equipment | - No direct entry of runoff from car-wash to Hrazdan river  
  - No spillages of fuel and lubricants found on the ground within and nearby the construction site  
  - Presence of basic fire extinguishing means on site | No specific extra cost: common responsibility of works contractor | Construction Contractor |
| Earth works | - Loss of vegetation due to ground piling and minimization of pollution of surface water with particles  
- Pollution with probably contaminated soil of surface and ground waters | - Topsoil removal and temporary storage at a separate place at the beginning of works (to dispose to landfill in case of pollution and for re-cultivation of the land)  
- Temporary storage of excavated soil at determined places  
- Backfilling of the excavated ground as needed and disposal of the excess mass to the places, approved in writing. | - Excess material disposed at the agreed upon safe permanent storage sites with no threat of erosion and no blocking of waterways  
- No remnants of excess material at the construction site upon completion of works  
- No damage to chance finds if encountered | 2000 USD | Construction Contractor |
| Borrowing for construction material | - Slopes erosion and landscape damage  
- River banks erosion, pollution of water flow with weighted particles, and disturbance of aquatic life | - Purchase of inert materials from the existing suppliers,  
- Obtaining of the license for production of inert materials and strict compliance with the license | - Construction contractor (if mining) or an external provider of inert materials able to present relevant license for mining upon inspection  
- Mining activity of construction contractor (if being undertaken) found technically sound and compliant with the license conditions | No specific extra cost: common responsibility of works contractor | Construction Contractor |
| Generation of construction waste | - Pollution of soil, surface water and ground water,  
- Accidents at construction site due to scattered fragments of construction materials and debris,  
- Deterioration of esthetic appearance of construction site and its surroundings | - Temporary storage of construction waste in especially allocated areas;  
- Timely disposal of wastes to the formally designated locations  
- Hand-over of larger amounts of hazardous wastes to the companies having license for decontamination and placement of hazardous materials. | - Construction waste found at the work site piled up in designated locations  
- No excessive amount of construction waste stored on site  
- Documents present on the handover of larger amounts of hazardous waste to companies licensed for its disposal | No specific extra cost: common responsibility of works contractor | Yerevan Municipality  
Construction contractor |
| Production of household waste | Pollution of soil and water with domestic waste | - Placement of waste collection containers at the construction site and construction base (if any)  
- Agreement with Yerevan Municipality on regular disposal of domestic wastes | - Waste collection containers found at the construction site  
- No pollution of the construction site with household waste | No specific extra cost: common responsibility of works contractor | Yerevan Municipality  
Construction contractor |
| Production of liquid wastes | - Flooding of the construction site and complication of activities  
- Pollution of surface and ground waters | - Arrangement and maintenance of toilets in compliance with sanitation norms at the construction site and construction base (if any)  
- Arrangement and regular cleaning of drainage system for storm water collection and drain  
- Arrangement of sedimentation pond for water used for domestic and machinery washing and cleaning purposes | - Toilets provided at the construction site and found in good sanitary condition  
- No water logging of construction site | No specific extra cost: common responsibility of works contractor | Construction contractor |
| Operation of concrete mixer | - Population disturbance near the construction site  
- Atmospheric air and surface water pollution | - Obtaining of emission permit by the construction contractor and strict compliance with it  
- Selection of a place for the plant that provides minimal disturbance of population with noise, dust and exhaust  
- Arrangement of sedimentation pond for waste water from the plant | - Adequate placement of a mixer, which is least harmful for the environment and disturbing for population  
- Presence of sedimentation pool for a mixer runoff.  
- No complaints from nearby residents | No specific extra cost: common responsibility of works contractor | Construction contractor |
| Construction site re-cultivation and landscaping | Loss of aesthetical value of the landscape due to construction of the ACEO | - Dismantlement of construction base (if any) and temporary access roads to the site (if any) and concrete mixer harmonization of the areas with the landscape  
- Final cleaning of the construction site and permanent access roads and landscaping-greening of the area | - No remnants of a work camp left behind after demobilization of contractor  
- Temporary access roads harmonized with landscape and enabling conditions provided for natural regeneration of vegetation  
- Construction site landscaped and greened | 4000 USD | Construction Contractor |
| Labor safety | Traumatism and accidents at work site | - Provision of construction workers with working clothes and PPE  
- Strict compliance with the rules of construction equipment operation and usage of PPE | - Construction workers found wearing uniform clothes and adequate protective gear during inspections  
- No violations of equipment operation and use instructions registered during inspections | No specific extra cost; common responsibility of works contractor | Construction Contractor |
| --- | --- | --- | --- | --- | --- |
| Generation of household, medical, and hazardous waste | - Pollution of ACEO building and its surrounding area  
- Possible spread of infection | - Waste separation and on-site storage in adequate containers  
- Arrangements in place for timely removal of household waste by municipal service provider  
- Arrangements in place for handover of medical waste and hazardous waste to respectively licenses companies | Good sanitary conditions in and around the ACEO building | To be included in the ACEO operation and maintenance budget | ACEO administration, Yerevan Municipality |
| Emergency cut-offs in the utility service provision (electric power, water, gas) and fire incidence | Disruption of the hospital operation causing nuisance to the staff and patients | - Back-up arrangements in place for ensuring permanent supply of electric power, hot water and healing to the ACEO  
- Fire emergency preparedness of the hospital staff and existence of water stock for fire-fighting | Smooth operation of the ACEO | To be included in the ACEO operation and maintenance budget | ACEO administration |
| Improper operation of boiler house | - Air pollution  
- Possible poisoning of personnel and patients | Periodic checks of devices and regular maintenance | Smooth operation of the heating system | To be included in the ACEO operation and maintenance budget | ACEO administration |
| Water damage to the building from leaking pipes, storm water, and melting snow | - Leakage of water and/or sewage pipes  
- Improper operation of storm water drainage system | - Periodic check-up of pipes and other internal communications  
- Timely cleaning of snow deposits on the roof and in the yard | - No water damage to the building  
- Clean yard area around MC | To be included in the ACEO operation and maintenance budget | ACEO administration |
**Operation of Radiotherapy and Radiology Center**

<table>
<thead>
<tr>
<th>Staff training</th>
<th>Non appropriate operation</th>
<th>Additional training required for some hospital staff</th>
<th>Operation quality</th>
<th>Operation and maintenance budget</th>
<th>Administration</th>
</tr>
</thead>
</table>
| Delivery of equipment | Radiation background increase | • Acceptance testing and commissioning  
• Quality control and radiation safety procedures | Radiation level | Operation and maintenance budget | Administration |
| Radiation Protection and Safety of Sources | Radiation background increase | • A quality control test before the donor decommissions the machine;  
• A full, safe and workable maintenance strategy | Radiation level | Operation and maintenance budget | Administration |
| Brachytherapy | Health of personal | Low dose rate brachytherapy can be performed by manually loading the sources into the applicators, which have been placed into the patient | Operation quality | Operation and maintenance budget | Administration |
| Occupational Protection | Health of personal | The establishment of investigation levels is a tool used to provide a ‘warning’ on the need to review procedures and performance, to investigate what is not working as expected and to take timely corrective action | Safe working conditions | Operation and maintenance budget | Administration |
| Accidental Medical Exposures | The great dependence of radiotherapy on human performance | The combination of sophisticated equipment with manual work | No Accidental Medical Exposures | Operation and maintenance budget | Administration |
| Emergency situations at the RTRC | The greatest hazard to staff, public and patients occurs when events do not follow accepted procedures | There need to be well prepared emergency plans that are concise and easily followed, and these should be developed before the startup of a radiation treatment programme | No Emergency situations | Operation and maintenance budget | Administration |

*Total cost of mitigation measures (without maintenance charges) is USD 6,000*
# Environmental Monitoring Plan. ACEO

<table>
<thead>
<tr>
<th>Activity</th>
<th>What parameter is to be monitored?</th>
<th>Where is the parameter to be monitored?</th>
<th>How is the parameter to be monitored?</th>
<th>When is the parameter to be monitored?</th>
<th>Why is the parameter to be monitored?</th>
<th>Who will monitor the parameter?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction phase</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Provision of construction materials</td>
<td>Purchase of construction materials from the licensed provider</td>
<td>In the provider’s office or warehouse</td>
<td>Verification of documents</td>
<td>During conclusion of supply contracts</td>
<td>Provide technical order of facility and its safety for human health</td>
<td>HPIU</td>
</tr>
<tr>
<td>Transportation of construction materials and waste</td>
<td>Technical condition of vehicles and machinery Confinement and protection of truck loads with lining Respect of the established hours and routes of transportation</td>
<td>- Construction site - Routes of transportation of construction materials and wastes</td>
<td>Inspection of roads adjacent to the construction object in the direction of the movement rout</td>
<td>Undeclared inspections during work hours and beyond</td>
<td>- Limit pollution of soil and air from emissions; Limit nuisance to local - Communities from noise and vibration; - Minimize traffic disruption.</td>
<td>HPIU, Road Police</td>
</tr>
<tr>
<td>Maintenance of construction equipment</td>
<td>- Washing of cars and construction equipment outside the construction site or on maximum distance from the river - Refueling or lubrication of construction equipment and outside the construction site or at the predetermined arranged point. - Technical order of the construction equipment maintenance point</td>
<td>Construction site and construction base adjacent to it (if any)</td>
<td>Inspection of activities</td>
<td>During operation of equipment</td>
<td>- Avoid pollution of water and soil with oil products due to operation of equipment - Timely localize and decrease expected damage in case of fire</td>
<td>HPIU</td>
</tr>
<tr>
<td>Earth works</td>
<td>Construction site</td>
<td>Inspection of activities</td>
<td>During earth works</td>
<td>HPIU</td>
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<td>---------------------------------------------------------</td>
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</tr>
<tr>
<td>- Topsoil removal and temporary storage at a separate place at the beginning of works (to dispose to landfill in case of pollution and for re-cultivation of the land if it is good)</td>
<td></td>
<td></td>
<td>- Limit loss of vegetation due to ground piling and minimization of pollution of surface water reservoirs with particles</td>
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<tr>
<td>- Temporary storage of excavated soil at determined and allowed places in compliance with ground piling parameters.</td>
<td></td>
<td></td>
<td>- Limit pollution with contaminated soil of surface and ground waters</td>
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<tr>
<td>- Backfilling of the excavated material as needed and disposal of the excess mass to the places, approved in writing.</td>
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<tr>
<td>- Immediate termination of activities in case of unexpected archaeological findings and providing of full information to the Agency of cultural heritage</td>
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</tr>
<tr>
<td>Extraction of inert material</td>
<td>Quarries of inert materials</td>
<td>Inspection of documents</td>
<td>During excavation and reclamation at quarries</td>
<td>HPIU, State Environmental Inspectorate of MNP</td>
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</tr>
<tr>
<td>- Purchase of inert materials from the existing suppliers, if there is such opportunity</td>
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<tr>
<td>- Obtaining of the license for</td>
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</tr>
<tr>
<td>Generation of construction waste</td>
<td>Construction site; Waste disposal site</td>
<td>Inspection of activities</td>
<td>Periodically during construction and upon its completion</td>
<td>HPIU Yerevan municipality</td>
<td></td>
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</tr>
<tr>
<td>- Temporary storage of construction waste in especially allocated areas; - timely disposal of wastes to the formally designated locations</td>
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</tbody>
</table>

**Periodically** during construction and upon its completion.

- Prevent pollution of soil, surface water and ground water, Avoid accidents at the construction site due to scattered fragments of construction materials and debris.

**Yerevan municipality**.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Location/Equipment</th>
<th>Inspection/Document</th>
<th>Time Period</th>
<th>Pollution Prevention</th>
<th>Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production of domestic wastes</strong></td>
<td>- Placement of waste collection containers at the construction site and construction base (if any) - Agreement with Yerevan Municipality on regular disposal of domestic wastes</td>
<td>Construction site and construction base (if any)</td>
<td>Visual observation</td>
<td>Total period of construction</td>
<td>Prevent pollution of soil and water with domestic waste</td>
<td>Construction Contractor Yerevan Municipality</td>
</tr>
<tr>
<td><strong>Production of liquid wastes</strong></td>
<td>- Arrangement and maintenance of toilets in compliance with sanitation norms at the construction site and construction base (if any) - Arrangement and regular cleaning of drainage system for rain water collection and drain - Arrangement of sedimentation pond for water used for domestic and machinery washing purposes</td>
<td>Construction site and construction base (if any)</td>
<td>Visual observation</td>
<td>Total period of construction In case of waste precipitations</td>
<td>In case of waste precipitations: - Prevent flooding of construction site and disruption of works due to water logging - Reduce pollution of surface and ground waters</td>
<td>Construction Contractor Yerevan Municipality</td>
</tr>
<tr>
<td><strong>Operation of concrete-mixer</strong></td>
<td>- Obtaining of emission permit by the construction contractor and strict compliance with it - Selection of a place for the plant that provides minimal disturbance of population with noise, dust and exhaust - Arrangement of sedimentation pond for waste water from the plant</td>
<td>Construction site and construction base (if any)</td>
<td>Inspection of documents Inspection of activities</td>
<td>Total period of plant operation</td>
<td>- Limit population disturbance near the construction site - Limit atmospheric air and surface water pollution</td>
<td>Construction Contractor, State Environmental Inspectorate of Ministry of Nature Protection</td>
</tr>
<tr>
<td><strong>Construction site re-cultivation and landscaping</strong></td>
<td>- Dismantlement of construction base (if any) and temporary access roads to the site (if any) and asphalt-concrete plant and harmonization of the areas with the landscape - Final cleaning of the</td>
<td>Construction site, construction base and temporary access roads (if any)</td>
<td>Inspection of activities</td>
<td>Final period of construction</td>
<td>Reduce loss of aesthetical value of the area</td>
<td>Construction Contractor Yerevan Municipality</td>
</tr>
<tr>
<td>Construction site and permanent access roads and landscaping-greening of the area</td>
<td>Workers’ health and safety</td>
<td>Total period of works</td>
<td>Reduce probability of traumas and accidents to constructors</td>
<td>Construction Contractor Ministry of healthcare</td>
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</tr>
<tr>
<td>- Provision of constructors with working clothes and PPE</td>
<td>- Construction site</td>
<td>Inspection of activities</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- Strict compliance with the rules of construction equipment operation and usage of PPE</td>
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</tr>
</tbody>
</table>

**Operation Phase**

<table>
<thead>
<tr>
<th>Emergency situations at the ACEO</th>
<th>ACEO premises</th>
<th>Inspection</th>
<th>Total period of operation of the ACEO</th>
<th>Smooth operation of the ACEO, safety of its staff and patients</th>
<th>Management of the ACEO Ministry of Emergency Situations</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Existence of back-up arrangements for sustaining electric power supply, water supply, and heating in case of external emergency cut-offs</td>
<td></td>
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</tr>
<tr>
<td>- Water stocked for firefighting</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation of boiler-house</th>
<th>ACEO premises</th>
<th>Inspection of temperature and color of exhaust gases</th>
<th>Weekly</th>
<th>Operation budget</th>
<th>Management of the ACEO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flue gases</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waste water management</th>
<th>ACEO area</th>
<th>Inspection of pipes</th>
<th>Monthly</th>
<th>Operation budget</th>
<th>Management of the ACEO</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Investigation level of effective dose at RTC</th>
<th>RTC premises</th>
<th>Measurement</th>
<th>Weekly</th>
<th>Operation budget</th>
<th>Management of the RTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) For persons working only with accelerators or remote control brachytherapy, a monthly level of 0.4 mSv effective dose; (b) For staff working with 60Co external beam therapy, brachytherapy nurses, and persons inserting and removing manual brachytherapy sources, a monthly level of 0.5 mSv effective dose.</td>
<td></td>
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</tr>
</tbody>
</table>
### ANNEX III. Environmental Management Plan (EMP). RPC

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential Impact</th>
<th>Mitigation Measure</th>
<th>Indicator of Mitigation</th>
<th>Cost of Mitigation</th>
<th>Responsibility for Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The movement of radioactive material</td>
<td>Radiation background increase</td>
<td>Keeping areas where radioactivity must be stored or handled in close proximity to each other</td>
<td>Radiation level</td>
<td>Operation and maintenance budget</td>
<td>RPC administration</td>
</tr>
<tr>
<td>Radioisotope production</td>
<td>Radiation background increase</td>
<td>Shielding around radioactive sources should be provided</td>
<td>Radiation level</td>
<td>Operation and maintenance budget</td>
<td>RPC administration</td>
</tr>
<tr>
<td>Working conditions</td>
<td>Personnel safety</td>
<td>All radiation workers shall be appropriately trained in handling radioactive materials</td>
<td>Radiation level</td>
<td>Operation and maintenance budget</td>
<td>RPC administration</td>
</tr>
<tr>
<td>Radioisotope production</td>
<td>Radiation background increase</td>
<td>Frequent washing of floors</td>
<td>Floor cleaning</td>
<td>Operation and maintenance budget</td>
<td>RPC administration</td>
</tr>
<tr>
<td>Ventilation of Cyclotron premises</td>
<td>Increasing of thermal conditions</td>
<td>Much of the heat load of the cyclotron and associated equipment must be removed by the air conditioning system.</td>
<td>Temperature control at 20° ± 2°C</td>
<td>Operation and maintenance budget</td>
<td>RPC administration</td>
</tr>
<tr>
<td>Working conditions of Cyclotron</td>
<td>Increasing of humidity</td>
<td>Ventilation adjustment</td>
<td>Humidity must not exceed 65%</td>
<td>Operation and maintenance budget</td>
<td>RPC administration</td>
</tr>
<tr>
<td>Generation of household, medical, and hazardous waste</td>
<td>- Pollution of RPC building and its surrounding area - Possible spread of infection</td>
<td>- Waste separation and on-site storage in adequate containers - Arrangements in place for timely removal of household waste by municipal service provider - Arrangements in place for handover of medical waste and hazardous waste to respectively licenses companies</td>
<td>Good sanitary conditions in and around the RPC building</td>
<td>Operation and maintenance budget</td>
<td>RPC administration, ACEO</td>
</tr>
<tr>
<td>Emergency cut-offs in the utility service provision (electric power, water, gas) and fire incidence</td>
<td>Disruption of the hospital operation causing nuisance to the staff and patients</td>
<td>- Back-up arrangements in place for ensuring permanent supply of electric power, hot water and heating to the ACEO - Fire emergency preparedness of the hospital staff and existence of water stock for fire-fighting</td>
<td>Smooth operation of the RPC</td>
<td>Operation and maintenance budget</td>
<td>RPC administration</td>
</tr>
</tbody>
</table>
## Environmental Monitoring Plan. RPC

<table>
<thead>
<tr>
<th>Activity</th>
<th>What is the parameter to be monitored?</th>
<th>Where is the parameter to be monitored?</th>
<th>How is the parameter to be monitored?</th>
<th>When is the parameter to be monitored?</th>
<th>Why is the parameter to be monitored?</th>
<th>Who will monitor the parameter?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handling of the radioactive sources</td>
<td>Radioactivity</td>
<td>RPC premises</td>
<td>Measurement by appropriate devices</td>
<td>Daily</td>
<td>To keep working conditions</td>
<td>RPC staff</td>
</tr>
<tr>
<td>Radioisotope production</td>
<td>Dust (PM)</td>
<td>RPC premises</td>
<td>Measurement by appropriate devices</td>
<td>Weekly</td>
<td>Requirement of operation manual of cyclotron and associated equipment</td>
<td>RPC staff</td>
</tr>
<tr>
<td>Air conditioning</td>
<td>Temperature of premises</td>
<td>RPC premises</td>
<td>Measurement by appropriate devices</td>
<td>Daily</td>
<td>To keep safety and working conditions</td>
<td>RPC staff</td>
</tr>
<tr>
<td>Air conditioning</td>
<td>Humidity of premises</td>
<td>RPC premises</td>
<td>Measurement by appropriate devices</td>
<td>Daily</td>
<td>To keep safety and working conditions</td>
<td>RPC staff</td>
</tr>
</tbody>
</table>
| Emergency situations at the RPC   | - Existence of back-up arrangements for sustaining electric power supply, water supply, and heating in case of external emergency cut-offs  
- Water stocked for firefighting | RPC premises                           | Inspection                             | Total period of operation of the RPC   | Smooth operation of the RPC, safety of its staff and patients | Management of the RPC, Ministry of Emergency Situations |
| Waste water management            | RPC area                              | RPC premises                           | Inspection of pipes                   | Monthly                                | Operation budget                    | Management of the RPC            |
### ANNEX IV. Construction of the building for the ACEO. Monthly Field Environmental Monitoring Checklist

<table>
<thead>
<tr>
<th>Site location</th>
<th>Name of contractor</th>
<th>Name of supervisor</th>
<th>Date of site visit</th>
<th>Status of civil works</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Documents and activities to be examined</th>
<th>Status</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor holds license for extraction of natural resources</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Contractor holds permit for operating concrete/asphalt plant</td>
<td>Partially</td>
<td></td>
</tr>
<tr>
<td>Contractor holds agreement for final disposal of waste</td>
<td>No</td>
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<tr>
<td>Contractor holds agreement with service provider for removal of household waste from site</td>
<td>N/A</td>
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<tr>
<td>Work site is fenced and warning signs installed</td>
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<td>Works do not impede pedestrian access and motor traffic, or temporary alternative access is provided</td>
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<td>Working hours are observed</td>
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<tr>
<td>Construction machinery and equipment is in standard technical condition (no excessive exhaust and noise, no leakage of fuels and lubricants)</td>
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<td>Construction materials and waste are transported under the covered hood</td>
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<td>Construction site is watered in case of excessively dusty works</td>
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<td>Contractor's camp or work base is fenced; sites for temporary storage of waste and for vehicle/equipment servicing are designated</td>
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<td>Contractor’s camp is supplied with water and sanitation is provided</td>
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<td>Contractor’s camp or work base is equipped with first medical aid and firefighting kits</td>
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<tr>
<td>Workers wear uniforms and protective gear adequate for technological processes (gloves, helmets, respirators, eye-glasses, etc.)</td>
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<td>Servicing and fuelling of vehicles and machinery is undertaken on an impermeable surface in a confined space which can contain operational and emergency spills</td>
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<tr>
<td>Vehicles and machinery are washed away from natural water bodies in the way preventing direct discharge of runoff into the water bodies</td>
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<tr>
<td>Construction waste is being disposed exclusively in the designated locations</td>
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<tr>
<td>Extraction of natural construction material takes place strictly under conditions specified in the license</td>
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<td>Excess material and topsoil generated from soil excavation are stored separately and used for backfilling / site reinstatement as required</td>
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<td>Works taken on hold if chance find encountered and communication made to the State agencies responsible for cultural heritage preservation</td>
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<tr>
<td>Upon completion of physical activity on site, the site and contractor’s camp/base cleared of any remaining left-over from works and harmonized with surrounding landscape</td>
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ANNEX V. Location and Ownership of Land Plots Allocated for ACEO and RPC

Plan of the land plot and the proposed building
View of the allocated land plot from space (Google map)
ANNEX VI. Architectural Concept

POLITECNICA ENEGNERIA E ARCHITETTURA

1. Existing Cyclotron
2. Existing Technical Building
3. New Oncological Center
4. New Radiotherapy and Radiology Therapy Center
ANNEX VII. Waste Management
ANNEX VIII. Minutes of Public Consultation Meeting

On October 10, 2016 in the Conference Room of the RA Ministry of Health HPIU, Public Consultations were held related to the environmental impact issues of the Armenian Center for Excellence in Oncology (ACEO) and Radioisotopes Production Center (RPC). The representatives of Yerevan Municipality, HPIU, ACEO and Designing Company, were present (List of Participants is attached).

The Chief Specialist of Yerevan Municipality Environmental Department, Arsen Hazarapetyan, made the session’s opening speech, after which the HPIU representative Davit Melik-Nubaryan presented the objective of the Consultations, the importance of ACEO, the environmental impact processes during its construction and further operation, as well as the developed Environmental Management Plan.

The Project and the Environmental Management Plan received positive evaluation with no comments or remarks expressed.

List of Participants

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<tr>
<th>N</th>
<th>Name</th>
<th>Organization</th>
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<tr>
<td>1.</td>
<td>Vram Tevosyan</td>
<td>Consultant</td>
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<tr>
<td>2</td>
<td>Davit Melik-Nubaryan</td>
<td>Hospital Network Optimization Component Coordinator, HPIU</td>
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<td>3</td>
<td>Arsen Hazarapetyan</td>
<td>The Chief Specialist of Yerevan Municipality Environmental Department</td>
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<td>4</td>
<td>Armen Harutyunyan</td>
<td>Director of Radiation Treatment Center</td>
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<td>5</td>
<td>Hajk Karapetyan</td>
<td>«Asq Med Dizain» Engineering company</td>
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<td>6</td>
<td>Arthur Knyazyan</td>
<td>«Asq Med Dizain» Engineering company</td>
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<td>7</td>
<td>Smbat Smbatyan</td>
<td>Architect-constructor/specialist of environmental protection of HPIU State agency</td>
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<tr>
<td>8</td>
<td>Arsen Mirzoyan</td>
<td>Civil Works Quality Supervisor</td>
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<td>9</td>
<td>Vachagan Alaverdyan</td>
<td>«Freedom and right» Public organization</td>
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<td>10</td>
<td>Ruzanna Astvatsatryan</td>
<td>HPIU The staff's education, training projects monitoring and support specialist</td>
</tr>
<tr>
<td>11</td>
<td>Syuzanna Amirikyan</td>
<td>HPIU Healthcare quality management specialist</td>
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<tr>
<td>12</td>
<td>Nona Ghazanchyan</td>
<td>HPIU Assistant to Monitoring and Evaluation Specialist</td>
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**List of participants**

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<th>Contact Person</th>
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*Signed by the head of the organizing committee on* 10.10.2016.
Dear Mister Zuloyan,
I would like to inform you that on October 10, 2016, having participated in the Public Consultations for the construction of new Radiological Treatment Center, the Environmental Department provides its positive Opinion.

Best regards,

Head of the Staff Environmental Department

Signed/

A. Martirosyan

Executor: A. Hazarapetyan
Phone: 011 514-263