



**MISSION REPORT  
ON  
THE INTEGRATED NUCLEAR INFRASTRUCTURE REVIEW (INIR)  
PHASE 1 MISSION**

**Counterpart: Ministry of Water Resources, Irrigation and Electricity,  
Republic of Sudan**

**27 August – 3 September 2018**

**Khartoum, Sudan**

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## EXECUTIVE SUMMARY

The Republic of Sudan currently has 3.2 GW(e) installed capacity with hydro power, steam turbines, gas turbines, combined cycle and diesel engines as the main sources for electricity generation. Overall, around 50% of the installed capacity is hydro and 50% is thermal. In addition, there is a 300 MW(e) interconnection (220 KV) with Ethiopia. The electrification rate in Sudan is about 35%. Additional capacity is needed to meet the rapidly increase in industrial, agricultural, mining sectors and providing electricity for unconnected household. Demand for electricity in Sudan is expected to reach ~8500 MW(e) by 2031.

The Government of Sudan established a Steering Committee and a Technical Committee in September 2007. A strategy report entitled *Strategy Report on the Preparations for Sudan Nuclear Power Programme* was completed in August 2009. In 2010, a nuclear energy program implementing organization (NEPIO) headed by the Undersecretary of the Ministry of Water Resources, Irrigation and Electricity (MWRIE) was established to supervise and coordinate Sudan's nuclear programme activities. The NEPIO chairman formed several national committees which cover the nuclear infrastructure issues identified by the IAEA Milestones Approach. The General Directorate of Nuclear Power under the Ministry of Electricity and Dams (the predecessor of MWRIE) was formed to play the role of the owner/operator and also the technical arm of the NEPIO regarding the nuclear power programme.

After the separation of South Sudan from Sudan in 2011, the energy resources of South Sudan could no longer be taken into account in Sudan's national energy plan. In June 2011, Sudan (Ministry of Electricity and Dams) signed a contract with an international consultancy company to undertake pre-feasibility studies for a nuclear power plant (NPP). The results of these studies were reported in annexes combined into a final report entitled *Feasibility Study and Selection of Technology for Sudan's—First NPP* dated May 2013. A summary of the studies was presented during the presidential meetings in September 2013, which resulted in the decision to embark on a nuclear power programme. In 2016, the Minister of Water Resources, Irrigation and Electricity issued Decree No. 9/2016 to reform the NEPIO structure. The NEPIO includes representation from relevant ministries.

The Nuclear and Radiological Regulatory Control Act (NRRCA) was enacted in 2017. The NRRCA establishes the legal framework for safety, security, safeguards and nuclear liability and provides for the establishment of the Sudanese Nuclear and Radiological Regulatory Authority (SNRRA) as a regulatory control authority with financial and administrative independence.

Under the coordination of the NEPIO, Sudan prepared a preliminary self-evaluation report (SER) and submitted it to the IAEA in 2016. The IAEA conducted a SER Support mission to Sudan from 7 to 9 March 2017, and on 6 November 2017, Sudan requested the IAEA to carry out a Phase 1 Integrated Nuclear Infrastructure Review (INIR) mission in the third quarter 2018. Based on the suggestions provided by the SER Support mission, Sudan revised and submitted an updated SER to the IAEA on 20 February 2018. A pre-INIR mission was conducted in Sudan from 9 to 10 May 2018, during which additional suggestions were made by the IAEA to further improve the SER. Sudan submitted an updated SER and 126 supporting documents to the IAEA in July 2018.

The Integrated Nuclear Infrastructure Review (INIR) Phase 1 mission was conducted from 27 August to 3 September 2018, to evaluate the status of the development of the national infrastructure to support the nuclear power programme, identify the areas needing further actions and provide recommendations and suggestions to the Government of Sudan.

H. E. Hassan AbdElgader Hilal, Minister of Environment, Natural Resources and Physical Development, H. E. Tabita Butros Shokai, State Minister of Water Resources, Irrigation and Electricity, Mr Mohammed H.M. Abuuznien, Secretary General of the Sudanese Nuclear and Radiological Regulatory Authority, Mr. AbduElah Musa Ali, Director General of the Sudan Atomic

Energy Commission, Mr Nasir Ahmed Almustafa, General Director of Nuclear Power of MWRIE, and Mr Dohee Hahn, Director of the Division of Nuclear Power in the IAEA, participated in the opening session for the INIR mission. On the Sudan side, the mission was coordinated by Mr Gaafar Kheir Alla Abd Elhada, Director, Technical Directorate of General Directorate of Nuclear Power. The INIR mission team was led by Mr Anthony Stott of the IAEA's Division of Nuclear Power, Nuclear Infrastructure Development Section, and consisted of staff from the IAEA's Department of Nuclear Energy and the Office of Legal Affairs and international experts recruited by the IAEA.

The INIR mission and associated activities were funded through a combination of a cost-sharing contribution from the Republic of Sudan, funds from the IAEA Technical Cooperation project *SUD2005 Enhancing Human Resources Development in Nuclear Science and Technology* and an extra budgetary contribution from Japan towards the IAEA activities to support the development of national infrastructure for nuclear power plants.

The INIR mission was conducted in a cooperative and open atmosphere. The INIR team concluded that there is a strong commitment from the Government of Sudan to developing the infrastructure needed for a nuclear power programme. Sudan has established a NEPIO that serves as an effective mechanism to involve a wide and comprehensive range of national stakeholders in the relevant activities. The future owner/operator has been designated and the nuclear regulatory authority established. Sudan has completed a significant number of studies on different nuclear infrastructure issues which contributed to the development of a pre-feasibility report. Some of those studies may need to be reviewed and updated to better prepare the country for the next stages of the nuclear power programme.

To assist Sudan in making further progress in its nuclear infrastructure development, the INIR team made 11 recommendations and 11 suggestions. The INIR team also identified 3 good practices that may benefit other countries considering the introduction of nuclear power.

Based on the recommendations and suggestions, the key areas for further action are summarized below:

- **Sudan should finalize national policies to support the nuclear power programme**

Key decisions have been or are being taken by the Sudanese Government pertaining to the safe, secure and peaceful use of nuclear power. These decisions need to be documented in the form of approved policies or strategies such as the energy plan, nuclear power policy, spent fuel strategy, and policy on industrial involvement.

- **Sudan should strengthen its plans to join the international legal instruments and continue assessing and developing its legal and regulatory framework**

Sudan intends to adhere to the relevant international legal instruments in the areas of safety, security, safeguards and civil liability for nuclear damage and should establish a workplan to complete this process at the appropriate time.

Sudan has already enacted a comprehensive nuclear law and reviewed other relevant legislation, including its environmental legislation, and is also drafting and updating safety and security regulations. As the nuclear power programme develops, Sudan is encouraged to continue assessing and developing the legal and regulatory framework, in line with relevant international legal instruments, IAEA safety standards and security guidance, as appropriate.

Sudan should develop a plan to rescind the Small Quantities Protocol to its Comprehensive Safeguards Agreement in a timely manner and continue its efforts to strengthen the State System of Accounting for and Control of Nuclear Material to deal with the increase of activities from the nuclear power programme.

- **Sudan should implement its plans to support the development of key organizations and to enhance public awareness on the nuclear power programme**

Sudan has prepared detailed studies on the human resources required for a nuclear power programme and should implement the activities identified to support the development of qualified and competent staff for the key organizations. It should also prioritize the development of management systems to support the regulatory body and future owner/operator, as both organizations are already established.

Sudan should begin the implementation of its plan for stakeholder involvement and public consultation to increase general awareness about the nuclear power programme at the national, state and local levels.

- **Sudan should further analyse the preparedness of the electrical grid and its approaches to funding, financing and radioactive waste management**

Sudan has completed or initiated a significant number of studies and activities. However, the programme would benefit from additional analysis in the following areas:

- Preparedness of the electrical grid for nuclear power;
- Cost estimate of all key activities specific to developing a nuclear power infrastructure;
- Implications of the preferred contracting options for the nuclear power plant;
- Preliminary assessment of the radioactive waste types and quantities arising from a nuclear power plant and the options and technologies for processing, storage and disposal of these wastes.

## 1. INTRODUCTION

The Government of Sudan established a Steering Committee and a Technical Committee in September 2007. A strategy report entitled *Sudan Strategy Report on the Preparations for Sudan Nuclear Power Program* was prepared in August 2009. In 2010, a nuclear energy program implementing organization (NEPIO) was established headed by the Undersecretary of the Ministry of Water Resources, Irrigation and Electricity (MWRIE) to supervise and coordinate Sudan's nuclear programme activities. The NEPIO chairman formed several national committees which cover the nuclear infrastructure issues identified by the IAEA Milestones Approach. The General Directorate of Nuclear Power under the Ministry of Electricity and Dams (the predecessor of MWRIE) was formed to play the role of the owner/operator and also the technical arm of the NEPIO regarding the nuclear power programme.

Under the coordination of the NEPIO, Sudan prepared a preliminary Self-Evaluation Report (SER) and submitted it to the IAEA in 2016. The IAEA conducted a SER Support mission to Sudan from 7 to 9 March 2017, and on 6 November 2017, Sudan requested the IAEA to carry out a Phase 1 Integrated Nuclear Infrastructure Review (INIR) mission in the third quarter 2018. Based on the suggestions provided during the SER Support mission, Sudan revised and submitted an updated SER to the IAEA on 20 February 2018. A pre-INIR mission was conducted in Sudan from 9 to 10 May 2018, during which additional suggestions were made by the IAEA to further improve the SER. Sudan submitted an updated SER and 126 supporting documents to the IAEA in July 2018. The INIR Phase 1 mission to Sudan was conducted from 27 August to 3 September 2018.

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session for the INIR mission. On the Sudan side, the mission was coordinated by Mr Gaafar Kheir Alla Abd Elhada, Director, Technical Directorate of General Directorate of Nuclear Power. The INIR mission team was led by Mr Anthony Stott of the IAEA's Division of Nuclear Power, Nuclear Infrastructure Development Section, and consisted of staff from the IAEA's Department of Nuclear Energy and the Office of Legal Affairs and international experts recruited by the IAEA.

The INIR mission and associated activities were funded through a combination of a cost-sharing contribution from the Republic of Sudan, funds from the IAEA Technical Cooperation project *SUD2005 Developing National Nuclear Infrastructure for a First Nuclear Power Plant* and an extra budgetary contribution from Japan towards the IAEA activities to support the development of national infrastructure for nuclear power plants.

## **2. OBJECTIVES OF THE MISSION**

The main objectives of the INIR mission were to:

- Evaluate the development status of the national infrastructure to support the nuclear power programme according to *Milestones in the Development of a National Infrastructure for Nuclear Power*, IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1), IAEA, Vienna (2015), and *Evaluation of the Status of National Nuclear Infrastructure Development*, IAEA Nuclear Energy Series No. NG-T-3.2 (Rev. 1), IAEA, Vienna (2016);
- Identify the areas needing further actions to reach Milestone 1: ‘Ready to make a knowledgeable commitment to a nuclear power programme’; and
- Provide recommendations and suggestions which can be used by the Sudan and national institutions to prepare an action plan.

## **3. SCOPE OF THE MISSION**

The INIR mission evaluated the status of nuclear infrastructure in Sudan covering all 19 infrastructure issues relative to the conditions identified in the above publications for Phase 1.

## **4. WORK DONE**

Prior to the mission, the INIR team reviewed the self-evaluation report and supporting documentation that included relevant national laws, regulations, studies and reports. The INIR team sought input from IAEA staff members with relevant expertise working with Sudan. INIR team meetings were conducted prior to the mission in Vienna from 23 to 24 August 2018 and in Khartoum on 26 August 2018.

The INIR mission was conducted from 27 August to 3 September 2018. The meetings were held at the Grand Holiday Villa Hotel and Suites in Khartoum. The main interviews were conducted over four days. Sudan was well prepared for the mission and managed its participation in the review effectively. During the interviews, the Sudan counterparts provided an update on the current status of issues where progress had been made since the self-evaluation report was finalized, and provided additional supporting documentation requested by the INIR team.

The preliminary draft report was prepared by the INIR team and discussed with the counterparts. The main mission results were presented to representatives of the Government in an exit meeting on 3 September 2018. The preliminary draft report was delivered to the counterparts during the exit meeting.

The results of the mission are summarized in Section 5 and presented in tabular form in Section 6 for each of the 19 infrastructure issues in Phase 1. Appendix 1 provides the evaluation results for each issue.

## 5. MAIN CONCLUSIONS

The Integrated Nuclear Infrastructure Review (INIR) Phase 1 mission was conducted in a cooperative and open atmosphere with participation from 10 organizations involved in the nuclear power programme and corresponding infrastructure development. The nuclear energy program implementing organization (NEPIO), headed by the Undersecretary in the Ministry of Water Resources, Irrigation and Electricity (MWRIE), coordinated the mission on the Sudanese side. The full list of participants is included in Appendix 2 to this report.

The INIR team concluded that there is a strong commitment from the Government of Sudan to developing the infrastructure needed for a nuclear power programme. Sudan has established a NEPIO that serves as an effective mechanism to involve a wide and comprehensive range of national stakeholders in the relevant activities. The future owner/operator has been designated and the nuclear regulatory authority established. Sudan has completed a significant number of studies in different nuclear infrastructure issues which contributed to the development of a pre-feasibility report. Some of those studies may need to be reviewed and updated to better prepare the country for the next stages of the nuclear power programme.

To assist Sudan in making further progress in its nuclear infrastructure development, the INIR team made 11 recommendations and 11 suggestions. The INIR team also identified 3 good practices that may benefit other countries considering the introduction of nuclear power.

Based on the recommendations and suggestions, the key areas for further action are summarized below:

- **Sudan should finalize national policies to support the nuclear power programme**

Key decisions have been or are being taken by the Sudanese Government pertaining to the safe, secure and peaceful use of nuclear power. These decisions need to be documented in the form of approved policies or strategies such as the energy plan, nuclear power policy, spent fuel strategy, and policy on industrial involvement.

- **Sudan should strengthen its plans to join the international legal instruments and continue assessing and developing its legal and regulatory framework.**

Sudan intends to adhere to the relevant international legal instruments in the areas of safety, security, safeguards and civil liability for nuclear damage and should establish a workplan to complete this process at the appropriate time.

Sudan has already enacted a comprehensive nuclear law and reviewed other relevant legislation, including its environmental legislation, and is also drafting and updating safety and security regulations. As the nuclear power programme develops, Sudan is encouraged to continue assessing

and developing the legal and regulatory framework, in line with relevant international legal instruments, IAEA safety standards and security guidance, as appropriate.

Sudan should develop a plan to rescind the Small Quantities Protocol to its Comprehensive Safeguards Agreement in a timely manner and continue its efforts to strengthen the State System of Accounting for and Control of Nuclear Material to deal with the increase of activities from the nuclear power programme.

- **Sudan should implement its plans to support the development of key organizations and to enhance public awareness on the nuclear power programme**

Sudan has prepared detailed studies on the human resources required for a nuclear power programme and should implement the activities identified to support the development of qualified and competent staff for the key organizations. It should also prioritize the development of management systems to support the regulatory body and future owner/operator, as both organizations are already established.

Sudan should begin the implementation of its plan for stakeholder involvement and public consultation to increase general awareness about the nuclear power programme at the national, state and local levels.

- **Sudan should further analyse the preparedness of the electrical grid and its approaches to funding, financing and radioactive waste management**

Sudan has completed or initiated a significant number of studies and activities. However, the programme would benefit from additional analysis in the following areas:

- Preparedness of the electrical grid for nuclear power;
- Cost estimate of all key activities specific to developing a nuclear power infrastructure;
- Implications of the preferred contracting options for the nuclear power plant;
- Preliminary assessment of the radioactive waste types and quantities arising from a nuclear power plant and the options and technologies for processing, storage and disposal of these wastes.

The recommendations, suggestions and good practices identified during the mission are listed below:

### **Recommendations**

**R-1.3.1** Sudan should complete the revision of the draft energy plan.

**R-1.3.2** Sudan should review and update as necessary the studies that form the basis for the decision to embark on nuclear power programme.

**R-4.1.1** The NEPIO should estimate the funds needed for all key activities specific to the development of infrastructure for the nuclear power programme.

**R-5.1.1** The NEPIO should coordinate the development of a comprehensive workplan to adhere to all relevant international legal instruments.

**R-6.1.1** SNRRA should prepare a detailed plan to rescind the SQP in a timely manner.

**R-6.2.1** The SNRRA should finalize the plan to strengthen the SSAC including the necessary resources and training.

**R-10.2.1** The NEPIO should finalize the implementation plan for the activities outlined in the HRD studies for all relevant organizations.

**R-11.1.1** The NEPIO should finalize and implement the plan for stakeholder involvement and public consultation.

**R-17.1.1** The NEPIO should make a preliminary assessment (order of magnitude) of the radioactive waste types and quantities arising from the operation and decommissioning of a NPP.

**R-17.1.2** The NEPIO should evaluate the different options and technologies for processing, storage and disposal of the various types of radioactive waste.

**R-18.1.1** The NEPIO should finalize the development and approval of a national policy on industrial involvement.

### **Suggestions**

**S-1.1.1** Sudan is encouraged to complete, approve and publish the nuclear power policy to document the decision to develop a nuclear power programme.

**S-2.1.1** The NEPIO is encouraged to consider actions and mechanisms to enhance the understanding of nuclear safety for all NEPIO members and other relevant stakeholders.

**S-3.1.1** The regulatory body (SNRRA) and the owner/operator (GDNP) are encouraged to accelerate their efforts in developing management systems.

**S-4.2.1** The NEPIO is encouraged to further study the implications of the preferred contracting options for the nuclear power plant.

**S-5.2.1** Sudan is encouraged to reassess and amend as necessary the provisions of NRRCA that may need to be revised or completed to ensure the adequacy and consistency of the legal framework as the nuclear power programme develops.

**S-8.1.1** The NEPIO is encouraged to finalize the identification of the scale of enhancements needed for the existing radiation protection programme for the nuclear power programme.

**S-9.1.1** Sudan is encouraged to undertake a study related to the risk of loss of power from the grid to the NPP.

**S-12.1.1** The NEPIO is encouraged to initiate stakeholder involvement with the public regarding siting (see also R-11.1.1).

**S-13.2.1** The NEPIO is encouraged to ensure that nuclear issues are incorporated in the regulations to be developed under the new Environmental Protection and Natural Resources Act.

**S-16.1.1** The NEPIO is encouraged to assess the required capacity for spent fuel storage.

**S-16.1.2** The NEPIO is encouraged to further explore the feasibility of repatriation of spent fuel.

### **Good Practices**

**GP-1.2.1** The establishment of technical committees through ministerial decrees with identified membership and clear terms of reference provides an official framework for the NEPIO's work, including for technical analysis and recommendations, and a formal basis for decision making and future work.

**GP-1.2.2** The establishment of the owner/operator within the Ministry of Water Resources, Irrigation and Electricity and its participation in national committees on various infrastructure issues ensures that the requirements for the owner/operator are being taken into account at an early phase.

**GP-12.1.1** The collaboration with the oil industry and the use of their technical data and expertise during the siting activities is an efficient and optimal use of resources.

## 6. EVALUATION RESULTS FOR PHASE 1

For the purposes of the INIR mission results, the following definitions are used:

### **Significant\* actions needed:**

The review observations indicate that important work still needs to be initiated or completed to meet the condition.

### **Minor\* actions needed:**

The review observations indicate that some additional work or steps are needed to meet the condition or that plans for the next phase need to be enhanced.

### **No actions needed:**

The available evidence indicates that all the work to meet the condition has been completed.

\*The judgment whether the actions are significant or minor is based on the importance of the work to the overall programme and/or the resources needed to complete it. The classification is done through a consensus of the INIR team and is not based solely upon the judgment of any individual team member.

### **Recommendations:**

Recommendations are proposed when the expectations of the condition have not been met. A recommendation should:

- Emphasize ‘what’ needs to be done, not ‘how’;
- Be based on the IAEA Milestones Approach/Evaluation Methodology;
- Be succinct, self-explanatory and achievable;
- Be supported by the Review Observation text—a ‘gap’ must be identified; already planned work can still be a recommendation if it is required to reach the milestone.

### **Suggestions:**

Suggestions propose the consideration of new or different approaches to develop infrastructure and enhance performance, or to point out better alternatives to current work. A suggestion:

- Should be clear and self-explanatory;
- Should be supported by the Review Observation text;
- May relate to work already under consideration for the next phase.

### **Good practices:**

A good practice is identified in recognition of an outstanding practice or arrangement, superior to those generally observed elsewhere. It is more than fulfilment of the conditions or expectation, and worthy of the attention of other countries involved in the development of nuclear infrastructure as a model in the drive for excellence.

**It should be noted that the results summarized in the following tables neither validate the country actions and programmes, nor certify the quality and completeness of the work done by a country.**

<b>1. National position</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
1.1. Long term commitment made and importance of safety, security and non-proliferation recognized		X	
1.2. The Nuclear Energy Programme Implementing Organization (NEPIO) established			X
1.3. National strategy defined	X		
<b>2. Nuclear safety</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
2.1. Key requirements of nuclear safety understood		X	
2.2. Support through international cooperation initiated			X
<b>3. Management</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
3.1. Need for appropriate leadership and management systems recognized		X	
<b>4. Funding and financing</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
4.1. Strategies for funding established	X		
4.2. Potential strategies for financing identified		X	

<b>5. Legal framework</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
5.1. Adherence to all relevant international legal instruments planned	X		
5.2. Plans in place for development of comprehensive national nuclear law		X	
5.3. Plans in place to enact and/or amend other legislation affecting the nuclear power programme			X
<b>6. Safeguards</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
6.1. Terms of international safeguards agreement in place	X		
6.2. Strengthening of the State System of Accounting for and Control of nuclear material (SSAC) planned		X	
6.3. Recommendations from any previous reviews or audits being addressed			X
<b>7. Regulatory framework</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
7.1. Development of an adequate regulatory framework planned			X
<b>8. Radiation protection</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
8.1. Enhancements to radiation protection programmes planned		X	
<b>9. Electrical grid</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
9.1. Electrical grid requirements considered		X	

<b>10. Human resource development</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
10.1. Necessary knowledge and skills identified, and gaps in current capability assessed			<b>X</b>
10.2. Development of human resources planned	<b>X</b>		
<b>11. Stakeholder involvement</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
11.1. Open and transparent stakeholder involvement programme initiated	<b>X</b>		
<b>12. Site and supporting facilities</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
12.1. General survey of potential sites conducted and candidate sites identified		<b>X</b>	
<b>13. Environmental protection</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
13.1. Environmental requirements considered			<b>X</b>
13.2. Framework for environment protection reviewed		<b>X</b>	
<b>14. Emergency planning</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
14.1. Requirements of, and resources for, developing an emergency response capability recognized			<b>X</b>
14.2. Recommendations from any previous reviews or audits being addressed			<b>X</b>

<b>15. Nuclear security</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
15.1. Nuclear security requirements recognized and the actions of all relevant organizations coordinated			<b>X</b>
15.2. Recommendations from any previous reviews or audits being addressed			<b>X</b>
<b>16. Nuclear fuel cycle</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
16.1. Options for nuclear fuel cycle (front-end and back-end) considered		<b>X</b>	
<b>17. Radioactive waste management</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
17.1. The requirements for management of radioactive waste from NPP recognized	<b>X</b>		
17.2. Options for disposal of all radioactive waste categories understood	<b>X</b>		
<b>18. Industrial involvement</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
18.1. National policy developed with respect to industrial involvement	<b>X</b>		
<b>19. Procurement</b>	<b>Phase 1</b>		
<b>Condition</b>	<b>Actions Needed</b>		
	<b>SIGNIFICANT</b>	<b>MINOR</b>	<b>NO</b>
19.1. Requirements for purchasing NPP services recognized			<b>X</b>



**APPENDIX 1: REVIEW OBSERVATIONS, RECOMMENDATIONS AND SUGGESTIONS  
FOR PHASE 1**

<b>1. National Position</b>		<b>Phase 1</b>
<b>Condition 1.1: Long term commitment made and importance of safety, security and non-proliferation recognized</b>		
<b>Summary of the condition to be demonstrated</b>	A clear statement adopted by the government of its intent to develop a nuclear power programme and of its commitment to safety, security and non-proliferation, with evidence that their importance is embedded in the ongoing work programme.	
<b>Examples of how the condition may be demonstrated</b>	1. A clearly stated government commitment; 2. Evidence of clear responsibilities for each issue, with government coordination of activities.	
<b>Observations</b>		
<p>The draft second cycle national energy plan for the period of 2012–2031 includes nuclear power as one of the options for the energy mix. During two presidential meetings held in September 2013 and attended by the President, two Vice Presidents, President's Assistants, Presidential Advisors, Head of the National Assembly, Minister of Foreign Affairs, Minister of Defence and General Manager of National Security and Intelligence Services, wide discussions on alternatives for the energy mix in Sudan resulted in a decision to embark on a nuclear power programme.</p> <p>In his national statement to the International Ministerial Conference on Nuclear Power in the 21st Century in Abu Dhabi, United Arab Emirates, 30 October – 1 November 2017, the Minister of Water Resources, Irrigation and Electricity stated that Sudan had embarked on the planning for nuclear power generation, and that the Government had taken number of steps to prepare the infrastructure relevant to the nuclear programme based on IAEA procedures and standards, specifically those pertaining to nuclear safety and security.</p> <p>The INIR team was informed that a national committee was established by the NEPIO to develop a nuclear power policy covering nuclear safety, security and safeguards, and which will document the decision to develop a nuclear power programme. The initial draft of this policy is almost complete, and once agreed by the NEPIO, will be submitted to the Minister of Water Resources, Irrigation and Electricity who will table it at the Council of Ministers for approval. Once approved, the policy would be signed by the President and subsequently published.</p> <p>The commitment to nuclear safety, security and non-proliferation in the implementation of a nuclear power programme is also reflected in the Nuclear and Radiological Regulatory Control Act (2017) which addresses the issues of nuclear safety, security and safeguards.</p> <p>Technical Cooperation projects with the IAEA (SUD9008: Strengthening National Regulatory Capabilities for Radiation, Safety and Security, and SUD9009: Strengthening National Nuclear and Radiological Safety Capabilities) address nuclear safety and security. Sudan is a party to the Convention on the Physical Protection of Nuclear Material and has signed the Convention on Nuclear Safety. Sudan is a party to the Treaty on the Non-Proliferation of Nuclear Weapons and has concluded a Comprehensive Safeguards Agreement with the IAEA.</p>		
<b>Areas for further action</b>	<b>Significant</b>	No

	<b>Minor</b>	Nuclear power policy		
<b>RECOMMENDATIONS</b>				
None				
<b>SUGGESTIONS</b>				
<p><b>S-1.1.1</b> Sudan is encouraged to complete, approve and publish the nuclear power policy to document the decision to develop a nuclear power programme.</p>				
<b>GOOD PRACTICES</b>				
None				
<b>1. National Position</b> <b>Condition 1.2: The NEPIO established</b>		<b>Phase 1</b>		
<b>Summary of the condition to be demonstrated</b>	<p>The NEPIO:</p> <ul style="list-style-type: none"> <li>a) Has clear terms of reference that call for a comprehensive review of all the issues relevant to making a decision to proceed with a nuclear power programme;</li> <li>b) Is recognized by all relevant ministries as having that role;</li> <li>c) Reports to a senior minister or directly to the head of government;</li> <li>d) Has appropriate human and financial resources;</li> <li>e) Involves all relevant stakeholders, including the country's major utilities, the regulatory body for security and radiation safety, other relevant government agencies, legislative representatives and other decision makers.</li> </ul>			
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. The charter establishing the NEPIO and to whom it reports;</li> <li>2. Evidence that the roles and responsibilities of the NEPIO are known by all its members and by other government ministries;</li> <li>3. A document defining objectives and timescales and an adequate scope of investigations;</li> <li>4. A clear description of how the NEPIO operates in terms of funding, planning, reporting, scope of studies and use of consultants;</li> <li>5. Evidence that the NEPIO has adequate skills to address all issues either directly or through commissioning specialist studies;</li> <li>6. Evidence of relevant interactions between the head of NEPIO and appropriate ministries, such as those responsible for energy and the environment.</li> </ol>			
<b>Observations</b>				
<p>In September 2007, the Government of Sudan established a Steering Committee and a Technical Committee to prepare the country's strategy report for the introduction of the first nuclear power plant. In 2010, Decree No. 22/2010 established a nuclear energy program implementing committee (NEPIO) headed by the Undersecretary of the Ministry of Water Resources, Irrigation and Electricity (MWRIE) to supervise and coordinate Sudan's nuclear programme activities. The NEPIO chairman formed several national committees covering almost all 19 nuclear infrastructure issues identified by the IAEA Milestones Approach. These committees made use of MWRIE's premises, facilities and funding to perform their functions. In 2010, the General Directorate of Nuclear Power under the Ministry of Electricity and Dams (the predecessor of MWRIE)</p>				

was formed to play the role of the owner-operator and also the technical arm of the NEPIO regarding the nuclear power programme.

In 2016, the Minister of Water Resources, Irrigation and Electricity issued Decree No. 9/2016 to reform the NEPIO structure.

The NEPIO members include representatives from relevant ministries and authorities:

1. Undersecretary	Ministry of Water Resources, Irrigation and Electricity (MWRIE)	Chairman
2. Secretary General	Sudan Nuclear and Radiological Regulatory Authority (SNRRA)	Member
3. Director General	Sudan Atomic Energy Commission (SAEC)	Member
4. Secretary General	Higher Council of Environment and National Resources (HCENR)	Member
5. Secretary General	Higher Council of Civil Defence (HCCD)	Member
6. Director General	General Directorate of Nuclear Power (GDNP)	Member and Reporter
7. Representative	Red Sea Government	Member
8. Representative	Ministry of Foreign Affairs	Member
9. Representative	Ministry of Justice	Member
10. Representative	Ministry of Finance and Economic Planning	Member

The INIR team was informed that the Decree makes provision for additional members, hence for example a representative of National Security and Intelligence Services is currently also a member.

The Decree identifies the mandate of the NEPIO as follows:

1. Representing the country in the implementation of the nuclear power program;
2. Supervising the development of nuclear power infrastructure;
3. Ensuring that all organizations are doing their roles in the implementation of Sudan's NPP;
4. Supervising the collaboration with the IAEA;
5. Make sure of readiness of institutes responsible for developing the regulations related to nuclear safety, security and safeguards;
6. Make sure of readiness of institutes responsible for issuing the licenses required;
7. Follow up the Sudan's accession to the international conventions and treaties;
8. Plan for emergency response;
9. Supervise the process of establishing the NPP Operator;
10. Make sure of readiness of the electrical grid to host the first NPP;
11. Supervise the process of selecting a suitable site;
12. Make sure of preparation of all documents related to construction license;
13. Supervise the process of contracting;
14. Facilitate the site studies and site registration in the relevant state government;
15. Facilitate obtaining the construction licenses required from the state government;
16. Supervise the planning and implementation of Public consultation and stakeholder engagement programs;
17. Make sure of providing safety and security in the pre-project phase;

18. Follow up the process of providing funding and finance required and provide sufficient guarantees;
19. Make sure of establishing bilateral agreement with the countries who might be partners in the Sudan NPP;
20. Make sure of the completeness of the Sudan legal framework for NPP.

The INIR team was informed that the chairman reports on NEPIO's activities to the Minister of Water Resources, Irrigation and Electricity, who, when appropriate, includes information on these activities in briefings to the Council of Ministers.

Following the issuing of Decree No. 9/2016, the focal points for each of the 19 infrastructure issues were selected for the purpose of supervising the preparation of the SER as follows:

- **General Directorate of Nuclear Power:**
  1. National Position;
  3. Management;
  4. Funding and financing;
  9. Electrical grid;
  10. Human resource development;
  11. Stakeholder involvement;
  12. Siting and supporting facilities;
  18. Industrial Involvement; and
  19. Procurement.
- **Sudan Nuclear and Radiological Regulatory Authority (SNRRA):**
  2. Nuclear safety;
  5. Legal framework;
  6. Safeguards;
  7. Regulatory framework;
  14. Emergency preparedness and response; and
  15. Nuclear security.
- **Sudan Atomic Energy Commission (SAEC):**
  9. Radiation protection;
  16. Nuclear fuel cycle; and
  17. Radioactive waste management.
- **Ministry of Environment, National Resources and Physical Development (MENRPD):**
  13. Environmental protection.

The INIR team was informed that each of these four organizations has human resources experienced in nuclear matters and financial resources allocated from the Minister of Finance and Economic Planning to perform their respective functions. In addition, and if required, the NEPIO can also provide funds from its budget to support the activities of other organizations.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		

None	
<b>GOOD PRACTICES</b>	
<b>GP-1.2.1</b> The establishment of technical committees through ministerial decrees with identified membership and clear terms of reference provides an official framework for the NEPIO's work, including for technical analysis and recommendations, and a formal basis for decision making and future work.	
<b>GP-1.2.2</b> The establishment of the owner/operator within the Ministry of Water Resources, Irrigation and Electricity and its participation in national committees on various infrastructure issues ensures that the requirements for the owner/operator are being taken into account at an early phase.	
<b>1. National Position</b> <p><b>Condition 1.3: National strategy defined</b></p>	<b>Phase 1</b>
<b>Summary of the condition to be demonstrated</b> <p>A comprehensive report, defining and justifying the national strategy for nuclear power, including:</p> <ul style="list-style-type: none"> <li>a) An analysis of energy demand and energy alternatives;</li> <li>b) An evaluation of the impacts of nuclear power on the national economy, for example gross domestic product and employment;</li> <li>c) A preliminary technology assessment to identify technologies that are consistent with national expectations;</li> <li>d) Consideration of siting possibilities and grid capacity;</li> <li>e) Consideration of financing options, ownership options and operator responsibilities;</li> <li>f) Consideration of long term costs and obligations relating to spent fuel, radioactive waste and decommissioning;</li> <li>g) Consideration of the human resource needs and external support needs of the regulatory body and the owner/operator;</li> <li>h) Recognition that there remains a non-zero possibility of a severe accident and the need to deal with the consequences of such an accident will need to be addressed;</li> <li>i) Consideration of the demands of each of the infrastructure issues and a plan for how they will be met in the next phase of development.</li> </ul> <p><i>Note: Any prefeasibility study conducted during Phase 1 can provide significant input to the comprehensive report, although it is important that the report fully address all 19 infrastructure issues.</i></p>	
<b>Examples of how the condition may be demonstrated</b> <ol style="list-style-type: none"> <li>1. List of the studies that are feeding into the report(s);</li> <li>2. Current status and conclusions;</li> <li>3. Contents list for the report(s);</li> <li>4. Executive summary of the report(s);</li> <li>5. Evidence of ministerial review of the report(s).</li> </ol>	
<b>Observations</b>	<p>The development of a strategy for nuclear power in Sudan was initiated in 2008, and in August 2009 a report entitled <i>Sudan Strategy Report on the Preparations for Sudan Nuclear Power Program</i> was completed. The report describes and makes recommendations on a strategy for preparing the various aspects of infrastructure in the country for the introduction of the first nuclear power plant, based on the IAEA Milestones Approach.</p> <p>In June 2011, Sudan (Ministry of Electricity and Dams) signed a contract with an international consultancy company to undertake pre-feasibility studies for a nuclear power plant (NPP). The results of these studies were reported in annexes combined into a final report entitled <i>Feasibility Study and Selection of Technology for</i></p>

*Sudan's First NPP* dated May 2013. This final report consists basically of five chapters.

The reports of studies supporting the selected chapters are the following:

**1. Introduction**

**2. National Context and Energy Supply Options**

- WASP Study Report Least Cost Power Development Plan 2010-2039 (May 2012);
- Compatibility and Position of NPP within Sudan Electric Power System (February 2013);
- Gap Analysis (February 2013);
- Options for the National Policy on NFC and RWM (April 2012).

**3. Selection of a NPP for Sudan**

- Selection of Technologies and Designs (April 2012);
- Information on the Available Sites in Sudan (March 2012);
- Lead Time for Construction of Nuclear Power Plant (February 2012);
- National Infrastructure Evaluation (May 2012);
- Cost Estimate and Financial Requirements for a NPP Project (January 2013);
- Ranking of the Vendors and Conclusions (April 2012).

**4. Feasibility of the Project Implementation**

- Human Resource Assessment (May 2012);
- Legal and Regulatory Framework Evaluation (May 2012);
- Licensing Structure and Licensing Process (May 2012);
- Public Information (May 2012);
- National Participation (April 2012)
- Environmental Impact Consideration (April 2012);
- Realization of the Nuclear Power Plant Project (May 2012);
- Project Risk Assessment (April 2011).

**5. Conclusions**

Included in the work undertaken by the consultancy company are several siting-related studies, each with its own report. The final report (May 2013) drew conclusions regarding further actions that would be required.

An international consultancy company was commissioned in May 2012 to prepare, in collaboration with a national team, a master plan for human resource development. The HRD Master Plan consists of three reports: (1) HRD Plan for the first NPP; (2) HRD Plan for the short-term requirements; and (3) HRD Plan for the long-term requirements. The consultancy company was also commissioned to prepare a Public Communication and Stakeholder Management Strategy, and to prepare a Quality Assurance Programme for the owner/operator and the regulator. The consultancy company also developed an overall schedule for the first NPP, from pre-project activities through to commercial operation.

The INIR team was informed that a summary of the conducted studies (reported in the Draft of Sudan second cycle energy plan,; and the 'Feasibility Study and Selection of Technology for Sudan's First NPP', May 2013) was presented during two Presidential Meetings in September 2013, and resulted in the decision to embark on a nuclear power programme (see Condition 1.1 above).The INIR team noted that some of the studies may need to be reviewed to confirm the on-going validity of the results and to take into account potential changes in the nuclear power programme, for example due to the 2018 initiative to consider a floating NPP.

The INIR team was also informed that after the separation of South Sudan in 2011, the energy resources of South Sudan could no longer be taken into account in the Sudan national energy plan. A national team was established to draft an energy plan based on the national resources in Sudan. The outputs of this draft updated energy plan have been used for the electricity system expansion plan. However, since the studies of the different energy resources used different commercially available energy planning tools, it was decided to use the IAEA energy planning tools to ensure a consistent approach. Hence a national committee has been

established to update the plan. The relevant Ministries are represented on a national committee, with MWRIE having the overall responsibility, to implement this decision.

The INIR team was informed that the update to the energy plan, and any other national policies, will be approved through the normal process: completion by a national committee involving the relevant Ministries, agreement by the NEPIO and submission to the Minister of Water Resources, Irrigation and Electricity for approval by the Council of Ministers.

<b>Areas for further action</b>	<b>Significant</b>	Review of energy plan and other studies
	<b>Minor</b>	No

#### **RECOMMENDATIONS**

**R-1.3.1** Sudan should complete the revision of the draft energy plan.

**R-1.3.2** Sudan should review and update as necessary the studies that form the basis for the decision to embark on nuclear power programme.

#### **SUGGESTIONS**

None

#### **GOOD PRACTICES**

None



2. Nuclear Safety		Phase 1		
<b>Condition 2.1: Key elements of nuclear safety understood</b>				
<b>Summary of the condition to be demonstrated</b>	The key requirements for nuclear safety, specified in the IAEA safety standards, are understood by the NEPIO and other relevant stakeholders, and their implications are recognized.			
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Evidence that the NEPIO has an understanding of, and commitment to, nuclear safety and the principles described in IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [8], and is aware of how nuclear safety requirements are taken into account in various designs of nuclear power plants (NPPs);</li> <li>2. Evidence that the responsibility for nuclear safety is recognized, for example in consideration of leadership, funding and expertise;</li> <li>3. Evidence that the need to develop adequate capability and skills in nuclear safety is recognized;</li> <li>4. Evidence of familiarity with IAEA safety standards and other States' practices, and recognition of the need for, and commitment to, the development of national safety standards.</li> </ol>			
<b>Observations</b>				
<p>The Nuclear and Radiological Regulatory Control Act (2017) includes provisions regarding the notification and authorization process; conducting inspections; performing reviews and assessments; requirements for safety analysis and periodical safety assessment; enforcement; training of employees in the field of safety; and the requirement for the operator to promote nuclear safety. The Act also assigns the prime responsibility for ensuring the safety of nuclear reactors and associated activities and practices to the operator.</p> <p>SNNRA and MWRIE recognize the importance of nuclear safety and that nuclear safety infrastructure needs to be based on IAEA safety standards and international best practice. The INIR team was informed that NEPIO members from the key organisations have attended IAEA national workshops and seminars, for example on leadership, management systems, safety culture, NPP technologies, and funding. Three members of the NEPIO (Ministry of Justice, National Security and Intelligence Services and High Council of Civil Defence) participated in a 3-week general training course on nuclear hosted by China, which included sessions on nuclear safety. However not all NEPIO members have received training on nuclear safety.</p> <p>The INIR team was informed that SNRRA intends to initiate the drafting of a national policy and strategy for nuclear safety soon and anticipates that it will be submitted to the SNRRA Board for approval by the end of 2018.</p>				
<b>Areas for further action</b>	<b>Significant</b>	No		
	<b>Minor</b>	NEPIO understanding of nuclear safety and its implications		
<b>RECOMMENDATIONS</b>				
None				
<b>SUGGESTIONS</b>				
S-2.1.1 The NEPIO is encouraged to consider actions and mechanisms to enhance the understanding of nuclear				

safety for all NEPIO members and other relevant stakeholders.				
<b>GOOD PRACTICES</b>				
None				
<b>2. Nuclear Safety</b> <b>Condition 2.2: Support through international cooperation initiated</b>		<b>Phase 1</b>		
<b>Summary of the condition to be demonstrated</b>	The need for international cooperation and open exchange of information related to nuclear safety as an essential element is recognized and demonstrated.			
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Evidence of review of options for bilateral or regional cooperation and specific actions for selected cooperation started, especially with countries with an established nuclear power programme;</li> <li>2. Implementation of a national technical cooperation programme with the IAEA and evidence of government financial support including nuclear safety aspects.</li> </ol>			
<b>Observations</b>				
<p>The Government has signed intergovernmental agreements with several countries with advanced nuclear power programs. Sudan has an agreement with China (CNNC), that includes nuclear safety in its scope. 70 employees from MWRIE have received training in China. Sudan has also an agreement with the Russian Federation (ROSATOM). The training under this agreement is in a planning stage.</p> <p>SNRRA is active in several international regulatory forums (RCF, FNRBA and ANNuR). The INIR team was informed that SNRRA is finalizing MoUs with regulatory authorities of Russia, Morocco and Ethiopia and negotiating Memoranda of Understanding (MoUs) with regulatory authorities of China, USA and South Africa.</p> <p>Sudan has Technical Cooperation projects with the IAEA and is participating in international information networks (INIS, ANENP, GNSSN). Sudan is considering the development of a comprehensive policy/strategy for multilateral and bilateral cooperation.</p>				
<b>Areas for further action</b>	<b>Significant</b>	No		
	<b>Minor</b>	No		
<b>RECOMMENDATIONS</b>				
None				
<b>SUGGESTIONS</b>				
None				
<b>GOOD PRACTICES</b>				
None				

<b>3. Management</b>	<b>Phase 1</b>
<b>Condition 3.1: Need for appropriate leadership and management systems recognized</b>	
<b>Summary of the condition to be demonstrated</b>	There is a commitment to leadership and management systems that will ensure success and promote a safety and security culture as well as the peaceful use of nuclear technologies. There are plans to ensure the knowledge gained by the NEPIO is transferred to the future regulatory body and the owner/operator of the programme.
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Plans to ensure appointment of leaders with the appropriate training and experience to plan, procure, construct and operate an NPP as well as to ensure the leadership and management of nuclear safety, security and safeguards;</li> <li>2. Evidence that the importance of nuclear safety and security culture in each of the organizations to be established is recognized;</li> <li>3. Evidence that the importance of ensuring the peaceful use of nuclear technology is recognized;</li> <li>4. Evidence of a clear understanding of management system requirements;</li> <li>5. A plan to implement management systems in future key organizations is consistent with the appropriate standards and guidance.</li> </ol>
<b>Observations</b>	
<p>The Nuclear and Radiological Control Act (2017) addresses, <i>inter alia</i>, the following:</p> <ul style="list-style-type: none"> <li>— The responsibility of the Regulatory Authority to establish a management system to discharge its functions, and</li> <li>— The responsibility of the Operating Organization to establish and implement a management system that shall be continuously improved with a view to providing confidence that safety requirements are met throughout the lifetime of the operation of the facility.</li> </ul> <p>The INIR team was informed that the General Directorate of Nuclear Power (GDNP), in the Ministry of Water Resources, Irrigation and Electricity (MWRIE), is responsible for developing an integrated management system for the Operating Organization. IAEA safety requirements and guides: The Management System for Facilities and Activities, IAEA Safety Standard Series No. GS-R-3 and Application of the Management System for Facilities and Activities, IAEA Safety Guide No. GS-G-3.1 will be used as key references.</p> <p>In 2012, an international consultancy company was commissioned to develop a quality assurance (QA) program, for the Owner, the operating organization and the regulatory authority. This QA program describes the elements of a comprehensive management system. The INIR team was informed that the development of an integrated management system and the related processes and procedures is under consideration. The intention is to upgrade the quality assurance program to an integrated management system. Due to other priorities, the completion of this activity — originally planned for end of 2018 — has been delayed.</p> <p>Based on the information provided, the INIR team considers that the NEPIO is aware of the importance of nuclear safety and security culture for nuclear power. Several training courses and workshops on nuclear safety in which both GDNP and SNRRA participated have been held in Sudan under IAEA Technical Cooperation projects.</p> <p>The INIR team was also informed that the Human Resources Development Master Plan establishes training needs for each management position for each phase of the nuclear power programme. The importance of training on nuclear safety and security culture is specially reflected in the syllabus for senior managers. Several managers and staff members of the NEPIO have participated in training workshops organized by the IAEA, as</p>	

well as workshops in China, hosted by CNNC, and in Russia, hosted by ROSATOM which included as topics nuclear safety and security culture.

The membership of the NEPIO includes representatives from the regulatory authority SNRRA, the operating organization (GDNP in MWRIE) and the Sudan Atomic Energy Commission (who will also provide TSO services for the owner/operator), at both the NEPIO level as well as at the technical committee level. These organizations are thus fully involved in the provision of inputs and analysis of results of studies conducted under the auspices of the NEPIO.

The INIR team noted the importance for the regulatory authority and the operating organization to accelerate their efforts in developing integrated management systems given that they already have been established and are actively involved in developing the infrastructure for a nuclear power programme.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	Management systems

#### **RECOMMENDATIONS**

None

#### **SUGGESTIONS**

**S-3.1.1** The regulatory body (SNRRA) and the owner/operator (GDNP) are encouraged to accelerate their efforts in developing management systems.

#### **GOOD PRACTICES**

None

4. Funding and Financing		Phase 1
<b>Condition 4.1: Strategies for funding established</b>		
<b>Summary of the condition to be demonstrated</b>	Mechanisms have been defined for funding a range of key activities that are specific to a nuclear power programme but may not be the fiscal responsibility of the owner/operator.  The activities include: a) Establishing the legal framework; b) Activities of the regulatory body for safety, security and safeguards; c) The government's stakeholder involvement programme; d) Siting and environmental protection activities that are the responsibility of the government; e) Emergency preparedness and response (EPR); f) Education, training and research; g) Any required improvements to the electrical grid, if such improvements are the government's responsibility; h) Any proposed incentives and direct government support to promote localization; i) Storage and disposal of radioactive waste, including spent fuel; j) Decommissioning of the NPP.	
<b>Examples of how the condition may be demonstrated</b>	1. Clear statements of how the above areas will be funded, based on a consideration of options; 2. Evidence that the scale of the costs of each of these activities has been recognized.	
<p><b>Observations</b></p> <p>The Strategy Report on the Preparation for the Sudan Nuclear Programme (2009), identified the initial strategy and source of funding for the development of the 19 infrastructure issues. The prefeasibility study entitled <i>Feasibility Study and Selection of Technology for Sudan's First NPP</i> (May 2013) estimated that US \$1 billion would be needed to develop all the required infrastructure including the necessary human resources; however, no breakdown of these costs was developed.</p> <p>Generally, the funding for all pre-project activities related to the development of the infrastructure has been provided by the Government of Sudan, either directly from the Ministry of Finance and Economic Planning or through the Ministry of Water Resources, Irrigation and Electricity (MWRIE). The INIR team was informed that Sudan plans to obtain additional funding through a bilateral agreement with China, specifically for siting studies and human resource development.</p> <p>The NEPIO operates on an annual budget provided by the Ministry of Finance and Economic Planning. Since its inception, the NEPIO has received a total of about €5 million plus the equivalent of €2 million in local currency to support the procurement of consultancy services. The INIR team was informed that no significant delays have been encountered due to a lack of funding for the requirements of the Phase 1.</p> <p>The INIR team was informed that the NEPIO estimates the scale of the costs required for specific activities through three paths: (1) the advice of a general advisor; (2) direct discussions with vendors; and (3) through international experiences shared with the Sudanese representatives at IAEA and other international organizations meetings. However, this approach does not provide a comprehensive estimation of the costs of all activities for the development of each infrastructure issue.</p> <p>The INIR team noted that as Sudan enters Phase 2, a significant increase of funds will be needed to support the activities of the key organizations.</p>		

Regarding the funding for decommissioning, the INIR team was informed that the prefeasibility study entitled *Feasibility Study and Selection of Technology for Sudan's First NPP* (May 2013) assumed 15% of overnight costs for decommissioning, based on an analysis obtained from an OECD document that estimated those costs between 9 and 15%. The INIR team was informed that the fund for decommissioning will be obtained from the electricity tariff that will be deposited into a savings escrow account, which will be overseen by the regulatory authority.

<b>Areas for further action</b>	<b>Significant</b>	Cost estimate for infrastructure
	<b>Minor</b>	No

## RECOMMENDATIONS

**R-4.1.1** The NEPIO should estimate the funds needed for all key activities specific to the development of infrastructure for the nuclear power programme

## SUGGESTIONS

None

## GOOD PRACTICES

None

## 4. Funding and Financing

**Phase 1**

### Condition 4.2: Potential strategies for financing identified

<b>Summary of the condition to be demonstrated</b>	Potential options have been identified with financial and risk management strategies, which together: <ol style="list-style-type: none"> <li>Create sufficient confidence for lenders and investors to support an NPP project;</li> <li>Ensure the long-term viability of the owner/operator to fulfil all its responsibilities.</li> </ol> <p><i>Note: A large part of the government's role in nuclear power financing, if the government is not directly a sponsor of the project, relates to financial risk reduction.</i></p>
<b>Examples of how the condition may be demonstrated</b>	A review of financing options and risk management strategies, considering the long-term economics and risks associated with the NPP and including the extent of government funding, equity partners and borrowing, among other things.

## Observations

A high level national committee was created in 2014 with a mandate that included the analysis of the funding and financing required for the construction of the first NPP in Sudan. The mandate included the following elements:

- Searching for a suitable contracting method for first NPP;
- Developing the strategy of funding and financing for the NPP;
- Executing the activities included in action plan of self-evaluation report (the funding and financing issues);
- Studying available guarantees for the investors;

- Reviewing and updating the bankability study of first NPP;
- Representing Sudanese side in the higher steering committee between Sudan and potential vendors.

The main outcome of the studies recommended that the contracting mechanism for the construction of the first NPP should be the adoption of either an EPC plus Finance or an IPP approach. The INIR team was informed that the IPP approach is more plausible due to loan guarantees complications. The INIR team was informed that Sudan has extensive experience with EPC plus Finance contracts, which are frequently used for the construction of conventional power plants, and that this experience will be used when discussing the details of the contract with the vendor. The INIR team noted that a BOO or BOOT contract for a nuclear power plant is much more complex than for conventional plants, due to the unique requirements that apply during construction, commissioning and operation, such as nuclear safety and licensing.

The INIR team was informed that under the umbrella of the intergovernmental agreement with China, negotiations are in progress for China to provide 85% of the financing for the NPP project. Similar negotiations are planned to be conducted with the Russian Federation. The INIR team was also informed that Sudan will also seek loans from the potential vendors to support its pre-project activities.

The prefeasibility study entitled *Feasibility Study and Selection of Technology for Sudan's First NPP* (May 2013), included a project risk assessment, and identified 27 risks for which a risk management plan was developed, covering the risk (threat), the cause, the likelihood of occurrence, the consequences, risk prevention and mitigation measures and the risk owner. The INIR team was informed that the NEPIO created a working group to analyse and propose an action plan to address these 27 risks.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	Contracting method
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
<b>S-4.2.1</b> The NEPIO is encouraged to further study the implications of the preferred contracting options for the nuclear power plant.		
<b>GOOD PRACTICES</b>		
None		



5. Legal Framework		Phase 1
<b>Condition 5.1: Adherence to all relevant international legal instruments planned</b>		
<b>Summary of the condition to be demonstrated</b>	<p>There is an understanding of the requirements of the relevant international legal instruments, their implications and a commitment to adhere to them.</p> <p>The following instruments are covered:</p> <ul style="list-style-type: none"> <li>a) Convention on Early Notification of a Nuclear Accident (INFCIRC/335);</li> <li>b) Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (INFCIRC/336);</li> <li>c) Convention on Nuclear Safety (INFCIRC/449);</li> <li>d) Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the ‘Joint Convention’) (INFCIRC/546);</li> <li>e) Convention on the Physical Protection of Nuclear Material (INFCIRC/274/Rev.1) and Amendment thereto (INFCIRC/274/Rev.1/Mod.1);</li> <li>f) Vienna Convention on Civil Liability for Nuclear Damage (INFCIRC/500);</li> <li>g) Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (INFCIRC/566);</li> <li>h) Convention on Supplementary Compensation for Nuclear Damage (INFCIRC/567);</li> <li>i) Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (INFCIRC/402);</li> <li>j) Comprehensive safeguards agreement — based on The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (INFCIRC/153 (Corrected));</li> <li>k) Additional protocol — following the provisions of Model Protocol Additional to the Agreement(s) Between States(s) and the International Atomic Energy Agency for the Application of Safeguards (INFCIRC/540 (Corrected));</li> <li>l) Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA.</li> </ul>	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Plans for when each of the instruments will be adhered to;</li> <li>2. Identification of the actions that will need to be undertaken and the required timescales;</li> <li>3. Evidence that the resources required are understood and have been defined.</li> </ol>	
<b>Observations</b>	<p>Among the international legal instruments adopted under IAEA auspices in the fields of nuclear safety, security, safeguards and civil liability for nuclear damage, Sudan is a party to the Convention on the Physical Protection of Nuclear Material (CPPNM) and has concluded a Comprehensive Safeguards Agreement (CSA) with the IAEA.</p> <p>A technical committee was established by Decree in 2010 to, <i>inter alia</i>, advise and assist the Government to understand the requirements and implications of the international legal instruments related to the peaceful uses of nuclear energy, draft a summary of each of these instruments and make recommendations for submission to the national approval process. The committee’s reports recommended adherence to several international legal</p>	

instruments. A one-day workshop was held in January 2017 to share the committee's findings and recommendations with institutional stakeholders.

The INIR team was informed that, based on the committee's report, the Secretary General of SNRRA requested the Ministry of Justice in August 2018 to start the process of ratification of, or adherence to, the following international legal instruments:

- Convention on Early Notification of a Nuclear Accident;
- Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency;
- Convention on Nuclear Safety;
- Amendment to the CPPNM;
- Vienna Convention on Civil Liability for Nuclear Damage and its Amendment Protocol;
- Convention on Supplementary Compensation for Nuclear Damage.

The national adherence process will include, as a first step, consultations with relevant stakeholder institutions prior to submission to the Cabinet for approval and to the National Assembly for ratification. Among the actions planned to support this process, Sudan requested the IAEA to conduct a workshop on civil liability for nuclear damage which is scheduled for November 2018.

The INIR team was informed that, based on the committee's report, the national process for adhering to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, and for concluding an Additional Protocol to the CSA would also be pursued; a detailed timeline for initiating this process is still under consideration. Sudan may also assess the possibility of adhering to the Joint Protocol relating to the Application of the Paris Convention and the Vienna Convention.

The INIR team noted that, due to the nature of the legislative process and the number of instruments to be considered, further planning and coordination among relevant stakeholders is necessary for timely initiation and completion of the national adherence process.

<b>Areas for further action</b>	<b>Significant</b>	International legal instruments
	<b>Minor</b>	No
<b>RECOMMENDATIONS</b>		
<b>R-5.1.1</b> The NEPIO should coordinate the development of a comprehensive workplan to adhere to all relevant international legal instruments.		
<b>SUGGESTIONS</b>		
None		
<b>GOOD PRACTICES</b>		
None		
<b>5. Legal Framework</b>		<b>Phase 1</b>
<b>Condition 5.2: Plan in place for development of a comprehensive national nuclear law</b>		
<b>Summary of the condition to be</b>	There is an understanding of the requirements of the comprehensive national nuclear law that needs to be enacted, a plan with the actions and	

<b>demonstrated</b>	<p>timescales for development and enactment, together with a commitment from the government to achieve the stated plan.</p> <p>The plan includes the need for the law to:</p> <ol style="list-style-type: none"> <li>Establish an independent nuclear regulatory body with adequate human and financial resources, and a clear and comprehensive set of functions;</li> <li>Identify responsibilities for safety, security and safeguards;</li> <li>Formulate safety principles and rules (radiation protection, nuclear installations, radioactive waste and spent fuel management, decommissioning, mining and milling, EPR and the transport of radioactive material);</li> <li>Formulate nuclear security principles;</li> <li>Give appropriate legal authority to, and define the responsibilities of, the regulatory body and all competent authorities establishing a regulatory control system (authorization, inspection and enforcement, review and assessment, and development of regulations and guides);</li> <li>Implement IAEA safeguards, including a State system of accounting for and control of nuclear material (SSAC);</li> <li>Implement import and export control measures for nuclear and radioactive material and items;</li> <li>Establish compensation mechanisms for nuclear damage.</li> </ol>
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. A plan on how the law will be developed and approved;</li> <li>2. A summary of how each of the areas listed above will be addressed within the law;</li> <li>3. Interactions with the IAEA and the other relevant organizations.</li> </ol>
<b>Observations</b>	

Sudan has enacted a comprehensive nuclear law, the Nuclear and Radiological Regulatory Control Act (NRRCA) 2017, which was approved by the National Assembly on 11 January 2017 and signed by the President in March 2017.

The NRRCA provides for the establishment of the Sudanese Nuclear and Radiological Regulatory Authority (SNRRA) as a “regulatory control authority, which is effectively independent from the institutions or bodies specialized in the nuclear and radiological technology development, the peaceful use or promotion thereof”, and with “financial and administrative independence in discharging its tasks” (see Article 5).

The Nuclear and Radiological Regulatory Control Act (NRRCA) is structured as follows:

- Chapter I: Preliminary Provisions (Articles 1–4);
- Chapter II: The Authority, the Board and the General Secretariat (Articles 5–15);
- Chapter III: Authorization, notification and inspection procedure (Articles 16–21);
- Chapter IV: Prohibited and restricted activities and safeguards (Articles 22–25);
- Chapter V: Safety of nuclear reactor and Decommissioning (Articles 26–27);
- Chapter VI: Mining and processing, Radioactive waste and spent fuel, Emergency preparedness and response (Articles 28–30);
- Chapter VII: Operator responsibilities, Civil liability for nuclear damage (Articles 31–33);
- Chapter VIII: Control of radiation sources, Transport of radioactive materials, Radiation protection and Nuclear security (Articles 34–37);
- Chapter IX: Financial Provisions (Articles 38–42); and
- Chapter X: General Provisions (Articles 43–46).

The INIR team noted that some aspects of the NRRCA may need to be reassessed as the nuclear power programme develops. These aspects include for instance the composition of the SNRRA Board, which includes members representing a wide range of ministries and institutions (see Article 7). As regulatory activities increase, this Board composition may need to be reconsidered if needed for enhancing efficiency in regulatory decision making. In addition, the process and steps for the authorization of nuclear power plants, which are being addressed through regulations, may also need to be reflected and clarified in the law to ensure legal certainty and consistency (see Articles 6(d)(i) and 26(1)). Furthermore, some provisions may need to be amended or completed to bring the legal framework in line with the international legal instruments to which Sudan intends to become a party (e.g. provisions on civil liability for nuclear damage (see Article 32), and criminalization of offenses under the Amendment to the Convention on the Physical Protection of Nuclear Material).

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	Reassessment of legal provisions
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
<p><b>S-5.2.1</b> Sudan is encouraged to reassess and amend as necessary the provisions of NRRCA that may need to be revised or completed to ensure the adequacy and consistency of the legal framework as the nuclear power programme develops.</p>		
<b>GOOD PRACTICES</b>		
None		
<b>5. Legal Framework</b> <b>Condition 5.3: Plans in place to enact and/or amend other legislation affecting the nuclear power programme</b>		<b>Phase 1</b>
<b>Summary of the condition to be demonstrated</b>	<p>There is an understanding of which legislation that affects the nuclear power programme needs to be enacted and/or amended, the timescales for its development and approval, together with a commitment from the government to achieve the stated plan. The legislation to be considered includes that on:</p> <ul style="list-style-type: none"> <li>a) Environmental protection;</li> <li>b) EPR;</li> <li>c) Occupational health and safety of workers;</li> <li>d) Protection of intellectual property;</li> <li>e) Local land use controls;</li> <li>f) Foreign investment;</li> <li>g) Taxation, fees, electricity tariffs and incentives;</li> <li>h) Roles of national and local governments;</li> <li>i) Stakeholders and public involvement;</li> <li>j) International trade and customs;</li> <li>k) Financial guarantees and any other required financial legislation;</li> </ul>	

	<p>I) R&amp;D.</p>
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. A plan on how the legislation will be developed and approved;</li> <li>2. A summary of how each of the areas listed above will be addressed within the proposed legislation;</li> <li>3. Interactions with the IAEA and the other relevant organization.</li> </ol>

### **Observations**

A technical committee was established to review national laws to ensure their appropriateness for activities associated with nuclear applications and their consistency with the NRRCA. The committee reviewed 21 national laws, including laws on investment promotion, electricity, water resources, health, environment, mining, land acquisition and other areas. The Regulation of the Use of Ionizing Radiation Act 1971 was repealed by the NRRCA.

The INIR team was informed that the review identified several laws that will need to be amended, such as the Standards and Metrology Act 2002, the Electricity Act 2009, and the Environmental Protection Act 2001. The new Environmental Protection and Natural Resources Act is already undergoing the national approval process. The amendment of other laws is being discussed with the relevant institutions.

The INIR team was further informed that the Sudan Atomic Energy Commission Act 1996 has been repealed and that a new law will be developed delineating the functions of SAEC. The assessment of all relevant laws is planned to be concluded by the end of 2018. The amendment and enactment of relevant laws will continue to be pursued on a case-by-case basis.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No

### **RECOMMENDATIONS**

None

### **SUGGESTIONS**

None

### **GOOD PRACTICES**

None



<b>6. Safeguards</b>		<b>Phase 1</b>
<b>Condition 6.1: Terms of international safeguards agreement in place</b>		
<b>Summary of the condition to be demonstrated</b>	<ol style="list-style-type: none"> <li>1. The Member State has a comprehensive safeguards agreement with associated subsidiary arrangements in force with the IAEA;</li> <li>2. If the Member State currently has concluded a small quantities protocol to its comprehensive safeguards agreement, a plan needs to be developed setting out the necessary steps to rescind the small quantities protocol in a timely manner;</li> <li>3. The Member State is aware of the requirements of the additional protocol; if the Member State has made the decision to ratify the additional protocol but has not already done so, a plan is in place for the timely ratification.</li> </ol>	
<b>Examples of how the condition may be demonstrated</b>		
<p><b>Observations</b></p> <p>Sudan is party to the Treaty on the Non-Proliferation of Nuclear Weapons since 1977 and has signed the Pelindaba Treaty (not yet ratified). Sudan has a Comprehensive Safeguards Agreement (CSA) in force with the IAEA (INFCIRC/245 of 10 June 1977), with a small quantities protocol (SQP), not amended. Sudan plans to amend the SQP by the end of the first quarter of 2019. Sudan has not concluded an Additional Protocol but intends to do so (see Condition No. 5.1). The INIR team was informed that currently there are no specific plans to rescind the SQP, as it was understood that the SQP would automatically become non-operational at a later stage. The INIR team noted the need for a detailed plan for the timely conclusion and ratification of the Additional Protocol (see Condition No. 5.1) and for rescinding the SQP at the appropriate stage of the nuclear power programme.</p> <p>The Nuclear and Radiological Regulatory Control Act 2017 has a chapter on safeguards and entrusts SNRRA with the authority to ensure the implementation of safeguards (see Condition No. 5.2). SNRRA is preparing for ensuring the implementation of the safeguards obligations that will arise from the amended SQP, including the development and establishment of the SSAC and elaboration of the initial report.</p> <p>SNRRA has identified relevant entities that may have small quantities of nuclear material such as universities, research institutes, users in the medical and industrial sectors and plans to contact them and organize workshops to raise awareness on safeguards requirements and reporting obligations.</p>		
<b>Areas for further action</b>	<b>Significant</b>	Rescinding SQP
	<b>Minor</b>	No
<b>RECOMMENDATIONS</b>		
R-6.1.1 SNRRA should prepare a detailed plan to rescind the SQP in a timely manner.		
<b>SUGGESTIONS</b>		

None		
<b>GOOD PRACTICES</b>		
<b>GP-6.1.1</b>		
<b>6. Safeguards</b>	<b>Phase 1</b>	
<b>Condition 6.2: Strengthening of the SSAC planned</b>		
<b>Summary of the condition to be demonstrated</b>	The Member State has a plan describing how the existing SSAC will be strengthened or adjusted to deal with the increase of activities and resources, as well as the need for enhancement of capabilities.	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Evidence that the NEPIO includes a representative knowledgeable in the requirements of the comprehensive safeguards agreement;</li> <li>2. A plan produced by the NEPIO covering the enforcement of national legislation, policies and procedures relevant to safeguards; the development of the legislation itself is covered under infrastructure Issue No. 5, Legal Framework;</li> <li>3. Evidence that approaches undertaken by one or more States with existing nuclear power programmes have been reviewed and the information gained has been adapted for the national context.</li> </ol>	
<b>Observations</b>	<p>The Nuclear and Radiological Regulatory Control Act 2017 gives SNRRA the responsibility to establish and maintain a State System of Accounting for and Control of Nuclear Material (SSAC). The INIR team was informed that the gaps identified in the Pre-feasibility Report 2013 were being addressed. The INIR team was also informed that SNRRA is drafting a plan to establish the SSAC which envisages actions to estimate the costs for safeguards, to finalize the establishment of an effective SSAC, to develop regulations on safeguards and to conduct training, workshops and seminars. SNRRA plans to seek support from the IAEA to review the establishment and effectiveness of the system. SNRRA is aware that a nuclear power programme implies a considerable increase of safeguards related activities, and that there is a need of resources, personnel and training in this area, particularly as two Sudanese staff members from SAEC and SNRRA who were trained in safeguards recently, left their organizations for a job abroad and post graduates studies, respectively. The HRD master plan includes an assessment of safeguards-related training/personnel needs.</p> <p>The NEPIO includes members from SNRRA, SAEC and MWRIE with knowledge of safeguards. A national workshop was organized by SNRRA in collaboration with the IAEA, in Khartoum in April 2018, to inform and raise awareness about safeguards requirements. The workshop was attended by about 40 persons from relevant entities. SNRRA staff also participated in a regional training course on safeguards in Bahrain in 2017, during which Egypt and the United Arab Emirates shared their experience on how to develop an SSAC for a nuclear power programme. Existing bilateral agreements with other regulatory bodies will be used for sharing experience on safeguards.</p> <p>The INIR team was informed that the owner/operator is aware of measures that will need to be taken to implement safeguards. The owner/operator is also seeking to cooperate with operators from non-vendor countries to exchange experiences on SSAC.</p> <p>The INIR team was informed that IAEA support will be requested for training of personnel and assistance in other safeguards matters.</p>	
<b>Areas for further action</b>	<b>Significant</b>	No

	<b>Minor</b>	Plan to strengthen SSAC		
<b>RECOMMENDATIONS</b>				
<b>R-6.2.1</b> The SNRRA should finalize the plan to strengthen the SSAC including the necessary resources and training.				
<b>SUGGESTIONS</b>				
None				
<b>GOOD PRACTICES</b>				
None				
<b>6. Safeguards</b>		<b>Phase 1</b>		
<b>Condition 6.3: Recommendations from any previous reviews or audits being addressed</b>				
<b>Summary of the condition to be demonstrated</b>	If any reviews or audits have been conducted on the existing safeguards provisions, there is evidence that the actions resulting from it are progressing.			
<b>Examples of how the condition may be demonstrated</b>	Action plans resulting from a review or audit with progress identified indicating the required timescales, responsibilities and resources required.			
<b>Observations</b>				
No reviews or audits have been conducted.  The Pre-feasibility Study 2013 identified gaps and actions needed to strengthen safeguards (see Condition 6.2, Observations).				
<b>Areas for further action</b>	<b>Significant</b>	No		
	<b>Minor</b>	No		
<b>RECOMMENDATIONS</b>				
None				
<b>SUGGESTIONS</b>				
None				
<b>GOOD PRACTICES</b>				
None				



7. Regulatory Framework		Phase 1
<b>Condition 7.1: Development of an adequate regulatory framework planned</b>		
<b>Summary of the condition to be demonstrated</b>	<p>The prospective senior managers of the regulatory body have been identified. There are plans to develop a regulatory framework for nuclear safety, nuclear security and safeguards that matches the overall plan for the NPP, and includes:</p> <ul style="list-style-type: none"> <li>a) Designation of an effectively independent competent regulatory body with clear authority, adequate human and financial resources, and strong government support;</li> <li>b) Assignment of core safety, security and safeguards regulatory functions for developing regulations, review and assessment, authorization, inspection, enforcement and public information;</li> <li>c) Authority and resources to obtain technical support as needed;</li> <li>d) A clear definition of the relationship of the regulatory body to other organizations (e.g. technical support organizations and environmental agency);</li> <li>e) Clearly defined responsibilities of licensees;</li> <li>f) Authority to implement international obligations, including IAEA safeguards;</li> <li>g) Authority to engage in international cooperation;</li> <li>h) Provisions to protect proprietary, confidential and sensitive information;</li> <li>i) Provisions for stakeholder involvement and communication with the public.</li> </ul> <p>There are agreed terms of reference for each regulator and a clear definition of roles of, and interfaces with, other regulators. There is recognition of the need for integrating existing security and radiation safety regulations with new regulations for NPPs.</p> <p><i>Note: Plans to develop competence are addressed under infrastructure Issue No. 10: Human Resource Development.</i></p>	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Evidence of what has been done, or is planned, to develop the experience of the senior regulators;</li> <li>2. Proposals on the overall approach to assessment, licensing, inspection and enforcement, among other things;</li> <li>3. Plans to develop the regulatory body for safety, security and safeguards;</li> <li>4. Plans to develop the required regulations;</li> <li>5. Evidence of interaction and cooperation with established regulatory organizations;</li> <li>6. Plans to enhance or develop appropriate technical support organizations (see also infrastructure Issue No. 10, human resource development) to support the regulatory body;</li> <li>7. Plans to secure support from international regulatory organizations.</li> </ol>	
<b>Observations</b>		<p>The regulatory framework in Sudan was established in 1996 under the Sudan Atomic Energy Commission Act. This Act established the Sudanese Atomic Energy Commission (SAEC) with scientific, regulatory control and technical service provider responsibilities. A number of regulations and codes on radiation protection were</p>

enacted based on this Act to regulate activities and facilities using radiation sources.

The Nuclear and Radiological Regulatory Control Act, 2017 established the Sudanese Nuclear and Radiological Regulatory Authority (SNRRA), as the new and independent regulatory control authority, which is composed of a Board of Directors and a General Secretariat. Members of the Board, the Secretary General and the other senior managers and staff have been appointed. The core functions of the SNRRA cover development of regulations, review and assessment, authorization, inspection and enforcement in the areas of safety, security, safeguards and nuclear liability. The SNRRA has also the function and the power to inform and consult the public and all stakeholders regarding the regulatory process and safety issues of the regulated activities and practices.

Currently, there are committees under the leadership of SNRRA developing regulations needed for nuclear power plants and updating existing regulations on radiation safety. The INIR team was informed that SNRRA has adopted a regulatory approach that is predominantly performance based, as this approach can apply to more technologies and is adopted by many countries.

The SNRRA is presently giving the priority to finalize and issue, by the end of 2019, the set of regulations needed for ongoing activities using radiation sources. This includes the update of existing regulations issued under SAEC 1996 Act. Four draft regulations have already been submitted to the Board for approval (general radiation protection procedures and radiation protection in occupational, medical and public exposures). Other regulations are at various stages of drafting (security of radioactive materials, management of radioactive waste and spent fuel, emergency preparedness and response, physical protection of nuclear and radiological facilities and the safe transport of radioactive material).

For nuclear power plants, draft regulations were developed or are at various stages of drafting, some of which (10 regulations) were submitted for an independent review by IAEA experts in 2017. The following is the SNRRA's proposed schedule for issuing those regulations:

- Early Phase 2: Site evaluation for nuclear facilities, management system for nuclear facilities, authorization process of nuclear facilities, safety of nuclear power plants design, and construction of nuclear facilities;
- During Phase 2: Export and import control on nuclear material, nuclear related items and nuclear related dual use items, authorization procedures for nuclear practices, and application of probabilistic and deterministic risk assessment at nuclear facilities;
- Early in Phase 3: Commissioning and operation of nuclear facilities, certification of operating personnel at nuclear facilities, and decommissioning of facilities.

The INIR team was informed that the SNRRA will draft, if needed, additional regulations based on the progress in the nuclear power programme.

The SNRRA is authorized to obtain experts and consultants support. The INIR team was informed that SNRRA is considering a foreign TSO with extensive experience in supporting regulatory processes for nuclear power plants and expects to continue receiving support from the IAEA and the Regulatory Cooperation Forum to enhance the competencies of its staff. In addition, SNRRA is finalizing MoUs with regulatory authorities of the Russian Federation, Morocco and Ethiopia and negotiating MoUs with regulatory authorities of China, USA and South Africa among others. A new law will define the role and functions of SAEC in particular with regard to its possible role as TSO.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No

<b>RECOMMENDATIONS</b>
None
<b>SUGGESTIONS</b>
None
<b>GOOD PRACTICES</b>
None



8. Radiation Protection		Phase 1
<b>Condition 8.1: Enhancements to radiation protection programmes planned</b>		
<b>Summary of the condition to be demonstrated</b>	<p>The needed enhancements to the existing radiation protection programme to address NPP operation have been identified, including consideration of transport of radioactive materials and radioactive waste management. They consider both the increase in scale and the need to cover new technical issues.</p> <p><i>Note: This issue is closely linked to infrastructure issue No. 7, regulatory framework. In particular, the development of regulations and whether the existing regulatory body will expand its role or whether the infrastructure issues will be addressed by a separate organization.</i></p>	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Evidence of discussions with specialists from other countries;</li> <li>2. Identification of the main areas requiring enhancement;</li> <li>3. Recognition that additional competences will be required to review proposed designs against the requirement to control contamination and to reduce exposures to as low as reasonably achievable, also known as ALARA;</li> <li>4. Recognition that the programme for dose assessment will need to be significantly expanded;</li> <li>5. Plans for who will be responsible for the main elements of a radiation protection programme.</li> </ol>	
<p><b>Observations:</b></p> <p>The Nuclear and Radiological Regulatory Control Act established the SNRRA with the functions and power to, inter alia, issue regulations, standards and technical guides to ensure protection of individuals and the environment from the harmful effects of radiation, including the adoption of radiation protection requirements. The prime responsibility for radiation protection rests with the operator, who shall also be required to implement a radiation protection programme.</p> <p>The NEPIO delegated the work associated with the advice on the infrastructure issues related to radiation protection to the SAEC. The prefeasibility report entitled <i>Feasibility Study and Selection of Technology for Sudan's First NPP</i> (May 2013), identified gaps in the areas of, inter alia: a) competencies and human resources required for radiation protection; b) the structure of a radiation protection unit; and c) the job descriptions of radiation protection employees and details of training needed.</p> <p>MWRIE, SAEC and SNRRA staff have attended several radiation protection events: regional events through AFRA and AAEA, international events through IAEA and bilateral events with potential vendors. The INIR team was also informed that contacts with foreign specialists were established through scientific visits, expert visits, workshops, international committees, fellowships and training with several countries operating research reactors and nuclear power plants.</p> <p>The SAEC identified enhancements needed in the following areas: neutron dosimetry and internal dosimetry, calibration services, measurements of radioactivity levels and contamination, transport and waste management services, and emergency response services, and is addressing them by increasing knowledge via training and by upgrading facilities, equipment and procedures. Some of the planned activities to cover new technical issues have already started, e.g. training of personnel in external and internal dosimetry, efforts to acquire neutron dosimetry devices and systems, and training of personnel for calibrating different types of detectors (e.g. Beta, Alpha and Neutron). New equipment and systems for radioactivity measurements in environment and food have already been procured. The cost of these activities will be covered by national funds from the Ministry of Finance and from the Ministry of Higher Education and Scientific Research. Additional assistance will also be</p>		

provided by the IAEA Technical Cooperation Programme, the AAEA and bilateral partners.

An initial identification of the increase in scale in several radiation protection areas has been performed, inter alia, of the expected number of workers to be monitored, the potential magnitude of releases and discharges and the increase in the scale of contamination monitoring. The INIR team noted that the current plans may not sufficiently identify the scale of all enhancements to the existing radiation protection programme that will be needed for a nuclear power programme.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	Scale of radiation protection enhancements
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
<b>S-8.1.1</b> The NEPIO is encouraged to finalize the identification of the scale of enhancements needed for the existing radiation protection programme for the nuclear power programme.		
<b>GOOD PRACTICES</b>		
None		

9. Electrical Grid		Phase 1		
<b>Condition 9.1: Electrical grid requirements considered</b>				
<b>Summary of the condition to be demonstrated</b>	A preliminary study of the grid system has been conducted covering: a) Capability and reliability to take the output from the NPP; b) Ability to withstand loss of the output; c) Reliability to minimize the risk of loss of power to the NPP from the grid.			
<b>Examples of how the condition may be demonstrated</b>	1. An analysis of the grid covering: a) The expected grid capacity; b) The historical stability and reliability of the electrical grid; c) The historical and projected variation in energy demand. 2. Evidence of consideration of: a) Available NPP designs to identify those with output consistent with required grid performance and reliability ('grid code'), with due consideration taken for safety aspects; b) Potential NPP sites and their impact on grid operation; c) The anticipated growth of grid capacity; d) The potential for local or regional interconnectors to improve the grid characteristics. 3. Preliminary plans to enhance the grid to meet the NPP requirements.			
<b>Observations</b>				
<p>The electricity industry of Sudan is comprised of independent generation, transmission and distribution companies. The latter two are the Sudanese Electricity Transmission Company (SETCO), with the National Load Dispatch Centre (NLDC), and the Sudanese Electricity Distribution Company (SEDC), respectively. The installed electricity generation capacity of Sudan is 3.2 GW(e), comprising of 50% of hydro and 50% of thermal (steam turbines, gas turbines, combined cycle and diesel engines). Electricity generated in the power stations is transformed for transmission to 66 kV, 110 kV, 220 kV and 500 kV. The distribution network is run at 33 kV and 11 kV.</p> <p>The national grid is divided into three areas, viz. Khartoum, Middle and North Areas, with Khartoum-to-Middle and Khartoum-to-North interconnections. The total transmission system length is about 5 896 km and a capacity of 12 509 MVA. The annual Transmission System Performance Report of 2015 indicates that peak and minimum system demands of 2562 MW(e) and 524 MW(e) were reached, respectively. The system availability in that period was 96.21%, with a reliability of 99.86%. These are in the same domain as performance achieved in 2014 which yielded 97.71% and 99.95%, respectively. The INIR team was informed that the annual Transmission System Performance Reports of 2016 and 2017 indicate that peak system demands of 2787 MW(e) and 2 972 MW (e) were reached respectively.</p> <p>The national grid is connected to Ethiopia via a 220 kV transmission line, providing 300 MW(e). The Ethiopian network is also connected to Djibouti and Kenya.</p> <p>The 2014 Master Plan of the Eastern Africa Power Pool (EAPP), of which Sudan is a member, recommended six new connections to be in place by 2020 with a capacity of 3400 MW(e). These are Sudan-Ethiopia 500 kV, Egypt-Sudan 500 kV, Rwanda-Tanzania 220 kV, Uganda-South Sudan 400 kV, Libya-Egypt 220 kV and Kenya-Uganda 400 kV. The Sudan-Egypt 220 kV line (Phase One) with 300 MW(e) capacity is currently under construction and planned for connection in October 2018. The Sudan-Ethiopia 500 kV line with 3000 MW(e) capacity is planned for connection in 2020. The INIR team was informed that the 500 kV network is the preferred connection for the future NPP.</p>				

The draft National Energy Plan, covering the period 2012–2031, includes three nuclear power units to be added to the national network in years 2027, 2029 and 2031 respectively. The INIR team was informed that the draft energy plan will be updated (refer Issue No. 1, Condition 1.3).

The INIR team was informed that the electrification rate of Sudan is 35%, with additional capacity projected to be needed to meet a rapidly increasing demand in industrial, agricultural, mining sectors and providing electricity for unconnected households.

A high-level study on the compatibility and position of a NPP within the Sudan Electric Power System formed part of the pre-feasibility studies conducted by an international consultant (May 2013). The study included a review of current grid performance, and the impact of connecting 600 MW(e) and 1000 MW(e) NPP to the grid post 2020. Voltage performance, line loading, short-circuit, power flows and means of improving stability are covered, but the study to understand grid reliability at the point of connection to minimize the risk of loss of power to the NPP from the grid is not covered.

Sudan recognizes the need to perform further studies in the subsequent phases. These studies are outlined in the Nuclear Grid Code.

The INIR team was informed that since May 2018, the grid is also being fed from a 150 MW(e) floating diesel power plant, which serves as a reference point should a floating nuclear power plant be included in the energy mix.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	Grid study on risk of loss of power to the NPP
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
<b>S-9.1.1</b> Sudan is encouraged to undertake a study related to the risk of loss of power from the grid to the NPP.		
<b>GOOD PRACTICES</b>		
None		

10. Human Resource Development		Phase 1	
<b>Condition 10.1: Necessary knowledge and skills identified, and gaps in current capability assessed</b>			
<b>Summary of the condition to be demonstrated</b>	<p>A broad assessment of the typical staffing needs of each of the key organizations and their technical support has been completed together with an assessment of improvements required in the current capability of the country to meet the projected need. The assessment covers the full range of scientific, technical, managerial and administrative disciplines and considers:</p> <ul style="list-style-type: none"> <li>a) Current human resource competences and capabilities;</li> <li>b) Estimated required competence and capability;</li> <li>c) Availability of domestic and foreign capacity for education and training;</li> <li>d) Additional education, recruitment, training and experience that will be required (gap analysis), including specialist training in nuclear safety, nuclear security, safeguards, radiation protection, spent fuel and radioactive waste management, management systems and EPR;</li> <li>e) Which facilities and programmes need to be established for education, training and experience building;</li> <li>f) Which research capability needs to be developed;</li> <li>g) A senior leaders' development programme.</li> </ul>		
<b>Examples of how the condition may be demonstrated</b>			
<b>Observations</b>	<p>In June 2011, Sudan (Ministry of Electricity and Dams) signed a contract with an international consultancy company to undertake pre-feasibility studies for a nuclear power plant (NPP). The results of these studies were reported in annexes combined into a final report entitled <i>Feasibility Study and Selection of Technology for Sudan's First NPP</i>, dated May 2013. One of the conducted studies was dedicated to the issue of human resource development (HRD) and reported in an annex <i>Human Resource Assessment</i> (May 2012). The report of the HRD study provided an initial analysis of the existing HR capabilities in Sudan as well as an overview of the current education and training infrastructure. The report also contained an analysis of the potential human resources for the nuclear power programme available from the conventional power sector.</p> <p>The study identified the following gaps:</p> <ul style="list-style-type: none"> <li>— Competence regarding nuclear regulatory functions;</li> <li>— Lack of nuclear engineers;</li> <li>— Orientation programs for engineers working at conventional power plants;</li> <li>— Development of strategic partnership with educational organizations and educational institutions in the nuclear field;</li> <li>— Lack of regulations in the field of personnel training, qualification and licensing;</li> <li>— Training on NPP construction management according to a HRD master plan;</li> <li>— Programs for the careful selection and qualification of nuclear program staff;</li> <li>— Competent staff to develop programs for the inspection and oversight of nuclear construction;</li> </ul>		

- Competent staff to develop requirements for operating personnel training and authorization;
- Competent staff to prepare requirements for operational inspection and oversight;
- HRD master plan.

Following the completion of the pre-feasibility study, Sudan established an interagency team dedicated to HRD and appointed an external consultant to further review this issue and to address the identified gaps. The interagency team worked together with the external consultant to finalize an HRD master plan serving as a strategy document to address these gaps, and to initiate the enhancement of the nuclear engineering related curriculum in the Sudan University of Science and Technology.

The INIR team was informed that currently there is one staff member in SNRRA and four staff members in MWRIE dedicated to the issue of HRD for the respective organizations.

The INIR team was further informed that Sudan had prioritized the development of senior leaders for the nuclear power programme, and that to date more than 40 individuals have received relevant education and training. It was noted that these individuals are all still actively involved in the programme. Sudan is conducting additional analysis on its human resource requirements through the use of the Nuclear Power Human Resource Modelling Tool provided by the IAEA.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No

#### **RECOMMENDATIONS**

None

#### **SUGGESTIONS**

None

#### **GOOD PRACTICES**

None

<b>10. Human Resources Development</b>		<b>Phase 1</b>
<b>Condition 10.2: Development of human resources planned</b>		
<b>Summary of the condition to be demonstrated</b>	Outline plans have been agreed to: <ul style="list-style-type: none"> <li>a) Enhance national education and training;</li> <li>b) Develop a detailed human resource development plan for each key organization;</li> <li>c) Integrate the plans to develop a national strategy including the development of an initial core leadership group.</li> </ul>	
<b>Examples of how the condition may be demonstrated</b>	1. Plans to develop human resources required including: <ul style="list-style-type: none"> <li>a) Identification of national organizations that could support human resource development;</li> <li>b) Enhancement of education and training infrastructure;</li> <li>c) Development of national competences (through schools, universities, institutes and industry);</li> <li>d) Non-national human resources that are needed to augment</li> </ul>	

	<p>national resources and how they will be secured;</p> <ul style="list-style-type: none"> <li>e) International cooperation and vendor support;</li> <li>f) Leadership development.</li> </ul> <ol style="list-style-type: none"> <li>2. Strategies for the recruitment and retention of staff.</li> <li>3. Recognition of the need for qualification and certification programmes for personnel.</li> <li>4. Evidence that key stakeholder organizations have participated in the development and review of the plans.</li> </ol>
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### **Observations**

An international consultancy company was commissioned in May 2012 to prepare, in collaboration with a national team, a master plan for human resource development. The HRD Master Plan consists of three reports: (1) HRD Plan for the First NPP; (2) HRD Plan for the Short-term Requirements; and (3) HRD Plan for the Long-term Requirements.

These documents present a broad analysis of the skills and competencies that will be required in the key organizations to support development of the nuclear power programme. The documents also provide initial job descriptions as well as training programmes for the respective job functions identified in the plans. The INIR team was informed that these studies provide the basis for the enhancements that are necessary to the education and training infrastructure for the nuclear power programme.

The INIR team was informed that Sudan plans to establish a national training centre for the further development of its human resources, and has initiated discussions with one of the potential NPP vendors to support this process. It was also noted that the existing bilateral cooperation agreements provide for education and training opportunities and that additional activities are planned.

To date, the following international training and education activities were conducted:

- Four staff completed MSc in nuclear engineering in 2017 (China, Egypt);
- 43 staff currently receiving MSc and PhD in nuclear engineering in China, Republic of Korea, Bulgaria and Egypt;
- 300 staff obtained a diploma and MSc in nuclear science and technology as well as radiation protection and medical physics at the Sudan Academy for Sciences which was under the auspices of the Sudan Atomic Energy Commission;
- 100 staff received 3 to 6-week nuclear power related training in China (in 2011, 2014 and 2016);
- 200 staff received nuclear power related training in Sudan, delivered by the IAEA and international consultants.

Once the national training centre is completed, Sudan intends to draw on these individuals to develop a cadre of national experts to deliver several training courses, including an initial qualification programme. The INIR team was informed that Sudan intends to follow the systematic approach to training. It was further noted that an agreement was put in place between the Sudan University of Science and Technology and the Alexandria University of Egypt to foster exchange between the universities and support enhancement of the nuclear engineering curriculum in Sudan.

The INIR team was informed that an implementation plan for the HRD Master Plan is being developed, initially it focused on the HR needed for the pre-project activities. This implementation plan will provide the detailed actions and steps required to develop the human resources for the key organizations in the nuclear power programme. It will also provide an opportunity to integrate an updated analysis of the remaining gaps in the education and training infrastructure into a nationally endorsed action plan, including the funding required to develop the human resources necessary for Phase 2.

The NEPIO recognizes that staff retention is a problem for all organizations in the nuclear power programme and is considering different ways of addressing this issue. Due to delays in the implementation of the nuclear

power programme, there are insufficient opportunities for those students returning following the completion of their education abroad.

The INIR team was informed that the NEPIO maintains a database of staff being educated abroad and receiving training who provide an annual report on the attended educational programmes or a training report respectively. Furthermore, the Sudanese organizations meet annually to discuss the status of those individuals in foreign universities. Once staff complete advanced degrees at foreign universities, those individuals receive an increase in salary, and potentially, an increase in responsibilities. The NEPIO recognizes that it will need to continue to consider incentives to retain qualified staff as the programme evolves.

As the programme moves into Phase 2, additional resources will be required to ensure the availability of qualified and experienced staff in SNRRA.

<b>Areas for further action</b>	<b>Significant</b>	Implementation plan for HRD
	<b>Minor</b>	No

#### **RECOMMENDATIONS**

**R-10.2.1** The NEPIO should finalize the implementation plan for the activities outlined in the HRD studies for all relevant organizations.

#### **SUGGESTIONS**

None

#### **GOOD PRACTICES**

None

<b>11. Stakeholder Involvement</b>		<b>Phase 1</b>
<b>Condition 11.1: Open and transparent stakeholder involvement programme initiated</b>		
<b>Summary of the condition to be demonstrated</b>	Stakeholder involvement strategy and plan, with the required resources and competence, implemented by the NEPIO based on transparency and openness. The public, and other relevant interested parties, receive information about the benefits and risks of nuclear power, including the non-zero potential for severe accidents.	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. A clear mandate for the NEPIO to engage with stakeholders;</li> <li>2. Actions to disseminate information in the context of the national energy outlook, policy and needs, and pros and cons of all sources of energy, using a range of effective tools;</li> <li>3. Evidence of a professional communication team available to the NEPIO, with appropriate financial resources;</li> <li>4. Results of surveys to determine the public's knowledge and receptiveness to nuclear power;</li> <li>5. Approaches to address public concerns, including waste management and severe accidents;</li> <li>6. Evidence of activities at the local, regional and national level;</li> <li>7. A plan for ongoing interaction with the public, in particular, opinion leaders, media, local and national governmental officials and neighbouring countries;</li> <li>8. Plans for regular opinion polls managed by specialist companies;</li> <li>9. A training programme to enable identified spokespersons to interact with stakeholders.</li> </ol>	
<p><b>Observations</b></p> <p>The decree establishing the NEPIO includes stakeholder involvement and public communication within its mandate. Additionally, the NEPIO's activities related to stakeholder involvement are supported by staff on three different levels: (1) senior staff from MWRIE that supervises the work on stakeholder involvement in addition to other oversight responsibilities; (2) five executive staff in MWRIE that are dedicated to stakeholder involvement; and (3) consultants, often journalists or members of the media, which are contracted for specific tasks. The executive staff have a background in communications and have attended several technical meetings and training courses organized by the IAEA.</p> <p>In 2012, Sudan worked together with an international consultant to prepare a Public Communication and Stakeholder Management Strategy that provided an overview of the stakeholder engagement process as well as an initial roadmap to guide its implementation.</p> <p>As a result of the study, a national committee was formed by the NEPIO chairman in 2016; this committee is funded by MWRIE and consists of journalists and other media representatives.</p> <p>The mandate of the committee includes establishing the policies and strategies, as well as an implementation plan for activities related to stakeholder involvement and public consultation based on the 2012 strategy. The INIR team was informed that this implementation plan was still under development and would be finalized in the near future. Sudan is also discussing the issue of stakeholder involvement with its potential vendors, and will likely sign an agreement with Russia to support a public outreach campaign.</p> <p>The staff reports to head of the NEPIO on a daily, monthly and ad hoc basis, ensuring that any news regarding the nuclear power programme in Sudan is shared in a timely manner. The INIR team was provided copies of all news articles regarding the nuclear power programme that were published to date since 2015 and which</p>		

document 168 stories, 19 reports, two interviews and seven feature articles from 20 different newspapers.

The INIR team was informed that the NEPIO is using a step-wise approach to stakeholder involvement, with its initial outreach focused on the national government agencies and parliament, as well as the local governments where the nuclear power plant may be sited. Outreach activities were also conducted at the Sudanese Society for Environmental Protection and the Sudan University of Science and Technology. Additionally, the NEPIO has provided briefings about the nuclear power programme to regional and international fora, such as the Arab League and the Arab Atomic Energy Agency and at IAEA meetings and the General Conference.

The NEPIO also plans to initiate educational and informational campaigns to elementary and secondary schools, as well as the general public.

The INIR team was informed that while limited public opinion surveys were conducted to date, more surveys would be planned for the near future. The NEPIO noted that there were currently no NGOs dedicated to questioning the nuclear power programme, but that some members of the public had expressed concerns due to the inherent risks.

SNRRA noted that its draft regulations were published online for public comment and that the planned licensing process would include public consultations as necessary.

<b>Areas for further action</b>	<b>Significant</b>	Plan for stakeholder involvement and public consultation
	<b>Minor</b>	No

## **RECOMMENDATIONS**

**R-11.1.1** The NEPIO should finalize and implement the plan for stakeholder involvement and public consultation.

## **SUGGESTIONS**

None

## **GOOD PRACTICES**

None

12. Site and supporting facilities		Phase 1
<b>Condition 12.1: General survey of potential sites conducted and candidate sites identified</b>		
<b>Summary of the condition to be demonstrated</b>	Exclusion and avoidance criteria (covering safety, security, cost, socioeconomic issues, engineering and the environment) have been identified and regional analysis to identify candidate sites has been conducted. The analysis includes the impact of external hazards on security and emergency response capability. Consultations with stakeholders have been part of the process.	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. A report covering:           <ol style="list-style-type: none"> <li>a) Safety and security criteria for initial NPP site selection;</li> <li>b) National criteria (e.g. socioeconomic and environmental);</li> <li>c) Engineering and cost criteria.</li> </ol> </li> <li>2. An assessment report issued and approved identifying:           <ol style="list-style-type: none"> <li>a) Regional analysis and identification of potential sites;</li> <li>b) Screening of potential sites and selection of candidate sites.</li> </ol> </li> <li>3. Evidence that the resources that were used for NPP site selection are competent and have experience with NPP site selection.</li> <li>4. Plans for the work that will be required in Phase 2 to select and justify the site.</li> <li>5. Evidence that safety and security related activities conducted (e.g. site evaluation and environmental impact studies) are included within the framework of an effective management system.</li> </ol>	
<p><b>Observations</b></p> <p>The pre-feasibility study entitled <i>Feasibility Study and Selection of Technology for Sudan's First NPP</i>, dated May 2013, included studies undertaken in collaboration with a national technical committee, dedicated to the identification and evaluation of sites in Sudan suitable for a NPP.</p> <p>Criteria for site survey and site selection were identified from international siting guidance such as the IAEA guidance, the USA regulations and the Chinese regulations. The Region Identification Report (September 2011) identifies various criteria to be used in regional analysis. The INIR team was informed that the key criteria utilised for exclusion were population density, availability of adequate cooling water and seismic hazards.</p> <p>Three potential regions were identified from the regional analysis, viz. the Red Sea, Dongola (along the Nile River) and Abu Hamad region, and further screening resulted in the identification of 9 candidate sites:</p> <ol style="list-style-type: none"> <li>1. Red Sea region: three candidate sites;</li> <li>2. Dongola (along Nile River): five candidate sites;</li> <li>3. Abu Hamad (along Nile River): one candidate site.</li> </ol> <p>The INIR team was informed that consultation with the oil industry resulted in extensive technical data being provided to support the siting studies for the NPP.</p> <p>Screening criteria such as radiation hazards to population, emergency planning for external zone around the NPP, seismic and geological hazards, flooding, extreme meteorological events, man-made hazards, geotechnical conditions, cooling conditions, and socio-economic impact were applied to rank the candidate sites.</p> <p>Consultations with the national, regional and local stakeholders were undertaken to identify regions and candidate sites. The INIR team was informed that the communication with local government and the local</p>		

council of the state (as a public representative) was done in the regional analysis and identification of candidate sites. No direct engagement with the general public and non-governmental organisations has occurred yet. However, the general public has been kept informed of the nuclear power programme through the media. A stakeholder involvement plan has been developed and will be rolled out at a later stage including communication with the public.

Technical parameters used in the siting studies are predominantly based on the ACP600/ACP1000 since these two types were identified by the pre-feasibility study as options for the first NPP in Sudan. The INIR team was informed that the enveloping nature of these parameters was tested against the international regulations/guidance (IAEA, US NRC, China, European Utility Requirements, etc.).

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	Stakeholder involvement with the public
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
<b>S-12.1.1</b> NEPIO is encouraged to initiate stakeholder involvement with the public regarding siting (see also R-11.1.1).		
<b>GOOD PRACTICES</b>		
<b>GP-12.1.1</b> The collaboration with the oil industry and the use of their technical data and expertise during the siting activities is an efficient and optimal use of resources.		

13. Environmental Protection		Phase 1
<b>Condition 13.1: Environmental requirements considered</b>		
<b>Summary of the condition to be demonstrated</b>	The NEPIO has considered the main environmental requirements related to the siting of a NPP including land use, water use, water quality and the impacts of low level radioactive effluents.	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Identification of key requirements for siting and during construction;</li> <li>2. Evidence of discussions by specialists with countries operating nuclear power;</li> <li>3. Evidence that the non-radiological environmental issues: water use, transporting materials, disposal of hazardous waste, additional environmental monitoring requirements, construction impact, etc. have been considered and taken into account by the NEPIO.</li> </ol>	
<p><b>Observations</b></p> <p>The institutional framework for environmental issues in Sudan includes the Ministry of Environment, Natural Resources and Physical Development (MENRPD) which is responsible for all environmental issues at the national level, the Higher Council for Environment and Natural Resources (HCENR), chaired by the Minister of Environment, as well as the State Councils which implement the environmental laws at a local level.</p> <p>The MENRPD is a member of the NEPIO. Members from the MENRPD and the relevant State Council are represented on the national siting technical committee and provided the environmental input and technical support for the siting studies. This interrelationship ensures efficient exchange of pertinent information on environmental aspects.</p> <p>The pre-feasibility studies for a nuclear power plant entitled <i>Feasibility Study and Selection of Technology for Sudan's First NPP</i>, dated May 2013, includes studies undertaken in collaboration with the national siting technical committee on the identification and evaluation of sites in Sudan suitable for a NPP.</p> <p>These studies considered issues pertinent to power plant construction and operations such as physical site parameters, radiological and non-radiological (e.g. temperature limitation, chemical releases) hazards, external hazards to the potential NPP, environmental protected areas, land use for agricultural purposes along the River Nile, tourism in the Red Sea area, and ecological conditions.</p> <p>The site identification studies utilized international siting guidance from bodies such as the IAEA, USA's NRC and other countries which have nuclear power plants. Related discussions have been held with countries such as China, Japan and India.</p>		
<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
None		

<b>GOOD PRACTICES</b>		
None		
<b>13. Environmental Protection</b> <b>Condition 13.2: Framework for environmental protection reviewed</b>		<b>Phase 1</b>
<b>Summary of the condition to be demonstrated</b>		The NEPIO has reviewed the suitability of the country's existing framework for environmental protection and for meeting its international obligations.
<b>Examples of how the condition may be demonstrated</b>		<ol style="list-style-type: none"> <li>1. Procedures for the elaboration, reporting and assessment of environmental studies for nuclear and other related facilities;</li> <li>2. Evidence of interactions by specialists with countries operating nuclear power.</li> </ol>
<b>Observations</b> <p>Sudan is a party of several regional and international conventions and protocols which are relevant to the protection of the environment, e.g. the Jeddah Convention for the Conservation of the Red Sea and Gulf of Aden Environment, the United Nations Framework Convention on Climate Change, the Kyoto Protocol, the United Nations Convention to Combat Desertification, the Convention on Biological Diversity, the Cartagena Protocol on Biosafety and the Stockholm Convention on Persistent Organic Pollutants.</p> <p>The Environmental Protection Act (2001) provides for policies and directives for the protection of the environment. The INIR team was informed that a new Environmental Protection and Natural Resources Act has been developed, which provides for standards and requirements for environmental impact assessments (EIAs) for major development projects and contains provisions for the protection of biodiversity, prohibition of pollution, raising the environmental awareness and population participation in the setting of policies and decision making.</p> <p>This new legislation, which is in the final stages of enactment, takes into account potential NPP projects. The local States have their own implementing agencies, the State's Councils, which participated in the elaboration process of the new Act, together with many other stakeholders from Government and local communities. These Councils will develop or update their own environmental regulations and tools after enactment of the new Act. There is a mechanism in place to ensure that the State regulations are consistent with the national framework.</p> <p>The INIR team was informed that Sudan has interacted mainly with China, but also with Japan (JICA), Egypt and Malaysia. Several staff have been trained in Japan on the management of hazardous waste at the national, state and local community's level.</p>		
<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	Environmental Regulations
<b>RECOMMENDATIONS</b>		
None		

SUGGESTIONS
<p><b>S-13.2.1</b> The NEPIO is encouraged to ensure that nuclear issues are incorporated in the regulations to be developed under the new Environmental Protection and Natural Resources Act.</p>
GOOD PRACTICES
None



14. Emergency Planning  Condition 14.1: Requirements of, and resources for, developing an emergency response capability recognized	Phase 1
<b>Summary of the condition to be demonstrated</b>	<ol style="list-style-type: none"> <li>1. The NEPIO is aware of the EPR arrangements and capabilities that will be required for the nuclear power programme. It has evaluated existing EPR arrangements and capabilities in the country and is aware of the major gaps that will need to be addressed;</li> <li>2. The NEPIO has identified the main organizations and resources that will need to be involved in the establishment of adequate national EPR capabilities;</li> <li>3. The lead for the execution of the action plan and the action plan coordination framework has been identified.</li> </ol> <p><i>Notes:</i></p> <p>(1) <i>The process of developing adequate EPR will be initiated in Phase 2 and will be largely carried out in Phase 3;</i></p> <p>(2) <i>The requirements of the conventions on early notification and assistance are covered under infrastructure Issue No. 5, Legal Framework.</i></p>
<b>Examples of how the condition may be demonstrated</b>	Report summarizing existing EPR arrangements and capabilities and identifying those to be enhanced and/or developed as well as identifying the main organizations and resources that will need to be involved in the establishment of adequate national EPR capabilities.
<b>Observations</b> <p>The Nuclear and Radiological Regulatory Control Act (2017) contains a section in Chapter six on Emergency Preparedness and Response (EPR) including provisions regarding on-site and off-site emergency plans and designates SNRRA for coordinating with local, regional and international authorities on EPR issues.</p> <p>SNRRA prepared draft regulations on EPR in 2017 that include provisions on the use of a graded approach in planning the response to nuclear/radiological emergencies, on the classification of emergencies, on the establishment of emergency planning zones and distances, and on the description of the content of the on-site emergency plan. The draft regulations also provide for the role and responsibilities of the operator (on-site EPR arrangements, obligation to perform hazard assessment, to identify protective actions, to prepare on-site protection strategy and to assist in the development of off-site protection strategy). The INIR team was informed that the MWRIE as the future operator is taking steps to assess what is needed for on-site emergency planning in a consistent manner with national requirements.</p> <p>The Strategy Report on the Preparation for Sudan Nuclear Power Program (2009) identified the need to develop a comprehensive emergency plan by the operator and the steps that need to be accomplished to build the national system for nuclear and radiological EPR.</p> <p>At the national level, a <i>Permanent Technical Committee for Nuclear and Radiological Emergencies Management — CRNEM</i> was established in 2007 by the Minister of the Interior which reports to the National Council for Civil Defence (NCCD). This technical committee is responsible for developing a national radiological emergency response plan, ensuring its effective implementation and coordination with plans at the local level. The membership of this technical CRNEM includes representatives from various organizations, such as Civil Defence, Health, Environment, Sudan Atomic Energy Commission, National Security Intelligence, Civil Aviation Authority, Customs and SNRRA. The membership of this technical Committee was updated in 2018; this update includes the MWRIE as the future operator and designates SNRRA as the chair of the committee.</p>	

The INIR team was informed that a draft national response plan for nuclear and radiological emergencies was developed by SNRRA. This plan will be submitted in September 2018 to the technical committee CRNEM for review and input and is intended to be part of all national hazards plan.

SNRRA envisions the following actions to be accomplished by the technical committee CRNEM: develop a work plan, finalize and revise the draft national emergency plan, issue and distribute the plan, organize drills and exercises and continue building capacity. The INIR team was informed that SNRRA plans to organize by the end of 2019 a national exercise intended to test the national response capabilities, once the draft national response plan has been finalized. The NEPIO supports the work on EPR issues by providing resources and training.

The INIR team was informed that there are ongoing efforts to update the self-assessment of the existing EPR capabilities and of potential gaps, using the IAEA tools such as the Emergency Preparedness and Response Information Management System (EPRIMS).

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
None		
<b>GOOD PRACTICES</b>		
None		
<b>14. Emergency Planning</b>		<b>Phase 1</b>
<b>Condition 14.2: Recommendations from any previous reviews or audits being addressed</b>		
<b>Summary of the condition to be demonstrated</b>	If any reviews or audits have been undertaken of the existing framework, there is evidence that the actions resulting from it are progressing.	
<b>Examples of how the condition may be demonstrated</b>	Presentation of any action plans resulting from a review or audit with progress identified.	
<b>Observations</b>		
No review or audit has been conducted.		
The INIR team was informed that Sudan is considering requesting an EPREV mission, once the assessment of its EPR capabilities and the draft national response plan are finalized.		
<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No

<b>RECOMMENDATIONS</b>
None
<b>SUGGESTIONS</b>
None
<b>GOOD PRACTICES</b>
None



15. Nuclear Security		Phase 1
<b>Condition 15.1: Nuclear security requirements recognized and the actions of all relevant organizations coordinated</b>		
<b>Summary of the condition to be demonstrated</b>	The NEPIO recognizes the importance of nuclear security, based on a national threat assessment and principles of prevention, detection and response. All competent authorities that are involved in nuclear security have been identified and there is a coordinating body or mechanism established that brings together all of the organizations that have responsibility for nuclear security.  <i>Note: The need to establish legislation and a regulatory framework is addressed under infrastructure Issues Nos 5 and 7, Legal Framework and Regulatory Framework, respectively.</i>	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Evidence of familiarity with IAEA Nuclear Security Series publications and other States' practices;</li> <li>2. Clear identification of all organizations that have roles and responsibilities for nuclear security and of the work that will need to be carried out in the subsequent phases;</li> <li>3. Evidence that nuclear security considerations for siting have been defined and have been considered as part of the siting assessment (see infrastructure issue No. 12, site and supporting facilities);</li> <li>4. Evidence that international cooperation and assistance is being used;</li> <li>5. Evidence that the need to address the interface with safety and safeguards is recognized.</li> </ol>	
<b>Observations</b>		
<p>Sudan is party to the Convention on the Physical Protection of Nuclear Material (CPPNM) and has started the national process to adhere to the Amendment to the CPPNM (see Issue No. 5.1) and to the International Convention for the Suppression of Acts of Nuclear Terrorism.</p> <p>Sudan has participated in IAEA regional projects on nuclear security since 2003. Staff of SNRRA and other relevant organizations have participated in 23 regional training events on security, with about 80 persons trained through IAEA regional nuclear security projects (2003–2015). Also, 13 national training courses based on IAEA Nuclear Security Series have been organized. Participants from Sudan attended a regional workshop on nuclear security culture in Ghana in June 2018, an international training course on nuclear security for embarking countries in Russia in May 2018, and a course in Jordan in June 2018. A Nuclear Security Support Center (NSSC) was established to develop capacity-building programmes in the area of nuclear security.</p> <p>In 2015, an Integrated Nuclear Security Support Plan (INSSP) for Sudan was approved, and updated in 2017, with an implementation plan to cover the period 2018–2020. The plan covers Legal and Regulatory Framework, Threat and Risk Assessment, Physical Protection Regime, Detection (MORC), Response (MORC), and Sustaining Nuclear Security Regime.</p> <p>The Nuclear and Radiological Regulatory Control Act (2017) contains provisions on nuclear security and gives SNRRA powers and functions to monitor the peaceful uses of nuclear energy to, inter alia, ensure the security of nuclear material, including the adoption of physical protection requirements.</p> <p>Regulation on security of radioactive sources has been developed and sent to IAEA for revision. Regulations on the physical protection of nuclear material and facilities are under development. The INIR team was informed that aspects not specifically mentioned in the Act, for example nuclear security culture and trustworthiness, will be addressed through these regulations, as well as through the training and education activities of the Nuclear Security Support Centre. SNRRA also plans to elaborate a nuclear security policy for</p>		

the Government's approval after the nuclear safety policy is finalized, as well as strategies for MORC and for regaining control on orphan sources.

A National Nuclear Security Committee established in 2003 is no longer active. This Committee was composed of representatives from SAEC (SAEC representative acted as Chairman), National Intelligence and Security, Civil Aviation, Justice, Border Control Army, Police, Foreign affairs, Civil Defence, Customs and Ministry of Finance and Economy. The INIR team was informed that SNRRA's Secretary General has established an executive committee on nuclear security, which coordinates the implementation of the INSSP and strengthening of the national nuclear security regime. The executive committee would act as a technical arm of the National Committee on Nuclear Security, once re-established as proposed by SNRRA to the Minister of Higher Education and Scientific Research. The INIR team noted the need to formalize the establishment of the new national committee for nuclear security so that there is an official national coordination mechanism among all relevant organizations in this area.

The INIR team was informed that work on the DBT will start after the national workshop on threat assessment and DBT, scheduled to be conducted in cooperation with IAEA in October 2018.

The INIR team was informed that if required, the support of the IAEA will be requested to review regulations and security considerations for floating nuclear power plants.

<b>Areas for further action</b>	<b>Significant</b>	No		
	<b>Minor</b>	No		
<b>RECOMMENDATIONS</b>				
None				
<b>SUGGESTIONS</b>				
None				
<b>GOOD PRACTICES</b>				
<b>GP-15.1.1</b>				
<b>15. Nuclear Security</b> <b>Condition 15.2: Recommendations from any previous reviews or audits being addressed</b>				
<b>Summary of the condition to be demonstrated</b>	If any reviews or audits have been undertaken of the existing framework, there is evidence that the actions resulting from it are progressing.			
<b>Examples of how the condition may be demonstrated</b>	Presentation of any action plans resulting from a review or audit with progress identified.			
<b>Observations</b>				
No reviews or audits have been undertaken.				

The INIR team was informed that once the nuclear security policy and regulations are issued, an IPPAS mission will be invited.

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
None		
<b>GOOD PRACTICES</b>		
None		



<b>16. Nuclear Fuel Cycle</b>		<b>Phase 1</b>
<b>Condition 16.1: Options for nuclear fuel cycle (front end and back end) considered</b>		
<b>Summary of the condition to be demonstrated</b>	At a strategic level, options have been considered for the front end and back end of the fuel cycle. For the front end, options for uranium sourcing and fuel manufacture and supply have been addressed. For the back end of the fuel cycle, spent fuel storage needs and capacities (on-site and off-site) and possible reprocessing have been considered.	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. A document:             <ol style="list-style-type: none"> <li>a) Identifying available national natural resources and capacities for individual steps in the nuclear fuel cycle;</li> <li>b) Identifying potential sources of supply and services;</li> <li>c) Assessing available options for a national fuel cycle strategy, taking into account non-proliferation issues.</li> </ol> </li> <li>2. A document clearly demonstrating that the NEPIO understands the long-term commitments related to the back end of the nuclear fuel cycle and has considered the options and their implications. The document needs to address the need for adequate capacity for spent fuel storage at the reactor site, the possibility of interim storage of spent fuel at a dedicated facility and any plans for reprocessing.</li> <li>3. Clear allocation of responsibilities for development of the fuel cycle policy and strategy (front end and back end) to be undertaken during Phase 2.</li> </ol>	
<p><b>Observations</b></p> <p>Sudan has decided to purchase nuclear fuel for the first 4 years of operation as part of the contract for the nuclear power plant. Thereafter the same vendor could continue to supply the fuel or it may be directly purchased from the market depending on the prevailing conditions. The INIR team was informed that no market survey of the available commercial nuclear fuel cycle services has been conducted. This will only be done after the nuclear power plant type has been selected.</p> <p>The INIR team was informed that, given the technical complexity, cost and time required to develop fuel cycle activities, Sudan is not considering at this stage to develop fuel cycle activities other than the use of nuclear fuel in the reactor and the management of the spent fuel. Nevertheless, stepwise embarking on other fuel cycle front end activities (e.g. uranium mining, yellow cake production and enrichment services) is not excluded for the future.</p> <p>The policy and strategy on spent fuel management will be established by SNRRA. This will be done after the regulations have been finalised.</p> <p>The NEPIO envisages storing the spent fuel for 5 to 10 years in spent fuel pools adjacent to the NPP. The INIR team was informed that Sudan's preferred option is to repatriate the spent fuel. The legal framework permits authorizing the export of spent fuel generated in Sudan (Article 23(1) of the Nuclear and Radiological Regulatory Control Act, 2017) and SAEC has experience with the repatriation of disused sealed radioactive sources. No discussions have yet been initiated with potential NPP vendors regarding the possibility to repatriate spent fuel. As a result, it is also not clear if such a spent fuel repatriation would involve the return of high level reprocessing waste to Sudan. Options other than spent fuel repatriation have not been explored. The INIR team was also informed that there are no plans to develop reprocessing infrastructure in Sudan.</p> <p>The INIR team was informed that the amount of spent fuel and the storage capacity that will be required have not been assessed. Such assessments will be made after a nuclear power plant type is selected. The INIR team</p>		

also noted that cost assessments to fuel cycle activities are limited to international benchmarking. Those assessments date from 2009 (strategy report) and 2013 (pre-feasibility study). Specific and more up to date analyses of the costs of the different spent fuel options (storage, repatriation, reprocessing and disposal) have not been conducted.

The INIR team was informed that a policy and strategy on the nuclear fuel cycle will be part of the nuclear power policy that is being developed (see Condition No. 1.3).

<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	<ul style="list-style-type: none"><li>• Capacity for spent fuel storage</li><li>• Feasibility of repatriation of spent fuel</li></ul>
<b>RECOMMENDATIONS</b>		
None		
<b>SUGGESTIONS</b>		
<b>S-16.1.1</b> The NEPIO is encouraged to assess the required capacity for spent fuel storage.		
<b>S-16.1.2</b> The NEPIO is encouraged to further explore the feasibility of repatriation of spent fuel.		
<b>GOOD PRACTICES</b>		
None		

17. Radioactive Waste Management		Phase 1				
<b>Condition 17.1: The requirements for management of radioactive waste from NPPs recognized</b>						
<b>Summary of the condition to be demonstrated</b>	The NEPIO understands the significantly increased requirements for the processing, storage and disposal of high, intermediate and low level radioactive waste from a nuclear power programme, and has developed options for the management of radioactive waste, taking into account existing arrangements.					
<b>Examples of how the condition may be demonstrated</b>	A document addressing possible approaches to the management of radioactive waste arising from NPP operation and decommissioning, the capabilities and resources needed, and the options and technologies for its processing, handling, storage and disposal. If reprocessing is being considered, this needs to include the management of high level waste. Regulatory framework and financing schemes are addressed under infrastructure issues Nos 7 and 4, regulatory framework, and funding and financing, respectively.					
<b>Observations</b>						
<p>Radioactive waste in Sudan comes from medical, educational, agricultural and industrial applications and are mainly disused sealed radioactive sources. These are managed by the Sudan Atomic Energy Commission (SAEC). The INIR team was informed that the capacity needed for the NPP will build on the expertise available within SAEC.</p> <p>Importing radioactive waste generated outside Sudan is prohibited (Article 22(1) of the Nuclear and Radiological Regulatory Control Act, 2017). It is an obligation for the operator of a nuclear facility or activity to minimise the generation of radioactive waste (Article 31 of the Nuclear and Radiological Regulatory Control Act, 2017).</p> <p>A scheme of the various categories of radioactive waste generated from a NPP has been established. The scheme is linked to the disposal requirements. This is consistent with the classification scheme presented in the IAEA Safety Guide GSG-1 (Classification of Radioactive Waste) which is based primarily on considerations of long term safety.</p> <p>The INIR team noted that an assessment of the radioactive waste arising from the operation and decommissioning of a NPP — the types and quantities of waste – has not been made. This is planned to be done once the NPP type has been selected. Detailed consideration of the different options and technologies for processing, storage and disposal of radioactive waste has not yet been made.</p>						
<b>Areas for further action</b>	<table border="1"> <tr> <td><b>Significant</b></td><td> <ul style="list-style-type: none"> <li>• Radioactive waste types and quantities</li> <li>• Radioactive waste management options</li> </ul> </td></tr> <tr> <td><b>Minor</b></td><td>No</td></tr> </table>	<b>Significant</b>	<ul style="list-style-type: none"> <li>• Radioactive waste types and quantities</li> <li>• Radioactive waste management options</li> </ul>	<b>Minor</b>	No	
<b>Significant</b>	<ul style="list-style-type: none"> <li>• Radioactive waste types and quantities</li> <li>• Radioactive waste management options</li> </ul>					
<b>Minor</b>	No					
<b>RECOMMENDATIONS</b>						
<p><b>R-17.1.1</b> The NEPIO should make a preliminary assessment (order of magnitude) of the radioactive waste types and quantities arising from the operation and decommissioning of a NPP.</p> <p><b>R-17.1.2</b> The NEPIO should evaluate the different options and technologies for processing, storage and</p>						

disposal of the various types of radioactive waste.				
<b>SUGGESTIONS</b>				
None				
<b>GOOD PRACTICES</b>				
None				
<b>17. Radioactive Waste Management</b> <b>Condition 17.2: Options for disposal of all radioactive waste categories understood</b>		<b>Phase 1</b>		
<b>Summary of the condition to be demonstrated</b>	The NEPIO understands the options for disposal of each of the different waste categories. Although the specific routes for disposal of the different waste categories (including spent fuel if considered as waste) can be decided later, the need to select and plan for adequate options is recognized.			
<b>Examples of how the condition may be demonstrated</b>	A document indicating that the NEPIO understands options for disposal of different radioactive waste categories and options for funding these activities.			
<b>Observations</b>				
The Strategy Report on the Preparations for Sudan Nuclear Power Programme (2009) links the waste categories with the options for their disposal:				
<ul style="list-style-type: none"> <li>— High level waste (HLW): transfer abroad;</li> <li>— Low and intermediate level waste: near surface and geological disposal;</li> <li>— Very low-level waste (VLLW): landfill-type facility;</li> <li>— Exempted waste (EW): disposal in conventional waste facilities.</li> </ul>				
The INIR team was informed that the NEPIO prefers to repatriate spent fuel or, in case of high level waste from potential spent fuel reprocessing, to transfer this waste abroad. The INIR team noted that no discussions have been undertaken with potential vendors about repatriation or with potential countries willing to accept high level waste.				
The NEPIO understands that there is a risk that the expectation to transfer high level waste abroad may not be fulfilled and that in that case a geological disposal facility will be needed. The geological disposal of high level waste or spent fuel has not further been studied. The INIR team also noted that no further consideration regarding the disposal of low and intermediate level waste arising from the nuclear power programme has been made.				
<b>Areas for further action</b>	<b>Significant</b>	Disposal options for the different waste categories		
	<b>Minor</b>	No		
<b>RECOMMENDATIONS</b>				
See recommendation R-17.1.2				

<b>SUGGESTIONS</b>
None
<b>GOOD PRACTICES</b>
None



<b>18. Industrial Involvement</b>		<b>Phase 1</b>
<b>Condition 18.1: National policy with respect to industrial involvement developed</b>		
<b>Summary of the condition to be demonstrated</b>	A policy for national involvement in the nuclear power programme has been developed, taking into account current industrial capacity and technical services, current and required quality standards, and potential investment requirements. The policy may include short term and long-term targets for industrial involvement.	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. A survey of companies with the potential to participate in the nuclear power programme for construction, equipment provision or support services, with a review of their ability to satisfy the requirements of a nuclear power programme;</li> <li>2. Meetings with, or training of, potential suppliers to explain standards and qualifications required, review feasibility of involvement, and identify required actions and funding requirements.</li> </ol>	
<p><b>Observations</b></p> <p>A survey of companies with the potential to participate in the nuclear power programme for construction, equipment provision and support services has been conducted using the available data base for such companies. An evaluation of these companies was carried out as part of the pre-feasibility studies for a nuclear power plant entitled <i>Feasibility Study and Selection of Technology for Sudan's First NPP</i>, dated May 2013. In this evaluation, a questionnaire was used to classify 22 companies into 10 categories which are relevant to the construction of NPPs, namely: ground works, concrete works, construction works, painting works, code welding works, generic welding works, piping works, electric works, instrumentation and control installation works and transportation services. The evaluation estimated the national industrial participation in the programme.</p> <p>The evaluation revealed four areas of concern namely: code welding works, piping works, electric works and instrumentation and control installation works. These areas require qualifications which are partially NPP specific.</p> <p>The INIR team was informed that a draft plan for forming a national policy on industrial involvement in the nuclear power programme, taking into account the available industrial capability and technical services, has been developed and will be submitted to the NEPIO for approval.</p> <p>This plan includes:</p> <ul style="list-style-type: none"> <li>— Establishing a national localization committee to implement the plan;</li> <li>— Performing a more comprehensive survey of the capabilities of the industry in 2019; and</li> <li>— Meeting with the potential vendors to include training and qualification for specific areas.</li> </ul> <p>The above national localization committee has also the responsibility to draft the national policy which is planned to be approved by the fourth quarter of 2019.</p> <p>The INIR team was also informed that in its efforts to promote national participation in the nuclear power programme, the MWRIE organized a national workshop on industrial involvement in Khartoum in November 2017 in collaboration with the IAEA.</p>		

<b>Areas for further action</b>	<b>Significant</b>	National policy on industrial involvement
	<b>Minor</b>	No
<b>RECOMMENDATIONS</b>		
<b>R-18.1.1</b> The NEPIO should finalize the development and approval of a national policy on industrial involvement.		
<b>SUGGESTIONS</b>		
None		
<b>GOOD PRACTICES</b>		
None		

<b>19. Procurement</b>		<b>Phase 1</b>
<b>Condition 19.1: Requirements for purchasing NPP services recognized</b>		
<b>Summary of the condition to be demonstrated</b>	Recognition of the requirements associated with purchasing services.	
<b>Examples of how the condition may be demonstrated</b>	<ol style="list-style-type: none"> <li>1. Appropriate procurement of consulting services in Phase 1;</li> <li>2. Evidence that the issues related to services for Phase 2 activities are recognized, allowing for both national and foreign suppliers.</li> </ol>	
<p><b>Observations</b></p> <p>The provisions of the Procurement, Contracting and Disposing of the Surplus Law (2010) and its executive regulation (2011) are applicable to MWRIE and SNRRA when procuring services needed for the nuclear power programme.</p> <p>MWRIE has chosen “the limited contracting method” (short listing) for procuring services for some of the pre-project activities (e.g. site selection study, pre-feasibility study) since a relatively limited number of international suppliers that provide consultancy services in the nuclear field were available to Sudan. In other cases, MWRIE used a “direct contracting method” (pre-qualification of the consultants before contracting with the specified supplier to implement the required services).</p> <p>MWRIE has a committee to implement procurement activities and plans to establish an organizational unit dedicated to procurement. The INIR team was informed that following the establishment of the dedicated unit, its staff will get more training on procurement. The unit will then develop organizational procedures for procurement including quality assurance of the services received.</p> <p>MWRIE procured several consultancy services in the past including pre-feasibility study, site survey studies, preparation of BID invitation specifications (BIS) document for Sudan’s first NPP, and review and revision of the partial deliverables of BIS document. The INIR team was informed that the main challenge faced during the procurement of above services was the lack of nuclear technical expertise in the required fields. This had been overcome by hiring experienced persons from conventional energy sectors and international consultants. MWRIE appointed a General Advisor to help outline requirements and to support the evaluation process for the procurement of services.</p> <p>A workshop is planned for quarter one in 2019 on procurement focusing on the preparation for and evaluation of the bid process for the first NPP. After the workshop, MWRIE will review the procurement rules to identify any need for modification to facilitate the procurement of the NPP. The INIR team was informed that in addition to MWRIE, SNRRA, Ministry of Finance and Economic Planning and the Ministry of Justice, legal, financial and technical consultants of MWRIE will attend the workshop. The same team will later participate in the review of the procurement rules.</p> <p>Regarding the plans for procurement in Phase 2, the INIR team was informed that MWRIE plans to procure consultancy services for site characterization, environmental impact assessment and electrical grid studies and procure equipment needed for environmental and radiological monitoring. SNRRA plans to procure consultancy services for the revision of regulations and for the review and assessment of submissions from MWRIE. SNRRA also has plans to buy radiological monitoring equipment.</p>		
<b>Areas for further action</b>	<b>Significant</b>	No
	<b>Minor</b>	No

<b>RECOMMENDATIONS</b>
None
<b>SUGGESTIONS</b>
None
<b>GOOD PRACTICES</b>
None

## APPENDIX 2: INIR TEAM MEMBERS AND COUNTERPARTS

INIR MISSION REVIEW TEAM	
Anthony Stott	Team Leader, IAEA
Mehmet Ceyhan	Mission Coordinator, IAEA
Fanny Tonos Paniagua	IAEA
Philippe Van Marcke	IAEA
Matthew Van Sickle	IAEA
Miroslav Gregoric	International Expert
Itimad Souffi	International Expert
Loyiso Tyabashe	International Expert
Humberto Viotti	International Expert

PARTICIPANTS FROM SUDAN			
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2	<b>Nuclear Safety</b>	<b>Amany Mokhtar Koko</b> Abdulbagi Abdulrahman Awad Fadul Eng. Gaafar Khieralla AbdElhadi Eng. Abdelgader Bakiet Abegader Mohamed Majzoop Ibrahim Mohammed Abuissa Eng. Awatif Alaydarous Albashir Rami Abdelmoti Elneem	Lead, SNRRA
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5	<b>Legal Framework</b>	<b>Mamdouh Yassin Osman</b> Mohamed Abdulaziz Ibrahim Albashir Almoiz Abdakareem Mohamed Abdalla	Lead, SNRRA
6	<b>Safeguards</b>	<b>Majzoop Ibrahim Mohammed Abuissa</b> Fatima Ahmed Mohamed Taha	Lead, SNRRA

7	<b>Regulatory Framework</b>	<b>Mamdouh Yassin Osman</b> Ezzeldein Mohammed Nour Mohammed Mohammed Ibrahim Hamed Amany Mokhtar Koko Mohammed Abbas Mohammed Altayeb Almoiz Abdakareem Mohamed Abdalla	Lead, SNRRA
8	<b>Radiation Protection</b>	<b>Ayman Abdulsafi Bieneen</b> Dr. Rani Osama A.Aziz Mr. Ali Mohammed Ali Yousif Dr. Ibrahim Idris Sulaiman Mr. Hyati abdulbagi	Lead, SAEC
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12	<b>Site and Supporting Facilities</b>	Eng. Bireer Ibrahim Elhag Dr. Nour Alla Altlib Eng. Karoori Elhag Hamad Dr. Hana Hamd Alla Eng. Ashraf AbdElwahab Eng. Muataz Zaki Adam Eng. Musab Osman Eng. Khalid Abdulrahman	Lead, MWRIE
13	<b>Environmental Protection</b>	<b>Dr.Hana Hamadalla Mohamed</b> Dr. Bushra Hamed Ahmed Dr. Manal Abdelrahim Osman Hassan Aisha SedAhmed Abdegader	Lead, MENRPD
14	<b>Emergency Planning</b>	<b>Nahla Sulieman M. Fadlalla</b> Majzoop Ibrahim Mohamed Abuissa Mohamed Yousif Mohammed Hamadalneel	Lead, SNRRA
15	<b>Nuclear Security</b>	<b>Mogahed Mahmoud Hamid</b> Mohammed Ibrahim Hamed Fatima Ahmed Mohamed Taha	Lead, SNRRA
16	<b>Nuclear Fuel Cycle</b>	<b>Dr. Alfatih Ahmed Alamin</b> Dr. Mustafa Mohamed Osman Dr. Rani Osama A. Dr. Mohammed Abdalsalam Elshaikh	Lead, SAEC
17	<b>Radioactive Waste Management</b>	<b>Dr. Rani Osama A.Aziz</b> Mr. Amjad Tajaldin Mr. Abbas Yasin AbdElla Mr. Ayman Abdulsafi	Lead, SAEC

18	<b>Industrial Involvement</b>	<b>Eng. Ammar Mohamed Hassan</b> Eng. Gaafar Khieralla AbdElhadi Mamdouh Yassin Osman Dr. Siddig AbdAlla Talha Dr. Yasir Badawi Mahmoud Elhag Eng. Abbas AbdElrasool Mariam Babikr Eng. Awatif Alaydarous Albashir Eng. Rofida Hamad Khalifa Eng. Minas Faisal Mohamed	Lead, MWRIE
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## **APPENDIX 3: REFERENCES**

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#### **APPENDIX 4: ABBREVIATIONS**

AAEA	Arab Atomic Energy Agency
AFRA	African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology
ALARA	As Low as Reasonably Achievable
ANENP	African Network for Enhancing Nuclear Power Program Development
ANNuR	Arab Network of Nuclear Regulators
AP	Additional Protocol
BOO	Build, Own and Operate
BOOT	Build, Own, Operate and Transfer
BOT	Build, Operate and Transfer
BPTC	Basic Principles Training Course
CV	Curriculum Vitae
CEO	Chief Executive Officer
CNNC	China National Nuclear Corporation
CNS	Convention on Nuclear Safety
CSA	Comprehensive Safeguards Agreement
CZEC	China Chongyuan Engineering Corporation
DG	Director General
DRC	Democratic Republic of Congo
EAPP	Eastern Africa Power Pool
EFQM	European Foundation for Quality Management
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction
EPR	Emergency Preparedness and Response
EPREV	Emergency Preparedness Review
FNRBA	Forum of Nuclear Regulatory Bodies in Africa
FR	Final report
FS	Feasibility Study
GDNP	General Directorate of Nuclear Power (under MWIRE)
GM	General Manager
GNSSN	IAEA Global Nuclear Safety and Security Network
GRAS	Geological Research Authority of Sudan
HCE	Higher Council of Environment, Sudan
HCENR	Higher Council for Environment and Natural Resources, Sudan
HLW	High-level Radioactive Waste
HR	Human Resource
HRDMP	Human Resource Development Master Plan, Sudan NPP
HRDP	Human Resource Development Plan

HSC	High Steering Committee for Sudan NPP
IAEA	International Atomic Energy Agency
INIR	Integrated Nuclear Infrastructure Review
INIS	International Nuclear Information System
INSServ	International Nuclear Safety & Security Advisory Service
INSSP	Integrated Nuclear Security Support Plan
INSSP	Integrated Nuclear Security Support Plan
IPP	Independent Power Producer
IPPAS	International Physical Protection Advisory Service
ISO	International Standards Organization
LWR	Light Water Reactors
MED	Ministry of Electricity and Dams
MENRPD	Ministry of Environment, Natural Resources and Physical Development
MoU	Memorandum of Understanding
MW(e)	Megawatt electric
MWRIE	Ministry of Water Resources, Irrigation and Electricity
NCCD	National Council for Civil Defence
NDT	Non-Destructive Testing
NEPIO	Nuclear Energy Programme Implementing Organization
NGOs	Non-Governmental Organizations
NLDC	National Load Dispatch Center
NP	Nuclear Power
NPP	Nuclear Power Plant
NPT	Non-proliferation Treaty
NRB	Norms of Radiation Safety (radiation safety regulations developed and accepted in the Russian Federation)
PCSHM	Public Consultation and Stakeholder Management
PMD	PM Dimensions (company name)
PMI	Project Management Institution (American institution)
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PSAR	Preliminary Safety Analysis Report
RAF	Code for Regional Technical Cooperation
RB	Regulatory Body
RCF	Regulatory Cooperation Forum
Rev/rev	Revision
RMP	Risk Management Plan
ROSATOM	Russian State Atomic Energy Corporation
RPP	Radiation Protection Program
SAEC	Sudan Atomic Energy Commission

SEC	State Environmental Councils
SER	Self-Evaluation Report
SETCO	Sudanese Electricity Transmission Company
SNRRA	Sudanese Nuclear and Radiological Regulatory Authority
SNTC	Science and Nuclear Technology Centre, Sudan
SoW	Scope of Work
SQP	Small Quantities Protocol
SSAC	State System of Accounting for and Control of Nuclear Material
SUD2004,	Sudan Technical Cooperation Project with the IAEA: <i>Developing the Strategic Plan and the Infrastructure for the Introduction of Nuclear Power</i>
SUD2005	Sudan Technical Cooperation Project with the IAEA: <i>Developing National Nuclear Infrastructure for a First Nuclear Power Plant</i>
TC	Technical Cooperation
TLD	Thermo-luminescence Dosimeters
ToR	Terms of Reference
TSO	Technical Support Organization
WASP	Wien. Automatic System Planning (an IAEA Computer Code for Power Generating System Expansion Planning)