

## Update of DEEP 3.2

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DEEP was developed for the IAEA in the eighties of the last century by General Atomics with the first release of (Co-generation and Desalination Economic Evaluation Spreadsheet, CDEE), has evolved through several modifications and developments until reached the latest version DEEP-3, which was released on August 2005.

DEEP has been increasingly used among scholars from member states to carry out feasibility studies of desalination systems (nuclear or non-nuclear-based systems). Currently, several versions of DEEP (with salient modifications to each version) are being utilized among users. This has resulted in high demand from scholars to have only one common version of DEEP with protection from unauthorised modifications and that includes all prior modifications made in recent years. Due to compatibility issues and software structure, an increasing number of users are encountering difficulties during the installation of new downloaded versions of DEEP.

Based on the above, a newer, user friendly, reliable and more secure version of DEEP is required. This led the IAEA to embark on an action plan to respond to such task. Among other tasks, this work constitutes a first milestone toward the development of a “toolkit” on nuclear seawater desalination.

Under **Special Service Agreement (SSA) 5381.188.1010.A5010221 200843779 dated 15 September 2008**, it was agreed between the IAEA and Dr Hussam Jouhara to accomplish the following tasks:

1. To protect DEEP front page and its design interface.
2. Correct all the commands in the programming of DEEP start-up.
3. Protect all the Visual Basic codes of DEEP so that no change on the source code can be made without authorisation.
4. Protect all templates of DEEP.
5. Update and maintain the main page of DEEP and data base as necessary.

In the following section, details of the work done will be reported.

### **Work done:**

The work started on the 1<sup>st</sup> of October 2008 by solving some programming problems related to the functionality of DEEP and the development of a fully functioning version of DEEP.

Understanding the programming methodology of DEEP and the work needed to be done, the tasks were re-arranged and the work focused on the followings (and in the same order):

1. Correct all the commands in the programming of DEEP start-up. This was done by removing errors from many locations in the “*Workbook\_Open()*” subroutine.
2. Protect all templates of DEEP. This work is done. All the case templates are now protected (and updated with the current DEEP version information) to enable the end-users to edit the input fields for their cases while preventing them from altering the calculation methodology. In the final product of DEEP, it is now much harder to modify any of DEEP equations used as they are protected with standard, password based, MS Microsoft protection.

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3. Protect all the Visual Basic codes of DEEP so that no changes on the source codes can be made without authorisation. This is now done. All the Visual Basic Codes of DEEP are password-protected and the password has been revealed to the IAEA representative, who can change this password accordingly, as needed.
4. Update and maintain the main page of DEEP and data base as necessary. This has now been done. The following were carried out:
  - a. The old, basic front page of DEEP is now replaced by a brand new page with new layout and a new background, which was designed graphically, to show a typical nuclear based desalination system.
  - b. There was an error with the way the help file was linked to the programme. This has now been corrected.
  - c. The “ABOUT DEEP” window, in the main page menu and the templates are now updated to reflect on the new version of DEEP.
5. To protect DEEP front page and its design interface. This is now done. The front page, with its contents is password-protected.

The final version of the fully functioning DEEP is to be released under DEEP version 3.2 December, 2008, as agreed with the IAEA representative, Dr Ibrahim Khamis. This version will include, in addition to all the above mentioned modification, the templates having the Rankin cycle instead of the Carnot cycle methodology. This task was done based on the original contribution of this update as provided from IAEA

The above mentioned work was done in the United Kingdom where Dr Jouhara resides, and during his four-day visit to the IAEA premises in Vienna, between the 8<sup>th</sup> and the 11<sup>th</sup> of November. During the visit, the final design of DEEP front page was selected and the final version of DEEP was delivered, and various aspects of security, structure, functionality of DEEP were disclosed.

### **Recommendations for future work:**

- Development of an up-to-date documentations including all modifications, improved version of the help file and operating manuals should be made available to users, preferably as a part of the toolkit the IAEA plans to develop.
- Development of DEEP quality assurance document.
- Development of test cases as part of an overall benchmarking process.
- Development of self training tutorials.
- Assurance of compatibility for DEEP software with rapidly evolving operating systems.
- Update of default values and data bases for each DEEP template case.

Other models such as Water cost transport template, detailed carbon tax and environmental impact foot print analysis should also be incorporated in future version of DEEP.

**The conditions and products specified in the SSA have been met and delivered.**

