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A LOGIC SCHEME FOR REGULATING SAFE OPERATION OF RESEARCH REACTORS

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ABSTRACT

This work presents a logic scheme for regulating the safe operation of research reactors in accordance with the IAEA Safety Series SS-35-S2 and revised by the Codes of Federal Regulations 10 CFR. It emphasizes the regulatory inspection and enforcement (RI&E) program in the reactor operation licensing phases. It is developed to provide information, guidance and recommendations to be taken when constructing a RI&E program to be applied in the operational phase of the Egyptian research reactors. The RI&E procedures for regulating safe operation of research reactors are presented as flow charts, and then developed as a computer logic scheme. The software program is efficient, friendly, simple and interactive in nature such that the program asks the user certain questions about essential steps that guide the RI&E for research reactors and the user responds by (yes) or (no) and the program proceeds based on this response until all the necessary RI&E steps are accomplished. Samples of results of the RI&E software execution showing some violation cases with their inspective and corrective paths throughout the program are presented and discussed.

KEY WORDS

Nuclear Safety, Logic Scheme, Enforcement & Inspection, Regulations, Reactor Operation, Reactor Operation License, Research Reactors.

INTRODUCTION

The operation License for any nuclear facility shall include several licensing phases; sitting, design & construction, commissioning, reactor operation, utilization & modification and decommissioning [1,2]. These phases are connected to be parts of the entirely reactor operation license and regulated in a consecutive manner such that the applicant/licensee (A/L) can only obtain a phase permit if the regulatory requirements of

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that phase are fulfilled. So, these licensing phases are controlled by a compliance action program which includes both regulatory inspection (RI) and regulatory enforcement (RE) action programs. For example, the construction phase permit is issued after reviewing the Primary Safety Analysis Report (PSAR) by the nuclear regulatory body (NRB) before starting the construction works and after finishing the sitting and design works. The RI&E program is conducted during the construction phase to assure that all A/L works are in consistent with the technical specifications (TS) in the PSAR, otherwise such construction permit is withdrawn by the NRB.

The objective of this RI&E program is to assure that any phase permit for each license phase are in consistent with the regulatory requirements, the technical specifications of the PSAR and the licensee administrative control [3]. The RI&E program shall be conducted by the NRB which is responsible for issuing/withdrawal of phase permits and reactor operation license.

In a previous work for the authors, the safety requirements for reactor operation license in research reactors are presented, discussed and applied to Egypt's research reactors[4] showing the particular areas of inspection interest in both reactor operation and modifications phases and giving examples for the violations categorized according to their severity levels in such both phases [4]. In another work, the future prospectives for reactor operation licensing and its regulatory problems in Egyptian research reactors are also discussed [5] explaining the various phases of the RI within its cycle and the various phases of RE within its action processes. The RI report format with its contents is also given [5].

In the present work, a logic scheme software for the compliance action program (RI&E) which regulates the safe operation of research reactors is developed. It was developed according to the requirements of the Egyptian AEA-NCNSRC- Rule No.-06 [6] and based on the NCNSRC-Guide-01 [7] and on the IAEA safety series SS-50-SG-S4 [8], SS-35-S1&S2 [1,2] and is revised by the 10CFR-Ch1 [9,10] and the Nuclear Regulatory Commission (NRC) Inspection and Enforcement Manual [3]. It was structured under two main principles; interactive viewing between A/L and the NRB and effective communication and feed back of information resulting in a continuous evaluation for different reactor plant systems and components. So, it was developed to help in assuring coverage of all aspects to be regulatory inspected and enforced and in providing overall coordination of both RI and RE activities.

THE RI&E LOGIC SCHEME

The RI&E is a compliance action program used for pursuing a nuclear facility from the moment of its construction to its decommissioning in order to continuously evaluate its effectiveness throughout its life time. The RI&E procedures for regulating safe operation of research reactors are presented as flow charts (shown in Figs.(1) & (2))and then developed as computer logic scheme software. This RI&E software helps in documenting all aspects of regulatory inspections and enforcement action processes for all licensing phases of any research reactor. So, it provides an easy method for collecting information, updating the detailed findings/observations histories and scheduling the RI&E activities. Consequently, it helps in selecting the optimum correction path (route) in a license phase for the sake of awarding a new permit after its withdrawal.

All these safety information of a nuclear facility can be easily pursued using the present RI&E logic scheme software. Moreover, it helps - to a great extent - in forecasting or predicting an accidental situation as a result of a malfunction/failure of any component/system due to the accumulation of observations/findings in that component or system. Thus, the causes leading to such accidental situation can be easily known throughout the RI&E software by following up the time history of each observation/finding occurred in that component / system even if it was a closed finding. Consequently, it helps in decision - making to withdraw the permit / license when it is felt that the safety of reactor operation is in jeopardy until the RE corrective actions are executed. On contrary, it helps in regulating safe operation of research reactors and continuing award for reactor operation license if the reactor systems and components are consistent with regulatory requirements, technical specifications and licensee's administrative control [3].

RI&E PROGRAM RESULTS AND DISCUSSION

The computer program helps the user in following RE and RI instructions according to the flow charts of Figs.(1) and (2). Thus, it helps the user to regulate safe operation for any research reactor and - in turns - evaluates its effectiveness. Figure (3) shows how the RI and RE program are working when violations take place and how the re-RI shall be started again after legal penalties are punished when an unclosed finding is reached. As shown in figure, when a violation firstly takes place, it is identified and evaluated in the identification phase of the RE procedures. Then after the problem is identified, presented and discussed, an agreement on RE action is taken. The required action may be investigative, remedial or corrective action. Once the action phase is started, the RI program is called and proceeds with its all phases until the follow up action, which finally leads to either a closed finding or an unclosed finding. Based on the results of the follow up action, a violation close-out occurs or a legal penalties is forced and the RI program is rerun again. As shown from the figures, the RE program should be resulted in a close out whereas the RI program has 14 possible paths only six of them lead to a close-out which implies to re-start the RI program. So this, RI&E program helps in selecting the optimum correction path - in a licensing phase - for the sake of awarding a new phase permit if it is withdrawn.

Output samples for the RI&E program execution are given in Figs.(4) and (5). Figure (4) shows how the RI&E program is terminated if the check lists, administrative data sheets and/or the previous preliminary reports are not fed to the RI team members to enable them to conduct the RI program. Figure (5) shows the RI procedures when the corrective action to the violational findings have not been executed and how it proceeds if an unclosed finding is reached.

CONCLUSIONS

- 1- This work has revealed on creating a logic scheme software for the RI&E procedures to be applied on research reactors throughout its life time to regulate its safe operation. It was developed according to the requirements of the IAEA Safety Series -S1 &S2 and revised by 10 CFR, Ch.1 and the NRC -Inspection & Enforcement Manual.
- 2- The program helps to correct a/some violation(s) happened in a nuclear facility during any of its licensing phases .

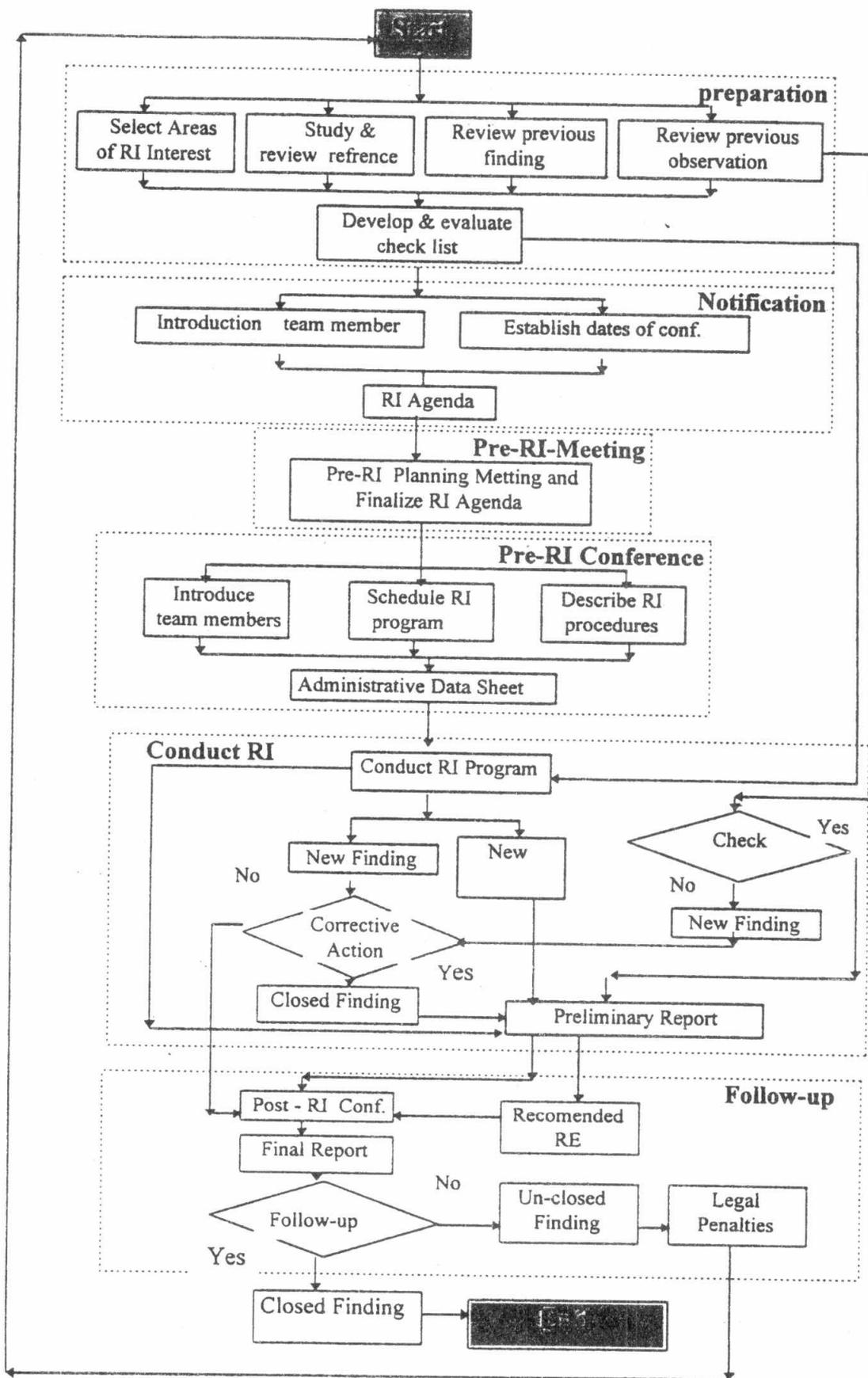


Fig.(1) RI Program Flow chart

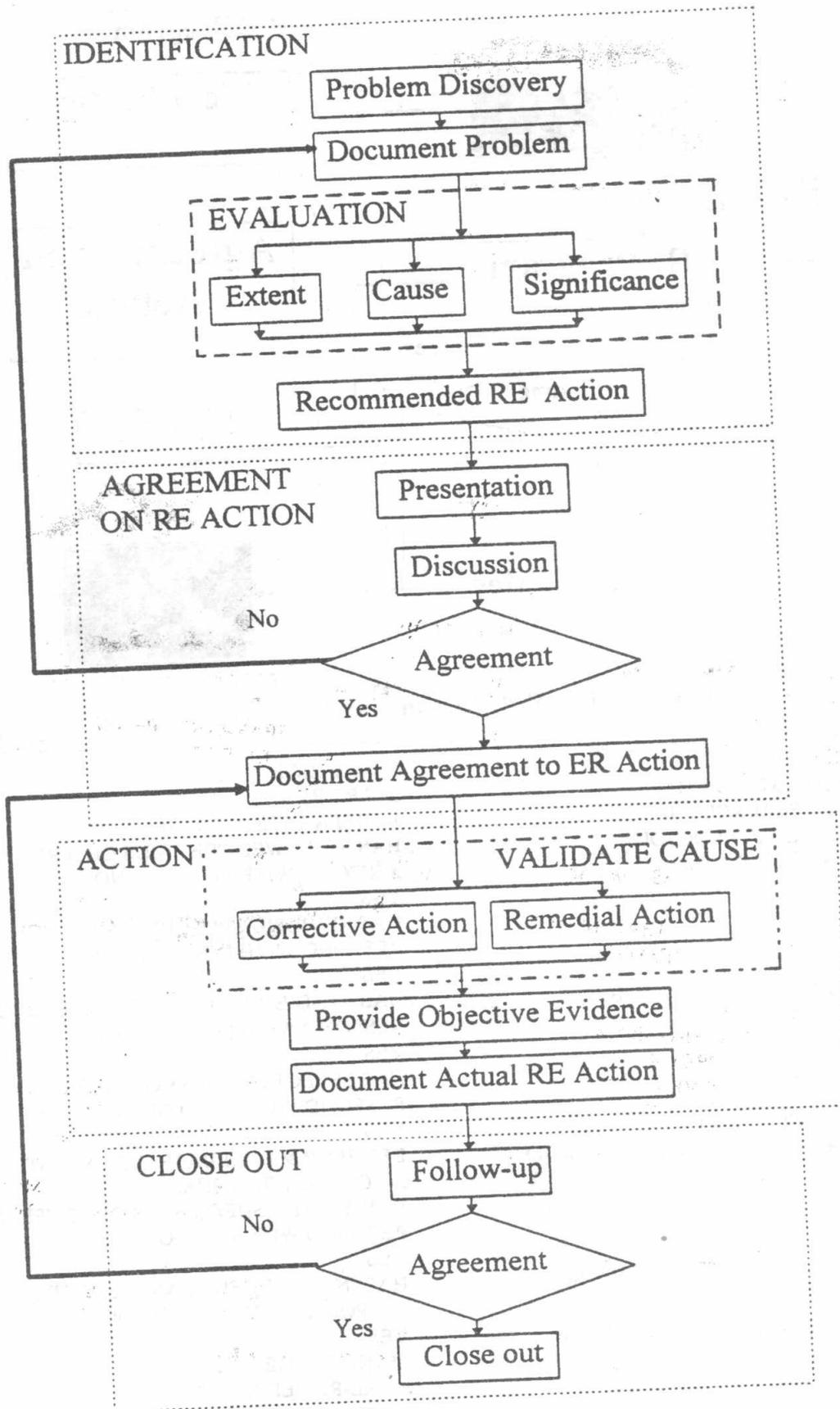


Fig.(2) RE Program Flow Diagram

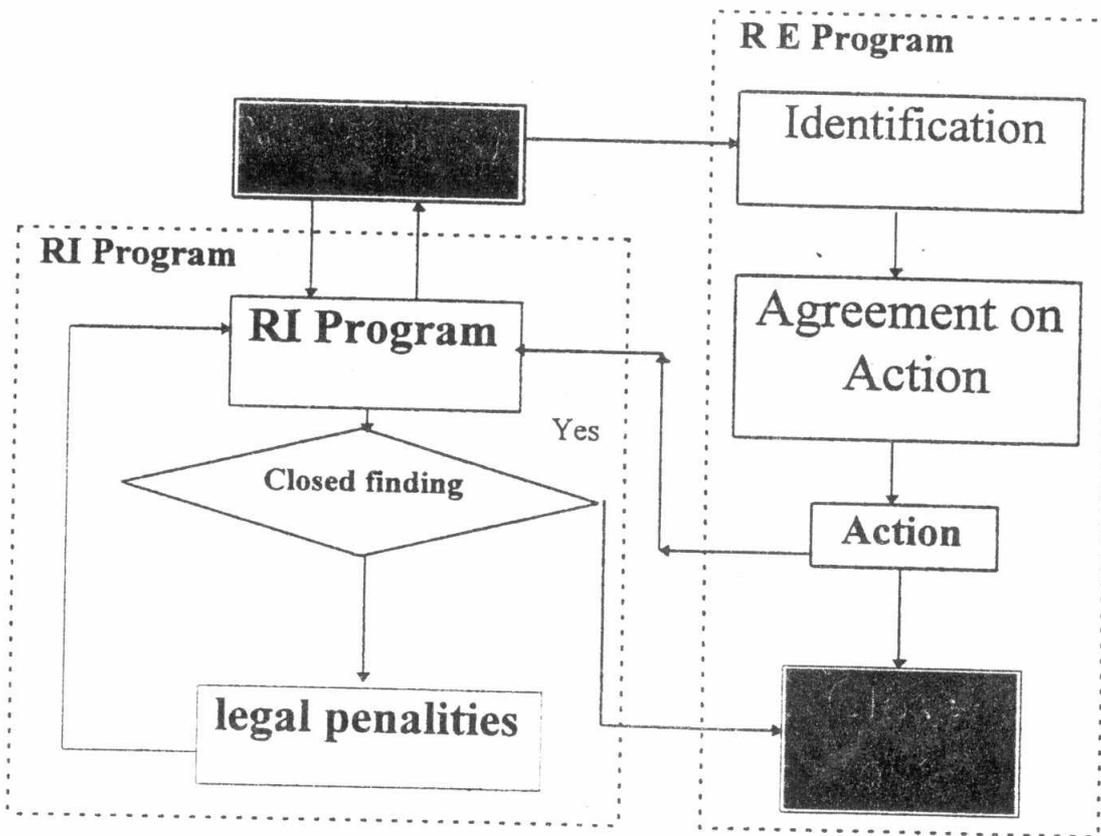


Fig.(3) RI & E Program Layout Chart

PLAN PRE-RI MEETING AND FINALIZE RI AGENDA 4-PRE-RI CONFERENCE PHASE HAS DESCRIBED RI PROCEDURES RESPOND WITH (YES) OR (NO) YES HAS SCHEDULED RI PROGRAM RESPOND WITH (YES) OR (NO) YES HAS INTRODUCED TEAM MEMBERS RESPOND WITH (YES) OR (NO) YES MAKE ADMINISTRATIVE DATA SHEET 5-CONDUCT RI PROGRAM CONDUCT RI PROGRAM IF ADMINISTRATIVE DATA SHEET WAS MADE AND CHECK LISTS WERE DEVELOPED & CHECKED RESPOND WITH (YES) OR (NO) NO RI PROGRAM WILL BE STOPPED DUE TO ABSENCE OF ADMINISTRATIVE DATA SHEETS & CHECK LISTS END	START RI&E START RI 1-PREPARATION PHASE HAS REVIEWED PREVIOUS OBSERVATIONS RESPOND WITH (YES) OR (NO) YES HAS REVIEWED PREVIOUS FINDINGS RESPOND WITH (YES) OR (NO) YES HAS STUDIED & REVIEWED REFERENCES RESPOND WITH (YES) OR (NO) YES HAS SELECTED AREAS OF INTEREST RESPOND WITH (YES) OR (NO) YES DEVELOP & EVALUATE CHECK LISTS 2-NOTIFICATION PHASE HAS ESTABLISHED DATES OF CONFERENCE RESPOND WITH (YES) OR (NO) YES HAS INTRODUCED TEAM MEMBERS RESPOND WITH (YES) OR (NO) YES MAKE RI AGENDA 3-PRE-RI MEETING PHASE
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Fig.(4) Example of RI&E Output Results

START RI
 1-PREPARATION PHASE
 HAS REVIEWED PREVIOUS OBSERVATIONS
 RESPOND WITH (YES) OR (NO)
 YES
 HAS REVIEWED PREVIOUS FINDINGS
 RESPOND WITH (YES) OR (NO)
 YES
 HAS STUDIED & REVIEWED REFERENCES
 RESPOND WITH (YES) OR (NO)
 YES
 HAS SELECTED AREAS OF INTEREST
 RESPOND WITH (YES) OR (NO)
 YES
 DEVELOP & EVALUATE CHECK LISTS
 2-NOTIFICATION PHASE
 HAS ESTABLISHED DATES OF CONFERENCE
 RESPOND WITH (YES) OR (NO)
 YES
 HAS INTRODUCED TEAM MEMBERS
 RESPOND WITH (YES) OR (NO)
 YES
 MAKE RI AGENDA
 3-PRE-RI MEETING PHASE
 PLAN PRE-RI MEETING
 AND FINALIZE RI AGENDA
 4-PRE-RI CONFERENCE PHASE
 HAS DESCRIBED RI PROCEDURES
 RESPOND WITH (YES) OR (NO)
 YES
 HAS SCHEDULED RI PROGRAM
 RESPOND WITH (YES) OR (NO)
 YES
 HAS INTRODUCED TEAM MEMBERS
 RESPOND WITH (YES) OR (NO)
 YES
 MAKE ADMINISTRATIVE DATA SHEET
 5-CONDUCT RI PROGRAM
 CONDUCT RI PROGRAM IF
 ADMINISTRATIVE DATA SHEET WAS MADE
 AND CHECK LISTS WERE DEVELOPED &
 CHECKED
 RESPOND WITH (YES) OR (NO)
 YES
 ARE NEW OBSERVATIONS SAME
 AS PREVIOUS OBSERVATIONS?
 RESPOND WITH (YES) OR (NO)
 NO
 GET NEW FINDING
 HAS MADE CORRECTIVE ACTION
 RESPOND WITH (YES) OR (NO)
 YES
 FINDINGS ARE CLOSED
 WRITE PRELIMINARY REPORT
 6-POST-RI CONFERENCE PHASE

HAS MADE POST-RI CONFERENCE
 RESPOND WITH (YES) OR (NO)
 YES
 HAS TAKEN RECOMMENDATIONS OF RE
 AND HAS TAKEN PRELIMINARY REPORT
 RESPOND WITH (YES) OR (NO)
 YES
 WRITE FINAL REPORT
 7-FOLLOW-UP PHASE
 HAS MADE FOLLOW-UP ACTION
 RESPOND WITH (YES) OR (NO)
 NO
 FINDINGS ARE UNCLOSED
 LEGAL PENALTIES
 RE-RI PROGRAM
 1-PREPARATION PHASE
 HAS REVIEWED PREVIOUS OBSERVATIONS
 RESPOND WITH (YES) OR (NO)
 YES
 HAS REVIEWED PREVIOUS FINDINGS
 RESPOND WITH (YES) OR (NO)
 YES
 HAS STUDIED & REVIEWED REFERENCES
 RESPOND WITH (YES) OR (NO)
 YES
 HAS SELECTED AREAS OF INTEREST
 RESPOND WITH (YES) OR (NO)
 YES
 DEVELOP & EVALUATE CHECK LISTS
 2-NOTIFICATION PHASE
 HAS ESTABLISHED DATES OF CONFERENCE
 RESPOND WITH (YES) OR (NO)
 YES
 HAS INTRODUCED TEAM MEMBERS
 RESPOND WITH (YES) OR (NO)
 YES
 MAKE RI AGENDA
 3-PRE-RI MEETING PHASE
 PLAN PRE-RI MEETING
 AND FINALIZE RI AGENDA
 4-PRE-RI CONFERENCE PHASE
 HAS DESCRIBED RI PROCEDURES
 RESPOND WITH (YES) OR (NO)
 YES
 HAS SCHEDULED RI PROGRAM
 RESPOND WITH (YES) OR (NO)
 YES
 HAS INTRODUCED TEAM MEMBERS
 RESPOND WITH (YES) OR (NO)
 YES
 MAKE ADMINISTRATIVE DATA SHEET
 5-CONDUCT RI PROGRAM
 CONDUCT RI PROG IF ADMINISTRATIVE
 DATA SHEET WAS MADE AND CHECK LISTS
 WERE DEVELOPED & CHECKED

RESPOND WITH (YES) OR (NO) YES	HAS MADE POST-RI CONFERENCE RESPOND WITH (YES) OR (NO) YES
ARE NEW OBSERVATIONS SAME AS PREVIOUS OBSERVATIONS? RESPOND WITH (YES) OR (NO) NO	HAS TAKEN RECOMMENDATIONS OF RE AND HAS TAKEN PRELIMINARY REPORT RESPOND WITH (YES) OR (NO) YES
GET NEW FINDING HAS MADE CORRECTIVE ACTION RESPOND WITH (YES) OR (NO) YES	WRITE FINAL REPORT 7-FOLLOW-UP PHASE HAS MADE FOLLOW-UP ACTION RESPOND WITH (YES) OR (NO) YES
FINDINGS ARE CLOSED WRITE PRELIMINARY REPORT 6-POST-RI CONFERENCE PHASE	FINDINGS ARE CLOSED END

FIG. (5) RI Program Output (An Example)

- 3- It helps in documenting all regulatory inspection and enforcement procedures and action processes for all licensing phases of a nuclear facility.
- 4- It also provides an easy method for collecting information, updating the detailed findings / observations histories and for scheduling the RI&E activities.
- 5- Consequently, it helps in selecting the optimum correction path - in a license phase - for the sake of awarding a new phase permit if it is withdrawn.
- 6- All safety information data needed for safe operation, inspection or enforcement, for any research reactor facility, can be easily pursued using the present RI&E logic scheme software.
- 7- Moreover, it helps - to a great extent - in forecasting or predicting an accidental situation as a result of malfunction / failure of any component / system due to the accumulation of the observations / findings in that component or system.

REFERENCES

- [1] IAEA Safety Series; "Code On The Safety Of Nuclear Research Reactors- Design", S.S.-35-S1, Vienna (1992).
- [2] IAEA Safety Series; "Code On The Safety Of Nuclear Research Reactors- Operation ", S.S.-35-S2, Vienna (1992).
- [3] NRC; "I&E Manual : Class I and Class II Non-Power Reactors", USA (1992).
- [4] Ahmed, Ensherah E.M. and Rahman, F.A.; " Nuclear Safety Requirements For Operation Licensing In Research Reactors", Under Press (1996).
- [5] Ahmed, Ensherah E.M. and Rahman, F.A.; "Future Prospectives For Licensing and Regulatory Problems In Egyptian Research Reactors", IAEA / SR- 183/53 (1993).
- [6] NRSC Safety Rule No. 6, "Nuclear Safety of Research Reactor and Critical Assemblies", National Center of Nuclear Safety and radiation Control (NCNSRC), Cairo (1985).
- [7] Rahman, F. A. ; "Guide for Regulatory Inspection and Enforcement for Egyptian Research Reactors", NRSC Guide -01, NCNSRC, Cairo (1988).
- [8] IAEA Safety Guide, Safety Series No. 50-SG-G4, "Inspection and Enforcement by the Regulatory Body for Nuclear Power Plants", Vienna (1980).
- [9] 10 CFR Chapter 1, Part 1, Section 1.64; "Office of Inspection and Enforcement", USA (1990).
- [10] 10 CFR Chapter 1, Part 2, Appendix C; "General Statement of Policy and Procedure for NRC Enforcement Section, Supplement I - Severity Categories "