EFFICIENCY AND EFFECTIVENESS OF IRRS MISSIONS

Working Material

Disclaimer: this working material is a background document for the technical report “Lessons Learned from the IRRS Missions to Countries with Operating NPPs, 2006-2013”, to be published. The final forms of conclusions in the technical report may differ from those appearing in the present document.
Table of Contents

EXECUTIVE SUMMARY .................................................................................................................. 2

I. INTRODUCTION .......................................................................................................................... 3

II. BACKGROUND ............................................................................................................................. 3

III. GENERAL REMARKS .................................................................................................................. 4

   III.1 Effectiveness versus Efficiency.............................................................................................. 4
   III.2 Individual Values versus Statistical Average ......................................................................... 4
   III.3 Selecting Limits for Criteria .................................................................................................. 5

IV. THE METHOD APPLIED ............................................................................................................. 5

V. EFFECTIVENESS AND EFFICIENCY CRITERIA OF AN IRRS MISSION ............................................ 6

   V.1 Size of an IRRS Team.............................................................................................................. 6
   V.2 Length of the IRRS Mission Report ........................................................................................ 8
   V.3 Time Available for ARM Review ............................................................................................ 10
   V.4 Advance Comments from the Reviewers .............................................................................. 11
   V.5 Feedback on the ARM .......................................................................................................... 12
   V.6 IRRS Experience of the Team Members .............................................................................. 13
   V.7 Feedback from the Host on the Initial Mission ................................................................... 14
   V.8 Feedback from the Team on the Mission .............................................................................. 15
   V.9 Extent and Coverage of the Action Plan .............................................................................. 16
   V.10 Balance of the Findings ....................................................................................................... 19
   V.11 Conciseness of the Mission Report ..................................................................................... 22
   V.12 Completion Time of the Mission Report ............................................................................. 23
   V.13 Open Issues in a Follow-up Mission .................................................................................. 24

VI. TOWARDS EFFECTIVENESS CRITERIA OF THE IRRS PROCESS .............................................. 25

   VI.1 Averaging the Individual Mission Values .......................................................................... 25
   VI.2 Extent of the Action Plan ..................................................................................................... 25
   VI.3 Feedback from the Host after the Mission ......................................................................... 26
   VI.4 Feedback from the Host before the Follow-up Mission ...................................................... 26
   VI.5 Number of closed issues in a follow-up mission ................................................................. 26
   VI.6 Number of good practices implemented in other countries .............................................. 26
   VI.7 Progress by time .................................................................................................................. 27
   VI.8 Operational events related to IRRS findings ..................................................................... 28

VII. APPLICATION TO RECENT MISSIONS .......................................................................................... 28

   VII.1 Effectiveness/Efficiency of the Missions by Criteria ............................................................ 28
   VII.2 Overall Effectiveness of the Missions ................................................................................. 34

APPENDIX 1: DEFINITION AND DERIVATION OF SPECIFIC QUANTITIES ........................................... 36

   A.I Notations .................................................................................................................................. 36
   A.II Definitions ............................................................................................................................. 36

APPENDIX 2: EVALUATION OF THE MISSION REPORT CONCISENESS – an example ...................... 39
EXECUTIVE SUMMARY

In response to the IAEA Nuclear Safety Action Plan, the IAEA secretariat was tasked with reviewing the effectiveness of its safety review services. This report addresses the review of the effectiveness and efficiency of the Integrated Regulatory Review Service (IRRS). Through a series of consultancy meetings, the secretariat developed several criteria and a method of characterizing the effectiveness and efficiency of the IRRS missions. The secretariat recognized the challenge of developing direct, quantifiable performance indicators (PIs) which measure effectiveness. As a result, a set of criteria based on measurable performance indicators that correlate with the efficiency and effectiveness of the IRRS process has been developed. The performance indicators of an IRRS mission introduced and used in the analysis are:

1) Size of the IRRS team
2) Length of the mission report
3) Time available for the review of the Advance Reference Material (ARM)
4) Number of advance written comments from the reviewers
5) Feedback from the team members on the quality of the ARM
6) IRRS experience of the team members
7) Feedback from the host country representatives
8) Feedback from the team members on the mission
9) Extension of the pre-mission Action Plan of the host country
10) Coverage of the pre-mission Action Plan by mission findings
11) Number of issues found beyond those in the Action Plan
12) Balance of the Recommendations and Good Practices
13) Balance of recommendations and Suggestions
14) Conciseness of the mission report
15) Completion time of the mission report
16) Number of issues remaining open in the follow-up mission

Based on a large amount of data collected from past IRRS missions, numerical values, limits and ranges were defined for all performance indicators. Selected missions held between January 2011 and December 2013 serve as examples to demonstrate the validity of the proposed ranges. The performance indicators correlate with the general objectives of the IRRS missions.

The applicability of the method is tested through the full evaluation of the 13 most recent missions.

The results of this evaluation demonstrated that although there are performance indicators which need attention in all missions, the overall performances of most of the missions fall into the effective range.

It is to be stressed that the criteria defined here relate to the effectiveness and efficiency of the conduct of the IRRS missions and do not involve any indication on the safety performance of the host country or its regulatory body.

Investigation of the effectiveness of the entire IRRS process has also been initiated and a number of global performance indicators (partly based on the PIs above) were considered. Such indicators of the global effectiveness may be:

1) The (arithmetic or weighted) average of the PIs in a mission
2) Extension of the Action Plans
3) Host feedback on the mission effectiveness
4) Host feedback on the initial mission prior to the follow-up
5) Number of closed issues in a follow-up
6) Number of good practices implemented in other countries
7) Progress of PIs by time

It is concluded that regular use of performance indicators by itself has a beneficial effect on their values and generates improved effectiveness and efficiency; the overall effectiveness of missions tends to increase in time. It is also concluded that the global measure of the effectiveness of the IRRS process can be introduced through the criteria proposed here as well as via further global qualitative and quantitative criteria that need to be defined through data collected from past and future IRRS missions. One specific area that will benefit from a larger data
sample is related to follow-up missions and developing performance indicators that may have a stronger correlation with effectiveness.

On the one hand, this work needs to be continued to elaborate further global criteria and on the other hand to collect mission data.

I. INTRODUCTION

One of the main objectives of the Nuclear Safety Action Plan of the IAEA is to "Strengthen IAEA peer reviews in order to maximize the benefits to Member States". Specific activities to realize this objective are outlined as follows in the Nuclear Safety Action:

2.4.1 IAEA Secretariat to review the effectiveness of their peer reviews: IRRS, and therein
   2.4.1.2 Define effectiveness criteria, apply the criteria to a representative number of selected IRRS missions and prepare a report

In reply to these Action Plan items, NSNI RAS initiated an activity to define effectiveness and efficiency criteria and to apply them to the IRRS missions recently held. The activity included the following steps:

Step 1: requesting 26 acknowledged international experts for their suggestions on possible criteria
Step 2: making use of the suggested ideas, elaborating a set of effectiveness and efficiency criteria, and applying them to the selected missions
Step 3: requesting comments from international experts and IAEA staff on the draft report
Step 4: finalizing the report

The results of these steps are summarized below. It is to be stressed that what is presented in this report are the first results of the work initiated by the IAEA Nuclear Safety Action Plan. This work needs to be continued in order to elaborate a concise and complete system of indicators describing both the efficiency and the effectiveness of the IRRS missions in the process of continuous improvement of nuclear safety worldwide.

This report may be of interest to governmental and regulatory bodies in the field of nuclear safety as well as for international organizations including the European Union, IAEA Member States, the IAEA Secretariat and other parties.

II. BACKGROUND

The criteria for the effectiveness and efficiency (E&E) of a mission should relate to the general objectives of an IRRS missions (c.f. IRRS Guidelines) listed below:

a) providing an opportunity for continuous improvement of national regulatory bodies through an integrated process of self-assessment and review;
b) providing the host country (regulatory body and governmental authorities) with a review of its regulatory technical and policy issues;
c) providing the host country (regulatory body and governmental authorities) with an objective evaluation of its regulatory infrastructure with respect to IAEA safety standards;
d) promoting the sharing of experience and exchange of lessons learned among senior regulators;
e) providing key staff in the host country with an opportunity to discuss regulatory practices with IRRS team members who have experience in other regulatory practices in the same field;
f) providing the host country with recommendations and suggestions for improvement;
g) providing other States with information regarding good practices identified in the course of the review;
h) providing reviewers from Member States and IAEA staff with opportunities to observe different approaches to regulatory oversight and broaden knowledge in their own field (mutual learning process); and
   i) contributing to the harmonization of regulatory approaches among Member States;
j) promoting the application of IAEA Safety Requirements;
k) providing IAEA staff with the opportunity to receive direct feedback from the use and application of IAEA Safety Standards.

These objectives and suggestions from C. Ciurea-Ercau (Romania), L. Creswell (UK), R. Gray (UK), I. Grlicarev (Slovenia), P. Guillaud (France), K. Janko (Slovakia), E. Jende (Sweden), L. Jova Sed (Cuba), L. Kueny (France), P.
Lietava (Czech Republic), V. McCree (US), J. Misak (Slovakia), F. Nitsche (Germany), C. Patchett (UK), H. Reponen (Finland), F. Rinfret (Canada), G. Rzentkowski (Canada), J-P. Semain (Belgium), U. Schmocker (Switzerland), G. Schwarz (Switzerland), A. Stritar (Slovenia), and P. Tiippana (Finland) as well as from the staff of IAEA NSNI RAS were taken into account in the elaboration of the criteria discussed below.

Data from missions conducted to Member States with operating nuclear power plants were used in the derivation and demonstration of the criteria. Figure 1 below shows all IRRS missions held in 2006-2014 up to the closure of the present analysis. Missions included in the E&E analysis are shown in colour; all other missions are shown in grey. (Note that colours have no specific meaning. They are used for illustration purposes.)

III. GENERAL REMARKS

The overall effectiveness of an IRRS mission is defined through a number of IRRS performance indicators (PI’s), which may use numerical values. Criteria related to the values of the PI’s are set to define effectiveness and efficiency ranges. The limits of the ranges are attempted to be defined objectively as discussed below.

III.1 Effectiveness versus Efficiency

The ultimate goal of the present work as well as of the application of the various criteria is the maximization of the benefits offered to the Member States through IRRS missions correlating with the maximization of the effectiveness of the IRRS process. There are only a few possibilities for direct assessment of the overall effectiveness (c.f. Chapter VI); however, the effectiveness of a method would be positively influenced by efficiency. This is the reason why both effectiveness and efficiency criteria are introduced in the next Chapter.

Effectiveness of the IRRS missions can be characterized by how the mission meets the general objectives a) through k) of the IRRS missions as listed in Chapter II. Efficiency generally describes the extent to which time, effort or cost is used well for the intended task or purpose, in this case for IRRS missions. When introducing a PI characterizing the effectiveness and/or efficiency of a mission, the PI correlates with one or more relevant IRRS objective(s).

Certain criteria depend on the activity of the host country, others on the review team or on the IAEA staff. When introducing the PI’s and the respective criteria, the main role in achieving the effectiveness/efficiency objectives is being indicated.

The issue of assessing the effectiveness of the entire IRRS process is elaborated further in Chapter VI where it is also noted that the collection and analysis of data from future missions will advance the assessment of the overall effect of the IRRS missions on strengthening the national regulatory infrastructure of the Member States.

III.2 Individual Values versus Statistical Average

Two of the criteria introduced in the next chapter are based on averages over data from several past missions. As such they represent expected values, whereas in particular cases the respective values of a mission may differ considerably from the average, simply due to random fluctuations. In such cases particular performance indicators may fall into unfavourable ranges with no obvious reason. Nevertheless, when averaging the individual deviations of the performance indicators from their optimum range as introduced in Chapter IV, the final Average

Figure 1: IRRS missions taken into account in the derivation and demonstration of the E&E criteria
Measure of Deviation is expected to filter out statistical fluctuations for the relatively large number of PI’s to be introduced in Chapter V.

One may ask, why do we think that data from past missions can be used as a basis for defining efficiency and effectiveness criteria? The simple answer to this question is that according to a general consensus, most of the past missions were sufficiently efficient and effective, thus their averaged characteristic data may serve as indicative values for effectiveness and efficiency performance indicators.

It may also be objected that when the criteria is based on the average of the actual values, the actual mission data shall fit well with the criteria. This, however, may only be true for an average, whereas the criteria are suitable to show the deviation of the individual mission values from the general trend. Furthermore, the criteria so defined may be and have indeed been used also for missions of which the data is not used in the present averaging.

III.3 Selecting Limits forCriteria

The effectiveness/efficiency criteria are expressed in terms of limiting values of the various PI’s. For defining the limiting values, in principle there are four possibilities:

a) *a priori* first principles
b) past experience
c) engineering judgement
d) common sense

In the present study possibility a) can be excluded as no first principles regulate the effectiveness/efficiency of the IRRS missions. The other three possibilities all apply. Application of past experience was commented upon in the previous section. Engineering judgement implies certain technical/numerical basis and therefore may only be used in a limited number of cases; common sense is applied almost always. Certain limit values may seem arbitrary or subjective. To see the effect of such arbitrariness, sensitivity analysis of the results to the limits shall be performed in a subsequent phase. The author of this study attempted to be as objective as possible; nevertheless other users of the method may adopt different approaches. The criteria of any PI can be easily changed and the data can be re-evaluated with little extra effort.

IV. THE METHOD APPLIED

Each of the IRRS performance indicators, defining the overall effectiveness of an IRRS mission may fall into one of the following ranges

a) Optimum range (colour code: green)
b) Acceptable range (colour code: yellow)
c) Needing attention range (colour code: red)

depending on their values with respect to criteria (limit values) determined from experience of the past missions or by common sense.

A relative distance of the actual value from its optimum range is calculated for every performance indicator of a mission. The relative distances are averaged to yield an Average Measure of Deviation denoted by $\Delta$. The effectiveness of the mission is then defined by the

**Overall Effectiveness Criterion:**

a) Optimum *(green)* if $\Delta = 0$
b) Effective *(white)* if $0 < \Delta \leq 0.1$
c) Acceptable *(yellow)* if $0.1 < \Delta \leq 0.2$
d) To be analysed *(red)* if $0.2 < \Delta$

depending on the value of the Average Measure of Deviation.

The Average Measure of Deviation gives the average distance of the mission from an optimum one. Thus a mission is optimum if every performance indicator of the mission is within the optimum range. The mission is effective if the average deviation of the performance indicators from their optimum ranges does not exceed 10%. The other ranges have similar explanations. Note that using weights of various individual distance values
characterizing their importance in E&E, averaging is expected to yield an even more realistic Average Measure of Deviation; furthermore, a sensitivity analysis would provide information on the role of the ranges.

Past missions have been evaluated using the criteria defined. Obviously, different values apply to the initial missions and to the follow-up missions and some criteria valid for the initial missions do not have meaning for the follow-ups and vice versa.

The practical implementation of the method discussed in this paper is straightforward. Primary data of a mission need to be input into an Excel spreadsheet and the algorithm built into the spreadsheet automatically displays the values of the performance indicators and the overall evaluation of the E&E of the mission in question.

Most of the methods introduced here relate to the E&E of individual missions through criteria that can be evaluated not long after the completion of a mission. Certain aspects, however, cannot be assessed in this timeframe, but only after a considerable time. This is typically the case when certain features of the initial mission can only be evaluated prior to or during the follow-up mission. Ideas of this nature will be expanded in Chapter VI below, not for the characterization of a single mission but for the sake of the global evaluation of the effectiveness of the entire IRRS process.

It is to be stressed that the criteria defined here relate to the effectiveness of the IRRS missions and do not involve any indication on the safety performance of the host country or its regulatory body.

V. EFFECTIVENESS AND EFFICIENCY CRITERIA OF AN IRRS MISSION

This Chapter introduces 16 performance indicators of an IRRS mission along with the respective criteria leading to the evaluation of their E&E in a mission. The background and the results of the performance indicator assessment are illustrated through the examples of past IRRS missions.

V.1 Size of an IRRS Team

The effectiveness and efficiency of a team is highly influenced by its size. Teams which are too small may not review the modules in the required detail (may not be sufficiently effective); teams which are too large are a waste of time and money (not efficient), not to mention the adverse effects of team members without real tasks. (Note that in fact the manpower invested is the real PI, but as the length of the mission is constant, team size is equivalent to that.)

Relationship with the IRRS objectives: Selecting the optimum team size has an important role in reaching the mission objectives c) (providing the host country with an objective evaluation), d) (promoting the sharing of experience and exchange of lessons learned among senior regulators...) and e) (providing key staff in the host country with an opportunity to discuss regulatory practices with IRRS team members...) since all these objectives assume sufficient time, concentration and devotion from the part of the team members during their review.

Responsibilities: Determination of the team size is the responsibility of the IAEA Team Coordinator and of the Team Leader.

In Appendix 1 the effective size of an IRRS mission (a) is expressed in terms of the size of the host country’s nuclear program and the number of modules, of facilities and activities, and of technical areas included into the mission [Eq.(A1)]. It is assumed that the optimum number of team members exhibits a linear dependence on the effective size. Examination of this relation in past IRRS missions may lead to a well-established value of the parameters in Eq.(A1). For this analysis, the IRRS missions to NPP countries (c.f. Figure 1) were considered up to the year 2013. The values of the non-NPP countries and of later missions may serve for cross checking the derived results.

Plotting the team size of the missions against the effective size of the missions and fitting a linear line on the plot results in the relation

\[ T_{opt} = 1.19 + 1.28 \times \sigma, \]  

for the initial missions, and

\[ T_{opt} = 1.38 + 0.84 \times \sigma + 0.5 \times n_{M+} \]  

for the follow-up missions, where \( \sigma \) is the size of the mission.
σ = ν * \[n_M + (n_X - 1) + 0.5(n_I - 1) + 0.25*n_P\]
as defined in Eq.(A1) in terms of the number of modules \((n_M)\), specific facilities/activities \((n_X)\), technical issues \((n_I)\) and policy discussions \((n_P)\), where \(n_M\) is the number extra new modules to be reviewed in the follow-up mission. \(ν\) quantifies the size of the nuclear program of the country.

The following ranges are offered to characterize the efficiency via the \textbf{team size} performance indicator \(T\):

\begin{itemize}
  \item \textbf{Criterion No.1 (C1 – Team size):}
    \begin{enumerate}
      \item \textbf{Green range}: \(0.9* T_{opt} < T < 1.1* T_{opt}\)
      \item \textbf{Yellow range}: \(0.8* T_{opt} \leq T \leq 0.9* T_{opt}\), or \(1.1* T_{opt} \leq T \leq 1.2* T_{opt}\)
      \item \textbf{Red range}: \(T < 0.8* T_{opt}\), or \(1.2* T_{opt} < T\)
    \end{enumerate}
\end{itemize}

This means that the team size is optimal if it is in the range of \(± 10\%\) of the optimum values in Eqs (1) and (2). The team size is acceptable if it is not optimal, nevertheless does not differ from the optimum value by more than \(20\%\), and it needs attention if the alteration is more than \(20\%\) to any direction.

Figure 2a shows the relationship of the team size and the mission size for the initial missions. Note that for follow-up missions this relationship is more scattered for the presence of the additional team members reviewing the extension modules.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{team_vs_missions_size_initial.png}
\caption{Team size – mission size relationship for initial missions}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{team_size_initial_missions.png}
\caption{Actual team size and the yellow range values in initial missions}
\end{figure}
It is worth noting that an expert consultancy on general issues of IRRS missions formulated a recommendation on the size of the IRRS teams. According to this recommendation, the average team size should be 11, 18 and 23 for missions to countries with small, medium and large nuclear programs, respectively. The recommended average size of a follow-up mission is 11 persons. The red lines in Figures 2b through 2d denote the recommended values.

In Figures 2b and 2c, the actual team size of the initial and the follow-up missions, respectively, are compared to the limits of the yellow range (±20%). Figure 2d summarizes the average team size of missions to countries with large and medium nuclear programmes and for follow-up missions, respectively.

![Figure 2c and 2d: Team size of follow-up missions and the average size of nuclear programmes](image)

### V.2 Length of the IRRS Mission Report

The effectiveness and efficiency of the IRRS team can also be characterized by their main product, i.e. by the IRRS mission report. Most naturally a report with an optimum length represents the most efficient working method and as such is expected to best contribute to the effectiveness of the mission. Reports which are too short may not capture the results of the review in sufficient details (not effective); reports which are too long may be left unread by the intended readership (not efficient).

**Relationship with the IRRS objectives**: The optimum size of the mission report may contribute to achieve the mission objectives b) *(providing the host country with a review of its regulatory technical and policy issues)* and i) *(contributing to the harmonization of regulatory approaches among Member States)* simply by providing the results in a balanced and readable form.

**Responsibilities**: Optimization of the mission report length is the responsibility of the Team Leader.

In Appendix 1, the size of a mission report is expressed in terms of the mission size and the number of findings [c.f. Eq.(A3)]. It is assumed that the mission report size depends on both these factors linearly. In order to have reference values, the data from the missions up to 2011 as in Fig. 1 were taken and the parameters in Eq.(A3) were fitted to these data with the least square method. Out of experience it was assumed that in average the mission reports are longer than they should be by about 10% [i.e. the overwrite factor in Eq.(A4) is chosen to 0,9] to yield the following expression for the optimum report length:

\[
P_{opt} = 17.5 + 5.82* \sigma + 0.63*(R + S + G),
\]

for the initial missions, and

\[
P_{opt} = 54.2 + 1.55* \sigma + 0.64*(R + S + G) + 4.27* n_{M+},
\]

for the follow-up missions, where \( \sigma \) is the size of the mission as defined in Eq.(A1), \( R, S \), and \( G \) are the numbers of recommendations, suggestions and good practices, respectively, offered in the report while \( n_{M+} \) is the number of new modules in an (extended) follow-up mission.

Let us note, that Eqs (3) and (4) duly reflect the fact that while in the initial missions the part of the report that is independent of the size of the mission and of the number of findings is relatively small \((P_0 = 17.5)\) and the main bulk is proportional to the mission size (essentially the number of modules), in case of the follow-ups, a greater part is determined by the findings in the first mission \((P_0 = 54.2)\) and only a minor part of the report depends on
the actual mission size and findings. It is interesting to see proven that the description of the findings need the same size independently of whether they derive from an initial or a follow-up mission.

Note that the number of findings in the initial mission could also be a factor in the report size of the follow ups, this, however, has not been accounted for. Also note that these values were deduced from the missions between 2006 and 2011 and have been indicative in subsequent missions. The result of this indication shall be seen below, as well as in chapters VI and VII.

The criterion related to the report length performance indicator $P$ is defined as below:

**Criterion No.2 (C2 – Report Length):**

- **Green range:** $0.9^{*} P_{opt} < P < 1.1^{*} P_{opt}$
- **Yellow range:** $0.8^{*} P_{opt} \leq T \leq 0.9^{*} P_{opt}$ or $1.1^{*} P_{opt} \leq T \leq 1.2^{*} P_{opt}$
- **Red range:** $P < 0.8^{*} P_{opt}$ or $1.2^{*} P_{opt} < P$

i.e. the report size is optimal if it is in the range of ±10% of the optimum values in Eqs (3) and (4). The report size is acceptable if it is not optimal, nevertheless does not differ from the optimum value by more than 20%. It also needs attention if the alteration is more than 20% to any direction.

The size of reports in the missions listed in Fig. 1 are compared to the limits above in Figures 3a and 3b below:

![Figure 3a and 3b: Size of reports with criterion ranges for initial and follow-up missions](image-url)
The figures show that in recent missions (i.e. in 2012 and 2013 when the optimum values were available and considered) the report length (black lines) tends to be close to the optimum values (green lines).

V.3 Time Available for ARM Review

The results and outcomes of the mission are largely influenced by the preparedness of the reviewers. This however is very much related to the time available for reviewing the Advance Reference Material. In cases where there is not sufficient time available for the reviewer to consult with the ARM, there is a real danger that the reviewer will not be properly prepared for the review which may detriment both the effectiveness and efficiency.

Relationship to the IRRS objectives: Sufficient available time for the evaluation of the ARM may contribute to achieve the mission objectives c) (providing the host country with an objective evaluation) and h) (providing reviewers from Member States and IAEA staff with opportunities to observe different approaches to regulatory oversight and broaden knowledge in their own field) since objective evaluation assumes adequate preparation of the reviewer and the same is needed in order to be able to take meaningful observations.

Responsibilities: this performance indicator is primarily determined by the time when the host countries submit the material and the influence by IAEA and by the team normally should be marginal (although this was not always the case).

For the reasons listed above, it seems to be expedient to consider the time period available for reviewing the ARM as a performance indicator of the mission. Let $t_{ARM}$ denote this time period in days and let us define the following criterion for the time available for the ARM review:

**Criterion No.3 (C3 – ARM Review Time):**

- **Green range:** $t_{ARM} > 45$ days
- **Yellow range:** $45$ days $\geq t_{ARM} > 30$ days
- **Red range:** $30$ days $\geq t_{ARM}$

Figure 4 shows the ARM review time available in recent missions.

Note that the IRRS Guidelines require the ARM to be provided at least two months prior to the mission. This, however, was often not done in recent missions; therefore, a less strict condition (45 days) has been stipulated. Moreover, disseminating the ARM too early does not increase efficiency; reviewers spend a certain amount of time with the material and do not start the review arbitrarily early prior to the mission. Furthermore, this
criterion can be handled in a less strict way e.g. by requiring that 90% of the documents be available 45 days prior to the mission thus giving the host the option of handling less important parts in a later stage.

V.4 Advance Comments from the Reviewers

As discussed above, the effectiveness of a mission largely depends on the competence and preparedness of the participating reviewers. Preparedness primarily means to be aware of the contents of the part of the self-assessment realized by the host country which concerns the module(s) reviewed (competence is treated in section V.6). In recent missions, the reviewers were requested to write down their first impressions and potential questions prior to the mission (Advance Written Comments), send the writing to the IAEA Team Coordinator and the Team Leader and present first impressions in the initial team meeting. Note that this may also contribute to the efficiency of the missions.

Let $N_{AWC}$ denote the number of Advance Written Comments i.e. the number of reviewers who prepared and sent comments to the Team Coordinator. This number will serve as a PI of the mission.

Relationship with the IRRS objectives: Advance written comments may effectively contribute to reach the objectives b) (providing the host country with a review of its regulatory technical and policy issues) and c) (providing the host country with an objective evaluation of its regulatory infrastructure with respect to IAEA safety standards) since they demonstrate that the reviewers have evaluated the self-assessment of the host country in due time.

Responsibility: Preparation of the advance written comments on the ARM is the responsibility of the team members.

It is natural to assume that in an ideal case the number of advanced written comments should be proportional to the size of the mission [c.f. Eq.(A1)]. (One could argue that comments are expected from the team members, thus the criterion should depend on the team size. However, comments are in fact needed on the modules and areas which appear in the mission size.) Therefore, a reasonable criterion of effectiveness on $N(AWC)$ may be defined in terms of mission size. We shall consider a mission optimum from this point of view if advance written comments arrive for at least 80% of the subjects in the mission size; it is still acceptable if 60% is covered, needing attention below that value. Thus the following criterion is introduced for the advance written comment performance indicator:

<table>
<thead>
<tr>
<th>Criterion No.4 (C4 – Advance Comments):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range: $N_{AWC} &gt; 0.8\times \sigma$</td>
</tr>
<tr>
<td>Yellow range: $0.8\times \sigma \geq N_{AWC} &gt; 0.6\times \sigma$</td>
</tr>
<tr>
<td>Red range: $0.6\times \sigma \geq N_{AWC}$</td>
</tr>
</tbody>
</table>

Advance written comments have only been requested in recent missions. Their numbers are shown in Figure 5 below in blue. The yellow and red bars show the corresponding ranges.
V.5 Feedback on the ARM

Quality and completeness of the ARM essentially influences the preparation of the reviewers to the missions and through that also the effectiveness and efficiency of the missions. In order to characterize the ARM, the reviewers are requested to answer the questionnaire below:

“Please offer your opinion on the Advance Reference Material (ARM) of the present IRRS mission by giving a mark to every question below between 1 and 5 (a mark 5 reflects the highest satisfaction):

- Qr1: How complete do you consider the ARM?
- Qr2: How realistic is the picture which you were able to obtain on the area you will be reviewing from the ARM?
- Qr3: What is your overall evaluation on the quality of the ARM?

Please provide any other comment related to the questions or on the ARM that you feel appropriate in order to increase the effectiveness of an IRRS mission or improve the quality of the ARM”

The marks of the answers are averaged to yield an ARM Feedback Value performance indicator

**Relationship with the IRRS objectives**: feedback on the ARM is a way to contribute to the implementation of objectives a) (providing an opportunity for continuous improvement of national regulatory bodies through an integrated process of self-assessment and review) and k) (providing real opportunities to IAEA staff to get direct feedback from the use and application of IAEA Safety Standards) since an objective criticism of the ARM may help the hosts to further improve. The textual comments may also reveal weaknesses in the IAEA standards.

**Responsibility**: Preparation of the advance written comments on the ARM is the responsibility of the team members.

The effectiveness as reflected by the ARM feedback PI is evaluated according to the criterion below:

**Criterion No.5 (C5 – ARM Feedback):**

- **Green range**: ARM Feedback Value > 4.0
- **Yellow range**: 4.0 ≥ ARM Feedback Value > 3.0 and there is no mark of value 1
- **Red range**: 3.0 ≥ ARM Feedback Value or there is (are) mark(s) of value 1

& if a mark 1 is given

This PI has been applied in most recent missions; Figure 6 below summarizes the results.

*Figure 6: Feedback on the ARM*
V.6 IRRS Experience of the Team Members

Further to what was said in section V.4, an essential constituent of the effectiveness and efficiency is the experience of the team members in the conduction of IRRS missions. The more IRRS-experienced a team member is, the more effective and efficient work can be expected from her/him. Therefore, it is expedient to characterize the expected effectiveness of a team by the relative number of reviewers who have previously taken part in IRRS missions.

**Relationship with the IRRS objectives:** Participation of team members with sufficient experience in the missions with no doubt assists in reaching the objectives d) (promoting the sharing of experience and exchange of lessons learned among senior regulators), e) (providing key staff in the host country with an opportunity to discuss regulatory practices with IRRS team members who have experience of other regulatory practices in the same field), and h) (providing reviewers from Member States and IAEA staff with opportunities to observe different approaches to regulatory oversight and broaden knowledge in their own field).

**Responsibility:** Recruiting experienced team members, is the responsibility of the Team Coordinator and of the Team Leader.

Let $\chi$ denote the ratio of the number of reviewers having such experience to the total number of reviewers (the IAEA staff is not taken into account in this performance indicator) and let us introduce the following criterion:

**Criterion No.6 (C6 – Team Experience):**

- **Green range:** $0.66 \geq \chi > 0.5$
- **Yellow range:** $0.5 \geq \chi > 0.33$, or $\chi > 0.66$
- **Red range:** $0.33 \geq \chi$

for *initial missions*, and

- **Green range:** $\chi > 0.66$
- **Yellow range:** $0.66 \geq \chi > 0.5$
- **Red range:** $0.5 \geq \chi$

for *follow-up missions*

In other words, we consider an initial mission team optimum from the point of view of experience if at least half and no more than 2/3 of the reviewers have previously taken part in IRRS missions. The experience is still acceptable if this ratio is one third. The upper limit is set to allow for the inclusion of new reviewers into initial missions. In follow-up missions the very optimum would be to have every team member from the team of the initial mission, but we still call a composition optimum with 2/3 experienced staff and in any case half of the team must be experienced.

Figures 7 illustrate the team experience performance indicator in the missions held in 2008-2013. (Altogether, there were four missions to nuclear countries before 2008, thus not much previous IRRS experience could be obtained for these missions. Therefore, these missions were left out from this analysis. Precedent IRRT missions have not been investigated from this point of view.) Green and red lines mark the range limits as defined above.

Note that this PI might be further refined by using weights representing the experience of the individual team members (e.g. equal to how many times they took part in a mission). This refinement shall be investigated in the future. Competence and qualification of the team members may also influence their expertise, yet quantification of these qualities is unsolved.
V.7 Feedback from the Host on the Initial Mission

A subjective, nevertheless meaningful and essential part of the evaluation of the mission effectiveness is based on the opinion of the host country representatives. Every mission should be concluded by filling out a short questionnaire that reflects the views of the representatives of the peer reviewed regulators. The questionnaire includes the following questions (which are in line with the main objectives of an IRRS mission):

"Please offer your opinion on the present IRRS mission by giving a mark to every question below between 1 and 5 (a mark 5 reflects the highest satisfaction):

Qh1: How effective do you consider the mission in assisting the continuous improvement of nuclear safety in the host country?
Qh2: How objective was the peer review?
Qh3: How has the mission helped the exchange of information, experience and good practice with other countries?
Qh4: How consistent was the use of the IAEA safety requirements and guides in the mission?
Qh5: How justified are the findings of the peer review?
Qh6: How relevant are the findings of the peer review for the future development of your regulatory body?
Qh7: How competent were the reviewers in their reviews and findings?

Please provide any other comment that you feel appropriate in order to increase the effectiveness of an IRRS mission"
Relationship with the IRRS objectives: the feedback from the hosts represents an excellent opportunity to reach objective k) (providing real opportunities to IAEA staff to get direct feedback from the use and application of IAEA Safety Standards).

Responsibility: Providing feedback on the mission is the responsibility of the host.

The marks of the answers are averaged to yield a Host Feedback Value performance indicator and the effectiveness is evaluated according to the criterion below:

Criterion No.7 (C7 – Host Feedback):
- **Green range**: Host Feedback Value > 4.0
- **Yellow range**: $4.0 \geq \text{Host Feedback Value} > 3.0$ and there is no mark of value 1
- **Red range**: $3.0 \geq \text{Host Feedback Value}$ or there is (are) mark(s) of value 1

The questionnaire was used in recent missions. The results are summarized in Figure 8 below.

![Host Feedback on mission](image)

Figure 8: Feedback from the host country

Note that the hosts also have the possibility to provide comments and suggestions along with every answer in the questionnaire.

V.8 Feedback from the Team on the Mission

The IRRS team members and the team leaders certainly have a clear picture on the effectiveness of their activity during the mission. It seems reasonable to ask for their opinion on that. At the end of a mission every member of the team is requested to answer the following questions:

- **Qt1**: How effective do you consider the activity of the experts of the team during the mission?
- **Qt2**: How effective do you consider the activity of the IAEA staff in the team during the mission?
- **Qt3**: How effective do you consider the activity of the Team Leader?
- **Qt4**: How effective do you consider the activity of the Deputy Team Leader?
- **Qt5**: How satisfied are you with the preparations of the mission (enough time for preparing yourself, information provided by IAEA, etc.)?

Please provide any other comment that you feel appropriate in order to increase the effectiveness of an IRRS mission
The Team Leader and the Deputy Team Leader shall not answer the questions related to themselves but shall give their opinion on each other’s activity. The answers shall be anonymous and the individual answers shall not be disclosed; only the averaged result represents a criterion of effectiveness as defined below.

Relationship with the IRRS objectives: team feedback may contribute to meeting objective k) (providing real opportunities to IAEA staff to get direct feedback from the use and application of IAEA Safety Standards) in the sense that the peer review is made against the IAEA Safety Standards.

Responsibility: Providing feedback as above is the responsibility of the team members.

A Team Feedback Value is calculated in the following way: The average mark for every question shall be 0.5 times the averaged marks of the team members plus 0.5 times the averaged marks of the team leaders (TL and DTL). Answers related to the TL and DTL are simply averaged. Then the Team Feedback Value performance indicator is just the average of the marks obtained as above from the individual answers. Similarly to the host feedback, this value defines a criterion of effectiveness as:

<table>
<thead>
<tr>
<th>Criterion No.8 (C8 – Team Feedback):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range: Team Feedback Value &gt; 4.0</td>
</tr>
<tr>
<td>Yellow range: 4.0 ≥ Team Feedback Value &gt; 3.0 and there is no mark of value 1</td>
</tr>
<tr>
<td>Red range: 3.0 ≥ Team Feedback Value or there is (are) mark(s) of value 1</td>
</tr>
</tbody>
</table>

& if a mark 1 is given

<table>
<thead>
<tr>
<th></th>
<th>3</th>
<th>4</th>
</tr>
</thead>
</table>

Again, the questionnaire was used in the latest missions and the results averaged according to the algorithm as above and are summarized in Figure 9 below.

Note that the team members also have the possibility to provide further comments and suggestions along with every answer in the questionnaire.

Let us also note that it may be worth considering the number of suggestions given by the team members to the IAEA for the improvement of the IRRS process as another criterion of effectiveness. This will be investigated in future work.

Figure 9: Feedback from the team members

V.9 Extent and Coverage of the Action Plan

As part of the Advance Reference Material, the host country prepares an Action Plan that lists those actions which are deemed necessary in order to comply with the requirements of the IAEA safety standards. On the one hand, the effectiveness of a mission can be characterized by the extent of the Action Plan (i.e. the number of items found necessary to include) and, on the other hand, by how well the team is able to cover the Action Plan through their findings. Three PI’s intended for this are given below.
A. It is commonly accepted that no matter how well-developed nuclear safety is in a country, a thorough review of the safety regime shall necessarily reveal a number of issues where further improvement can be reached. This principle is usually expressed by the term of “continuous improvement of safety”. However, the scope of the mission certainly influences the number of items that can be included in the Action plan. Consequently, it seems to be expedient to define an efficiency-related performance indicator of the self-assessment process of the host country as the number of items included in the Action Plan relative to the size of the IRRS mission.

If again $\sigma$ denotes the size of the mission as defined in Eq.(A1) and $N_{AP}$ represents the number of issues in the Action Plan, then, as it is seen from Figure 10,

$$N_{AP} = 1.5*\sigma$$

Accordingly, the performance indicator

$$\beta_0 = N_{AP}/1.5*\sigma$$

is expected to characterize the Extent of the Action Plan well.

**Relationship with the IRRS objectives:** The Action Plan Extent PI by definition may rather well characterize objective a) (providing an opportunity for continuous improvement of national regulatory bodies through an integrated process of self-assessment and review).

**Responsibility:** Reaching a good Action Plan Extent is the responsibility of the host country.

The respective criterion is defined as such that AP Extent above 1 (i.e. above average) is optimum, while the acceptable range is between 0.8 and 1.0, thus:

**Criterion No.9 (C9 – Action Plan Extent):**

- **Green range:** $\beta_0 > 1.0$
- **Yellow range:** $1.0 \geq \beta_0 > 0.8$
- **Red range:** $0.8 \geq \beta_0$

Figure 11 below shows the extension of the Action Plans of recent missions. (Note that in the US mission the Action Plan items were deduced from the executive summaries of the ARM modules.)
B. Turning to the relationship of the Action Plan and the mission findings, one measure of coverage is the *ratio of those action plan items which are reflected also by mission findings* (suggestion or recommendation). This ratio measures how far the reviewers reached in their peer review (also related to efficiency).

Let \( N_{\text{AP}} \) again denote the number of items in the Action Plan, \( N_{\text{R+S}} \) the number of findings (suggestions and recommendations) of the mission and let \( N_{\text{c}} \) be the number of coincidences (i.e. the number of those Action Plan items that have also been addressed by one or more findings). Let

\[
\beta_1 = \frac{2*N_{\text{c}}}{N_{\text{AP}}} \quad (6)
\]

then \( \beta_1 \) is called the **Action Plan Coverage value** and it is proportional to the ratio defined above.

**Relationship with the IRRS objectives:** The Action Plan Coverage PI is a good measure of the objectives f) *(providing the host country with recommendations and suggestions for improvement)* and i) *(contributing to the harmonization of regulatory approaches among Member States)* since it is related to the number of findings offered by the reviewers in order to help the host country to comply with the IAEA standards.

**Responsibility:** Coverage of the Action Plan by findings is the responsibility of the team members.

It is reasonable to expect that at least every second item in the Action Plan be an issue in the peer review, i.e. that \( \beta_1 > 1 \). Thus, the following criterion may be defined:

**Criterion No.10 (C10 – Action Plan Coverage):**

- **Green range:** \( \beta_1 > 1.0 \)
- **Yellow range:** \( 1.0 \geq \beta_1 > 0.8 \)
- **Red range:** \( 0.8 \geq \beta_1 \)

C. On the other hand, an effective mission is able to identify issues that have not been realized by the host or at least have not been included in the Action Plan. To measure this, let us introduce the following value, called **Beyond Action Plan Coverage value:**

\[
\beta_2 = \frac{2*N_{\text{R+S}}}{N_{\text{av}} + N_{\text{AP}}} \quad (7)
\]

where \( N_{\text{av}} \) is the typical average number of findings in a mission. Eq. (7) is an increasing function of the ratio \( N_{\text{R+S}}/N_{\text{AP}} \), i.e. it measures the ratio of findings beyond the Action Plan, whereas by the term \( N_{\text{av}} \) in the denominator it also reflects that if the number of Action Plan items is close to the typical number of findings/mission (i.e. if the host country did an excellent job in compiling the Action Plan) then the mission is not expected to result in much more findings than those in the AP.

**Relationship with the IRRS objectives:** The Beyond Action Plan Coverage PI is also a good measure of the objectives f) *(providing the host country with recommendations and suggestions for improvement)* and i)
(contribution to the harmonization of regulatory approaches among Member States) for the same reasons as the previous PI.

**Responsibility:** Coverage of the Action Plan by findings is the responsibility of the team members.

In past missions to nuclear countries, there were two occasions which resulted in an exceptionally large numbers of findings. Leaving those out of the averaging, the average number of findings is \(N_{av} = 39\) as also demonstrated in Figure 12 below. This value shall be used when evaluating Eq. (7). The criterion for this PI is similar to the previous ones:

**Criterion No.11 (C11 – Beyond Action Plan Coverage):**

<table>
<thead>
<tr>
<th>Range</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range:</td>
<td>(\beta_2 &gt; 1.0)</td>
</tr>
<tr>
<td>Yellow range:</td>
<td>(1.0 \geq \beta_2 &gt; 0.8)</td>
</tr>
<tr>
<td>Red range:</td>
<td>(0.8 \geq \beta_2)</td>
</tr>
</tbody>
</table>

Figure 13 below shows the values of the last two PI’s in those IRRS missions where Action Plans were available. Green and red lines mark the range limits as defined above.

Let us note here that another measure of effectiveness related to the Action Plan can be defined as the number of issues inserted into the Plan after the mission. This performance indicator, however, is not discussed here, because there is not enough data available yet to demonstrate its usefulness.

**V.10 Balance of the Findings**

Although the number of various findings does not represent any measure of effectiveness or efficiency of a mission, it has a definite correlation. It is clear that in missions with relatively numerous recommendations, the expected number of good practices shall be low and vice versa. Similarly, in a mission where the number of recommendations is high, the number of suggestions is expected to be so as well, while with a low number of recommendations, fewer suggestions are usually formulated. These heuristically obvious correlations are used for introducing two more PI’s. These PI’s are meant to indicate whether the various observations in a mission are sufficiently balanced. These PI’s are mainly related to the effectiveness of the mission.

A. The opposing trends of the recommendations and the good practices are seen in Figure 14 where the blue line shows the number of recommendations (divided by its average) and the gold line shows the number of good practices (again divided by its average) in past missions. In other words, the opposite tendencies mean that
the two quantities are negatively correlated and therefore their empirical correlation ratio is expected to be negative if calculated over efficient missions. Calculating the Pearson’s correlation coefficient as

\[
r_{xy} = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n \sum x_i^2 - (\sum x_i)^2} \sqrt{n \sum y_i^2 - (\sum y_i)^2}}
\]  

where

- \(x_i\) is the number of Good Practices in the \(i^{th}\) missions;
- \(y_i\) is the number of Recommendations in the \(i^{th}\) mission; and
- \(n\) is the number of missions taken into account.

The value of the empirical correlation coefficient is

\[
r_{GR} = -0.57
\]

Note that in the calculation of this coefficient, results of the same 18 missions were taken into account as in case of Criterion 11 above. Since the correlation coefficient is lower than -0.5, the two sets are strongly negatively correlated in statistical sense.

This observation leads to the definition of the **Balance of Recommendations and Good Practices** performance indicator. Let \(N_r\) denote the number of recommendations, \(N_G\) the number of good practices in a mission and let \(N_{Av}(R*G)\) be the average of the product \(N_r* N_G\) (as calculated in past missions). The PI describing the balance of the R’s and GP’s in a mission is defined as

\[
\rho_1 = \sqrt{\frac{N_r * N_G}{N_{Av}(R*G)}}
\]  

In Figure 14, the red line shows the values of this indicator in past missions. It is apparent that although the numbers of the recommendations and good practices assume substantially differing values in various missions, this indicator shows only moderate changes around the value 1.

**Relationship with the IRRS objectives**: a balanced mission shall contribute to achieve objective c) *(providing the host country with an objective evaluation of its regulatory infrastructure with respect to IAEA safety standards).*

**Responsibility**: for a balanced set of findings the main responsibility rests with the Team Leader whereas the team members share this responsibility.

It is reasonable to assume that in a balanced mission, the indicator in Eq. (9) falls in the neighbourhood of unity and the following criterion is defined:
Criterion No.12 (C12 – Balance of R’s and GP’s):

Green range: \[ 1.25 \geq \rho_1 > 0.75 \]

Yellow range: \[ 0.75 \geq \rho_1 > 0.50, \text{ or } 1.5 \geq \rho_1 > 1.25 \]

Red range: \[ 0.50 \geq \rho_1, \text{ or } \rho_1 > 1.50 \]

Figure 15 shows the values of the balance of R’s and GP’s indicator in recent missions along with the boundaries of the ranges. It is apparent that in the majority of the missions the balance of R’s and GP’s is either optimum or acceptable.

Let us stress that this PI does not set any requirement on the absolute numbers of observations, it only defines an optimum value for their balance.

B. The trend of Recommendations and Suggestions is expected to be similar. This is indeed seen in Figure 15 where the number of the observations in recent missions is shown.

Calculating the correlation coefficient of the two sets (leaving out the singular cases again) according to Eq. (8), we obtain that

\[ r_{RS} = 0.41 \]

i.e. in a statistical sense, the two sets are positively correlated, which can also be seen in the Figure.

This observation leads us to introduce the Balance of Recommendations and Suggestions performance indicator. Let \( N_R \) again denote the number of Recommendations, \( N_I \) the number of Suggestions in a mission, while \( N_{Av}(R/S) \) be the average of \( N_R/N_I \) over the past missions \( [N_{Av}(R/S) = 0.77] \). Then the PI characterising the balance of the R’s and S’s in a mission is defined as

\[ \rho_2 = \sqrt{\left( \frac{N_R}{N_I} \right) / N_{Av}(R/S)} \]
The relationship of this PI with the IRRS objectives is the same as of the other balance PI and shall not be repeated here. Similarly, the responsibilities are identical to those in the other case.

Again, it is reasonable to assume that in a balanced mission, the indicator in Eq. (10) falls within the neighbourhood of unity and the following criterion is defined:

**Criterion No.13 (C13 – Balance of R’s and S’s):**

Green range: \[ 1.25 \geq \rho_2 > 0.75 \]

Yellow range: \[ 0.75 \geq \rho_2 > 0.50 \text{, or } 1.5 \geq \rho_2 > 1.25 \]

Red range: \[ 0.50 \geq \rho_2 \text{, or } \rho_2 > 1.50 \]

In Figure 17, the values of the Balance of R’s and S’s performance indicator are shown for recent missions along with the boundaries of the ranges.

![Balance of Recommendations and Suggestions](image)

*Figure 17: Balance of R’s and S’s in the recent missions*

Note again that this PI does not set any requirement on the absolute number of findings; it only defines an optimum value for their balance.

**V.11 Conciseness of the Mission Report**

Although the IRRS Guidelines define the structure and contents of an IRRS report, this definition provides the report writer with quite some freedom regarding the inclusion or omission of certain details. An effective and efficient mission needs to consider every important topic of the regulatory regime of the host country. Therefore, it appears to be a good idea to compare the contents of a mission report to an “ideal one”. In this paper, ideal refers to the one report that includes all issues proved to be important in past missions. Based on the topics suggested by the IRRS Guidelines, the table of contents of an ideal mission report has been compiled. This contents was used for the comparison of the contents with the actual mission reports in the end of 2012. In the last mission of 2012 and in subsequent missions, a Standard Mission Report Template was introduced to guide the reviewers in their reviews and report writing. Since then, the Standard Template is considered to be the “ideal one” and is used for comparison purposes. An example of the evaluation of the report contents is given in Appendix 2.

It is to be noted here that an ideal report does not necessarily include a lengthy paragraph or section on every topic; rather it is expected to deal with every topic according to its actual merit and importance, sometimes only keywords related to certain subjects which need to appear in the text. Furthermore, this PI and PI No. 2 on the report length characterize the effectiveness of a report.

**Relationship with the IRRS objectives:** a concise mission report shall contribute to achieve objectives c) (providing the host country with an objective evaluation of its regulatory infrastructure with respect to IAEA safety
standards) and j) (promoting the application of IAEA Safety Requirements) in the sense that an objective peer review needs to cover all important aspects and is always based in the IAEA safety Standards.

**Responsibility:** for the preparation of a concise mission report, the Team Leader bears the primary responsibility whereas the team members share this responsibility.

Let us introduce the performance indicator *Report Contents Ratio* which is the ratio of the number of topics appearing in the mission report compared to those in an ideal report. The following criterion is defined for an effective mission:

<table>
<thead>
<tr>
<th>Criterion No.14 (C14 – Report Contents):</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Green range:</strong> Report Contents Ratio &gt; 0.90</td>
</tr>
<tr>
<td><strong>Yellow range:</strong> 0.90 ≥ Report Contents Ratio ≥ 0.80</td>
</tr>
<tr>
<td><strong>Red range:</strong> 0.80 &gt; Report Contents Ratio</td>
</tr>
</tbody>
</table>

In Figure 18, the Report Contents ratio of recent missions is shown together with the range limits.

In case of follow-up missions, the report contents is determined through the first missions, therefore, this indicator does not apply.

*Figure 18: Ratio of topics in recent mission reports to those in an ideal report*

### V.12 Completion Time of the Mission Report

The final product of a mission is the mission report and as such, in an efficient mission, it should be completed as soon as possible. The completion of the report after the end of the mission is a collective activity, it includes: editing and formatting by the IAEA, commenting by the host country and proofreading by the team leader and by the team members. The IRRS Guidelines describe in detail the time requirements for the activities above. The performance indicator of *Report Completion Time* is defined as the entire time period between the end of the mission and the submission of the report (final form sent by electronic or surface mail) to the host country to characterize the efficiency of this corporate action.

**Relationship with the IRRS objectives:** a report issued within a reasonable timeframe contributes, although indirectly, to the completion of almost all IRRS objectives

**Responsibility:** timely release of the mission report is the common responsibility of all mission participants.

The Report Completion Time indicator is then used to define the following effectiveness criterion:

<table>
<thead>
<tr>
<th>Criterion No.15 (C15 – Report Completion):</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Green range:</strong> Report Completion Time &lt; 90 days</td>
</tr>
<tr>
<td><strong>Yellow range:</strong> 90 days ≤ Report Completion Time &lt; 120 days</td>
</tr>
<tr>
<td><strong>Red range:</strong> 120 days ≤ Report Completion Time</td>
</tr>
</tbody>
</table>

Figure 19 shows the Report Completion Times in missions included in the investigations. The green and red lines denote the limits of the various ranges.
V.13 Open Issues in a Follow-up Mission

The purpose of follow-up missions is to review the progress made by the host in response to recommendations and suggestions concluded in initial missions. It is reasonable to assume that a measure of the effectiveness of the initial IRRS mission (and also of the IRRS process) may be based on the number of issues that have been closed (or are left open) by the host country. There may be several reasons for an issue to remain open (e.g. the host could not deal with the issue, the recommendation or suggestion was not properly formulated or more time is needed for the completion), this can be assessed on the basis of the host feedback before the follow-up mission as discussed in the next Chapter. Here we introduce a PI measuring the overall progress through the relative number of issues remaining open after the follow-up mission.

Relationship with the IRRS objectives: striving for keeping the ratio of open issues low shall help to reach the goals of objectives a) (providing an opportunity for continuous improvement of national regulatory bodies through an integrated process of self-assessment and review) and j) (promoting the application of IAEA Safety Requirements)

Responsibility: The host country is responsible for responding to the findings of the first mission

Based on past experience, on average, 20% of the issues remain open, thus it seems reasonable to assume that a follow-up mission with less than 20% open issues can be called optimum, whereas if more than 40% of the issues remain open, special attention is needed. Thus the following criterion is offered:

**Criterion No.16 (C16 – Open Issues):**

- **Green range:** Ratio of Open Issues < 0.2
- **Yellow range:** 0.2 ≤ Ratio of Open Issues < 0.4
- **Red range:** 0.4 ≤ Ratio of Open Issues

Figure 20 demonstrates the ratio of the number of open recommendations and suggestions and the sum of them in past follow-up missions compared to the total number of them collected initial missions.
VI. TOWARDS EFFECTIVENESS CRITERIA OF THE IRRS PROCESS

The ultimate objective of the present analysis is the elaboration of a system of quantitative criteria describing both the effectiveness and the efficiency of the IRRS process. In other words, besides the characterization of the efficiency of the particular IRRS missions, an estimation of the effect of the IRRS missions on the regulatory framework of the nuclear countries, as well as of their influence on the continuous increase of nuclear safety is to be provided. The first efforts summarized in previous chapters demonstrate that an estimation of the effectiveness of the IRRS process is not an easy, straightforward task; rather it is a complicated and long lasting process that needs to take into account a great number of qualitative and quantitative aspects of the IRRS missions.

Some of the criteria introduced are directly related to the effectiveness of the particular missions; they need to be used in future missions to provide data for the effectiveness estimation. Other criteria to be introduced below are based on the results of several missions or still need further considerations before they can provide quantitative results. It is to be stressed again that the process of analysing the effectiveness of the IRRS missions is an ongoing one, which is in its first phase of establishing the methodology and elaborating the right metrics. Application of the analysis is already possible by using the criteria so far defined; nevertheless, the finalization of a well-established method needs further efforts.

In what follows are the first hints on the quantities that can be used in the elaboration of the effectiveness criteria.

VI.1 Averaging the Individual Mission Values

As defined in Chapter IV, the final quantity to characterize a mission is the Average Measure of Deviation (of the optimum ranges) which is defined as the arithmetic average of the relative deviation values of the performance indicators of a mission. Note that the averaging method can be further refined by introducing weights that express the importance of the individual effectiveness/efficiency criteria in the evaluation of the global IRRS effectiveness and using these weights for a weighted average. Selection of such weights, however, needs either some kind of objective methodology or well-established experts’ opinions. In the present study, arithmetic averaging shall be used (c.f. Section VII.2), weights may be introduced in a continued analysis.

VI.2 Extent of the Action Plan

In Section V.9, the Extent of the Action Plan PI was introduced. This performance indicator is a good measure of the effectiveness of a particular IRRS mission as it quantitatively characterises the effect of the IRRS mission on the safety improvement process going on as a consequence of the mission. As argued in the introduction of this PI, no matter how well-developed the nuclear safety regime of the host country is, in the sense of the principle of continuous safety improvement, an effective self-assessment shall certainly result in a meaningful Action Plan. Outlining Figure 11 in Section V.9 in another form (Figure 21 below), shows the favourable development of this PI. More information on such time dependence is given in Section VI.7 below.

![Figure 21: Variation of the Action Plan Extent performance indicator](image-url)
VI.3 Feedback from the Host after the Mission

Although somewhat subjective and influenced by the immediate impressions of the mission, the feedback from the host country representatives on the effectiveness and usefulness of the mission as given according to Section V.7 may be a good contribution to the effectiveness criteria of the IRRS programme. Average values over a sensible number of missions may certainly evaluate the process in an objective manner.

Figure 8 in Section V.7 summarizes the average feedback values which are repeated in a numerical form in Table 1 below.

<table>
<thead>
<tr>
<th>Host</th>
<th>SWI</th>
<th>SWE</th>
<th>SR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.29</td>
<td>3.83</td>
<td>4.14</td>
<td>3.57</td>
<td>4.40</td>
<td>4.71</td>
<td>5.00</td>
<td>4.14</td>
<td>3.91</td>
<td>4.71</td>
</tr>
</tbody>
</table>

It can be seen that in most cases the host-feedback is rather favourable; the average mark (4.27) is in the optimum range.

VI.4 Feedback from the Host before the Follow-up Mission

As discussed in Chapter IV, certain features characterizing the effectiveness of a mission can only be assessed prior to or just at the time of the follow-up mission. Such assessment shall than contribute to the global evaluation of the effectiveness of the IRRS process rather than to that of a specific mission. A means for that is given here.

The idea is that during the preparations to a follow-up mission, the host country representatives have the opportunity to form an opinion on the effectiveness of the first mission and by answering a set of questions may contribute to the evaluation of the process. The questions and answers may conveniently be included in the follow-up ARM material.

The following questions are posed:

- “Please offer your opinion on the first IRRS mission by giving a mark to every question below between 1 and 5 (a mark 5 reflects the highest satisfaction) for each of the recommendations and suggestions:
  - Qf1: How accurate was the particular recommendation/suggestion?
  - Qf2: How helpful was the given recommendation/suggestion for the improvement of the regulatory body?
  - List those areas and issues which were not identified in the first mission but should have been!
  - Please provide any other comment that you feel appropriate in order to increase the effectiveness of an IRRS mission”

The questionnaire was used in two missions so far with the average marks as shown below:

<table>
<thead>
<tr>
<th>UK-fu2</th>
<th>RUS-fu</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.28</td>
<td>4.20</td>
</tr>
</tbody>
</table>

VI.5 Number of closed issues in a follow-up mission

The complementary value of the open issues introduced in Section V.13 may be a measure of the beneficent effect of a mission on the nuclear safety regime of the host country. Whether the absolute number, the number relative to the number of initial findings or relative to some average value is the optimum solution, needs to be investigated further.

VI.6 Number of good practices implemented in other countries

The very essence of a good practice is that it might give an indication to other Member States in how to improve their regulatory regime. The effectiveness of the IRRS process can be characterized among others by the number of those good practices established in IRRS missions and implemented in other Member States.

Good practices offered by previous missions have been collected and structured according to the IRRS modules. Host of recent as well as of future missions are requested to answer the following questions:
From the enclosed list of good practices, please select those which your organization

Qg1: has applied as good practices from past IRRS missions,
Qg2: intends to apply as good practices from past IRRS missions,
Qg3: has applied independently from the results of past IRRS missions

Summarizing the answers, one obtains a measure of the effectiveness of good practices in increasing nuclear safety worldwide; answers to the third question, however, may lead to selecting those good practices which were offered, but are not necessarily outstanding new achievements. A collection of answers to the questions above has been initiated.

VI.7 Progress by time

One of the long term effects of the performance indicator approach may be that when these indicators are accepted and observed by the IRRS programme participants, the improving individual values of the indicators may call for a general increase in efficiency of the entire IRRS process. In other words, common trends in the values of the various performance indicators well represent the general trend in the efficiency of the process. One example of such trend was shown in Section VI.2, Figure 21 through the variation in time of the PI Action Plan Extent. The increasing (i.e. improving) trend is clear.

Another example of the self-improving effect of the PI approach is related to the length of the mission reports. As already seen in Section V.2, Figures 3, and clear from Figure 22 below, an introduction of the concept of optimum report length has inspired the reviewers to produce reports accordingly.

Figure 22: Variation in time of mission report length relative to its optimum

A similar (although not so definite) trend is being observed in the number of advance comments (Section V.4). Figure 23 shows the number of such initial comments relative to their optimum value as function of time.

Figure 23: Variation in time of the number of advance comments relative to their optimum
VI.8 Operational events related to IRRS findings

This indicator was originally proposed for OSART missions. The original idea is that “if any major accident happens or significant weakness of NPP operations is reported in the nuclear media, and an OSARTs took place in the last 5 years at that plant, the OSART TL should make a critical assessment whether the OSART mission was able to identify these significant latent weaknesses or precursors and if not, why”. This idea can be transposed to the IRRS process by requiring that if any significant event that may relate to regulatory activities is reported from a country where an IRRS mission was recently conducted, a critical assessment should clarify whether the IRRS mission was able to identify related regulatory issues. A pilot study needs to be initiated to investigate the applicability of this indicator.

***

The evaluation method of the indicators proposed in the previous sections as well as further performance indicators of the IRRS process need to be elaborated in order to establish the global definition of the effectiveness criteria of the entire IRRS process.

VII. APPLICATION TO RECENT MISSIONS

In what follows, the criteria introduced in Chapter V are applied to the missions conducted to nuclear countries in 2011 - 2013. It is not possible to present a full evaluation for all of the missions since some of the data is missing because it was not provided in earlier missions (e.g. the host and team feedbacks). Furthermore, Action Plans are not prepared for every mission (not at all for follow-ups) and the report content of the follow-up missions is determined by that of the first missions and therefore may not necessarily comply with that of an ideal report. Nevertheless, the overall results are meaningful and demonstrate the applicability of the proposed method.

The missions included into the analysis are:

- Initial mission to Korea, 10-22 July 2011
- Follow-up mission to Germany, 4-10 September, 2011
- Initial mission to Slovenia, 25 September – 5 October 2011
- Initial mission to Switzerland, 20 November – 2 December 2011
- Follow-up mission to Canada, 27 November – 9 December 2011
- Initial mission to Sweden, 5-17 February 2012
- Initial mission to Slovakia, 28 May – 8 June 2012
- Initial mission to Finland, 15-26 October 2012
- Initial mission to Bulgaria, 8-19 April 2013
- Second follow-up mission to the UK, 30 September – 11 October 2013
- Follow-up mission to the Russian Federation, 11-19 November 2013
- Initial mission to the Czech Republic, 18-29 November 2013,
- Initial mission to Belgium, 2-13 December 2013

VII.1 Effectiveness/Efficiency of the Missions by Criteria

In this section, the effectiveness and efficiency performance indicators introduced in Chapter V are compared to the respective criteria values of the missions above. The results are summarized in tables. The second and third rows of the tables contain the limits of the green and yellow ranges of the indicator values, respectively; the fourth row gives the actual value of the PI; the last rows show the value of the relative distance ($\delta$) of the actual values from the optimum range as defined in section A.II.4, and the range where the performance indicator value is shown in colour (green, yellow, red) as introduced at the beginning of Chapter IV. Note that the maximum value of the relative distance is 0.30 as discussed in Section A.II.4.

The results related to the performance indicators are briefly commented.
**C1 – Team Size**

The team size in all cases except for one was optimum or acceptable. This is not a surprise as the optimum size was made fit to the data of past missions. Nevertheless, the uniform fitting to the optimum values is remarkable.

**C2 – Report Length**

In the vast majority of the missions, the report length is optimum and in the rest it is longer than optimum. This is logical, since the range has been defined with the assumption that the reports are often overwritten (c.f. section A.II.3). It is reassuring that in the newer missions, the report length is very close to optimum.

**C3 – ARM Review Time**

Time available for reviewing the Advance Reference Material was acceptable in the majority of the missions. However, they were not always optimum. As mentioned in section V.3, this is mainly due to the host countries’ timing and the effectiveness may only be increased by proper arrangements taken during the preparatory meetings. Note that although a time period of even longer than 45 days would be desirable for the reviewers’ sake (c.f. section V.3), in the light of the past experience this does not seem to be realistic.

**C4 – Advance Comments**
Requesting advance written comments seemed to be a good initiative. Although their number was seldom optimum, it was always acceptable. Perhaps the PI needs to be reconsidered.

**C5 – Feedback on ARM**

<table>
<thead>
<tr>
<th>Values</th>
<th>ROK</th>
<th>GFR-fu</th>
<th>SLO</th>
<th>SWI</th>
<th>CAN-fu</th>
<th>SWE</th>
<th>SLR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow range</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual value (AFV)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.36</td>
<td>4.05</td>
</tr>
<tr>
<td>Criterion value (δ)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.16</td>
<td>0.10</td>
</tr>
</tbody>
</table>

The reviewers seem to be critical on the ARM yet in all cases, the quality of the ARM was considered acceptable. The average mark on the ARM is 3.69. More guidance may be needed for the host on the preparation of the ARM.

**C6 – Team Experience**

<table>
<thead>
<tr>
<th>Values</th>
<th>ROK</th>
<th>GFR-fu</th>
<th>SLO</th>
<th>SWI</th>
<th>CAN-fu</th>
<th>SWE</th>
<th>SLR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td>&gt; 0.50, &gt; 0.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow range</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td>&gt; 0.33, &gt; 0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual value (χ)</td>
<td>0.40</td>
<td>1.00</td>
<td>0.50</td>
<td>0.17</td>
<td>0.60</td>
<td>0.28</td>
<td>0.25</td>
<td>0.65</td>
<td>0.24</td>
<td>0.58</td>
<td>0.91</td>
<td>0.63</td>
<td>0.5</td>
</tr>
<tr>
<td>Criterion value (δ)</td>
<td>0.20</td>
<td>0</td>
<td>0</td>
<td>0.30</td>
<td>0.09</td>
<td>0.30</td>
<td>0.30</td>
<td>0</td>
<td>0.30</td>
<td>0.12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Obviously, the teams of the follow-up missions are more experienced (even if the stricter criterion is taken into account) than those in the initial missions because several team members of the initial missions are invited to the follow-ups. Experience of the initial mission teams is often not sufficient; in many missions, the number of experienced reviewers is very low. The tendency is positive, partly due to the increasing number of experienced reviewers and partly because the IAEA puts emphasis on recruiting sufficient number of experienced participants.

**C7– Host Feedback**

<table>
<thead>
<tr>
<th>Values</th>
<th>ROK</th>
<th>GFR-fu</th>
<th>SLO</th>
<th>SWI</th>
<th>CAN-fu</th>
<th>SWE</th>
<th>SLR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td>&gt; 4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow range</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td>&gt; 3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual value (HFV)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.29</td>
<td>-</td>
<td>3.83</td>
<td>4.14</td>
<td>3.57</td>
<td>4.40</td>
<td>4.71</td>
<td>5.00</td>
<td>4.14</td>
</tr>
<tr>
<td>Criterion value (δ)</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>0.11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Host countries seem to be fairly satisfied with the results of the missions. Average value of the marks offered is 4.27.
**C8 – Team Feedback**

The feedback from team members so far available all rate missions very positively. The average mark of these ratings is 4.29.

**The feedback from team members so far available all rate missions very positively.**

**C9 – Action Plan Extent**

In the majority of the missions where an Action Plan was prepared, it was rather extensive; yet in some cases obviously no sufficient importance was attributed to a detailed Action Plan. It is also apparent that in most recent missions, the Action Plan extent was always in the optimum range.

**C10 – Action Plan Coverage**

The coverage of the Action Plans (i.e. the ratio of the number of issues in the Plans to the number of those among them that have been raised in findings) is rather good in four missions, whereas four other missions show very low coverage. The reason for this may be twofold. On the one hand, the reviewers do not realize that the Action Plans may serve as a basis for their review and findings. On the other hand, it seems reasonable that in the case of an extensive Action Plan (with large number of actions), it is more probable that the reviewers shall cover only a smaller portion of it than for an Action Plan with relatively low number of actions. This latter case is reflected by Figure 24 below showing the Action Plan Coverage values ($\beta_1$) and the Action Plan size (number of actions in the Plan relative to their average – 23) for the missions considered. It can be seen that in the case of lower size Action Plans, the coverage is higher than for larger ones.
C11 – Beyond Action Plan Coverage

The number of findings beyond the issues in the Action Plan is optimum or acceptable in six cases out of eight. One mission exhibits low performance in both coverage indicators just because the extensive Action Plan was prepared by the hosts.

C12 – Balance of Recommendations and Good Practices

The balance between recommendations and good practices is optimum or close to the optimum in case of seven missions out of nine. It is acceptable, although it is close to the red range in two cases. In case of Slovenia, this balance is lower than optimum, i.e. either the number of the recommendations or that of the good practices is too low, whereas in case of Sweden one of these numbers is too high.
C13 – Balance of Recommendations and Suggestions

<table>
<thead>
<tr>
<th>Values</th>
<th>ROK</th>
<th>GFR-fu</th>
<th>SLO</th>
<th>SWI</th>
<th>CAN-fu</th>
<th>SWE</th>
<th>SLR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
<td>1.0±0.25</td>
</tr>
<tr>
<td>Yellow range</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td>1.0±0.50</td>
<td></td>
</tr>
<tr>
<td>Actual value (\rho)</td>
<td>1.04</td>
<td>0.64</td>
<td>0.93</td>
<td>-</td>
<td>1.30</td>
<td>0.85</td>
<td>0.72</td>
<td>0.76</td>
<td>-</td>
<td>1.24</td>
<td>1.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criterion value (\delta)</td>
<td>0</td>
<td>0.15</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The balance between the recommendations and the suggestions show a picture similar to the case of the R-GP balance, i.e. in the majority of the missions it is optimum, in the other cases it is acceptable. The two balances suggest that in the case of Slovenia, the number of Recommendations is lower than what would be yielded optimum PIs.

C14– Mission Report Contents

<table>
<thead>
<tr>
<th>Values</th>
<th>ROK</th>
<th>GFR-fu</th>
<th>SLO</th>
<th>SWI</th>
<th>CAN-fu</th>
<th>SWE</th>
<th>SLR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td>&gt; 0.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow range</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td>&gt; 0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual value (RCR)</td>
<td>0.91</td>
<td>-</td>
<td>0.74</td>
<td>0.80</td>
<td>-</td>
<td>0.79</td>
<td>0.80</td>
<td>0.83</td>
<td>0.81</td>
<td>0.96</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criterion value (\delta)</td>
<td>0</td>
<td>0.18</td>
<td>0.11</td>
<td>0.12</td>
<td>0.12</td>
<td>0.08</td>
<td>0.10</td>
<td>-</td>
<td>-</td>
<td>0.19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This indicator is uneven but there are no major deviations. From the detailed data it can be seen that in case of the Slovenian mission, mainly the inspection and enforcement modules resulted in the red range indicator. For the Swedish mission, the authorization and the review and assessment modules had the most lacking items; in the Slovak mission, the authorization and the management system modules were considerably below the average. In the Belgian mission, missing items were more or less uniformly distributed over the entire report.

C15 – Mission Report Completion Time

<table>
<thead>
<tr>
<th>Values</th>
<th>ROK</th>
<th>GFR-fu</th>
<th>SLO</th>
<th>SWI</th>
<th>CAN-fu</th>
<th>SWE</th>
<th>SLR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
<td>&lt; 90</td>
</tr>
<tr>
<td>Yellow range</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
<td>&lt; 120</td>
</tr>
<tr>
<td>Actual value (RCT)</td>
<td>89</td>
<td>99</td>
<td>143</td>
<td>148</td>
<td>51</td>
<td>55</td>
<td>114</td>
<td>64</td>
<td>47</td>
<td>160</td>
<td>122</td>
<td>103</td>
<td>117</td>
</tr>
<tr>
<td>Criterion value (\delta)</td>
<td>0</td>
<td>0.10</td>
<td>0.30</td>
<td>0.30</td>
<td>0</td>
<td>0</td>
<td>0.27</td>
<td>0</td>
<td>0</td>
<td>0.30</td>
<td>0.30</td>
<td>0.14</td>
<td>0.30</td>
</tr>
</tbody>
</table>

The time spent with the completion of the mission report is satisfactory in most cases, although there are unacceptable large values, usually for specific reasons.

C16 – Open Issues in Follow-ups

<table>
<thead>
<tr>
<th>Values</th>
<th>ROK</th>
<th>GFR-fu</th>
<th>SLO</th>
<th>SWI</th>
<th>CAN-fu</th>
<th>SWE</th>
<th>SLR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green range</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td>&lt; 0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow range</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td>&lt; 0.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual value (ROI)</td>
<td>-</td>
<td>0.23</td>
<td>-</td>
<td>-</td>
<td>0.06</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.03</td>
<td>0.34</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Criterion value (\delta)</td>
<td>0.17</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.30</td>
<td>0.30</td>
<td>0.14</td>
<td>0.30</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The few follow-up missions in the period of interest performed quite well, two optimum and two acceptable numbers of open issues were recorded.

Let us note that this PI is included to measure the effectiveness/efficiency of the follow-up mission although it is a characteristic of the entire IRRS process held for the given host. This refinement shall be reconsidered during the continuation of the work.

VII.2 Overall Effectiveness of the Missions

Averaging the distances from the optimum ranges throughout all performance indicators of a mission as introduced in Chapter IV, results in the Average Measure of Deviation denoted by $\Delta$. The overall effectiveness of a mission is then determined by the criterion also introduced there.

Putting together the results listed for the various performance indicators in the previous section yields Table 2 below.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>ROK</th>
<th>GFR-fu</th>
<th>SLO</th>
<th>SWI</th>
<th>CAN-fu</th>
<th>SWE</th>
<th>SLR</th>
<th>FIN</th>
<th>BUL</th>
<th>UK-fu2</th>
<th>RUS-fu</th>
<th>CZR</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 – Team Size</td>
<td>0</td>
<td>0.2</td>
<td>0.03</td>
<td>0</td>
<td>0</td>
<td>0.01</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C2 – Report Length</td>
<td>0.11</td>
<td>0.08</td>
<td>0</td>
<td>0</td>
<td>0.08</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C3 – ARM Review Time</td>
<td>0.13</td>
<td>0.16</td>
<td>0.18</td>
<td>0.3</td>
<td>0.00</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>0.17</td>
<td>0.08</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C4 – Advance Comments</td>
<td>-</td>
<td>-</td>
<td>0.12</td>
<td>0</td>
<td>0.20</td>
<td>0.04</td>
<td>0</td>
<td>0.16</td>
<td>0.08</td>
<td>0</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C5 – ARM Feedback</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0.16</td>
<td>0</td>
<td>0.12</td>
<td>0.11</td>
<td>0.08</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>C6 – Team Experience</td>
<td>0.20</td>
<td>0.00</td>
<td>0.30</td>
<td>0.09</td>
<td>0.30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C7 – Host Feedback</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>0.11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C8 – Team Feedback</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C9 – Action Plan Extent</td>
<td>0.30</td>
<td>-</td>
<td>0.14</td>
<td>0.30</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C10 – Action Plan Coverage</td>
<td>0.30</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.30</td>
<td>0</td>
<td>0</td>
<td>0.29</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0.16</td>
</tr>
<tr>
<td>C11 – Beyond AP Coverage</td>
<td>0.02</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>0.30</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C12 – Balance of R and GP</td>
<td>0</td>
<td>-</td>
<td>0.15</td>
<td>0</td>
<td>0.18</td>
<td>0.04</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C13 – Balance of R and S</td>
<td>0</td>
<td>-</td>
<td>0.15</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0.06</td>
</tr>
<tr>
<td>C14 – Mission Report Contents</td>
<td>0</td>
<td>-</td>
<td>0.18</td>
<td>0.11</td>
<td>0.04</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td>C15 – Report Completion Time</td>
<td>0</td>
<td>0.10</td>
<td>0.30</td>
<td>0.30</td>
<td>0</td>
<td>0</td>
<td>0.27</td>
<td>0</td>
<td>0</td>
<td>0.30</td>
<td>0.30</td>
<td>0.14</td>
<td>0.30</td>
</tr>
<tr>
<td>C16 – Open Issues</td>
<td>-</td>
<td>0.17</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0.30</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average Measure of Deviation ($\Delta$)</td>
<td>0.096</td>
<td>0.092</td>
<td>0.101</td>
<td>0.094</td>
<td>0.078</td>
<td>0.070</td>
<td>0.088</td>
<td>0.061</td>
<td>0.053</td>
<td>0.075</td>
<td>0.095</td>
<td>0.015</td>
<td>0.058</td>
</tr>
<tr>
<td>Average over missions</td>
<td>0.075</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Summary of the PI criterion values of recent missions
It is rather reassuring that although there are performance indicators that need attention in all missions, the overall performance of the missions in all but one case, falls into the effective range. This may evidence that the effectiveness and efficiency of the IRRS process – although may certainly be increased – are not far from the expectations. The results summarized in Table 2, however, suggest that there is plenty of room for investigation of the specific reasons for certain performance indicators falling into the red range.

Note again that weights might be attributed to the individual PI’s to characterize their importance in the averaging process. Such a weighted averaging – if the weights are selected properly – may make the estimate of the overall effectiveness even more realistic. Proper selection of the weights, however, needs further considerations and experimental data.

Let us stress here again that the performance indicator values in Table 2 and all throughout this report characterize the effectiveness and efficiency of the IRRS missions led in various countries and representing no indication whatsoever on the safety performance of the host country of the missions.

The variation in time of the Average Measure of Deviation of the various missions is shown in Figure 25.

![Figure 25: Variation in time of the Average Measure of Deviation of missions](image)

The conclusion drawn in connection with Table 2 is well reflected by the figure. As it is shown by the trend line – with certain fluctuations – the effectiveness and efficiency of missions tend to increase in time.
APPENDIX 1: DEFINITION AND DERIVATION OF SPECIFIC QUANTITIES

A.I Notations

- \( R \) - Number of recommendations
- \( S \) - Number of suggestions
- \( G \) - Number of good practices
- \( n_M \) - Number of IRRS modules in the mission, modules are defined in the IRRS Guidelines, Appendix I.
- \( n_{M+} \) - Number of the supplementary IRRS modules in the follow-up mission (which were not reviewed in the first mission)
- \( n_X \) - Number of specific facility and activity types in the mission for which all core regulatory activities are reviewed (e.g. research reactors or radiation sources, c.f. IRRS Guidelines, Appendix I in relation with Modules 5 – 9).
- \( n_T \) - Number of additional, or thematic areas in the mission, thematic areas usually belong to Module 11, as defined in the IRRS Guidelines, Appendix I.
- \( n_P \) - Number of policy issues in the mission. Policy issues are requested by the host as defined in the IRRS Guidelines
- \( P \) - Number of pages of the mission report
- \( T \) - Number of team members in a mission
- \( \nu \) - Size of the nuclear program in the host country

A.II Definitions

A.II.1 Size of the mission

The size of a mission can be characterized by the number of modules and by the number of general issues as well as by the thematic areas included. It also depends on the size of the nuclear program of the host country. Let \( \sigma \) denote the effective size of an IRRS mission and let us define

\[
\sigma = \nu \times [n_M + (n_X - 1) + 0.5(n_T - 1) + 0.25n_P].
\]

Note that the expression above assumes that at least one specific facility/activity is always present, whereas the first thematic area is considered to form Module 11, included in \( n_M \). Therefore, only the second specific facility/activity type and thematic area represent an extra size. This definition of the size expresses the assumption that every supplementary specific facility/activity can be considered equivalent to a module (since these topics appear in all core regulatory modules), every supplementary technical issue increases the size of a mission by about half of what a module represents, whereas a policy issue needs the effort about ¼ of a module. The weight of the supplementary technical issues derives from the fact that there is a large variety of technical issues with well-defined limited scope that can be included in a mission and usually several of them are present. The factor \( \nu \) that takes into account the size of the nuclear program in the country is defined as follows:

\[
\nu = \begin{cases} 
0.6 & \text{for small programs (no NPP, few facilities/activities)} \\
0.8 & \text{for medium programs (less than 5 NPP units, few facilities/activities)} \\
1.0 & \text{for large programs (at least 5 NPP units and/or many facilities/activities)}
\end{cases}
\]

The data of past missions used in the derivations are given in the table below.
A.II.2 Team size – mission size relationship

We can assume that the work to be done in an initial mission has a constant component and one that is proportional to the size of the mission and also that the size of the team (the number of the team members) is proportional to the work to be performed. Accordingly

\[ T = T_0 + \lambda_T \sigma, \quad (A2a) \]

where

- \( T_0 \) is the team-size constant
- \( \lambda_T \) is the team-size factor

to be determined numerically (e.g. by regression) from the data of the past IRRS missions. In case of a follow-up mission, sometimes new modules that have not been reviewed in the first mission are introduced in the scope of the mission (extended follow-up missions). Peer review of such supplementary modules usually takes more effort than the follow-up modules. To account for this, the team size of the follow-up missions is approximated by the formula

\[ T = T_0 + \lambda_T \sigma + 0.5 \lambda_M n_{M^+}, \quad (A2b) \]

where

- \( n_{M^+} \) is the number of supplementary modules

It is to be noted that these modules are also included in the mission size \( \sigma \) through \( n_M \) thus the third term in Eq.\((A2b)\) expresses the extra workload due to the new module type.

A.II.3 Size of the mission report

It is reasonable to assume that the size of the mission report is the sum of three components. One component is a constant that represents the introductory and more or less permanent descriptive parts, the second is proportional to the size of the mission (which implies that each module needs certain description) and the third is proportional to the number of observations (meaning that substantiation of the observations needs to be given in writing). Thus the number of report pages is

\[ P = P_0 + \lambda_M \sigma + \lambda_F (R + S + G), \quad (A3a) \]

where

- \( P_0 \) is the report-size constant,
- \( \lambda_M \) is the modules page-factor, and
- \( \lambda_F \) is the findings page-factor.

The constant and the factors are to be determined from the data of the past IRRS missions (e.g. by regression analysis). Again, in case of extended follow-up missions, the description of the newly included review areas may need text size different from the texts related to the modules in the follow-up review. This can be expressed in terms of the difference of the modules-page factors for initial and for follow-up missions, thus for follow-up missions the number of report pages reads

\[ P = P_0 + \lambda_M(fup) \sigma + \lambda_F(R + S + G) + [\lambda_M(init) - \lambda_M(fup)] n_{M^+}, \quad (A3b) \]

where

- \( \lambda_M(init) \) and \( \lambda_M(fup) \) are the modules page-factors for the initial and the follow-up missions, respectively

Experience of past IRRS missions shows that most of the reports are “overwritten”, i.e. are somewhat longer than they really should be. Therefore, when defining the optimum length of a mission report (to be denoted by \( P_{opt} \)) we introduce

- \( \mu \) as the overwrite factor

(where \( \mu < 1 \)) and we define the optimum report length as
$P_{\text{opt}} = \mu P$, \hspace{1cm} (A4)

where $P$ is given in Eqs.(A3) and $\mu$ is chosen arbitrarily, based on subjective judgement of the general overwriting.

### A.II.4 Relative distance from the optimum range

In order to define the overall effectiveness of a mission, the individual performance indicator values need to be assessed from the point of view of their proximity to their optimum range. Let the optimum range of the performance indicator $x$ be the interval between the values $x_1$ and $x_2$. The relative distance $\delta$ of the $x$ value of the performance indicator from the optimum range is defined as below:

If $x < x_2$ then \[ \delta = \frac{(x_1-x)}{x_1}; \]

if $x_1 \leq x \leq x_1$ then \[ \delta = 0; \] \hspace{1cm} (A5)

if $x_2 < x$ then \[ \delta = \frac{(x-x_2)}{x_2}. \]

The figures behind the formula illustrate the definition of the relative distance $\delta$. Clearly, the farther the actual value of the performance indicator is, the larger the relative distance is. The distance is zero if the value of the performance indicator falls into the optimum range. The value of $\delta$ characterizes well the performance of the mission in the area of the indicator.

**The value of $\delta$ is maximized to 0.3**, i.e. should it take a value greater than 0.3, it is set to 0.3. This is done in order to avoid that an extremely wrong performance of a single indicator might determine the effectiveness of the entire mission.
### APPENDIX 2: EVALUATION OF THE MISSION REPORT CONCISENESS – an example

**Conciseness of the Mission Report**

<table>
<thead>
<tr>
<th>Report section</th>
<th>in scope</th>
<th>in report</th>
<th>M</th>
<th>Module-wise</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 1.1 National policy and strategy</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.81</td>
</tr>
<tr>
<td>I 1.2 Establishment of a framework for safety - legal background covering all activities and facilities</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.81</td>
</tr>
<tr>
<td>I 1.3 Establishment of a regulatory body - legal authority</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.81</td>
</tr>
<tr>
<td>I 1.4 Compliance with regulations and responsibility for safety - prime responsibility for safety</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.81</td>
</tr>
<tr>
<td>I 1.5 Coordination of different authorities with responsibilities for safety within the regulatory framework</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.81</td>
</tr>
<tr>
<td>I 1.6 System for protective actions to reduce existing or unregulated radiation risks</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.81</td>
</tr>
<tr>
<td>I 1.7 Provision for decommissioning of facilities and the mgmnt of rad. waste and spent fuel - gov.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.81</td>
</tr>
<tr>
<td>I 1.8 Competence for safety - required for all parties with responsibilities for safety</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.81</td>
</tr>
<tr>
<td>I 1.9 Provision of technical services</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>II 2.1 International obligations and arrangements for international cooperation</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>II 2.2 Sharing of operating experience and regulatory experience</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>III 3.1 Organizational structure of the regulatory body and allocation of resources - organization</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.89</td>
</tr>
<tr>
<td>III 3.2 Effective independence in the performance of regulatory activities - independent decision making</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>III 3.3 Staffing and competence of the regulatory body - sufficiency and competence of staff</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>III 3.4 Liaison with advisory bodies and support organizations - advisory bodies</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.89</td>
</tr>
<tr>
<td>III 3.5 Liaison between the regulatory body and authorized parties - meeting types and schedules</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>III 3.6 Stability and consistency of regulatory control - predictability</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>III 3.7 Safety related records - scope of records to be kept</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>III 3.8 Communication and consultation with interested parties - interfaces with the media and the public</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>IV 4.1 Implementation and documentation of the MS - existence, defined, integrated</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.89</td>
</tr>
<tr>
<td>IV 4.2 Management responsibility - demonstration of commitment</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.89</td>
</tr>
<tr>
<td>IV 4.3 Resource management - determination of needs and requirements</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.89</td>
</tr>
<tr>
<td>IV 4.4 Process implementation - identification, documentation of processes, process owners</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>IV 4.5 Measurement, assessment, improvement - self-assessment</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>V 5.1 Generic issues - roles and responsibilities in authorization</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td>V 5.2 Authorization of nuclear power plants - application for authorization</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.88</td>
</tr>
</tbody>
</table>
5.3 **Authorization of research reactors**
- safety committees, communication with the reactor manager 0 0
- licensing of personnel 0 0
- ageing management 0 0
- experimental devices 0 0

5.4 **Authorization of fuel cycle facilities**
- specific authorization requirements for facilities 0 0

5.5 **Authorization of radioactive waste management facilities**
- specific authorizations requirements 1 1
- authorization of closure of disposal facilities 1 1
- hazards associated with industrial and health applications 1 1
- reuse or recycling 1 1
- authorization of export and import of sealed sources 1 1

5.6 **Authorization of radiation sources facilities**
- specific authorization requirements 1 1
- preservation of key staff 1 0
- responsibilities of financial provisions 1 0
- demonstration of compliance with the decommissioning plan 1 0

5.7 **Authorization of decommissioning activities**
- specific authorizations requirements 1 1
- preservation of key staff 1 0
- responsibilities of financial provisions 1 0
- demonstration of compliance with the decommissioning plan 1 0

5.8 **Authorization of transport activities**
- specific authorization requirements 1 1

---

**VI**

6.1 **Generic issues**
- graded approach for the various facilities 1 0
- responsibility for the R&A 1 1
- safety assessment has to address all radiation risks 1 0

6.2.1 **Management of R&A (NPP)**
- availability of internal guidance for R&A 1 1
- availability of R&A plan 1 1
- documentation, monitoring, tracking, QA of the R&A process 1 1
- graded approach 1 1

6.2.2 **Organization and technical resources for R&A (NPP)**
- staff competence and training for R&A 1 1
- external resources, advisory bodies 1 1
- specific regulatory R&A tools (codes, experiments) and 1 1

6.2.3 **Bases for R&A (NPP)**
- availability of relevant regulations and guides for the licensee 1 1
- guidance on the scope of probabilistic/deterministic safety analysis 1 1

6.2.4 **Performance of the R&A (NPP)**
- methods for verification of comprehensiveness and quality 1 1
- periodic safety review 1 1
- feedback of operating experience 1 0

6.3 **R&A for research reactors**
- specific R&A methods 0 0
- periodic safety review 0 0

6.4 **R&A for fuel cycle facilities**
- specific R&A methods 1 1
- periodic safety review 1 0

6.5 **R&A for waste management facilities**
- specific R&A methods 1 1

6.6 **R&A for radiation source facilities**
- specific R&A methods 1 1

6.7 **R&A for decommissioning activities**
- specific R&A methods 1 1

6.8 **R&A for transport activities**
- specific R&A methods 1 1

---

**VII**

7.1.1 **Inspection approaches, methods and plans**
- inspection areas and aspects related to facilities and activities 1 1
- graded approach 1 0
- types and methods of inspections 1 1
- inspection plans 1 1
- use of third parties and joint inspections 1 0

7.1.2 **Inspection processes and practices**
- procedures, guides, check lists 1 1
- observation, recording, reporting 1 1
- follow-up and use of inspection results 1 0

7.1.3 **Inspectors**
- manpower, qualification, training 1 1
- resident inspectors, presence of inspectors on-site 1 1
- authority of inspectors (unlimited access, enforcement tools) 1 1

7.2 **Inspection of nuclear power plants**
- specific issues from 7.1 1 1

7.3 **Inspection of research reactors**
- specific issues from 7.1 0 0

7.4 **Inspection of fuel cycle facilities**
- specific issues from 7.1 1 1

7.5 **Inspection of waste management facilities**
- specific issues from 7.1 1 0

7.6 **Inspection of radiation source facilities**
- specific issues from 7.1 1 1

7.7 **Inspection of decommissioning activities**
- specific issues from 7.1 1 1

7.8 **Inspection of transport activities**
- specific issues from 7.1 1 1

---

**VIII**

8.1 **Enforcement policy and process**
- graded approach 1 1
- enforcement processes, tools and powers 1 1
- appeal 1 1

8.2 **Enforcement implementations**
- roles of inspectors and the regulatory body 1 1
- guidance, training and criteria for enforcement 1 1
| IX | 9.1 | Generic issues | - process of development and promotion of regulations and guides | 1 | 1 |
|    |     |             | - graded approach | 1 | 1 |
|    |     |             | - review and updating of regulations and guides | 1 | 0 |
|    |     |             | - specific review and assessment topics (PSA, PSR, OEF, SAM) | 1 | 1 |
|    |     |             | - specific authorization topics | 1 | 0 |
|    | 9.2 | R&Gs for nuclear power plants | - regulatory requirements and guidance on design | 1 | 1 |
|    |     |             | - regulatory requirements and guidance on operation | 1 | 1 |
|    | 9.3 | R&Gs for research reactors | 0 | 0 |
|    | 9.4 | R&Gs for fuel cycle facilities | 1 | 1 |
|    | 9.5 | R&Gs for radioactive waste management facilities | - requirements on national policy and strategy | 1 | 0 |
|    |     |             | - requirements on the identification, control and minimisation of radioactive waste | 1 | 1 |
|    |     |             | - requirements on waste acceptance criteria | 1 | 1 |
|    | 9.6 | R&Gs for radiation sources facilities | 1 | 1 |
|    | 9.7 | R&Gs for decommissioning activities | - decommissioning strategy, financial provisions, retaining key staff | 1 | 0 |
|    |     |             | - compliance with the end state criteria | 1 | 1 |
|    |     |             | - availability of guides to meet TS-R-1 requirements | 1 | 1 |
|    | 9.8 | R&Gs for transport activities | - covering all modes of transport | 1 | 1 |
|    |     |             | - availability of guides to meet TS-R-1 requirements | 1 | 1 |

| X  | 10.1 | General requirements | - basic responsibilities | 1 | 1 |
|    |     |             | - assessment of threats | 1 | 1 |
|    | 10.2 | Functional requirements | - establishing emergency management and operation | 1 | 1 |
|    |     |             | - identifying, notifying, activating / assessing initial phase | 1 | 1 |
|    |     |             | - taking urgent protective and/or mitigatory actions/protecting | 1 | 1 |
|    |     |             | - providing information / keeping the public informed | 1 | 1 |
|    | 10.3 | Infrastructural requirements | - plans, procedures | 1 | 1 |
|    |     |             | - availability of emergency response facilities | 1 | 1 |
|    |     |             | - training, drills, exercises | 1 | 1 |

| XI | 11.1 | Control of medical exposures | 1 | 1 |
|    | 11.2 | Occupational radiation protection | - general responsibilities (registrants, licensees, employers, workers) | 1 | 1 |
|    |     |             | - requirements for radiation protection programmes | 1 | 1 |
|    |     |             | - monitoring programmes and technical services | 1 | 1 |
|    | 11.3 | Control of rad. discharges and materials for clearance, remixing, monitoring and reporting | - dose constraints in the R&Gs | 1 | 1 |
|    |     |             | - regulatory limits for discharges from facilities and activities | 1 | 1 |

| XII | 12.1 | Legal basis | - existence of legal framework for oversight and enforcement | 1 | 1 |
|    | 12.2 | Regulatory oversight activity | - related regulatory programme and organization | 1 | 1 |
|    |     |             | - authorization, inspection, enforcement activity | 1 | 1 |
|    |     |             | - operational experience feedback | 1 | 1 |
|    | 12.3 | Interface with other authorities | - cooperation and distribution of responsibilities and activities | 1 | 1 |