Independent Peer Review of

Regulatory Science Information

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INTRODUCTION

This manual describes the independent peer review processes developed by the Institute for Regulatory Science (RSI) that support regulatory science activities conducted by government agencies at the federal, state, regional, or local levels; various segments of industry; and other organizations. Consistent with the historic tradition of science, the RSI peer-review process provides an unbiased, independent, economical, and timely response to those organizations needing support on specific actions related to regulatory science.

Before the requirements of independent peer review are discussed it is necessary to define regulatory science. Although regulatory science is a distinct scientific discipline, it encompasses numerous areas of study, as do other scientific disciplines such as physics, chemistry, or biology. Consequently it is often collectively referred to as "regulatory sciences" to include the various regulatory activities ncies that deal with regulatory toxicology, regulatory pharmacology, regulatory ecology, regulatory atmospheric sciences, regulatory engineering, etc. to mention a few. The most recent definition of regulatory sciences is as follows:

> *Regulatory Sciences consist of those scientific disciplines that constitute the scientific foundation of regulatory, legislative, and judicial decisions.*

Appendix I of this manual includes a brief description of Metrics for Evaluation of Regulatory Science Information (MERSI) that is based on Best Available Science (BAS) and Metrics for Evaluation of Scientific Claims derived from BAS. A closer look at the nature of regulatory sciences indicates that in most favorable cases, regulatory sciences fall in the Partially Reproducible Science Class. This class consists of information that relies upon Reproducible Science (either Proven or Reproducible Evolving Science) but uses assumptions, judgments, and often default data to draw conclusions.

Consequently, the traditional peer review of a project, as performed routinely by many scientific and engineering organizations for their technical publications, may have to be modified to accommodate the unique needs of regulatory sciences.

STRUCTURE OF THE PEER REVIEW PROGRAM

A properly managed peer review process requires compliance with several key criteria:

1. It is critical that written policies are established to ensure that all parties involved in the process understand and follow the requirements of the independent peer review process.

2. A Review Panel (RP) consisting of at least three reviewers must review the project under consideration.

3. A Committee must oversee compliance with policies including the election of the reviewers. This committee must ensure that the reviewers are qualified, that they are independent with no conflicts of interest, and that proper peer review policies are followed.

4. The peer review process must be transparent so that stakeholders can observe the process and obtain relevant information without jeopardizing the confidentially requirements of specific projects.

Required Qualifications of the Reviewers

The key to the success of every peer review is the selection of qualified reviewers. The selection of a reviewer must be based on the totality of that individual's qualifications as follows:

Education: A minimum of a B.S. degree in an engineering or scientific field is required for any peer reviewer. In practice, most reviewers likely have advance degrees as well.

Professional Experience: Because of the rapid advancement in scientific and engineering fields, relevant professional experience is equally or more important than are earned academic degrees. Consequently, significant experience in the area under review is necessary.

Peer Recognition: Participation in activities that demonstrate recognition by one's professional peers is necessary to qualify as a peer reviewer. Examples of appropriate activities might include election to office of a professional society, service on technical committees of scholarly organizations, receipt of relevant awards, etc.

Contribution to the Profession: The reviewer's contribution to professional advancement may be demonstrated by publications, particularly those in peer-reviewed journals. Additionally, patents or other professional work product are also considered.

Conflict of Interest

Members of the Review Panel must be completely independent and have no conflict of interest with the process under review. The ideal member of the panel is someone who is intimately familiar with the subject matter but with no monetary interest in it. Despite this apparent difficulty, the scientific and engineering communities have been successfully performing peer reviews and scientific assessments without having a real or an apparent conflict of interest for a very long time. The guiding principle for conflict of interest in

peer reviews as defined by a team of the American Society of Mechanical Engineers and the Institute for Regulatory Science is as follows:

> *Those who have a stake in the outcome of the review may act as a reviewer or as a participant in the selection of the reviewers.*

In order to comply the guiding principle every reviewer must sign a statement (see Appendix II) indicating a lack of conflict of interest in the outcome of the review. Note that although the subject of conflict of interest is complex, there are several key criteria for the evaluation of the conflict of interest of members of the RP.

Financial Interest: If the result of a regulatory scientific activity would positively or negatively impact an individual's finances, that individual would have a conflict of interest.

Personal Interest: The author of a document has a personal conflict of interest in reviewing it. Similarly, there is a potential conflict of interest if the result of the scientific activity would impact the immediate family of an individual.

Institutional Interest: The participation of an individual in peer review activities by those who are affiliated with an organization may be associated with a conflict of interest, especially if the result of the scientific activity would impact the standing of that organization.

Intellectual Interest: There are individuals who are committed to a certain approach, religious belief, an idea, or process and their commitment may preclude them to be objective.

Peer Review Panels

The peer review of a project is performed by a Review Panel (RP). The number of individuals constituting a Panel depends upon the

complexity of the subject to be reviewed or assessed. A typical panel consists of at least three individuals and, depending upon the nature of the subject, may be significantly larger. Members of a panel are selected based on appropriate qualifications and competencies in the area under review.

The following categories are common for peer review regulatory science activities:

Document Review: In this category, the Review Panel reviews a document to assess its scientific validity. This is the least extensive form of peer review and in most cases the interaction between panel members is conducted electronically, making it unnecessary for the panel to meet.

Single Project Review: As the name describes, these panels typically meet and perform a review of one project. Although very popular at one time, increasingly this type of panel is being replaced by "Document Review" using electronic communication.

Review of Complex or Multiple Projects: Panels in this category are made up of at least five individuals who meet in person and conduct a review of either a single complex project or of several similar projects. Occasionally, these panels visit specific facilities in order to review the planning, operation, and other aspects of projects at that facility.

Review of Competing Submissions: This type of peer review is commonly used to review grant submissions and other competing project proposals. Although the number of individuals on a review panel for competing submissions depends upon the number and nature of the submissions, no fewer than three people are required to review each submission.

Rapid Response Reviews: These provide a review of a specific and limited technical issue requiring a rapid response. This review requires that the panel have access to unique infrastructure and specific personnel.

Criteria for Peer Review

The work of a Review Panel is guided by specific questions or points that are called review criteria, review questions, or lines of inquiry. Although there are a number of generally applicable criteria for peer reviews, regulatory science peer review activities must ensure that the chosen criteria take its unique nature into consideration. The generic review criteria used by scientific journals and funding agencies consist of three primary points: scientific validity, originality, and scientific creativity. There are numerous other criteria covering style, format, and relevancy to the mission of the scientific journal or funding agency. There are also specific criteria for investigators seeking funding who intend to use radioactive, chemical, or microbiological agents, competency of the investigators, and other requirements. Some of these criteria could be applicable to regulatory science activities. However, the following list provides guidance for preparation of project-specific review criteria relevant to regulatory science:

Scientific and engineering validity: One of the most important aspects of any project is its consistency with established scientific and engineering principles and industry standards. The panel must verify that these standards are met or exceeded in the project under review.

Regulatory Science Information: The panel is responsible for verifying that the project identifies and justifies all assumptions, judgments and the selection of default data.

Other Criteria: There are numerous other criteria that must be included in the peer review of regulatory science activities. For example, the panel needs to inquire as to whether the scientific judgment used in a regulatory science activity is consistent with the legal mandate.

Oversight Committee

An Oversight Committee must be formed to oversee peer review of a particular program covering one or multiple projects. The selection process for members for the Oversight Committee is similar to that described for members of a Review Panel. In creating the Oversight Committee, an attempt must be made to ensure that all required competencies and a diversity of technical views applicable to the process under review are represented. Specific functions of the Oversight Committee include the following:

1. As the overseer of the entire peer review or technical assessment, the Oversight Committee enforces all relevant policies including compliance with professional and ethical standards.
2. The Oversight Committee approves the appointment of Review Panel members based on the criteria described above.
3. The Oversight Committee reviews and approves all peer review reports in various stages of their development in order to ensure compliance with peer review policies, not to impact the outcome of the report.

Review Panel Reports

Each member of the Review Panel is expected to participate in the preparation of the *Review Panel Report*, which contains a compilation of the panel members' comments as well as the outcome of the review. The *Review Panel Report* contains some or

all of the following parts:

- An introduction or preface describing activities that led to the preparation of the *Review Panel Report*
- An executive summary of the report
- A description of the peer review process
- A summary of the subject that was reviewed
- A description of the review criteria used and the findings of the Review Panel including both the shortcomings and meritorious aspects of the project
- Recommendations set forth by the Review Panel
- References to any and all documents used during the review
- Biographical summaries of each member of the Review Panel, the Oversight Committee, and any others who participated in the review
- Appendices containing any comments by the reviewers upon which no consensus could be reached or that were considered to be beneficial to the investigators and managers but were not important enough to be included in the main body of the *Review Panel Report*

Despite the complexity of the items described above, the *Review Panel Report* could be as short as a few pages or as long as several hundred pages.

STAKEHOLDER PARTICIPATION

There is ample evidence suggesting that stakeholder participation enhances the appreciation of the decision making process. In particular, the participation of stakeholders in the peer review process increases the probability of their acceptance of the solutions resulting from the peer review. Stakeholders are primarily

concerned with the review criteria used in the peer review process. Consequently, the development of these criteria should take stakeholder concerns into consideration. Experience shows that stakeholder comments are taken seriously by the Review Panels and thus provide a powerful incentive for stakeholder participation. The impact of comments by the stakeholders is the main reason for their acceptance of the results of peer review. There are several categories of stakeholders that should be engaged early in the peer review process. These stakeholder categories can be described as follows:

Personally Impacted: Personally impacted stakeholders are people who are directly affected by the outcome of the proposed action. The impact may be in regard to personal health, financial gain/loss, alteration of property value, or notable changes in other aspects of life that may cause discomfort of inconvenience such as noises, smell, etc.

Administratively Impacted: These stakeholders are the elected, appointed, or employed individuals that will ultimately be responsible for implementing the action resulting from the peer review process. Elected officials may represent groups of Personally Impacted Stakeholders while employees of governmental regulatory agencies or of private industries are primarily responsible for preparing and issuing permits, licenses, and enforcing regulations that support the proposed action.

Generally Concerned: This group of stakeholders is not personally impacted by the outcome of the decision but they hold an interest in the outcome nonetheless. Advocacy organizations or citizen groups typically represent these interests.

Process Concerned: Process Concerned Stakeholders are a

subset of the general public that are primarily concerned with the overall fairness of the peer review and decision making processes. These individuals seek to ensure that all categories of stakeholders are engaged and heard, that the science used in decision making is evaluated and determined to be the Best Available Science, and that no single group of stakeholders is given undue influence over the process.

Decision Makers: This category encompasses the people or the organizations that initiate the proposed change, for example the executives of a corporation or the government officials responsible for the proposed action. Other examples might include a manager of the agency proposing new regulations or an individual or company proposing construction of a new facility. As the initiators of the proposed action, these individuals have a clear stake in the outcome of the peer review process.

Facilitators: Facilitators are the individuals or organizations that are responsible for implementing the actions of the Decision Makers. This might include company or regulatory agency employees, or any other individuals with a key role in facilitating the process under review.

Identification of and Communication with Stakeholders

Stakeholder participation is important to the integrity of the decision making process. In order to ensure adequate participation, members of each stakeholder category must be identified and notified so that they might become engaged in the process. The identification and notification of each group must be consistent with the manner in which they will be impacted by the action under consideration.

Personally Impacted: Since members of this group typically

live or work near the existing or proposed facility in question, they may be identified either by physical address or through local professional organizations that would keep lists of those directly involved. Through experience, it is clear that members of this category are often reluctant to participate in the process unless they perceive the impact of the proposed action to be particularly imminent. As a result, an Affirmative Outreach approach is typically required to encourage their participation. Such an approach includes mailing invitations, contacting individuals by phone, or going door to door to speak with those potentially affected.

Administratively Impacted: Administratively Impacted Stakeholders can typically be identified through the institution or organization for which they work, or elected officials can be easily identified through their constituency. Once identified, they can be notified either in writing or by phone.

Generally Concerned and Process Concerned: Members of both of these groups are usually either affiliated with advocacy groups or other organizations or are simply concerned individuals. Either way, they must be self-identified as there is no other means by which to find them. Once this had occurred, large-scale notification can be accomplished through electronic media or printed information.

Decision Makers and Facilitators: Similarly to the Administratively Impacted Stakeholders, both Decision Makers and Facilitators can be identified based on their employment or affiliation with a company, organization, or agency and therefore notified in writing or verbally on that basis.

APPENDIX I

METRICS FOR EVALUATION OF REGULATORY SCIENCE INFORMATION (MERSI)

There is a significant confusion regarding the nature of regulatory sciences and how one assesses the validity of regulatory science claims. The details of this problem are addressed in a report prepared for the Japan Science and Technology Agency. Briefly, Metrics for Evaluation of Regulatory Science Information (MERSI), as described below, was derived from the concept of Best Available Science and Metrics for Evaluation of Scientific Claims. There are four Fundamental Principles that govern MERSI and three Pillars that implement these principles; they are described below.

Fundamental Principles

Open-Mindedness Principle: This principle implies that the regulatory science community and the general public must be willing to consider new knowledge and new scientific claims.

Skepticism Principle: This principle requires that it is incumbent upon those who make a scientific claim to provide sufficient evidence supporting their claim. The Skepticism Principle provides balance and ensures that the Open-Mindedness principle is not misused.

Universal Scientific Principles: The Universal Scientific Principles (USP) are a set of basic principles and standards that apply to virtually all of the scientific disciplines including regulatory sciences.

Reproducibility Principle: Reproducibility is the proof of validity of any scientific claim, and separates undisputed areas of science from those that include assumptions and interpretations.

Pillar: Classification of Scientific Information

It is well established that science evolves and that new discoveries, advancement of scientific knowledge, and numerous technologies result from the evolution of science. Therefore, it is necessary to classify scientific information in terms of its level of maturity and its reproducibility.

Class I: Proven Science. This class consists of scientific laws (or principles) and their application. The scientific foundation of information included in this class is understood and meets the requirements of the Reproducibility Principle. These concepts are predictable and reliable. As the majority of information covered in regulatory sciences seldom qualifies as Proven Science, further discussion is not required.

Class II: Evolving Science. The overwhelming majority of scientific advancements are included in this class.

Reproducible Evolving Science: Reliable and reproducible information dealing with a subject that is not completely understood constitutes the core of this class. Much of medical science provides a good example of Reproducible Evolving Science. Like Class I (Proven Science), information in this class meets the Reproducibility Principle. However unlike Proven Science, the scientific foundation of information in this class is often either unknown or the knowledge is incomplete.

Partially Reproducible Science: Formerly referred to as Rationalized Science or Scientific Extrapolation this class includes certain segments of regulatory science information including predictive models. Although it builds upon Proven or Reproducible Evolving Science, it uses assumptions, extrapolations, and default data to derive its results. An important characteristic of this class is its level

of reproducibility. Whereas the scientific foundation of this class meets the Reproducibility Principle the choice of assumptions, mathematical processes, default data, and numerous other prerequisites are inherently arbitrary and thus are not necessarily reproducible.

Evidence-Based Science: This class attempts to correlate systematic observations performed in accordance with Universal Scientific Principles to an effect. There is an extensive literature covering this class including a large segment of epidemiology. Experience shows that correlation does not necessarily imply causation and as expected, some correlations have correctly identified their cause but others have proven to be unrelated. Much of evidence-based medicine belongs to this class.

Hypothesized science: Hypothesized science consists of an organized response to an observation, an idea, or any other initiating thought process. It is not necessarily based on Proven or Reproducible Evolving Science. For obvious reasons, this class does not comply with the Reproducibility Principle.

Scientific Judgment: In the absence of scientific information, decision makers may call upon scientific experts to make an educated judgment. There is an accepted methodology for this process that involves asking multiple qualified and knowledgeable individuals to answer specific questions and statistically assessing the results. Even so, the results are still tantamount to an educated guess.

Speculation: Speculation does not meet the standards for any of the discussed classes of scientific information addressed above. It is based solely on the opinion and intuition of an individual. Often the objective of

speculation is to initiate a research project or stimulate a scientific discussion.

Fallacious Information: Most unfortunately, the scientific community and the general public are often provided fallacious information presented as science. Often called "junk science" or "pseudo science," some of the science provided to the regulators by special interest groups qualifies as fallacious information.

Pillar: Reliability of Scientific Information

This Pillar requires a formal and generally acceptable process to categorize the reliability of scientific information. Consequently, scientific information is divided into several distinct categories in ascending level of reliability

Category I: Personal Opinions. Expression of views by individuals regardless of their training, experience, and social agenda are seldom reliable.

Category II: Gray Literature. Reports prepared by government agencies, advocacy groups, and others that have not been subjected to an independent peer review are included in this category. Gray Literature is often no more reliable that personal opinion. Note that people who claim that regulatory sciences are not normal, research-driven, or academic, often claim that this category constitutes the bulk of regulatory sciences.

Category III: Peer-Reviewed Science. The acceptability of a scientific claim requires that it has passed strict scrutiny by independent scientific peers. an acceptable peer reviewer is an individual who is capable of understanding and performing the project under review with little or no additional study. Furthermore, the reviewer must also be independent and without conflict of interest. Despite its acknowledged shortcomings a peer review is the only available mechanism to

assess the validity of a scientific claim, aside from reproducing the actual claim.

Category IV: Consensus-Processed Science. In the consensus process an expert panel, convened in a manner similar to that described for Review Panels, evaluates the proposed information. Since much of regulatory science falls into the Rationalized Science, Hypothesized Science, and occasionally the Borderline Science classes, it is not surprising that contradictory information can be found in peer-reviewed literature covering a specific subject. In such cases, the consensus process increases the likelihood that its outcome would be consistent with the information that will result from relevant future studies. The consensus process of evaluation is similar to that used for independent peer review.

Pillar: Outside the Purview of Science

One of the most often violated requirements of regulatory science is the inclusion of societal objectives, ideology, beliefs, and numerous other non-scientific issues. On occasion, the regulators claim that they must include societal objectives in their scientific activities to be protective of human health, the ecosystem, and numerous other worthwhile goals. What is being overlooked is that all of these goals, as desirable as they might be, are outside the purview of science and must be addressed after the scientific issues have been resolved. The confirmation of this Pillar is provided by the Ruckelshaus Effect which states that "…all scientists must make it clear when they are speaking as scientists –*ex cathedra*- and when they are recommending policy they believe should flow from scientific information…."

APPENDIX II

DECLARATION REGARDING CONFLICT OF INTEREST

FOR MEMBERS OF THE REVIEW PANEL

I certify that I am unaware of any matter which may reduce my ability to participate in an unbiased and professional manner in the peer review program as a member of the Review Panel for the project listed below. In making this certification, I have considered all my financial interests and employment arrangements and those of my spouse and minor children.

Program, Project, or Topic:

_____

Signed: _____Date:_____

Name: _____

REFERENCES

ASME/RSI (American Society of Mechanical Engineers/Institute for Regulatory Science) Assessment of technologies supported by the Office of Science and Technology, Department of Energy: Results of the peer review for the fiscal year 2002. New York, NY ASME Press 2003

Love B R, Straja SR, Streeter JR, Jones SD, and Moghissi AA. Stakeholder Participation: A New Process and Its Application to Environmental Decisions. *Technology* 11; 61-74: 2010

Moghissi AA, Swetnam S, Love BR, Straja SR. Best Available Science: Fundamental metrics for evaluation of scientific claims. Arlington, VA Potomac Institute Press 2010

Moghissi AA, McBride DK, Amin M. Regulatory Sciences: Description of disciplines, education, ethics. Tokyo, Japan Science and Technology Agency, 2011

Moghissi AA, Love BR, Straja SR. Peer review and scientific assessment: A handbook for funding organizations, regulator agencies and editors Cambridge UK Cambridge University Press 2011

OMB (Office of Management and Budget). Final information quality bulletin for peer review. *Federal Register* 70; 2664-2677: 2005