

Argonne National Laboratory

Material Science Division (MSD) Project Safety Review

Description

Version 2, June 12, 2008

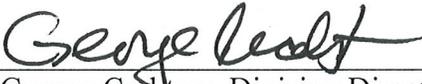
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1. Introduction

The project safety review is the primary implementation tool of Integrated Safety Management in the Materials Science Division. It is a required process for all experimental work at Argonne (ES&H Manual, Section 21.2). **Experimental work may not be performed until the experiment safety review has been completed, procedures have been approved, and the work has been authorized.**¹ This document applies the requirements of 21.2 to the Materials Science Division and gives additional guidance for a successful experiment safety review.

A complete experiment safety review consists of documentation with approval signatures and, except for low risk activities, a facility walk-down by independent reviewers to verify the completeness of the hazard analysis and the implementation of controls. The safety review documentation contains the following parts:

- Safety Analysis Form (see section 5 for detailed instructions and additional guidance) with approval signatures
- Participant Signature Form
- Supporting experiment description documents (designs, drawings, etc.)
- Operating procedures consistent with the hazard analysis
- Copies of required permits (e.g. Laser Operating Permit)
- NEPA Environmental Review Form unless experiment falls under an approved site wide categorical exclusion (only AAO-CX-160 "Bench Scale Research" is relevant to MSD)
- Other supporting documents as appropriate

Authorization to start work may be given with the final approval of the safety review, or separate authorization may be required at the discretion of the Division Director.

The rigor of safety review should be commensurate with the risks, hazards, and complexity of the experiment (Graded Approach).

2. Definitions, Acronyms

Approval

Authorization

Complexity

Experiment

Hazard

Operating Procedure

Project

Risk

Safety Review

Safety Review Documentation

¹ ESH Manual 21.2.3 (responsibilities of the lead experimenter)

Safety Review Team

Subject Matter Expert

Standard Operating Procedure

DD Division Director

ECR Environmental Compliance Representative

NEPA National Environmental Protection Act

SAF Safety Analysis Form

3. Responsibilities

The general responsibilities of Division Management, Line Supervisors (Group Leaders), Principal Investigators (PI, "lead experimenter" in ESH Manual), and others are described in the ESH Manual (21.2). The most important points and those specific to MSD are described here.

The **Division Director** must:

- Establish and maintain a safety review process
- Approve required safety review
- Determine whether the approval constitutes work authorization or a separate authorization step is needed
- Appoint safety review teams as needed to provide for an objective review
- Coordinate with other divisions the review of projects that are carried out by participants from multiple divisions

Line Supervisors must:

- Ensure that all experimental work under their supervision is covered by a project safety review
- Ensure that all project reviews are updated when the scope of the work or the hazards associated with the project change
- Verify that all Argonne requirements are addressed in the project review documentation and work procedures
- Report emergency notifications to division management

Principal Investigators must:

- Provide sufficient advance notice of proposed experiments or significant modifications in scope or hazard to enable a project safety review to be performed prior to performing the experiment
- Prepare appropriate documentation required for the project safety review. At the minimum, this consists of filling out the MSD Safety Analysis Form
- Assist the review team leader in the assignment of a risk level that will determine the rigor of review

All **Project Participants** (Experimenters) must:

- Read the approved project review documentation, including the Safety Analysis Form and all work procedures that pertain to their work, and certify annually that they have read them
- Follow all work procedures approved with the project safety review
- Keep required experiment records
- Inform the principal investigator of any unusual experiment outcomes
- Be familiar with all experiment-specific emergency procedures, location of emergency equipment and egress routes
- In emergencies call 911 and immediately notify their supervisor (if not available, work up the management chain), and the building manager

The members of the **Safety Review Team** must:

- Review submitted review documentation and provide feedback to the principal investigator in a timely fashion
- Participate in experiment walk-downs
- Participate in the formulation of the review team comment that becomes part of the project safety review record

The **Chair (or Co-Chairs) of the Safety Review Team** must:

- Add the consensus comment of the review team to the safety review documentation
- Sign the safety review documentation when a project is approved
- Enlist the help of additional experts (e.g., Argonne designated Subject Matter Experts) for high risk projects or for those where additional expertise is needed to make an informed approval decision
- Facilitate the communication between the team members and the PI, and make the arrangements for an experiment walk-down where required

The **Environmental Compliance Representative** must:

- Review each project to determine whether the NEPA process has been carried out, and if not, assist the PI in the submission of the necessary documentation to the NEPA Owner.
- Assist the safety review team in the assessment of proposed waste handling procedures during the review process

The **ESH Coordinator** may assume the duties chair (or co-chair) of the safety review team. In any case, the ESH Coordinator must:

- In the early stages of the review, and in consultation with the principal investigator, determine the risk level of the project
- Assist the PI and the safety review team in technical safety-related questions at all stages of the review
- Coordinate with the Divisional Records Coordinator the means by which a set of completed safety review documents is maintained for the Division
- Coordinate the annual review of existing project review documentation and the updating of the participant signature lists

The **Divisional Records Coordinator**

- Maintains the division copy of the project review documents in readily retrievable form

4. The Review Process

The safety review process is initiated by the Principal Investigator (PI, "lead experimenter" in ESH Manual 21.2) under the following circumstances:

- Prior to a new project
- When planning significant modifications (a simplified process is available for minor modifications, see section 3.3)
- Periodically (annual review of existing documentation, full review every three years, see section 4.2)
- When directed by line management

4.1 Procedure for Full Review

Sufficient lead time must be given to ensure completion of the review before the experiments are started. Steps 1 to 15 may be handled by electronic transfer of documents. Signatures will be applied to a hardcopy. Additional documents, such as permits, procedures triggered by the review process, and additional supporting documents identified by the review process are added as soon as they become available. Blank safety analysis forms and participant signature lists are available on the MSD intranet at <http://www.msd.anl.gov/resources/esh/>. The ESH Coordinator may be consulted at any time to provide guidance in the process.

1. PI submits draft safety analysis form and supporting documents to ESH Coordinator.
2. ESH Coordinator assigns number.
3. ESH Coordinator and PI agree on review category: high hazard/complexity vs. low hazard/complexity. Division Director has final authority in case of disagreement.

High hazard/complexity:

4. ESH Coordinator (advised by PI) identify review team (members of standing Safety Review Team, official Subject Matter Experts, other experts with relevant expertise) optionally assigns a chair² to coordinate the review
5. Chair distributes submitted documents to review team.
6. Review team members review documents, make comments and suggestions, return to chair.
7. Based on returned comments and suggestions, if extensive revision of the documentation is required, returns to PI for revision; repeat steps 5 to 7 until no more major revisions are required. Minor revisions may be saved for step 10.
8. Chair arranges for a meeting of the review team with the PI at a location near the proposed experiment, advises team on required PPE (safety glasses, TLD badges, etc.) necessary to visit experiment location.
9. At the meeting, the documentation is discussed, reviewed and the experiment (or its proposed location) is visited.

² Two co-chairs may be enlisted instead of a single chair

10. Team decides whether no revisions (to experiment or documentation), minor revisions, or major revisions are necessary. The PI is responsible for making the changes and resubmitting to the Chair (return to step 5 for major revisions, repeat step 10 for minor revisions).

Low hazard/complexity:

11. ESH Coordinator identifies a small review team (in some cases, a single person is sufficient) and a chair for this review.
12. Chair distributes submitted documents to team for review.
13. Review team members review documents, make comments and suggestions, return to coordinator.
14. Based on returned comments and suggestions, if extensive revision of the documentation is required, documentation returns to PI for revision; repeat steps 12 to 14 until no more revisions are required.

All levels:

15. Divisional Environmental Compliance Representative verifies that environmental impact has been properly characterized and mitigated, decides whether further NEPA review is necessary (step 17 may be concurrent with 15 and 16).
16. If necessary, NEPA review is carried out (ECR, NEPA Owner, NEPA Site Coordinator, DoE Site Office).
17. Coordinator inserts written review team comments (including review cycle requirement) in safety analysis form and inserts names of committee members.
18. An electronic version of the complete safety review document will be retained by the PI to facilitate later re-reviews and submission of experiment modifications. This electronic copy is also be retained by the divisional ESH Coordinator.
19. PI signs hard copy of Safety Analysis Form, prepares Participant Signature Form.
20. Coordinator (and divisional ESH Coordinator if different) signs hard copy.
21. Division director decides whether the review documentation may serve as authorization to start work immediately³, or whether a separate authorization is necessary.
22. Division director signs Safety Analysis Form.
23. ESH Coordinator, with the assistance of the divisional records coordinator, retains a copy of the signed complete safety review document for divisional file.
24. PI retains signed original safety review document and places it in the primary laboratory for this experiment as a readily retrievable and conspicuously placed document. Copies must also be placed in all other laboratories where this project is carried out.
25. PI collects signatures from all participants who certify that they have read the review documentation, that they have the required training, and that they will follow the procedures contained therein. The signed Participant Signature Form is returned to the ESH Coordinator, where it is added to the divisional file copy of the safety review documentation.

³ Conditional on required permits (e.g., laser operating permit)

4.2 Periodic Review

The PI must review the experiment **annually** and certify (by memo or e-mail to the ESH Coordinator) that no significant modifications have taken place in the experiment to warrant a full review. Concurrence by the ESH Coordinator is required.

All participants are required to sign the Participant Signature Form **annually**.

All experiments must be fully reviewed at a cycle recommended by the review team, the ESH Coordinator, or the Division Director, not to exceed three years.

The PI promptly informs the ESH Coordinator of changes in the participant list. New participants are added to the current Participant Signature Form, where they sign (additional forms may be used). Removals from the list are noted on the form by the ESH Coordinator.

The PI promptly informs the Division Director and the ESH Coordinator when a project is terminated.

4.3 Minor Modifications to Existing Projects (Supplements)

A simplified process will be utilized for the review of projects where a modification of the project scope leads to minor deviations from the original safety envelope. The principal investigator should consult with the ESH Coordinator if there is uncertainty whether a modification qualifies as minor, or the entire project review document should be updated with the modifications incorporated and the full review process utilized (section 4.1).

The same Safety Analysis Form as for the full review shall be used, with the following adaptations:

- Supplements must always be considered in conjunction with the original safety review document, never as stand-alone documents.
- Assign a project number that derives from the main project number by adding a decimal fraction, e.g., the first modification to project 60001 becomes 60001.1
- Use the same title as the main project, then add "Supplement:" and the nature of the modification.
- For all narrative sections, describe the changes from the original version (and all supplements prior to the current one).
- Complete the hazards checklist (section 2.1).
- If any associated procedures need to be modified, indicate so in the appropriate sections of the safety analysis form and attach them to the form.
- The principal investigator signs the submitted safety analysis form and any updated procedures.
- If the modification is minor enough as to not introduce any new hazards (safety analysis form 2.1) or environmental impact, the supplement may be reviewed by the ESH Coordinator, who, after resolution of any deficiencies in the documentation, will sign in lieu of a review team.
- If the modification introduces a new hazard or significantly changes the environmental impact of the project, a more thorough review, preferably by the same team that reviewed the original project safety review, will be conducted, in analogy to a full review.

- The supplement is submitted to the Environmental Compliance Representative who will verify that no additional environmental impact arises .
- The supplement is submitted to the Division Director for authorization.
- The division retains a copy of the supplement. The signed original is returned to the principal investigator.
- It is the duty of the principal investigator to notify all participants of the modification. Copies of the supplement must be added wherever the main document and previous supplements are kept.

5. Detailed Form Instructions

5.1 Safety Analysis Form

This Safety Analysis Form is grouped by the five ISM steps:

1. Define scope of work
2. Analyze hazards
3. Define and implement controls
4. Perform work within controls
5. Feedback

The title page of the form contains basic information of the project. List all FWPs. If this project is funded entirely by other sources, provide sufficient detail. Add a list of all attachments after the table of contents.

Section 1 contains the description of the project. The general overview (1.1) should contain sufficient scientific background to inform the operational description. A project often contains multiple components. Define these (1.2) and include additional information as required. Supporting attached documents are often useful to provide more detail. Single scientific projects often deal with a large variety of materials and experimental conditions. As it is impossible to list them all, try to define the limits of the project (1.3), such that it is possible to verify later whether a particular variation or set of conditions falls within the reviewed safety margins. For equipment-centered projects, define the types of samples that are acceptable and those that are not. Remember to include peripheral actions in the project description, e.g., sample mounting, post-synthesis processing, or routine clean-up operations that involve hazardous chemicals. If this project obtains samples from, or produces samples for other projects, these other projects should be mentioned.

It is essential that the scope of the project is described very carefully, hence you should give this section your utmost attention. On the one hand, it should not be too narrow, in order not to constrict future work. On the other hand, it cannot be excessively broad because it would be impossible to document all hazards potentially present in the project, and their mitigation. This is the document that describes how you will be doing work for the next few years!

Section 2 identifies the hazards encountered in the project. An extensive list of possible hazards is given in appendix A to section 21.2 of the ESH Manual. A subset relevant to most work in MSD is presented in section 2.1, with the possibility to add others (examples: peroxide-forming chemicals, strongly oxidizing or reducing agents, ultraviolet radiation). Note that in some rare

cases, the hazard may be marked as unknown (toxicity, carcinogen). The hazard control described in section 3 should treat unknown hazards as if they were present. All of these hazards must be addressed and described in more detail in subsection 2.2 (except hazardous waste, which is described in 2.3). Section 3 (hazard control) returns to these hazards, therefore you should limit yourself to the description of the hazard in 2.2. For the purpose of ISM, the generation of waste and environmental impact (water and air) are considered analogous to hazards. Details are described in subsections 2.3 and 2.4; the controls are addressed in section 3.

Note that in Buildings 200 and 223, the disposal of chemicals into drains is essentially banned due to the condition of the piping. There is no current building-wide restriction in Building 212, although there may be posted locations where such disposal is prohibited. For all other locations, section 10.4 of the Argonne ESH Manual gives procedures to determine whether a particular liquid may be disposed into the drain, and it indicates that all locations where such disposal takes place must be registered, and detailed records of what is disposed must be kept.

This section of the form also contains the PI's judgment whether the project could be considered bench-scale research (defined as a research activity where a single experiment, measurement, or test uses less than 5 gallons or 5 lb of hazardous material or less than 1 lb of extremely hazardous material) or not. Most experiments in MSD are bench-scale, but there are a few exceptions. Finally, the hazards of the project need to be analyzed in the context of other nearby projects and the emergency planning for the building where it is housed.

The building emergency plans list the locations of certain broad types of hazards, e.g., chemical, flammable, laser. They also contain statements regarding safe-shutdown procedures for emergency situations. It is essential that these emergency plans really reflect the actual situation because they are consulted by first responders such as the Fire Department, and you should contact the area emergency supervisor if you find discrepancies, so that these plans can be updated.

The emergency plan for Bldg. 223 is available on the MSD intranet website. The plans for Buildings 200 and 212 are not currently available on-line to non-emergency personnel, but the building managers and/or area emergency supervisors can let you look at them if necessary. The MSD ESH Coordinator also has paper copies of these plans. At the time of this writing (June 2008), selected relevant information regarding experiment-related hazards and procedures is summarized as follows⁴:

Item	Bldg. 200	Bldg. 212	Bldg. 223
Area emergency supervisor	Tory Steed	John Herman	Deon Ettinger
Building Manager	Tory Steed	John Herman	Mick Pahnke
Equipment requiring shutdown before sheltering	Not listed	Responsibility of individual project (known for EMC)	None

⁴ Specific room locations only listed if occupied by MSD

Equipment considerations during evacuation	Not listed	Responsibility of individual project (known for EMC)	None
Radiological hazards, radiologically controlled areas	Yes (A158)	Yes (MSD X-ray not listed; G-wing accelerator)	Radiation-producing equipment (D104, D126, A226, A234, D226), but no radioactive materials
Laser hazards	Yes (D110)	Yes	Yes
Pressure hazards	Not listed	Yes	Yes
Vacuum hazards	Not listed	Yes	Yes
High voltage	Yes (throughout building)	Yes	Yes
Furnaces	Not listed (but present at least in A174, D102)	Yes	Yes
Cryogen hazards	Yes	Yes	Yes
Chemical hazards	Yes (all labs)	Yes	Yes
Carcinogens	Yes (A114, A178, A182, B150, B154, B158, B168, D102, D142, D166)	Not listed	Yes (minimal)
Biohazards	Not listed	Not listed	No
Special nuclear materials	Yes (not MSD)	Yes	No
Flammable metals	Not listed (but present at least in A114)	Not listed	Yes
Access via cyberlocks, keypad, bar code readers	Not listed (after-hours building and computer room access via bar code reader)	Not listed (after-hours building access via bar code reader)	No

Section 3 returns to the hazards of section 2 and addresses the controls that are applied for all of them. The first line of defense should be design and engineered controls, i.e., barriers and other installed devices that prevent the hazard from causing harm. Automatic hazard alarms may be included in this or the following subsection. The limitation to minimal amounts of hazardous chemicals and other agents may be considered an additional designed hazard control feature. Where engineering controls are not possible, or to supplement them, procedural and administrative controls are implemented, such as warning signs or checklists. All applicable safety procedures should be attached to the safety analysis form.

Personal protective equipment (PPE) should be the last defense against hazards; it should be listed in section 3.3. The description should be specific, e.g., include the material and minimum thickness of gloves. Training (3.4) is another form of hazard control. See Appendix A for a cross reference of hazard categories, corresponding questions on the Job Hazards Questionnaire,

and Argonne-provided safety classes. The next three subsections deal with the safe handling of chemicals, samples, and wastes and should be self-evident.

Emergency equipment and procedures (including hazard communication to emergency responders) are addressed in 3.8. Again, be as specific as possible. In some buildings, eyewash stations and emergency showers are located in every lab, but this is not the case in other buildings. It is essential that all participants know the locations of this equipment and are able to reach it quickly (usually defined as: within 10 seconds and without obstructions that require the use of hands to remove). For projects using hydrofluoric acid, the emergency equipment must be within the same room.

Subsection 3.9 gives an opportunity to document any relevant hazard control that was not specifically asked for in the previous sections. In the final subsection, 3.10, relevant references should be listed, e.g., sections of the ESH Manual, the MSD Chemical Hygiene Plan, or other references. Only list those references that actually provide useful guidance on hazard control, not pointer and general requirements documents.

Section 4 contains the safety information most relevant while the work is performed, such as the procedures that are followed, and any monitoring and medical surveillance during and after the work. Health Physics personnel should be contacted to arrange for the issuance of dosimeters. See ESH Manual section 4.3.8 regarding hazard monitoring using equipment that is owned by the users/project (for radiological monitoring, see 5.9, 5.19, 5.27).

The information entered in **section 5** details how the work experience is used to improve the safety experience for the project. The feedback mechanisms should list how both problems (emergencies, unexpected results) and good results (including ideas for making the experiment even better) are communicated. (ISM core function 5 has traditionally not been addressed well in the experiment safety review, and others are very interested in seeing how MSD is implementing it.)

Section 6 is only filled out if radioactive materials are involved in the project. The requested information is utilized in the divisional radioactive materials inventory.

Section 7 contains the certifications, approvals, and authorizations. The PI signs the certification at the beginning of the section. The remainder is filled out by the review team and division officers.

Technical Notes:

The form is set up in two main text styles: All user-entered text should be in style Normal (font Arial, dark blue), whereas the preprinted form is in style Prefill Text (font Times New Roman, black), in order to improve legibility. Formatting problems arise when text including format controls is pasted from other documents or applications. For best results, use menu command Edit > Paste Special > "Unformatted text".

Please fill in the form header: on the left-hand side, last name of PI followed by the title of the project (abbreviate to fit), on the right-hand side the project number as soon as it is assigned. In the form footer, the <version> should indicate a version number for this project. Original review documents should start with version 1.0. For renewals, increment the version number by a full unit from the previously reviewed version. Complete project documents,

whether original or renewals, should be prefixed by the word "Version", e.g., "Version 2.0". Supplemental submissions should increment the decimal number and be prefixed by the word "Supplement", e.g., "Supplement 1.2"

Please update the automatic table of contents before final printout: right-click (PC) or command-click (Mac) into the table of contents, from the contextual menu select "Update Field", then "Update page numbers only".

5.2 Participant Signature Form

All participants are expected to sign that have read the Project Safety Review Documentation referenced at the top of the form and will obey all requirements stated in the document, its accompanying procedures, and in the relevant portions of the ANL safety manuals. The certify that they have received the required training, and that their Job Hazards Questionnaire (JHQ) accurately reflects their work as a participant in this project.

This form is to be signed by all participants when the review is complete, and before work can start. The original signatures are retained by the Division together with the division copy of the project review documents. A copy of the signature form is returned to the PI who attaches it to the original project review documents and all posted copies thereof.

Additional participants may be added at a later date. Their signatures may be added to the others on the original form, or an additional form may be used, as long as it clearly marked to be an addendum.

It is the PI's responsibility to communicate to the Division via the ESH Coordinator when participants are removed from the project. Their signatures will be struck through on the original form, and the PI's are expected to do so on their copies.

This form is to be signed by all participants annually.

Appendix A: Hazards vs. JHQ vs. Safety Classes

This cross-reference is based on the matrix of JHQ vs. training requirement as of 3/21/08. This matrix may change at any time. The selection of JHQ is representative, but individual situations may trigger additional questions to be checked. Supervisors of those working with specific hazards should look for corresponding supervisor questions nearby in the JHQ. Nobody working on experimental projects should have question G5 checked!

<i>Hazard</i>	<i>JHQ Questions</i>
Chemical Hazards	C3.1.1, PPE questions in P11, P13, usually EN1.2
Use of toxic chemicals	C3.1.1, (C5, C6 if applicable), PPE questions in P11, P13
Use of flammable chemicals	C3.1.1, PPE questions in P11, P13
Use of carcinogenic chemicals	C3.1.1, C6.9.1/2, specifically listed carcinogens in C6, PPE questions in P11, P13
Generation of hazardous or toxic wastes	C3.1.1, EN1.2, (EN2.1 for waste area custodians and others writing up waste, D6.1.2.1 for project managers and higher line management), PPE questions in P11, P13
Use of explosive or highly reactive chemicals	C3.1.1, PPE questions in P11, P13
Use of strong acids or bases	C3.1.1, PPE questions in P11, P13
Use of carbon monoxide gas	C3.1.1, PPE questions in P11, P13
Use of hydrogen gas (above 4% concentration)	C3.1.1, PPE questions in P11, P13
Use of perchloric acid or perchlorate salts	C3.1.1, PPE questions in P11, P13
Use of hydrofluoric acid	C3.1.1, C6.15, P11.4, P11.14, (P11.15 if applicable), P13.1
Nanomaterials	Section NA, whatever is applicable, PPE questions in P11, P13
Nanoparticles dispersible in air	NA2.1 among others, PPE questions in P11, P13
Nanoparticles dispersible in liquids	NA2.2 among others, PPE questions in P11, P13
Biological Hazards	C1 and C2, whatever is applicable, PPE questions in P11, P13
Work with Biosafety Level 2 or above	C1 and C2, whatever is applicable, PPE questions in P11, P13

Use of radioisotopes (see section 6)	R1, R2, R3, R4, whatever is applicable, PPE questions in P11, P13
Exposure to ionizing radiation (excluding radioisotopes) ⁵	R1, R3, R5, R6, whatever is applicable; G1
Generation of radioactive wastes	add EN1.3.1/2/3 (EN2.2 for waste custodians and others writing up waste, D6.1.2.2 for project managers and higher line management), PPE questions in P11, P13
Use of Class III or Class IV lasers	P5.3.1/2 or P5.4.1/2 (P1 if UV), P11.14
Use of cryogenic fluids	P7.2, P11.14, P11.15, P13.8
Use of high magnetic fields	P3
Various electrical hazards	See below, (P11.17, P13.12 if applicable)
Operation of equipment at high vacuums	P7.3
Operation of equipment at elevated pressures	P7.2
Use of compressed gases	P7.1
Operation of equipment at high temperatures	PPE questions in P11, P13
Working in areas with high noise levels	P4 (>85 dBA over 8 hours)
Potential exposure to climatic extremes	P10
Working at elevated heights	P9.2.1
Entering confined spaces	P6.1
Use of self-contained breathing apparatus or respirators	P11.6-9 (filled in by WPS)
Work in areas of mechanical hazards	M1 and other questions in M as applicable, PPE questions in P11, P13

For electrical hazards:

- Those working *with* electrical equipment as intended by the manufacturer, e.g., plugging in, operating switches, turning knobs, need not check any questions in section E, G6. P14.3 may be checked but no others in P14. None of the questions in P15 should be checked.
- Those working on electrical equipment (e.g., repair, construction, testing, troubleshooting, generally equipment with exposed conductors) need to wade through section E (Electrical Hazards). Start by collapsing all questions. Only open those branches (DC vs. AC, various voltage/current/power combinations) that apply. E.g., almost nobody in MSD should be checking anything in E1, but E2 is applicable to a number of people. Parts E3, E4, and E5 may be applicable to some. Again, only check anything if work is done where circuitry is exposed (whether energized or not).
- Generally, anybody who checked questions in section E except for the lowest levels voltage/power combinations also needs to check G6 (see JHQ for exceptions).

⁵ Note that radiologically controlled areas due to X-ray equipment are not usually radiation areas in the sense of question R3.1. All persons working in the vicinity of radiologically controlled areas should check G1, whether they enter or not.

- Check lockout/tagout questions as applicable (incl. supervisors)
- Check P15 only if one of the sub-questions applies.

The following table links the JHQ questions mentioned above to courses triggered by the TMS:

JHQ Question	Course triggered	
C1	ESH536	OSHA Bloodborne Pathogens
C1.1.2	ESH536GEN	Bloodborne Pathogens - General
C1.3.3	ESH536RES	Bloodborne Pathogens Training for Researchers
C2.1.8	BIO100	Introduction to NIH Guidelines for Recombinant DNA
C3.1.1	ESH115	Laboratory Hazard Communication Training
C3.1.1	ESH574	Chemical Waste Generator
C5.1	ESH170	OSHA Lead Standard Orientation
C6.any	ESH107, 158	(suggested fire extinguisher orientation, hands-on)
C6.most	ESH246	Safe Handling of Carcinogens
C6.15	ESH230	Hydrofluoric Acid Safety (required in MSD)
D6.1.2	EQO140M	Integrated Safety Management Awareness for Managers
D6.1.2.1	ESH115	(suggested Laboratory Hazard Communication Training
D6.1.2.2	EQO104	Price-Anderson Amendments Act (PAAA) Program
D6.1.2.2	ESH524	Radioactive Waste Generator Training
E....	complex ⁶	Training levels in order of increasing electrical hazard severity are: ESH377 (Electrical Safety Awareness), ESH371 (Electrical Safety Training - General), ESH376 (Electrical Safety Training for R&D - NFPA 70E Standard), ESH375 (NFPA 70E 2004 One Day Course)
EN1.2	ESH574	Chemical Waste Generator
EN1.3	ESH524	Radioactive Waste Generator Training
EN2.1	ESH456	Chemical Waste Certification
EN2.1	ESH574	Chemical Waste Generator
EN2.2	ESH524	Radioactive Waste Generator Training
G1	ESH738	GERT (General Employee Radiation Training)
G6	ESH114	Lockout/Tagout Training
M1.1	ESH141	(suggested Portable Hand & Power Tool Safety)
M4.2	ESH107	Fire Extinguisher Training - Orientation
M4.2	ESH119	Pressure Safety Orientation
M4.3	ESH107	Fire Extinguisher Training - Orientation
P4	ESH174	Noise and Hearing Conservation Training
P5.3.1	ESH121	Low-Power Laser Safety
P5.4.1 ⁷	ESH120	Laser Safety Training
P5.4.1	ESH120PR	(suggested Laser Safety Practical Factors)
P6.1	ESH113A	Confined Space Entry Program
P7.1	ESH119	(suggested Pressure Safety Orientation)
P7.2	ESH145	(suggested Cryogenic Safety)

⁶ See <http://www.tms.anl.gov/ReqCorrelations.asp?TYPE=QUESTION&RETRIEVE=YES> for specific questions

⁷ Also: eye examination required

P9.2	ESH117	(suggested Ladder Safety)
P9.2.1	ESH520	Fall Protection
P11	ESH195	Personal Protective Equipment
P11.6-9		various respirator training levels
P11.6-9	MEDCERT114	Respirator Medical Certification
P14.1	ESH114	Lockout/Tagout Training
P14.1	ESH114PR	Lockout/Tagout Annual Review Practical Factor
P14.3	ESH114	Lockout/Tagout Training
P14.4	ESH114	Lockout/Tagout Training
P14.4	ESH660	Lockout/Tagout Custodian
P15.2	ESH375	NFPA 70E 2004 One Day Course
R1.1	ESH700	Radiation Worker Training Level I
R1.1	ESH5.17	ES&H Manual 5.17 January 2008 Revision
R2	ESH700	Radiation Worker Training Level I
R2	ESH700PR	Radiation Worker Training Level I - Practical Exercise
R2	ESH5.17	ES&H Manual 5.17 January 2008 Revision
R2	BIOAS900	Employee Bioassay Protocol
R3.1	ESH700	Radiation Worker Training Level I
R3.1	ESH5.17	ES&H Manual 5.17 January 2008 Revision
R4.1	ESH700	Radiation Worker Training Level I
R4.2	ESH700	Radiation Worker Training Level I
R4.2	ESH700PR	Radiation Worker Training Level I - Practical Exercise
R4.2	ESH709	Sealed Radioactive Source Custodian
R5.1.1	ESH738	GERT (General Employee Radiation Training)
R5.1.3	ESH705	Analytical X-Ray Device Safety
R5.1.3	ESH713	Radiological Worker for X-Ray Users (ESH700 acceptable)
R5.2	ESH700	(suggested Radiation Worker Training Level I)
R6	ESH738	GERT (General Employee Radiation Training)
R6	ESH707	(suggested Accelerator Worker Training)