Building a Better Lessons Learned Program

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Introduction

Lessons learned are more in vogue today than at any time in our history. You can't tune into a news broadcast without hearing a reference to the concept – and for good reason. People are finally accepting the idea that they may be able to benefit from the experiences of others. Corporations, government departments, and even the military are actively using lessons learned information to help them to achieve their varied goals.

The Department of Energy is one of the government departments that has a Lessons Learned Program and requires its contractors to develop a program of their own. Unfortunately, adequate guidance is not available to enable contractors to design a fully mature program (i.e., a program that will immediately meet their every need) and to ensure that it is implemented such that it will be deemed acceptable during subsequent assessments.

The purpose of this paper is to present the reader with information that might help him or her better plan and develop a new or upgraded Lessons Learned Program. The information is based on the actual development and implementation of a "second generation" lessons learned program and is presented as a chronicle of the steps taken to build the rudimentary system and the subsequent events and problems that led to the programs present-day configuration.

Building Our Initial System

As with many endeavors, change is usually in response to an event, which almost always has an undesirable consequence. Change seldom results from someone having the time to analysis a process, develop meaningful recommendations, and then implement them. In our case, change was mandated as a result of a fatal accident [1] caused by the release of CO_2 from a fire suppression system in a building occupied by 13 workers. Two major findings relative to lessons learned resulted from the subsequent investigation of this accident: 1) the need to expedite the implementation of Integrated Safety Management (specifically Core Function 5) and 2) the failure to apply lessons learned from previous accident investigations.

The DOE M&O contractor at the time of the accident developed the criteria for the new lessons learned system. The high level criteria for the system are listed below:

- The platform for the new system would be web-based.

- The system would have both "search" and "submit" capabilities.

- A maximum of two or three personnel would be required to "operate" the system.

- The cost for developing/implementing/operating the system would have to be low.

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[1] DOE Type A Accident Investigation Board Report of the July 28, 1998, Fatality and Multiple Injuries Resulting from Release of Carbon Dioxide at Building 648, Test Reactor Area, Idaho National Engineering and Environmental Laboratory

Prior to the accident, the contractor had a lessons learned system that relied on e-mail and a subscriber list for distribution to serve more than 6,000 workers. This system's search capabilities were very limited and personnel generally complained that they had to wade through too many reports to find examples of the kind of information they needed (i.e., most searches resulted in "data overload").

With these facts in mind, work began in February 1999 to design an advanced search engine for a new system that would have the ability to "drill down" to an ever-smaller set of reports with each search. Searches using this advanced search engine would result in displaying only those remaining search options **known** to exist in the database, thus eliminating the frustration of finding <u>nothing</u> on a subsequent search. This methodology allows the user to continue searching until the desired number of reports is obtained.

In order for this search engine to be effective however, the fields (categories) capable of being searched must be "labeled" both logically and accurately. This process (hereafter called **coding**) was started at the same time that the search engine was being developed.

Rather than "reinventing the wheel," an analyst modified a functional category list from the company's legacy program and added five additional code categories based on lists contained in existing company, DOE, and industry documents. The six high-level search categories are:

- Cause Codes (28)
- Crafts (21)
- Functional Categories (24)
- Consequences (6)
- Hazard Source (132)
- Equipment/Components
  - Electrical (26)
  - Mechanical (29)

  Note: The numbers in parentheses are the actual numbers of sub-codes available in each category. See Appendices A-F.

Once these categories/codes were approved, a group of three analysts, working together closely to ensure consistency/accuracy, started coding the legacy lessons learned reports, dated 1997 or later, as well as the new lessons learned being received. This task took approximately 18 months, at the end of which, more than 1,200 lessons learned reports had been coded and entered in the new database.

In addition to coding these reports, information was entered into a new 256-character "synopsis" field for each report. The purpose of the synopsis is to present a concise description of the report, including applicable consequence and cause information. The objective of the synopsis is to keep the users (usually work planners) from having to open and read each report in the search set to determine whether or not that report is applicable to their needs.

The new system, called the Lessons Learned Management System, went on-line in August of 2000 and received mostly "rave reviews." In addition to being user-friendly, "click-on" searchable (while maintaining a word search capability), and "accurate" in terms of coding, there were a number of other new features. Users could click on a "submit" function, which brings up a template to facilitate them in submitting a new Good Work Practice or an adverse-event lessons learned. Also available on the system's search page were a number of "roll-up" reports based on information gleaned from sets of "like" operational event reports. The topics initially placed on the system were:

- Mixing of Chemicals
- Lockout/Tagout
- Heat Stress
- Freeze Protection
- Integrated Work Control Process

These topics were selected based on recent on-site events or upcoming seasonal considerations and many more were planned.

Phase I - System In Place

The time was now August of 2000, the company had a new lessons learned **system** in place, a new procedure had been written and implemented, and a computer-based training course had been made available to all employees. There was talk of exporting the system to other DOE sites and the four individuals who remained working on the project were receiving nothing but accolades. In fact, the only criticism that was received for months was from some of the personnel who had submitted a lessons learned and did not understand the logic used by the analysts to code their report. The typical comment received was "You coded the consequence as an injury, but no one was actually hurt." We would then explain that all coding was done based on the '**likely consequences**", not on what actually occurred. Thus a report describing the details of a near miss event would not be excluded when searching for "Injury" events. (Note: Continued questioning led us to the conclusion that the list of selected codes should not have been displayed in the user's lessons learned report, and thus they were subsequently "masked.")

Good times, as we all have come to learn, have a way of quickly turning bad, and an audit by DOE headquarters in late 2000 demonstrated this axiom once again. Suddenly our "**program**" lacked rigor and formality and was not ineffective in ensuring adequate information exchange and/or the implementation of change. Where had we gone wrong? What had changed? The answer was found to lie in a difference of perceptions – our perception of the scope of our **system** was not the same as the auditor's perception of the scope of a lessons learned **program**.

The Problem

When we envisioned our new lessons learned system, and proceeded to develop it, we mistakenly believed that once we developed a system, the information it contained would be shared by those in the field and lead to actions being implemented that would reduce the number of problems being encountered. But what we learned was that making lessons learned information easily available to everyone does not guarantee that the information will be used. In short, we had developed a tool, but not one that most people wanted to use. Our downfall came when a worker, who was asked about a specific high profile event that was contained in our database, stated he had no knowledge of the event. We had a great system, but the company suddenly had an ineffective program.

Looking back, it is certainly reasonable to expect all of our welders to know some details concerning the death of a welder at another DOE site. But, at the time, it seemed unreasonable to place the responsibility for ensuring that this information was read by all welders on the same three individuals charged with getting the information on the lessons learned database – and the company ultimately reached this same conclusion.

A New Paradigm

Realizing that the Lessons Learned Office's small staff could not effectively administer a company-level program without help, the following actions were initiated:

- A process improvement team was formed to develop a plan that would ultimately result in improved processing/transmitting of lessons learned information and the implementation of change, when required.

- Lead Operation (OPS) personnel and Site Area Lessons Learned (LLCs) coordinators were assigned to aid in the distribution of lessons learned information to applicable personnel.

- The Lessons Learned procedure was revised to reflect the team's plan and to formalize process responsibilities.

Most members of the process improvement team wanted all lessons learned (both internal and external) to be reviewed for applicability by an appropriate Subject Matter Expert (SME) and, if applicable, to have that SME generate a list of recommended actions and/or a target audience. Recommended actions/target audiences would then be subject to approval by the OPS Leads, who would ensure that the recommended actions were be entered in to the Company's Issues Management tracking system (ICARE). The Site Area LLCs were charged with transmitting all lessons learned reports placed on the system database to those workers, groups, and/or organizations deemed to required knowledge of the information they contained.

However, a problem developed when the revised procedure failed to make it through the comment phase because it was deemed incapable of being implemented (i.e., it would have required too much of the SME's time). This turned out to be a good call and resulted in a shift of

emphasis to "high-priority" lessons learned (i.e., those events that could result in severe consequences). At this point, the procedure was rewritten to include this "**graded approach**" for processing lessons learned. Severe consequence lessons learned, **from external sources**, would require SME review. All others would be processed as they had been previously, except that the OPS Leads were required to review all "low-priority" lessons learned reports and, at their discretion, could elevate the priority of a report (i.e., from low to high).

By procedure, all high-priority lessons learned that required actions and/or dissemination to a target audience would be entered into ICARE and/or documented via a Required Read or Tailgate Training, respectively. Thus the actions taken to address high-priority lessons learned are fully documented (i.e., there is a closed-loop documentation process in place for high-priority lessons learned).

Phase II: The Seeds for a Program are in Place

Its now February 2002; the database contains more that 2600 records, the re-revised procedure has been in place since October of 2001, and a second edition of computer-based all employee lessons learned training was given. Program/functional area LLCs were assigned, a fledgling lessons learned coordinator Working Group has been formed, and our new M&O contractor is working hard to ensure that the lessons learned program is viable. But there are still many opportunities for improvement.

Before continuing with details of where the program is heading next, there is another issue that must be discussed. This issued reared its head early in the life of the new system, but failed to be recognized as something that had to be dealt with until much later.

The Need for Immediate Notification

Everyone who works with lessons learned will tell you that a lessons learned report is the last product of an adverse event. Only after an event has been fully investigated, a corrective action plan has been developed, and the corrective actions have been implemented and determined to be effective by performing a subsequent audit or assessment, is there sufficient information to generate a "true" lessons learned. But people require information about such events long before all these processes can be completed and a lessons learned written, and most companies have processes in place to disseminate such information. However, our system was not designed to effectively disseminate immediate notification type information; but ever more frequently, that was what our Office was being asked to do. People who didn't understand how our system worked were asking why we hadn't gotten information out to company personnel in a "timely" manner. The biggest problem of course was that there was no mechanism in place to notify the lessons learned staff of an event or to provide them with information obtained from critiques/investigations. Even after some information became available, the staff was usually told, by those that do understand lessons learned, not to put the information out, because it was considered "premature."

The company has addressed this concern for their internal events, by implementing both a Flash and a Flash II process. A Flash message is issued to upper management as soon as a significant

event occurs. The Lessons Learned Office can then forward that Flash to all company LLCs. Within 48 hours a Flash II can be generated and forwarded to an expanded management audience. The Flash II is also forwarded to the company LLCs. Flash II messages are typically much more informative and can even contain instructions concerning immediate actions that should be taken. Personnel who receive and read these Flash II messages and find that they are planning or performing activities similar to those discussed in the message, then have an opportunity to stop and modify their activities, thus lessening the likelihood of experiencing the same kind of problem/hazard.

While the Flash and Flash II messages are excellent ways to provide immediate notification type information for internal events, little can be done to obtain timely information involving external events (i.e., those events that happed at other DOE sites). In an effort to try to address this concern, our Office recently implemented a new process, but its effectiveness has yet to be proven. We have begun working with our company SME for the Occurrence Reporting and Processing System (ORPS), to obtain those ORPS notification reports from other sites that describe significant events whose consequences or corrective/recommended actions may be of interest to the INEEL. We then forward these reports to the appropriate SME(s) for review. If there is sufficient information in the report for the SME to make a recommendation, he forwards it back to us and we will then request upper management approval to issue the information and the SME's recommendations via a Flash II. Often, however, the ORPS notification reports do not contain enough information and the SME(s) must wait for an update/final report. Still, this process should speed up the flow of information from other DOE sites.

Safety-related notification type information (e.g., Safety Alerts and/or product recalls) from external sources is immediately forwarded to applicable personnel or organizations, given there is a high probability that the information is applicable to our site. When in doubt and personnel safety is not of an immediate concern, notices and recalls are forwarded to the appropriate SME for review/comments and, if applicable, can be disseminated using the Flash II process.

Tomorrow Goals

Our goal for the immediate future is to refine the lessons learned program to a point that program changes are required less frequently (stabilization has ceased to be thought of as attainable in the near term). Certain processes will be easier to try to stabilize than will others (e.g, the database, the processing of input data, and the maintenance of records), but the flow of information to applicable personnel and determining how information is used, (if at all) will continue to present a very real challenge.

An example of continuing change is the recent recognition, as a result of a serious injury suffered by a subcontract worker, that subcontractor personnel do not have the same level of access to lessons learned information as do company personnel. As a result, the lessons learned procedure, along with other company procedures, are scheduled for revision in the next few months.

Our long-term goal is to continue to improve to the point that the Lessons Learned Program is effective in getting the right information to the right people, both in a timely manner and in a way that will require them to institutionalize selected information.

Summary

In closing, I would like to present a list of, in lessons learned parlance, Recommended Actions. This list contains some guidance that should be considered by anyone wanting to build or modify a lessons learned program. Had we had this list before starting work, we could have significantly reduced the time required to complete the job and our program would probably have been much more robust.

- Ensure that you understand the expectations of senior management, users, and all stakeholders concerning the scope/intended use of a company program.

- Ensure sufficient monies are budgeted to maintain and upgrade your system's server/software.

- Carefully weigh the pros and cons of various staffing options. A small staff (i.e., two or three personnel) will require a lot of help from company personnel whose primary duties have little to do with lessons learned. A larger staff (i.e., five or more personnel) would be better able to focus on the program's goals, would be able to handle crises better, and would certainly have more time to develop needed products (i.e., roll-up reports on pertinent/timely subjects).

- Ensure that the platform and software used to develop your lessons learned database are approved for company use. The resulting configuration should be an "enterprise" system.

- Design your system, procedure, and processes to be as flexible as possible, because "program" changes are inevitable. For example, the database should be designed such that it is capable of being queried for "date" information (such as the number of lessons learned placed on the database since a certain date). And users should have the capability to download a report and forward it electronically, without having to copy it into a Word document and then reformat it.

- Develop a set of defendable criteria that can be used to reduce the sheer number of lessons learned that end up being placed on the database. The goal should be to **not** put a lessons learned on the database **unless** it describes a new way of experiencing a consequence or contains a recommended action/good work practice that hasn't already been identified.

- Develop ways to make it easier for your users to develop and submit Good Work Practices. This may be more easily accomplished if you decide to go with a large staff.

- Develop meaningful measurements for program effectiveness. Though opinions vary greatly on what these might be, remember - "What gets measured, gets improved."

- Ensure you have a process for capturing "success stories" (i.e., documented cases of lessons learned information being implemented at your site). An increasing number of success stories is a positive measurement of program effectiveness.

- Seek and obtain upper management support in requiring more line management participation in the lessons learned process. Line management participation is critical to ensuring that applicable lessons learned information is being effectively distributed and implemented. Senior management at some DOE sites has defined their lessons learned expectations to line management in the form of annual requirements on performance appraisals.

- **Find a Champion**. He or she must fully embrace the lessons learned concept, be cognizant of your organization's resources, abilities, and needs, as well as those of the company, be well respected, and be able to effectively communicate with both senior management and the workers. (Note: Although presented last, this recommendation may be the one with the most potential to influence the success of your program!)

By now you have probably figured out that this paper is really just a long lessons learned that describes the many problems and setbacks that we experienced while building to where we are today. Hopefully, it will provide some insight so that you and others can avoid making some of our mistakes. Did we succeed in creating a world class program? Not yet, but the program we have today is clearly superior to the one we use to have, and we will continue to implement improvement designed to help us reach that goal.

APPENDIX A

Cause Codes

1. **Equipment/Material Problems**
   a. Defective or Failed Part
   b. Defective or Failed Material
   c. Defective Weld, Braze, or Soldered Joint
   d. Error by Manufacturer in Shipping or Marking
   e. Electrical or Instrument Noise
   f. Contaminant
   g. End of Life Failure

2. **Procedure Problem**
   a. Defective or Inadequate Procedure
   b. Lack of Procedure

3. **Personnel Error**
   a. Inattention to Detail
   b. Procedure not Used or Used Incorrectly
   c. Communication Problem
   d. Other Human Error

4. **Design Problem**
   a. Inadequate Work Environment
   b. Inadequate or Defective Design
   c. Error in Equipment or Material Selection
   d. Drawing, Specification, or Data Errors

5. **Training Deficiency**
   a. No Training Provided
   b. Insufficient Practice or Hands-On Experience
   c. Inadequate Content
   d. Insufficient Refresher Training
   e. Inadequate Presentation of Materials

6. **Management Problem**
   a. Inadequate Administrative Control
   b. Work Organization/Planning Deficiency
   c. Inadequate Supervision
   d. Improper Resource Allocation
   e. Policy Not Adequately Defined, Disseminated, or Enforced
   f. Other Management Problem

7. **External Phenomenon**
   a. Weather or Ambient Condition
   b. Power Failure or Transient
   c. External Fire or Explosion
   d. Theft, Tampering, Sabotage, or Vandalism

8. **Radiological/Hazardous Material Problem**
   a. Legacy Contamination
   b. Source Unknown

9. **Other**

APPENDIX B

Crafts

1. Laborers
2. Equipment Operators
3. Painters
4. Welders/Helpers
5. Electricians
6. Carpenters
7. Insulators
8. Machinists
9. Custodians
10. Mechanics
11. Sheet Metal Workers
12. Fitters (plumbers)
13. Construction fitters
14. Demolition Personnel
15. Iron Workers
16. Heavy Equipment Operators
17. Instrument Technicians
18. Masonry Workers
19. Concrete Workers
20. Others
21. Craft Foremen/Supervisors

APPENDIX C

Functional Categories

1. Alternate Fuels
2. Conduct of Operations
3. Configuration Management
4. Construction
5. Criticality (Nuclear Safety)
6. Design
7. Emergency Management
8. Environmental (includes Energy Management, Environmental Protection and Restoration, and Waste Management)
9. Fire Protection
10. Hoisting/Rigging
11. Human Factors (design and analysis functions)
12. Human Resources
13. Information Technology
14. Maintenance (includes D&D, surveillance, and I&C)
15. Natural/External Hazards
16. Operations
17. Packaging and Transportation
18. Quality (M&TE/Cal Lab, procurement-services, materials, contracts, and suspect parts)
19. Radiological Protection
20. R&D
21. Safety (includes Industrial and Occupational)
22. Safeguards and Security
23. Training and Qualification
24. Management

APPENDIX D

Consequences

1. Injury (site personnel)

2. Injury (general public)

3. Environmental Concerns

4. Mission Interruption

5. Regulatory Noncompliance

6. Negative Public Perception

APPENDIX E

<u>Hazard Source/Specific Hazards by Source</u>

1. Biological

  a. Bacterial (e.g., bodily fluids, sewage, food processing, cuts, water, soil, animals)
  b. Viruses (e.g., bodily fluids, animals)
  c. Fungus (e.g., soil, bat and bird droppings)

2. Chemical

  a. Carcinogens (e.g., asbestos, PCB)
  b. Corrosives
  c. Explosives
  d. Flammables
  e. Heavy metals
  f. Storage problems
  g. Oxygen depleting (e.g., CO_2, CO, smoke)
  h. Pesticides
  i. Poisonous
  j. Reactive gases (e.g., chlorine)
  k. Reactive liquids
  l. Reactive solids
  m. Spontaneously combustive
  n. Toxic

3. Electrical

  a. Batteries
  b. Capacitors
  c. Exposed energized conductors
  d. High voltage ($\geq$ 600v)
  e. Low voltage ($<$ 600v)
  f. Hidden energized conductors
  g. Static charges
  h. Faulty power tools (e.g., insulation problems)
  i. Unwanted grounds/shorts (e.g., water, tools, other conductors)
  j. Improper/No LO/TO

4. Environmental

  a. Noncompliance (e.g., NEPA, EPA, State, RCRA)
  b. Fugitive airborne materials (e.g., dust)
  c. Leaks/spills
  d. Poor material storage practices
  e. Improper material labeling
  f. Poor inventory planning/control
  g. Disturbance of archaeological site
  h. Damage/loss of plants or animals
  i. Degradation of drinking water source
  j. Excessive use of natural resources
  k. Medical waste (e.g., silver in sewage system)
  l. Contaminated waste water (e.g., rain water from deactivated buildings)
  m. Inadequate flood controls
  n. Inadequate waste characterization
  o. Inadequate waste water management

Hazard Source/Specific Hazards by Source

4. Environmental (cont.)

    p.   Failure to consider wildlife/habitat issues (e.g., protected or endangered species)
    q.   Poor landfill management
    r.   Release of ozone depleting substances
    s.   Inadequate PCB management
    t.   Misapplication of pesticides/herbicides
    u.   Inadequate rad. Management/containment
    v.   Inadequate tank management
    w.   Pollution of Waters of U.S.

5. Extreme Temperature (cold)

    a.   Cryogens (e.g., liquid nitrogen)
    b.   Ice/dry ice

6. Extreme Temperature (hot)

    a.   Chemical reactions
    b.   Cutting/welding processes
    c.   Electrical arcs and grounds
    d.   Explosions
    e.   Fire
    f.   Friction (includes grinding sparks)
    g.   Process/plant equipment (e.g., radiant and conductive)
    h.   Hot fluids/Steam
    i.   Engines/engine exhausts
    j.   Improper/No LO/TO

7. Gravity/Mass

    a.   Slips/trips/falls
    b.   Dropped objects (small)
    c.   Unsecured overhead objects (e.g., that earthquakes could dislodge)
    d.   Excavations (cave-in)
    e.   Dropped objects (large) (e.g., hoisting/ rigging problems, cranes)
    f.   Working at heights
    g.   Roof/floor loading
    h.   Inclined surfaces
    i.   Slick surfaces

8. Motion

    a.   Any mass in motion (include vibration)
    b.   Belts
    c.   Construction equipment (power)
    d.   Excavation/drilling equipment
    e.   Gears/pulleys/shafts
    f.   Material handling equipment
    g.   Hand tools
    h.   Power tools (e.g., drills, saws)
    i.   Machine tools (e.g., a lathe, a brake)
    j.   Vehicles (includes trailers)
    k.   Human actions, repetitive (CTD)
    l.   Human, movement/lifting (ergonomics)
    m. Improper/No LO/TO

<u>Hazard Source/Specific Hazards by Source</u>

9. Natural/External/Field
   a. Lightning
   b. Wind, force
   c. Dust
   d. Rain
   e. Snow, hail, ice
   f. Weather, hot (exhaustion)
   g. Weather, cold (frostbite)
   h. Wind chill
   i. Flood
   j. Fire/smoke
   k. Sunburn
   l. Toxic/poisonous plants
   m. Bites (e.g., insect, snake, predator)
   n. Animal (attacks/obstacles on roads)

10. Pressure
   a. Chemical reactions
   b. Confined/bottled gases
   c. Explosives
   d. Gunpowder actuated devices
   e. Confined high temperature/pressure, gas/liquids
   f. High intensity sound waves
   g. Failed pressure containing devices (e.g., check valves)
   h. Vacuum equipment/tubes/chambers
   i. Improper/No LO/TO
   j. Confined material expansion

11. Radiation
   a. Construction instruments
   b. Intense light
   c. Infrared
   d. Ionizing radiation (e.g., x-ray equipment, reactors, sources, electron beam)
   e. Lasers
   f. Magnetic fields
   g. Nuclear criticality (e.g., fuel bearing solutions, stored fuel/rad. waste)
   h. RF fields (e.g., microwave, radar)
   i. Ultraviolet (UV)
   j. Radioactive material (e.g., legacy contamination, isotopes, spent fuels)

<u>Hazard Source/Specific Hazards by Source</u>

12. Others (Area Specific)

    a. Construction in area
    b. Excavation (oxygen/drowning concerns)
    c. Ingress/egress obstructions/concerns (e.g., scaffolding)
    d. Poor lighting
    e. Confined space environment
    f. Lockout/tag out already on equipment/ system, but performed by other(s)
    g. Others working in area (e.g., radiography)
    h. Fire watch concerns
    i. Personnel protection equipment adequacies
    j. Emergency equipment availability (includes alarms, communications equip. etc.)
    k. Contamination uptake/ingestion concerns
    l. Dust/ash/fumes/etc.
    m. Pinch points/sharp edges
    n. Inadequate ventilation/HVAC

APPENDIX F

Equipment/Components

1. Electrical

    a.   Alarms

    b.   Battery/battery charger

    c.   Breaker

    d.   Bus bar

    e.   Instrumentation

    f.   Generator

    g.   Motor

    h.   Fuse

    i.   Relay

    j.   Switch

    k.   Transformer

    l.   Cable/wire

    m.   HVAC equipment

    n.   Lighting

    o.   Valve operators (electric)

    p.   Lightning arrestor

    q.   Junction box/panel

    r.   Conduit

    s.   Heat tracing

    t.   Substation equipment

    u.   Transmission lines

    v.   Capacitors

    w.   Grounding devices/systems

    x   Other (e.g., lasers, microwaves)

2. Mechanical

    a.   Pipe/pipe supports

    b.   Valve/valve supports

    c.   HVAC equipment

    d.   Engines

    e.   Vehicles (except engine, includes trailers)

    f.   Pumps

    g.   Turbine

    h.   Tanks (large)

    i.   Compressor/blower

Equipment/Components

2. Mechanical (cont.)

    k. Crane

    l. Boiler/furnace/incinerator

    m. Heat exchanger

    n. S/G

    o. Belts/bearings/bushings/gears

    p. Door/cover/hatch

    q. Vessels/accumulators/reservoirs/drums/
casks/bottles

    r. Rx systems

    s. Gas bottles and manifold

    t. Cooling tower/basin

    u. Pressure control equipment

    v. R&D equipment/systems/devices

    w. Structures (includes scaffolds)

    x. Elevators/man-lifts/etc.

    y. Rigging equipment

    z. Fire fighting/suppression equipment

    aa. Glovebox/glovebox gloves

    ab. Fuel storage racks

    ac. Excavation equipment (e.g., backhoe, jackhammer, shovel)