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**Occurrence Classifications,
Severity Weighting, and
Normalization for the DOE
Packaging and
Transportation Safety
Metrics Indicator Program
(SMIP)**

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**Occurrence Classification, Severity Weighting, and Normalization
for the Department of Energy Packaging and Transportation
Safety Metrics Indicator Program**

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ABBREVIATIONS AND ACRONYMS

A	Administrative control area
Ac	Accident
ALARA	As low as reasonably achievable
C	Contract area
CAIRS	Computerized Accident/Incident Reporting System
Cr	Crash
CY	Calendar year
DEAR	U.S DOE Acquisition Regulations
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
ETAS	Enterprise Transportation Analysis System
Fa	Fatality
FAR	Federal Acquisition Regulations
FHWA	Federal Highway Administration
FTL	Full truckload
FY	Fiscal year
HC	Hazard class
HM	Hazardous material
HSR	Hazard significance rating
In	Injury
IP	Industrial package
ITS	Intelligent Transportation System
LL	Lessons learned
LLW	Low-level waste
LTL	Less-than-truckload
M	Management area
MW	Mixed waste
NHTSA	National Highway Transportation Safety Administration
NOC	Nature of Occurrences
NRC	Nuclear Regulatory Commission
NTPA	DOE National Transportation Program Albuquerque
OHIM	Office of Highway Information Management
OR	Occurrence report
ORNL	Oak Ridge National Laboratory
ORPS	Occurrence Reporting and Processing System
P	Procedures
PG	Packing group
PIH	Poisonous by inhalation
Pkg	Packaging
P&T	Packaging and Transportation
Q	Quality assurance/quality control area
QA	Quality assurance

QC	Quality control
QT	Quarter
Q _{ty}	Quantity
RCRA	Resource Conservation and Recovery Act
R _f	Repetitive factor
RSF	Repetitive significance factor
SAFER	Safety and Fitness Electronic Records System
SARP	Safety Analysis Report for Packaging
SMAC	Shipment Mobility/Accountability Collection
SMIP	Safety Metrics Indicator Program
SPR	Stakeholder and publicity rating
T	Training area
TRAGIS	Transportation Routing Analysis Geographic Information System
Trnp	Transportation
TRU	Transuranic waste
WG	Working group
Wst	Waste
W _{EC}	Event consequence measure
W _{HC}	Quantity classification measure

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Occurrence Reporting and Processing System (ORPS) is an interactive computer system designed to support DOE-owned or -operated facilities in reporting and processing information concerning occurrences related to facility operations. The Oak Ridge National Laboratory has been charged by the DOE National Transportation Program Albuquerque (NTPA) with the responsibility of retrieving reports and information pertaining to packaging and transportation (P&T) incidents from the centralized ORPS database. These selected reports are analyzed for trends, impact on P&T operations and safety concerns, and "lessons learned" in P&T safety.

To support this analysis and trending, the Safety Metrics Indicator Program (SMIP) was established by the NTPA in FY 1998. Its chief goal is to augment historical reporting of occurrence-based information by providing (1) management notification of those incidents that require attention; (2) DOE with a more accurate picture of contractors' P&T-related performances; and (3) more meaningful statistics for comparison of occurrences at a particular site, among different contractor sites, and between DOE and the private sector. To this end, the SMIP supports the establishment of a severity weighting system for classification of the occurrences and normalization of the data for standardization and trending. This initiative is part of the NTPA's effort to develop a methodology for reporting occurrences with appropriate metrics to show rates and trends.

This report establishes and discusses SMIP's methodology for classifying, severity weighting, and providing indicators for P&T occurrences. Three top-level measures are used for defining the indicators for occurrences involving hazardous material: (1) the hazard significance rating (HSR), (2) the repetitive significance factor (RSF), and (3) the stakeholder and publicity significance factor (SPR). These measures allow an objective assessment of occurrence reports, giving consistency and a basis for comparing the severity of one occurrence with another.

The measure HSR is intended to indicate the actual risk posed by an occurrence. It is a weighted measure of the hazard significance of the occurrence from the standpoint of personnel, public safety, and environmental impact. The measure RSF is then applied to HSR to indicate whether the occurrence has a history of repetitiveness. This combination of HSR and RSF can be used by the NTPA to identify specific areas needing special attention or for which the development of a specific lessons-learned statement is warranted. The measure SPR is independent of HSR and RSF and is used to identify the level of significance of the occurrence from a stakeholder and publicity perspective.

P&T-related incidents that occur in preparing for transport, during transport, or during unloading of hazardous materials will be classified and have severity ratings assigned to them. After this assignment, they will be normalized, that is, the data will be averaged by a common element to show similarities and produce standardized output for comparison. This work will assist the SMIP in determining the safety records and relative rankings of DOE contractors who package

and ship hazardous materials, as well as making possible comparisons between DOE P&T safety with that of private industry.

Occurrences will be categorized according to whether they occur onsite or offsite. Also, occurrences involving pipelines will be accessed and archived, but no additional action will be taken.

In addition to obtaining a data source, a major concern is finding a common basis of comparison between DOE's transportation activity and that of private industry. Of the many possible approaches to normalization, the number of miles traveled by each hazardous material package and the number of accidents (for both hazardous material and nonhazardous material shipments) per vehicle-miles are the most significant. The number of crashes—and resulting injuries and fatalities—will also be used for comparison because the U.S. Department of Transportation tracks and trends these statistics. Another useful indicator will be provided by the number of hours worked by site personnel per accident, data of which will be obtained from the Computerized Accident/Incident Reporting System.

As more data sources are identified, more metrics will be developed for normalizing data. The development of a severity weighting for occurrences and refinement of normalization methodology go far in fulfilling SMIP's goal of answering the question, *"How safe is DOE's offsite transport activity compared with that of the private sector?"*

1. INTRODUCTION

The U.S. Department of Energy (DOE) Occurrence Reporting and Processing System (ORPS) is an interactive computer system designed to support DOE-owned or -operated facilities in reporting and processing information concerning occurrences related to facility operations. The requirements for reporting and the extent of the occurrences to be reported are defined in DOE Order 232.1-1A, "Occurrence Reporting and Processing of Operations Information." The centralized database provides computerized support for the collection, distribution, updating, analysis, and sign-off of information in the occurrence reports (ORs).

The Oak Ridge National Laboratory (ORNL) has been charged by the DOE National Transportation Program Albuquerque (NTPA) with the responsibility of retrieving reports and information pertaining to packaging and transportation (P&T) incidents from the centralized ORPS database. These selected reports are analyzed for trends, impact on P&T operations and safety concerns, and "lessons learned"(LL) concerning P&T safety. Moreover, the selected ORs are reviewed to verify that the DOE Order 232.1-1A requirement to provide for appropriate corrective actions is being conducted. This task is designed, not only to keep the NTPA aware of what is occurring on DOE sites and of potential P&T problems that may need attention, but also to allow dissemination of LL to the Operations Offices and then the subsequent flow of information to contractors.

The Safety Metrics Indicator Program (SMIP) was established by the NTPA in fiscal year (FY) 1998. One of SMIP's chief goals is to augment historical reporting of occurrence-based information and present more meaningful statistics for the comparison of occurrences. To this end, the SMIP supports establishment of a severity weighting system for the classification of the occurrences and the normalization of the data for standardization and trending. This initiative is part of the NTPA effort to develop a methodology for reporting occurrences with appropriate metrics to show rates and trends.

The following sections provide a detailed discussion of the methodology that has been developed for classifying, severity weighting, and providing indicators for P&T occurrences. Specifically,

- Section 2 provides a brief overview of the SMIP methodology;
- Section 3 details the significance rating methodology for occurrences involving hazardous material;
- Section 4 provides hypothetical examples of the application of the methodology to hazard classification, safety/environmental significance, and stakeholder and publicity considerations;
- Section 5 considers a means of normalizing the occurrences, concentrating on mileage as the main parameter;

- Section 6 concludes with the understanding that the methodology is evolving;
- *Tables are listed at the end of the text, appearing in chronological order;*
- Appendix A provides Nature of Occurrences (NOC) codes; and
- Appendix B lists key definitions.

2. SMIP METHODOLOGY

The following discussion summarizes the methodology for assessing ORs in the SMIP. The methodology has been developed to facilitate a logical and consistent process for evaluating each OR and documenting the impacts of the OR.

Figure 1 depicts the overall SMIP screening and decision process. The details of the use of the tables, the various parameters shown, and the significance rating factors will all be covered in later sections.

Each action box or question diamond in Fig. 1 is identified by an encircled number, which facilitates discussion as indicated below. For each OR, the SMIP staff will step through the process as follows:

- Step1 [question] – Using the criteria of Fig. 2, the SMIP staff asks whether the OR is P&T related.
- Step 2 [action] – If the OR is not P&T related, then no further action is needed, and the OR is set aside and not considered further.
- Step 3 [action] – If the OR is P&T related, the staff will then download and classify the OR into the SMIP P&T Occurrence Database. (If the OR is P&T related but not classified in the ORPS as having a NOC or activity description of transportation, then such misidentified reports will have an errata form generated to correct occurrence misclassification.)
- Step 4 [question] – The staff will then ask whether the OR involved pipeline transport of oil.
- Step 5 [action] – If the OR involved *pipeline* transport of oil, the occurrence will be evaluated according to the criteria of Fig. 2 and stored in a subsidiary database.
- Step 6 [question] – The staff will next assess whether the OR involved hazardous material.
- Step 7 [action] – If it is determined that the OR involved *nonhazardous material*, the occurrence will be placed into the subsidiary database and later tabulated in Table 1.
- Step 8 [question] – If the OR involved *hazardous material*, the staff will then ask whether the OR occurred onsite.

Fig. 1. Flowchart of the decision process for selecting and evaluating an occurrence.

- Step 9 [action] – If the hazardous material OR was *onsite*, the specifics of the OR are then evaluated according to the criteria in Fig. 2 and tabulated in the SMIP database, as in Table 2.
- Step 10 [action] – If the hazardous material OR was *offsite*, the specifics of the OR are evaluated and tabulated in the SMIP database, as in Table 3.
- Step 11 [action] – The results of Table 2 or Table 3 are summarized into Table 4 for external presentations by NTPA.
- Step 12 [action] – The occurrence groups are combined with other similar occurrences and normalized for trending and comparisons between other DOE sites and with the private sector in periodic and quarterly reports.

Steps 1 through 11 are addressed in detail in Sect. 3, whereas Step 12 is addressed in Sect. 5.

Fig. 2. Guidelines for processing onsite and offsite P&T events.

3. SIGNIFICANCE RATING METHODOLOGY

The following three top-level measures are to be used in the NTPA SMIP for defining the indicators for occurrences involving hazardous material:

1. HSR = hazard significance rating,
2. RSF = repetitive significance factor, and
3. SPR = stakeholder and publicity significance rating.

The measure HSR is intended to indicate the actual risk posed by an occurrence. The measure RSF is then applied to HSR to indicate whether the occurrence has a history of repetitiveness. This combination of HSR and RSF can be used by the NTPA to identify specific areas needing special attention or situations for which the development of a specific LL is warranted. The measure SPR is independent of HSR and RSF; SPR is used to identify the level of significance of the occurrence from a stakeholder or publicity perspective.

3.1 DETERMINING THE HSR

The HSR is a weighted measure of the hazard significance of the occurrence from the standpoint of personnel, public safety, and environmental impact. The hazard portion is itself weighted by a factor that indicates the quantity of hazardous material. HSR is composed of three factors:

$$HSR = W_{EC} \times W_{HC} \times Q_{ty}.$$

The HSR was subdivided into these three factors to allow analysts to break down an event and consistently make judgements on the various elements that contributed to the degradation of safety and the potential or actual impacts on the environment. When combined, HSR has a numeric range of 1 to 100.

The first weighting, the Event Consequence Measure, W_{EC} , assigns a value ranging from 1 to 5 to indicate the seriousness of the event itself. W_{EC} ranges from an anomaly (which has a very low significance of consequence relative to safety and the environment, and value of 1) to very serious (which has a major significance relative to safety and the environment, and a value of 5). A W_{EC} weighting factor is assigned to each event based upon actual consequences resulting from the event. The value of the weighting factors and the associated descriptions used to judge each event against these factors are shown in Table 5.

The second factor that is used in developing the HSR is the Hazard Classification Measure, W_{HC} . This measure is used to assign a value ranging from 1 to 4. It indicates the relative risk to personnel and the environment posed by the general physical contents of the hazardous material involved in the event.

The value assigned to W_{HC} , which indicates the relative threat posed by the hazardous material, is based upon the hazardous material classification methodology specified in the U.S. Department of Transportation (DOT) hazardous material regulations and upon pragmatic judgement. W_{HC} ranges from a low value of 1 for relatively innocuous hazardous materials (Class 9 materials) to a maximum value of 4 for the most hazardous of the hazardous materials (including Class 1 explosives, Class 4.1 wetted explosives, and radioactive materials). The range of weighting factors, as assigned to each class or subclass of hazardous material, is shown in Table 6.

The factor W_{HC} provides an indication of the potential hazard of a material, but does not provide a measure of the quantity of material involved. The quantity of material in a shipment can significantly affect the actual hazard posed. One indicator of the relative amount or quantity of material in a shipment is the type of package used. For example, with radioactive materials for which a graded approach to packaging is used, the lower-integrity packages are used for either lower quantities of material or the less hazardous of that class of materials. The packages range from the least robust [bulk, strong-tight, and industrial package (IP-1)], to the more robust (IP-2, IP-3, and Type A), to the most robust (Type B). Similarly, for other hazardous materials, the packages range from the least robust (limited quantity), to the more robust [packing group (1, 2, and 3)], to the most robust (bulk*).

Thus, the third factor, Q_{ty} , is used to indicate the relative amount and graded hazard within a class. Q_{ty} is based on the type of packaging used in the shipment and indicates the relative amount and hazard. For example, for radioactive materials, a very low quantity of material is allowed to be transported in an excepted package (indicating a very low risk), and the Q_{ty} value for these packagings is 1. In contrast, a Type B package is used if the risk posed by the contents is high, and the Q_{ty} value assigned for a Type B package is 5. The Q_{ty} values for the other radioactive material package types, which implicitly also account for the total quantities allowed on a conveyance through the operational controls imposed by regulations, range between 2 and 4. Similar arguments were used to establish the weighting factors for nonradioactive hazardous materials. As a result, Q_{ty} infers the quantity and relative hazard posed by the hazardous material, and is based upon (1) the package requirements for hazardous material specified in the DOT hazardous material regulations and (2) pragmatic judgement. In summary, as noted in this discussion, Q_{ty} ranges from a low value of 1 for limited-quantity shipments in excepted packages to a maximum value of 5 for the largest quantities in a class and the most hazardous within a class of materials.

In addition, a measure is assigned for Q_{ty} to account for the presence of contamination, the source of which may or may not be known. For example, a radioactive material package may have leaked some of its contents onto the bed of a trailer or floor of an in-transit storage area. Although the total contents of the package could represent a significant hazard if all were released, the actual amount released may be of minor consequence. Therefore, the Q_{ty} factor

*Note that the bulk packagings for radioactive material are used for the least hazardous of this class, whereas bulk packagings for other hazard classes represent the largest quantities of these materials and therefore the quantities posing the greatest hazard.

takes this actual amount into account by considering order-of-magnitude increases in the amount of contamination that occurred relative to the threshold above which action is required in the regulations. Q_{ty} is used to specify the significance of radioactive contamination on transport vehicles or packages, in operational facilities, or on equipment that appears to be a result of transportation. This accounting for contamination levels ranges from a Q_{ty} low value of 1 for limited levels of contamination to a high value of 4 for major levels of contamination, and is specifically measured in terms of order-of-magnitude increases above the wipe limits allowed by the DOT regulations (49 CFR Part 173.443) for nonfixed radioactive surface contamination on a package.

The range in Q_{ty} weighting factors is shown in Table 7.

3.1.1 Applying HSR Methodology to Offsite Occurrences

Table 3 provides the method that will be used to assess individual offsite hazardous material occurrences and to summarize the parameters used to determine HSR for that event. A similar procedure will be used to process onsite hazardous material events (See Table 2). It is proposed that Table 3 be used to process the P&T-related occurrences that are downloaded from the ORPS (beginning with FY 1998 occurrences to establish a trending base). Only those incidents that occur in preparation for offsite transport, during offsite transport, or during unloading of hazardous material are included in this table. This table will be used to screen and classify occurrences before they are added to the P&T Occurrence Database.

The table has three sections: database classification, responsibility allocation, and severity measures. It includes a listing of the other parameters used in screening the occurrence, including identification of whether it is packaging or transportation related, whether it is related to hazardous material or waste, the NOC as defined by SMIP criteria, and the assigning of responsibility for the occurrence. Appendix A provides a detailed description of the NOCs and related reporting criteria. Because the hazard class of a material is the concern during transport and not the end use of the material, "waste" should be considered as radioactive waste or Resource Conservation and Recovery Act (RCRA) waste, but not as general trash or debris. Location focuses on whether the P&T incident happened onsite or offsite, not necessarily where the event was discovered. *Onsite* is defined as occurring within the boundaries of a DOE facility (whether fenced or administratively controlled), in contrast to *offsite*. (See Appendix B for other relevant definitions.) The NOC includes a category for those occurrences that are the responsibility of non-DOE contractors or DOE contractors other than those whose name may be assigned to the occurrence simply because they dutifully reported it to the ORPS. Note that Table 3 also includes the development of the RSF and SPR severity ratings. These severity ratings are discussed in the next two sections.

The parameter On/Off is used to define whether the occurrence is attributed to onsite or offsite activities. Offsite activities will have the HSR values normalized to provide indicators since data are available from the Enterprise Transportation Analysis System [ETAS, which was formerly Shipment Mobility/Accountability Collection (SMAC)]. ETAS can be used to develop the

indicators needed by NTPA. However, since a data source for onsite shipping rates does not exist, the onsite occurrences will be tabulated, but not normalized.

The parameter Pkg/Trnp is used to denote whether the occurrence is related to packaging, transport, or both.

The parameter HM/Wst is used to identify whether the occurrence involves hazardous material or waste (RCRA waste, low-level waste (LLW), transuranic (TRU) waste, etc.). If the occurrence did not involve hazardous material or waste, then statistics will be developed for accidents, but the severity ratings will not apply since the methodology discussed here is focused entirely upon hazardous material.

The parameter QT simply identifies the quarter of the fiscal year in which the occurrence happened.

The parameter NOC is the nature of the occurrence as identified by the NTPA program, not as identified in the ORPS. The NTPA NOC evaluates occurrences from the perspective of the transportation specialist, whereas the ORPS-assigned NOC is more generic, including other categories.

The parameter Ac is used to identify whether the occurrence involved an accident. It will have four discriminators (N = none, Cr = crash, In = injury, and Fa = fatality), as outlined previously in the abbreviations. The accident statistics for both hazardous materials and nonhazardous material occurrences will be used in assessing the question, "*How safe is DOE?*," and compared with national accident rate statistics. Again, however, accidents for onsite shipments cannot be included in this indicator since the data for establishing rates do not exist and since there is no common basis for comparison.

The parameter HC is used to identify the hazard class (or classes) of materials involved in the occurrence. This is a key parameter in proceeding to identify the HSR.

The ownership—or Responsibility Allocation—will be attributed to the "Technical Program" (i.e., to the programs outside of the P&T organization, such as operational programs supplying hazardous materials for transport) or to the P&T organizations if the occurrence is attributable to that area—or possibly both. Responsibility allocation (or ownership) assigns the occurrence to the program—as contrasted with the site—that produced it.

The responsibility allocation occurs in two phases: First, it will assign responsibility based upon whether the occurrence was generated by the technical or operational programs and/or by the P&T group. Second, it will assign responsibility based upon the subprogram parameters to which the occurrence relates. A check will be placed in the area(s) under the appropriate program(s) to which the occurrence applies. However, until (or unless) the occurrence reporting procedures are changed and the inputs to ORs start providing additional information, it is not possible from the current input to ORs to identify top-level responsibility for onsite occurrences. Thus, the

methodology here assumes that all onsite occurrences are the responsibility of the "Technical Program."

The subprogram parameters M, C, P, T, A, and Q are used to identify "ownership" and areas where problems arose that resulted in the occurrence. These letters donate the following, respectively:

M = Management area

C = Contract and procurement area

P = Procedures area

T = Training area

A = Administrative control area

Q = Quality assurance/quality control area

The manner in which the individual ORPS cause codes "map" into the SMIP subprogram parameters is shown in Table 8. This mapping facilitates consistent processing of the individual ORs.

Assignment of responsibility to operational programs rather than directly to the P&T group can be difficult because program or subprogram responsibilities may overlap. If a packaging is packed by the technical group based upon advice received from the P&T group, then an event could be charged either to the technical group if the packaging was improperly packaged or to the P&T group if incorrect advice was originally given. If the technical program offers a packaged material to the P&T organization to ship, then the technical program could be responsible for the packaging and markings but the P&T program may be only responsible for shipping papers, vehicle placarding, and transportation. If the P&T organization contracts its transportation responsibilities to a subcontractor, the P&T organization itself should be liable for any P&T occurrences.

As an example of responsibility assignment, let us consider the mock case where medical isotopes are placed into a packaging by a operational program. The operational program also labeled the packaging and generated the shipping papers before taking it to the P&T organization for offsite shipment. If errors are discovered with the contents (i.e., too much to be shipped as exempted), the packaging (should have been shipped in a Type A container), or shipping papers (omitted mention of a daughter product), then the technical program will be charged with the responsibility. At another facility, the operational program called the P&T organization and asked it to package and ship their radioisotopes. In this case, any discrepancies other than the assay of isotopic contents would be the responsibility of the P&T organization.

In the first example, the ORPS report listed the Direct Cause as Personnel Error-Inattention to detail, two Contributing Cause(s) as Management Problem-Work Organization/Planning Deficiency and Management Problem-Policy Not Adequately Defined, respectively, and a Root Cause of Personnel Error-procedure not used or used incorrectly. Based on Table 8, this item would be entered in the database under the technical programs' responsibility as a Training (T) and Procedures (P) area problem. The contributing cause would not have been included in this

detail because inclusion of more than two areas does not facilitate trending analysis. If reviewing the occurrence revealed that the contributing cause was more germane to the issue (i.e., there was no guidance or policy to maintain procedures), then categorizing the incident as Training (T) and Management (M) would be appropriate. In most cases though, the direct and root cause will immediately provide the proper classification.

In general, because the Management subprogram parameter (M) may overlap other subprograms, care will need to be taken to properly classify occurrences into the most pertinent area. (The Management parameter includes communication, notification, certifications and reports, permits and licenses, routing, records, exemptions, inspections, audits/assessments, transportation plans, vehicle maintenance controls and records, and tracking of occurrences and corrective actions.) The contracts and procurement subprogram parameter (C) addresses the inclusion of P&T requirements in contracts and P&T technical requirements in procurement activities. Even though the indicators for these measures [the percentage of contracts that include P&T Federal Acquisition Regulations (FAR) and DOE Acquisition Regulations (DEAR) and the percentage of procurement procedures that include directions to use P&T experts, respectively] do not seem to be directly applicable to the processing of an occurrence without knowledge of a site's records and contracts, the more general applicability of the subprograms will be accessed in determining whether to choose these parameters.

3.2 DETERMINING THE RSF

The repetition of an event by a given site is a clear indicator that attention may need to be paid assessing activities leading to the repetitive occurrence, assisting the site in rectifying the causes, looking for root causes, and developing LL for communicating to the DOE complex to reduce the likelihood of such events occurring at other sites in the future.

A repetitive occurrence is the repetition of a given type of event occurring at a DOE site or results from activities at a DOE site after the site has issued a notification report to the ORPS of a previously occurring similar event and identified corrective actions. The Repetitive Factor (R_r), which is used to define RSF, is simply the number of such events at that single DOE site. However, only events that occur within three years of a previously reported incident will be considered repetitive. Using a time period for repetitiveness consideration avoids penalizing a site that had a similar event happen years earlier. Moreover, using a three-year cutoff will (in most cases) include the same personnel and procedures that any previous events may have been processed under. The RSF is then the multiplication of the Repetitive Factor by the Hazard Severity Rating.

$$RSF = R_r \times HSR .$$

The value of R_r for each occurrence is to be determined by the SMIP analysts and tabulated in Table 3, and the value of RSF then will be calculated.

Note that as this methodology is applied to the P&T ORs—unless the same team of analysts are used who consistently apply the methodology to their assessment of the ORs—the repetitive occurrences may not be readily identified since they can occur over a number of years. For example, in a recent effort to assess LLW and mixed waste occurrences in support of the IP Working Group, it was found that the same type of offsite event occurred four times at one site in one fiscal year, that another type of offsite event occurred three times at one site over a span of six years, and that one series of the same type of onsite events occurred at one site twice in the same year. (Review of Field 31 of the ORPS report, *Similar Occurrences Report Number*, may help provide clues to the analysts that similar events may have occurred.)

3.3 DETERMINING THE SPR

The SPR is to be applied separately, after both the HSR and RSF are determined. SPR serves as a “stand-alone” indicator of the potential impact of an occurrence on actual or potential stakeholders or public response to the occurrence. The SPR is not multiplied by either HSR or RSF, but it simply is tabulated by the SMIP analysts. It allows users to understand how an event has affected, or may affect, DOE’s P&T operations relative to stakeholder and mass media impact. Sometimes, although an event may have posed little risk or resulted in little hazard or safety consequences, its perceived risk may seem major.

SPR is comprised of four levels and respective weights:

- Local levels have a weight of 1,
- State or tribal levels with possible impact to other DOE facilities have a weight of 3,
- Multistate or tribal levels with possible impact on other DOE contractors or sites which have similar operations have a weight of 6, and
- National or international pertinence levels with possible LL implications and impact on the entire DOE complex have a weight of 10.

Because the seriousness of the event and its direct safety impacts have been captured by HSR, the SPR measure addresses those concerns that go beyond safety. It is an important indicator of where LL may be beneficial to all DOE facilities.

For the lowest level (SPR weighting factor of 1), these events are those having only truly local effects to a county, a city, or an individual site. Such events probably have only routine LL potential. For instance, let us consider a site's failure to segregate incoming chemicals, thus resulting in a small fire. Because segregation of material is an established DOE practice, the lesson-learned impact of this event could be little more than a caution or reminder to follow safe practices. Thus, such an event could be considered local.

For the second level (SPR weighting factor of 3), it is recognized that although an event may occur locally, it could have implications to other, nearby DOE sites (e.g., an event at one Oak Ridge site could have implications to the other DOE sites in the Oak Ridge area). Alternatively, such an event could have statewide or local tribal area implications. For example, let us consider a situation in which a worker is injured by the lid of a drum projected at him because the drum was overpressurized during preshipment storage. Because the DOE policy on protection from such incidents is established (but implementation may not be), the safety implications and LL derived from this incident could be relevant and valuable to those DOE sites which store drummed material, even though the direct effect of the incident was local. Though an occurrence may be relatively minor and localized to a single site, continuous attention by state or tribal oversight boards or by press coverage could result in a focus and scrutiny of the occurrence beyond the local site and community area, thereby elevating the stakeholder and publicity attention beyond local boundaries.

For the third level (SPR weighting factor of 6), an occurrence might have significance or influence in regions of the United States (such as the Southeast region or the Western region, etc.). This occurrence is therefore denoted as having multistate- or multitribal-level impact. This category also considers the importance and impact of the incident to other DOE contractors and sites outside a local area. For example, an event at one Oak Ridge site could have implications, not only to the other DOE sites in the Oak Ridge area, but might also impact other regional DOE

sites (such as Paducah, Portsmouth, Savannah River, etc.). Moreover, LL at one DOE reactor facility could be important to other DOE reactor facilities that perform similar operations.

For the fourth level (SPR weighting factor of 10), an occurrence might have the potential to impact the entire DOE complex or to impact most or all the nation or even other countries. An example of such an event occurred on Dec. 15, 1997, during which a package leaked some water while in transit to a western state. Although this event posed minimal hazard, the occurrence caused major efforts to be undertaken in terms of investigations, shutdown of site activities for a long period of time, significant cost, and delayed site approval for future waste-receiving shipments. This event clearly had DOE-complex-wide implications and resulted in attention and scrutiny by multiple state and national political bodies. Although the hazard posed by such an event may be (and was) very small, the stakeholder and publicity impacts could be (and were) very high. Similarly, LL which indicate needed safety precautions in areas where policy and onsite procedures are deficient complex-wide or innovations that communicate how to more efficiently apply "as low as reasonably achievable" (ALARA) principles could be of interest to the entire DOE complex.

In summary, the SPR is determined as summarized in Table 9.

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4. HYPOTHETICAL EXAMPLES OF SEVERITY RATINGS FOR HAZARDOUS MATERIAL ORs

To illustrate how the severity rating will be applied, examples of occurrences with varying levels of severity based upon the measures that are impacted are postulated below for the severity measures. The examples have been chosen to be as clear and applicable to the interpretation as possible. The scenarios present the more severe cases first.

4.1 HAZARD CLASSIFICATION

Using the hazard classification assignment for events (see Table 6 for grouping details), the following assessment is made:

1. A properly marked and packaged container of 52 g of infectious substance, which is a Class 6.2 material, is transported on a passenger aircraft. [$W_{HC} = 4$; Qty = 4 (Packaging Group 1)]
2. Three metallic cylinders of compressed ethane, which is a Class 2.1 flammable gas, are transported on a truck along with a shipment of fusee matches. [$W_{HC} = 3$; Qty = 3 (Packaging Group 2)]
3. Upon arrival of a waste package at a burial grounds, tritium contamination at a level of 22,000 disintegrations per minute per 100 cm² were discovered. [$W_{HC} = 4$; Qty = 2 (if solely based on contamination level, this would be one less)].
4. A packaging of limited quantity radioactive material is mislabeled. ($W_{HC} = 4$; Qty = 1)

4.2 SAFETY/ENVIRONMENTAL SIGNIFICANCE

Examples of the applicability of these safety and environmental criteria to decreasing degrees of seriousness can be postulated based upon a waste shipment:

1. Incompatible chemicals result in an explosion that kills a dock worker. ($W_{EC} = 5$)
2. Incompatible chemicals release caustic fumes from drums, causing dock workers to need medical attention. ($W_{EC} = 4$)
3. Incompatible materials transported on the same truck leak material and fume, but threatening condition is detected before combustion or explosion. ($W_{EC} = 3$)
4. Drums of properly packaged and marked incompatible materials are shipped on same truck. ($W_{EC} = 2$)

5. Leaking and fuming waste drums staged for shipment offsite are noticed and dealt with by onsite emergency crews. ($W_{EC} = 2$)
6. Upon opening a received waste drum, someone discovers a break in the outer containment system of an enclosed lab pack. ($W_{EC} = 2$)
7. A waste manifest is provided that did not list all the compatible chemicals shipped in a lab pack. ($W_{EC} = 2$)
8. Waste manifest is proffered that did not have an emergency phone number listed. ($W_{EC} = 1$)

4.3 STAKEHOLDER AND PUBLICITY IMPORTANCE

Keep in mind that many lesser-rated events might be increased to a higher rating if the media decide to sensationalize the event, thus magnifying its importance as larger than its true significance. Stakeholder and publicity importance can be illustrated by the following examples:

1. As part of a joint experiment on cancer research, a properly marked and packaged container of 52 g of infectious substance is transported on a passenger aircraft *from a DOE facility to a foreign country*. (SPR = 10)
2. As part of a joint experiment on cancer research, a properly marked and packaged container of 52 g of infectious substance is transported on a passenger aircraft *from a DOE facility across country to another DOE facility*. (SPR = 6)
3. As part of a joint experiment on cancer research, a properly marked and packaged container of 52 g of infectious substance is transported on a passenger aircraft *from a DOE site to a destination within the same state*. (SPR = 3)
4. A researcher transports 52 g of a properly packaged infectious substance *in his car 10 miles from his office at one DOE site to another adjacent DOE site in the same city*. (SPR = 1)
5. The plant shift superintendent's office of a DOE site is notified by the driver of a truck transporting LLW (paper, wood, plastic, and absorbent pads) that an oily substance is leaking from a shipping container onto the parking lot at a truck stop in a distant state. (SPR = 6)

4.4 TYPICAL SEVERITY RATINGS

The severity measures involved in an occurrence can be analyzed to show how a severity rating could result from their composite analyses:

1. As part of a joint experiment on cancer research, a package containing 3 samples (averaging 21 g each) of an infectious substance is transported on a passenger aircraft from a DOE site to a foreign country. Because loose containers in the cargo area of the plane shift during extreme turbulence, one of the vials is damaged and leaks a small portion of its contents.

A worker notices the damaged package only upon physical examination of it. This incident involves an infectious substance (Class 6.2, $W_{HC} = 4$; Qty = 4). So, this hypothetical event would have very serious consequences because workers might become infected ($W_{EC} = 4$) and because the international press could sensationalize the occurrence; moreover, it is an international event (SPR = 10): $HSR = W_{EC} \times W_{HC} \times Q_{ty} = 4 \times 4 \times 4 = 64$.

2. A mislabeled package of TRU material is shipped in a Type B packaging (Qty = 5) from a DOE site cross-state to the Waste Isolation Pilot Plant. The label specifies a mixture containing 20 g of ^{239}Pu instead of ^{240}Pu . The event involves the shipment of radioactive material (Class 7, $W_{HC} = 4$), has significant consequences with offsite applicability and much public concern ($W_{EC} = 2$), and has multistate or tribal concerns (SPR = 6). The severity rating for this event would be $HSR = 2 \times 4 \times 5 = 40$.
3. A small package of self-reactive type B flammable solid (Packaging Group 2, Qty = 3) is shipped 10 miles from a DOE site to an adjacent DOE site within the same city. Other than not including the subsidiary label "EXPLOSIVE," the packaging is properly labeled. The transport vehicle itself is routinely used for explosive transport and is so placarded. Because the event involved a self-reactive material (Class 4.1, $W_{HC} = 3$), has significant consequences chiefly because of its offsite applicability ($W_{EC} = 1$), and has virtually no stakeholder or publicity ramifications (SPR = 1), it would be rated as $HSR = 1 \times 3 \times 3 = 9$.
4. A shipment of 38 drums (Packing Group 3, Qty = 2) containing radioactive waste (Class 7, $W_{HC} = 4$) arrived at a DOE site from offsite. A leak from one of the drums contaminated an employee's boot with a maximum level of contamination reading 264,000 dpm/100 cm² beta/gamma ($W_{EC} = 3$). This incident was dutifully reported to the ORPS, and an action plan was written to address its occurrence. Because this is a contamination event, the highest value of either the packaging or contamination level will be applied. Since this level of contamination is 120 times that allowed by regulation, the quantity classification for contamination should be applied: Qty = 3. The stakeholder impact applies to multi-state or DOE sites; hence, the SPR = 6. The event is rated as $HSR = 3 \times 4 \times 3 = 36$.
5. Three months after Scenario 4 above, a shipment of 40 drums (Packing Group 3, Qty = 2) containing radioactive waste (Class 7, $W_{HC} = 4$) arrived at a DOE site from offsite for disposal. A leak from one of the drums contaminated an employee's boot with a maximum level of contamination reading 230,000 dpm/100 cm² beta and gamma ($W_{EC} = 3$). Because an OR with corrective actions had been issued and acted upon for the earlier, similar event, this event should be flagged as repetitive. In addition to the considerations in the previous example, a repetitive factor of 2 should be applied (one for the first shipment and another for this instance). Hence, the event is rated as $HSR = 3 \times 4 \times 3 = 36$, with a repetitive factor of 2, giving an RSF of 72. The stakeholder impact would be the same as in Scenario 4, SPR = 6, having pertinence to different DOE sites.
6. A shipment of 4 stainless steel drums (Packing Group 3, Qty = 2) containing sludge were transported in the back of a pickup truck—which had its tailgate securely locked—from the main waste storage bunkers of a site to the staging area within the same facility (only 100 ft

away) for later transport for disposal. Because of the short distance involved, tie-downs were not used on the drums even though operation procedures specify that all material moved should be secured. The event involved an unspecified miscellaneous hazardous material (Class 9, $W_{HC} = 1$), had slight safety/environmental significance ($W_{EC} = 2$), and a significance only to local operations ($SPR = 1$). Hence, the severity rating of this event would only be $HSR = 2 \times 1 \times 2 = 4$. Note that if the movement had been simply of stainless steel drums (non-hazardous commodity), the event would not have been severity-rated for SMIP purposes.

For quick reference, Table 10 is a summary of these six events and their respective ratings.

4.5 ALARM THRESHOLDS FOR PARAMETERS

At what numerical value do the severity-weighted parameters indicate that they are significant and may deserve scrutiny? For the W_{EC} , its assignment of 4 to significant events is a good indicator of where concern should register. Hence any occurrence that has an event consequence for the safety or environmental significance of 4 (significant) or 5 (serious) should be meaningful. Thus, in the hypothetical examples given in Sect. 4.4, Scenario 1 would be "meaningful" from a safety- and environmental-consequence standpoint.

For the stakeholder and publicity measure, SPR , only an event that has national or international importance or possible impact to the entire DOE complex should be considered. Hence, a red flag would be waved when events are assigned an SPR of 10. Again, in the hypothetical examples given in Sect. 4.4, Scenario 1 would be "meaningful" from a stakeholder and publicity standpoint.

For events that are repeats of similar occurrences within a 2-year period, any repetition should be of concern since it indicates a reoccurring problem and possibly a breakdown in the LL and corrective action process. Hence, a R_f of 2 (within a 2-year period) should be considered a warning signal. Thus, in the hypothetical examples given in Sect. 4.4, Scenario 5 would be "meaningful" from a repetitive standpoint.

If Q_{ty} is considered from a radioactive-contamination perspective, then events with >1000 the contamination control level allowed by 49 CFR Part 173.443 (i.e., with a Q_{ty} of 4 or 5) should alarm. Otherwise, the alarm threshold is established by HSR rather than the Q_{ty} . To determine the limit at which HSR should alert, assume that we are dealing with a radioactive material, $HC = 4$, contained in a Type A packaging (or having contamination >1000 times the allowed), $Q_{ty} = 4$. Then given a W_{EC} of 4 would indicate an HSR alarm level of 64. Thus, in the hypothetical examples given in Sect. 4.4, Scenario 1 would be "meaningful," triggering the HSR alarm.

For hazardous material other than radioactive material, any material shipped or stored in a packaging that is rated higher than a Packaging Group 3 should have some dangers inherent to the class else more modest containment would have been sufficient (i.e., a Q_{ty} of 3 for Packaging Group 2). Consequently, an HSR of 48 for nonradioactive material should send out a warning or call for attention.

Table 11 summarizes this discussion pertaining to warning levels. Based upon the preliminary classification and severity rating of over 70 occurrences, these levels seem appropriate to call attention to anomalous occurrences—especially since the average HSR for all the ORs processed in a test of the SMIP methodology was about 12.

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5. NORMALIZATION OF OCCURRENCES

5.1 POSSIBLE MEANS OF NORMALIZING

After the occurrences have been classified and severity ratings are assigned to them, they will be normalized. *Normalization* is the averaging of the data by a common element to show similarities and to produce standardized output. Normalization will assist the SMIP in (a) determining the safety records and relative rankings of DOE contractors who package and ship hazardous materials and (b) making possible comparison of DOE P&T safety with that of private industry.

Several approaches can be postulated for this normalization: dividing the number of P&T-related occurrences by (1) the number of hazardous material packages shipped; (2) the number of staff hours worked by DOE contractor personnel, or even more specifically the hazardous material-handling staff; (3) the number of deliveries made by for-hire carriers; (4) vehicle-miles involved in shipments; or (5) the distance traveled by the package (package-miles).

Basing the normalization upon the number of hazardous material packages shipped could be useful, and data to support these calculations are available from ETAS and ORPS. Even though the comparisons between and among different contractor sites could be slightly biased because their operations vary in size and mission, the measure can certainly be used to provide an informative comparison of DOE contractors with themselves. Therefore, this would be an excellent metric to base trending upon for an individual site. Too, this metric could be used to provide a measure of how DOE as a whole is performing from year to year. Hence, a metric will be developed based upon the number of packages shipped, where it is recognized that a manifested shipment is generally comprised of several packages.

Basing the normalization upon the number of hours worked by a site's personnel is another useful metric to apply. DOE's Computerized Accident/Incident Reporting System (CAIRS) has data that can be used for this development. Using the total worker population at a site for a specified period would have the obvious shortcoming that workers other than those directly involved in the handling and shipping of hazardous materials are being used. However, other organizations that perform trending accept this in their analysis and still produce reliable statistics. Moreover, hours worked by the total population are more reliable and readily obtained than those for a particular class of workers. Hence, this is a metric that will be used to develop P&T indicators.

Basing the normalization upon the number of deliveries is possible. Data are available on "for-hire" carriers from sources such as the U.S. Federal Highway Administration's Safety and Fitness Electronic Records (SAFER) System. A listing of for-hire carriers used by DOE during a particular time period can be obtained from ETAS, along with the carrier's corresponding number of deliveries. Any incidents involved in their movement from origin to destination (i.e., delivery) can then be correlated from the ORPS. Thus, an indicator of incidents per deliveries by for-hire carriers can be developed for comparison of DOE shipments with the motor carrier industry based

upon for-hire carriers that the two entities have in common. Thus, a useful metric for accidents or occurrences per number of deliveries can be developed.

Basing the normalization upon vehicle-miles offers the opportunity to compare DOE's transportation activity with that of the private sector. However, vehicle-miles are not directly available from DOE's data collection system, ETAS, but can be inferred by inputting data from ETAS into DOE's routing model, the Transportation Routing Analysis Geographic Information System (TRAGIS). As discussed in Sect. 5.2.4, this also requires some assumptions on how materials (both hazardous and nonhazardous) were shipped relative to determining less-than-truckload (LTL) and full-truckload (FTL) shipments and the estimated routes the shipments followed. Through this methodology, a very useful measure can be developed for a given time period, both for individual DOE sites and for the DOE complex. SMIP's chief approach for allowing DOE's activities to be compared with the private industry is to normalize accidents (graded by property damage, injury, and death, for both hazardous and nonhazardous material shipments) by vehicle-miles. In addition, some trending at a given site with time or trends between sites for occurrences normalized by total estimated mileage associated with hazardous material shipments will be evaluated.

Basing the normalization upon the distance traveled by hazardous material packages currently appears to be the best method for evaluating trending of occurrences at a given site with time, or trends of occurrences between sites. Though it is conceded that occurrences will result from the loading or unloading of the packaging from the transport vehicle (and it is unusual that any occurrences other than vehicle accidents, load shifts, or leaks caused by bad packagings occur during transport), basing normalization upon this package-miles is practical and is definitely a measure that can be used for comparison between and among DOE sites in general.

Onsite occurrences will not be normalized because no substantiated databases collect numbers of shipments or number of packages shipped onsite. This lack of information is consistent with private industry practices, which does not require reporting of onsite events to DOT. Hence, reliable data will not be available for comparison with those of private industry.

5.2 NORMALIZING BY PACKAGE-MILES AND VEHICLE-MILES

SMIP defines (in Appendix B) *indicator* as severity-rated occurrences normalized to indicate a rate. Such rates could be shown as HSRs (or RSFs) per package-miles, per consignment-miles, or per vehicle-miles. The following addresses how the mileage denominators might be developed for DOE shipments using data from ETAS, analyses from TRAGIS, and assumptions concerning how DOE performs transportation.

5.2.1 Consignment-miles

For each shipment (consignment), ETAS provides consignment data, derived from bills of lading or waste manifests, on commodity, number and type of packages, weight, mode of transport, origin, and destination. Thus, for FTL or full railcar shipments (consignments), TRAGIS can be used for directly estimating the miles involved in that consignment. For LTL, and intermodal

shipments (e.g., shipment of packages by air), additional assumptions need to be made (as discussed in greater detail in Sect. 5.2.4) in order to obtain meaningful values of consignment-miles.

5.2.2 Package-miles

An approach similar to that described in Sect. 5.2.1 for consignment-miles can be used to estimate package-miles. The same limitations apply; that is, for LTL, and intermodal shipments (e.g., shipment of packages by air), additional assumptions need to be made as discussed in greater detail in Sect. 5.2.4 in order to obtain meaningful values of package-miles.

An early estimate of package-miles by hazard class for FY 1998 has been made and is presented in Table 12.

As data such as these are developed, it is anticipated that they will be assembled on a quarterly basis and then aggregated into multiple quarters as needed. For example, depending upon the comparisons being made, they may be aggregated into either FY or calendar years (CY) so that trending can be meaningfully defined (trends on a quarterly basis would probably lead to data sets that are too sparse).

5.2.3 Vehicle-miles

To estimate vehicle-miles, additional assumptions beyond those required for either consignment-miles or package-miles will be needed. As a result, the level of uncertainty for this estimated denominator will be greater. This metric will be used primarily to allow DOE to compare its level of incidents with those of private industry. The data from the private sector that have been identified which can be used for comparison are available from the National Highway Transportation Safety Administration (NHTSA), which maintains a database on truck accidents and statistics for DOT. To help identify carrier safety fitness, the Federal Highway Administration (FHWA) Office of Motor Carriers bases its rates upon 100 million vehicle-mile profiles, and, hence, has direct parallels with SMIP's development. The Office of Highway Information Management (OHIM) webpage provides data for "occurrences per vehicle-miles." Also, DOT's data are based upon all forms of material movement, not just hazardous material shipments. Thus, when comparisons are being made between DOE contractor sites or the DOE complex and those of private industry, a metric of vehicle-miles is needed.

As vehicle mile data are developed, a common basis for comparison between DOE's data and those from the DOT for private industry will need to be established. The indicator previously defined for DOE transportation activities was "accidents per 100 thousand miles." This value will need to be adjusted to a basis used by DOT, which is "*accidents per 1 million miles*." This basis is more practical to represent DOE miles than a basis of 100 million miles because it would take DOE trucks over a decade to log 100 million vehicle-miles.

For discussion only, let us assume that DOE had two injury-only crashes in FY 1997 and 20 million vehicle-miles for all goods transported (hazardous and nonhazardous). The metric for

DOE would then become 2 injury crashes in 20 million miles (or 0.1 injury crashes per 1 million miles). The FHWA gives a rate of 0.94 injury-only crashes per 1 million miles of transport by highway for CY 1997. One must remember, though, that DOT actual vehicle-miles for 1997 were 2.56 E12, yielding 2,399,643 actual, injury-only crashes. Further, note that, even though DOE crashes would probably have been included in DOT vehicle crash data, the total number of DOE accidents is very small relative to the total number across the United States. *Thus, inclusion of DOE's accidents in DOT's data does not measurably impact the overall statistic, and, thus, the comparison would still be valid.*

5.2.4 Problems with Estimating Mileage for DOE Shipments

Problems are associated with basing the normalization of DOE accidents or occurrences on mileage, whether it be consignment-miles, package-miles, or vehicle-miles. The problems arise because a shipment (1) often entails the movement of more than one package, (2) can involve movement by different modes, (3) can be intermodal (e.g., road-air-road), and/or (4) can involve full-vehicle or less-than-full vehicle shipments. For example, for truck, ETAS does not define whether the shipment is FTL or LTL. Currently, the ETAS operational staff, when requested, estimate the number of packages per vehicle based upon the total weight of a consignment as follows:

- (a) An FTL shipment is a consignment from a single origin to a single destination with a payload weight of at least 10,000 lb.
- (b) An LTL shipment is a consignment from a single origin that weighs <10,000 lb.
- (c) Vehicle-miles are then estimated through a combination of the distance traveled by vehicle carrying truckload and LTL shipments.
- (d) Vehicle-miles based upon an estimated origin to destination route for a consignment may underestimate the actual distance because of the manner in which a carrier may accommodate that shipment.

It could be more nearly accurate to base distance estimates upon a DOT-defined term "movement." However, this would require changes in the way DOE collects its shipment data and could be applied only to future shipments using such modified data-collection methodology. This problem was addressed by a paper prepared for the Office of Hazardous Materials Safety in October 1998, *Hazardous Materials Shipments*. It presented a figure similar to Fig. 3 to distinguish between a shipment (Shp) and movement (Mov) and is repeated here:

Fig. 3. Shipment and movement schematics (Adapted from Hazardous Materials Shipments, U.S. DOT, Washington, D.C., October 1998).

The first schematic represents a truckload operation where material was loaded at Point A and shipped directly to Point B. This operation can be viewed as one shipment, one delivery, and one movement. The second schematic represents a less-than-truckload operation where a shipment is picked up at Point A, transported locally to Point B (perhaps being consolidated with other packages), placed in long-haul carriage to Point C, where it is sorted for local distribution, and finally delivered to Point D. This complete operation would be viewed as one shipment with three movements. Figure 3 emphasizes that movements convey a more nearly accurate picture of traffic volume and risk than shipment numbers alone, but they may result in skewing data where multiple vehicles or modes are involved.

Data reported to ETAS might be error-prone because multiple lightweight consignments (a) could be shipped from the origination point on a given day in the same truck, or (b) could be split into multiple truck shipments as a result of break-bulk operations. Hence, indicators based upon the estimate of vehicle miles based on current data collection methods may (or may not) be conservative because the estimated number of vehicle-miles could be larger (or smaller) than actually listed in ETAS. In the future, the application by DOE of more stringent requirements for reporting information to ETAS could eliminate or significantly reduce this problem.

Notwithstanding the shortcomings previously described, ETAS data can be used today by SMIP personnel for developing indicators. Further work is underway with the ETAS Development staff

to define the best way to proceed in obtaining reasonable estimates of distance metrics for use in SMIP.

5.3 MAKING COMPARISONS WITH PRIVATE INDUSTRY

The DOT-based data provide (1) crashes/heavy-vehicle-miles, (2) injuries/heavy-vehicle-miles, and (3) deaths/heavy-vehicle-miles. These data for all transport by highway (not just hazardous material shipments by highway) have been assembled for 1996 and 1997 as Table 13.

Information for comparing accident rates among carriers—as well as vehicle maintenance programs—can be obtained from the SAFER System. The SAFER System is a component of DOT's Intelligent Transportation System (ITS), a program of the FHWA. SAFER provides carrier, vehicle, and driver safety and credential information to fixed and mobile roadside inspection stations. This information allows the roadside inspector to select vehicles and drivers for inspection based on the number of prior carrier inspections and historical carrier, vehicle, and driver safety and credential information.

At a minimum, these data can be used to compare DOE total crash rates (for hazardous material movements) with DOT-reported crash rates. In doing this, it is recognized that any DOE-related crashes will probably also be in DOT's database; however, the portion of DOE's accident data in DOT's database will be sufficiently small such that they are insignificant and would not change the global DOT statistic. DOT's classification of "single-unit 2-axle, 6-tire or more trucks and combination trucks" compares well with DOE's shipping data, since essentially all of DOE's hazardous material shipments by road involve trucks of this category.

As an example of how crash data could be related, the SMIP-based NOC could be used to determine those occurrences which need to be compared with the NHTSA/OHIM data: (1) NOC 6A – Modal Safety/Motor or driver safety, and (2) NOC 8D – Occurrence Created by Others (non-DOE or non-DOE Contractor).

Review of occurrences having these two NOCs would then lead to a list of crash-related accidents, subdivided by those caused by DOE and those caused by entities other than DOE. For example, if a DOE vehicle is operated by a DOE employee or a DOE contractor employee is involved in a crash (regardless of the extent of damage or injury as long as it meets the ORPS threshold for reportability), a 6D/crash occurrence will be tabulated. Similarly, if a carrier hired by a DOE contractor has a DOE hazardous material package (or packages) onboard and is involved in a crash, an 8D/crash occurrence will be tabulated.

Then, over a given period of time (3-month period minimum), the number of DOE crashes per million miles will be determined (both for crashes "created by" DOE and for crashes involving DOE materials "created by" others). This indicator can then be compared directly with the number shown in Table 13, for example:

1996 – 0.11 (hypothetical) DOE vehicle crashes per million miles

1997 – 0.12 (hypothetical) DOE vehicle crashes per million miles

The shipment distance associated with this indicator will come from runs of the ETAS, coupled with TRAGIS, producing data on a quarterly basis. Each DOE site provides data to ETAS; the methods of input vary from site to site. Once origin-destination-commodity data are available, TRAGIS will be used to perform batch runs to develop associated shipment distances for all DOE hazardous material shipments undertaken by road and rail during the given period. This will then establish a basis for DOE's "crash indicators" for comparison with the general truck "crash indicators" extracted from data similar to Table 13.

Thus, when completed, it is expected that a summary table of findings for a given quarter, and later a given year (to establish a more statistically meaningful set of occurrence-reported crash data) will be available to assist in answering the question, *"How safe is DOE's offsite transport activity compared with that of the private sector?"*

This analysis is, of necessity, limited to statistics on hazardous material shipments undertaken by DOE. The statistics cannot be developed for all shipments made by DOE since a decision was made a few years ago not to collect and validate all of DOE's shipment data. Hence, such collection and validation is currently being done only for hazardous materials in ETAS [through inputs from the field using site-specific-operated Automated Transportation Management System (ATMS) and other input methods].

Also, in addition to "crashes," statistics for "injuries" and "deaths" associated with DOE offsite hazardous material shipments should be capable of being developed. The data from previous fiscal years could be assessed to answer the "how-safe-is-DOE" question and establish a basis for comparison with the current fiscal year data. Using ETAS and TRAGIS data, such as shown in Table 12 with occurrences involving crashes, similar comparisons with the U.S. averages could be produced. The summary table of indicators for addressing the "how safe is DOE" question, might appear as Table 14.

As the data are assembled, the results would also show other indicators and trends, as well as those relating to comparisons with the private sector. For example, Table 15 depicts one method for using the occurrence severity rating data for individual sites to develop indicators based on 1 million miles. The data shown are entirely fabricated at this time, but they have been included to illustrate how data would be used. These data could then be used by DOE management to compare performance by site, using the weighted occurrences and normalizing these weighted occurrences by applicable shipping distances. These data would then help to establish trends at each site with time and also allow comparisons between sites.

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6. CONCLUSIONS

The transition of the occurrence reporting system for DOE's P&T activities to the SMIP for P&T was initiated in late FY 1998. This document presents the methodology that is proposed for SMIP to classify and indicate the actual risk incurred by an occurrence. The methodology results from numerous discussions between DOE and contractor personnel and from discussions with independent experts (e.g., a significant dialogue was held with University of South Carolina personnel in early March 1999).

In addition, the methodology has benefited from testing against real occurrences, using various independent personnel to assess the adequacy and consistency of the approach. Early in the development of the severity-rating methodology, occurrences that had been selected from October 1997 and three other noteworthy occurrences were chosen to test the applicability of the process. A more recent test of March 1999 resulted from a request by DOE NTPA personnel for an assessment of LLW and mixed waste (MW) shipments reported to the ORPS during the last decade. Data for LLW-related, and MW-related occurrences were extracted from the ORPS, and shipment data were extracted from the NTPA ETAS for the time period 1992 through 1998. These data and the resulting analysis were assessed using the methodology. The methodology was later refined based on that experience, and the results were prepared for consideration by the IP Working Group.

The methodology presented in this document should be used to objectively assess P&T ORs, giving consistency and a basis for comparing the severity of one occurrence with another. This document has demonstrated that this methodology (1) can be applied in a practical sense, (2) is viable, and (3) can serve as a valuable tool of the NTPA for assessing P&T ORs. Using the proposed method for normalization, immediate comparisons can be made among DOE sites and limited comparisons can be made between DOE safety and that of private industry. As further refinements are made by SMIP and data sources become available, more comprehensive comparisons between DOE and private industry will be possible.

Table 1. Tabulation of P&T ORs involving nonhazardous material

[illegible]

Table 2. Tabulation of P&T ORs involving onsite hazardous materials

Database Classification							Responsibility Allocation						Severity Measures			HSR	R _f	RSF	SPR
Occurrence Report Number	Pkg/ Trnp	HM/ Wst	QT	NOC	Ac	HC	M	C	P	T	A	Q	W _{EC}	W _{HC}	Q _v				

Table 3. Tabulation of P&T ORs involving offsite hazardous materials^a

DATABASE CLASIFICATION							Responsibility Allocation										SEVERITY MEASURES			HSR	R _f	RSF	SPR
							Technical Program						Packaging & Transportation Organization										
Occurrence Report Number	Pkg/Trnp	HM/Wst	QT	NOC	Ac	HC	M	C	P	T	A	Q	M	C	P	T	A	Q	W _{EC}	W _{HC}	Q _v		

^aAbbreviations:

A = Administrative Control Area

Ac = Accident

N = None

Cr = Crash (property damage)

In = Injury

Fa = Fatality

C = Contract and Procurement Area

HM = hazardous material

M = Management Area

NOC = Nature of occurrence

Off/On:

OFF = Offsite

ON/OFF = Onsite, related to offsite shipment

ON/ON = Onsite, not related to offsite shipment

P = Procedures Area

Pkg = packaging related

Q = QA/QC Area

QT = Quarter of Notification Report

T = Training Area

Trnp = transportation related

Wst = Waste

Table 4. P&T occurrences evaluated using SMIP criteria

Occurrence Report No.	Summarized description	HSR	RSF	SPR

Table 5. Event Consequence Measure W_{EC} (Safety/Environmental Significance)

W_{EC} Weighting	Consequence of the Event	Description
1	Anomaly	<u>Occurrences^a that could have led, but did not lead, to endangerment of people^b or contamination of property, or pollution of the environment, including (a) occurrences arising from improper communications,^c packaging, contents, storage or stowage incident to or during transport, or segregation or (b) occurrences arising from containment system (Class 7 material) or packaging^d (other classes) failure, spills, leaks, radiation levels or contamination or (c) occurrences that could serve as precursors to, but did not lead to, an accident. Anomalous occurrences have low significance, but serve as indicators of events that could lead to more severe consequences if the causes are not addressed; offer the potential for affecting process efficiency, and might result from situations where safety or operational limits and conditions are not exceeded.</u>
2	Slight	<u>Occurrences which resulted in minimal safety consequences, with little potential for ultimately leading to suspected endangerment of people or suspected contamination of property, or suspected pollution of the environment, including occurrences (a) arising from improper communications, packaging, contents, storage or stowage incident to or during transport, or segregation or (b) arising from containment system (Class 7 material) or packaging (other classes) failure, spills, leaks, resulting in minimal releases of contents, radiation levels or contamination. Events having slight consequences result in reduced margins of safety including incidents such as minor contamination, slight release of contents, mislabeled packaging, procedural inadequacies, or equipment failure.</u>
3	Minor	<u>Occurrences which resulted in moderate safety consequences which led to actual, but minimal, endangerment of people, or to measurable contamination of property, or measurable pollution of the environment, including occurrences (a) arising from improper communications, packaging, contents, storage or stowage incident to or during transport, or segregation or (b) arising from containment system (Class 7 material) or packaging (other classes) failure, spills or leaks resulting in minor releases of contents, radiation levels or contamination. Occurrences having minor consequences include loss of use of equipment or normal functioning of a facility for one day or less, and could include events involving significantly reduced safety margins or safety system degradation, where any further degradation might have led to significant accident conditions, or radiological incidents with workers receiving doses or exposure to hazardous materials in excess of annual acceptable limits or measurable contamination, or measurable damage to property, or measurable pollution of the environment.</u>
4	Significant	<u>Occurrences which resulted in significant overexposure or injury of people, significant contamination of property, or significant pollution of the environment, including occurrences (a) arising from improper communications, packaging, contents, storage or stowage incident to or during transport, or segregation; (b) arising from containment system (Class 7 material) or packaging (other classes) failure, spills, or leaks resulting in significant releases of contents, radiation levels or contamination; (c) resulting in vehicle or property damage in excess of \$5,000, loss of use of equipment or normal functioning of a facility for more than one day; or (d) resulting in life-threatening conditions.</u>
5	Serious	<u>Occurrences which resulted in fatalities, widespread injuries or one or more injuries requiring overnight hospitalization, major overexposure of people with the potential for latent cancer death or other long-term health affects, serious contamination of property, or serious pollution of the environment, or risk or hazard which could result in lawsuits or major actions by regulatory and oversight bodies, or safety-related consequences sufficiently significant to result in facility or operation shutdown, including occurrences (a) arising from improper communications, packaging, contents, storage or stowage incident to or during transport, or segregation; (b) arising from containment system (Class 7 material) or packaging (other classes) failure, spills, or leaks resulting in major releases of contents, radiation levels or contamination; or (c) resulting in vehicle or property damage in excess of \$50,000, or loss of use of equipment or normal functioning of a facility for more than three days.</u>

^a "Occurrences" include events often described as incidents or accidents.

^b "People" includes workers, emergency response personnel, and members of the public.

^c "Communications" include marking and labeling of packages, placarding of conveyances and freight containers, and shipping documents.

^d For Class 7 material, see 49 CFR Part 173.403; for all other classes, see 49 CFR Part 171.8.

Table 6. Hazard Classification Measure, W_{HC}

W _{HC} weighting	Hazard class (HC) Description of material involved
1	Class 9
2	Precedence Table [CFR Part 173.2a(8)] Class material (3, 8, 4.1 ^a , 4.2, 4.3, 5.1, 6.1 ^a)
	Combustible liquids
3	Class 2.1 Flammable Gases
	Class 2.2 NonFlammable Gases
	Class 6.1 Packaging Group 1, Poisonous-by-inhalation (PIH) substances
	Class 4.1 Self-reactive material
	Class 4.2 Pyrophoric material
4	Class 1 Explosives and 4.1 wetted explosives
	Class 5.2 Organic peroxides and 6.2 infectious substances
	Class 7 Radioactive materials
	Class 2.3 Poisonous gases

^a Excluding Class 4 and Class 6 hazardous materials otherwise specified in this table in weighting area 3.

Table 7. Quantity Classification Measure, Q_{ty}

Q_{ty} Weighting	Type of packaging used in shipment and/or level of radioactive contamination ^a	
	Class 7	Other Hazard Classes
1	Limited quantity in excepted packages. Radioactive contamination in the transport environment at levels 1 to ≤ 10 times that allowed by 49 CFR Part 173.443. ^b	Limited quantity for other hazard classes. Broken or leaking packages of hazardous materials (other than radioactive materials) where the packagings are repaired according to 49 CFR Part 177.854(b), (c), and (d).
2	Bulk, strong-tight and IP-1 packages. Radioactive contamination in the transport environment at levels >10 to ≤ 100 times that allowed by 49 CFR Part 173.443. ^b	Nonbulk quantities of PACKING GROUP III for other hazard classes. Broken or leaking packages of hazardous materials (other than radioactive materials) where the packagings cannot be safely and adequately repaired according to 49 CFR Part 177.854(b), (c), and (d); and requires storage pending proper disposition according to 49 CFR Part 177.854(e).
3	IP-2 packages of Class 7 materials. Radioactive contamination in the transport environment at levels >100 to ≤ 1000 times that allowed by 49 CFR Part 173.443. ^b	Non-bulk quantities of PACKING GROUP II for other hazard classes.
4	Type A packages and IP-3 packages. Radioactive contamination in the transport environment at levels >1000 times that allowed by 49 CFR Part 173.443. ^b	Non-bulk quantities of PACKING GROUP I for other hazard classes.
5	Type B packages of Class 7 materials.	Bulk for all other hazard classes.

^a If an occurrence involves both a package type and contamination, then the highest value of the two will control.

^b The DOT regulations (49 CFR Part 173.443) specify that the nonfixed radioactive contamination wipe limits are 22 dpm/cm² (10^{-5} μ Ci/cm²) for beta, gamma, and low-toxicity alpha emitters, and 2.2 dpm/cm² (10^{-6} μ Ci/cm²) for other alpha emitters.

Table 8. Mapping of ORPS cause codes to SMIP responsibility allocation codes

DOE M232.1-1A, Cause Code (pp. 51-54)	Responsibility allocation ^a	
	Primary ^b	Secondary ^b
1. Equipment/material problem	Q	C, A
2. Procedure problem	P	A, M
3. Personnel error	T	P
4. Design problem	Q	C, A
5. Training deficiency	T	M, A
6. Management problem	M	A
7. External phenomena	P	A

^a In the majority of cases:

- The Technical Program Office will have responsibility for onsite occurrences.
- Packaging and Transportation Office will have responsibility for offsite occurrences.

^b M – Management area, C – Contract and procurement, P – Procedures area,
T – Training area, A – Administrative control area, Q – QA/QC area.

Table 9. Stakeholder and publicity significance rating

Weighting (SPR)	Impact of occurrence from stakeholder and publicity perspective
1	Local impact
3	State or tribal or DOE facility impact
6	Multistate, multitribal or DOE site impact
10	National, international or DOE-complex-wide impact

Table 10. Summary of hypothetical examples

Scenario	Description of event	HSR	RSF	SPR
1	Infectious substances of >50 g are shipped internationally on a passenger aircraft	64	NA ^a	10
2	Mislabeled packaging of TRU material is shipped offsite to Waste Isolation Pilot Plant	40	NA	6
3	A self-reactive flammable solid, which does not have a required subsidiary label, is shipped locally to an offsite location	9	NA	1
4	Employee boot contamination reading of 264,000 dpm/100 cm ² beta and gamma	36	NA	6
5	In a related event to the previous occurrence, another leaking container is shipped months later which again contaminates a worker	36	72	6
6	Drums of sludge are moved onsite without tie-downs	4	NA	1

^aNA = not applicable

Table 11. Alarm threshold of parameters

Parameter	Alarm Threshold
W_{EC}	4
SPR	10
R_f (in 2-year period)	2
Q_{ty} (radioactive material contamination only)	4
HSR for <i>radioactive</i> material	64
HSR for <i>nonradioactive</i> hazardous material	48

**Table 12. Estimated package-miles per hazard class during CY 1998
(from ETAS and TRAGIS)**

Hazard class	Total miles
Class 1 (Explosive)	189,591
Class 2 (Compressed Gas)	579,239
Class 3.0 (Flammable Liquid)	437,804
Class 4 (Flammable Solid)	93,973
Class 5 (Oxidizer)	89,779
Class 6 (Poison)	108,107
Class 7 (Radioactive Material)	2,216,065
Class 8 (Corrosive Liquid)	642,336
Class 9 (Miscellaneous)	392,809
Non-Regulated Waste	84,426
RAM-contaminated, Exempt	13,429
Total package-miles:	4,847,558

Table 13. Total highway vehicle and large truck statistics

Year	1996		1997		Comments
Vehicle type	All ^a	Large ^b	All	Large	
Total vehicle distance ($\times 10^{12}$ miles)	2.49	0.18	2.56	0.19	OHIM highway statistics
Fatal crashes	37,351	4,413	37,280	4,572	Large-vehicle data from contact within NHTSA. Original vehicle data from FHWA web page
Fatal crash rate (crashes/million miles)	.0150	.0245	.0146	.0241	
Fatalities	41,907	5,142	41,967	5,355	
Fatality rate (fatalities/million miles)	.0168	.0286	.0164	.0281	
Injury only crashes	2,410,794	88,000	2,399,643	94,000	
Injury crash rate (crashes/million miles)	.9682	.489	.937	.494	
Property damage only crashes	NA ^c	285,000	NA	329,000	
Property damage only crash rate (crashes/million miles)	NA	1.583	NA	1.732	
Total crashes	NA	377,413	NA	427,572	
Total crash rate (crashes/million miles)	NA	2.097	NA	2.250	

^a All = all vehicles on highways reported by DOT including large trucks.

^b Large = single-unit 2-axle 6-tire or more trucks and combination trucks.

^c NA = not available.

Table 14. Crash-Injury-Fatal highway crashes safety indicators – U.S. total and DOE

Total crashes per 1 million miles			Injury crashes per 1 million miles			Fatal crashes per 1 million miles		
U.S. average for 1996/97	DOE for X months of FY YYYY		U.S. average for 1996/97	DOE for X months of FY YYYY		U.S. average for 1996/97	DOE for X months of FY YYYY	
2.17	DOE caused	Caused by others	.491	DOE caused	Caused by others	.0243	DOE caused	Caused by others
	FY 1996 = TBD ^a	FY 1996 = TBD		FY 1996 = TBD	FY 1996 = TBD		FY 1996 = TBD	FY 1996 = TBD
	FY 1997 = TBD	FY 1997 = TBD		FY 1997 = TBD	FY 1997 = TBD		FY 1997 = TBD	FY 1997 = TBD
	FY 1998 = TBD	FY 1998 = TBD		FY 1998 = TBD	FY 1998 = TBD		FY 1998 = TBD	FY 1998 = TBD
	FY 1999 = TBD	FY 1999 = TBD		FY 1999 = TBD	FY 1999 = TBD		FY 1999 = TBD	FY 1999 = TBD

^aTBD = to be determined

Table 15. Proposed method for using HSR indicators to measure performance by site and with time

Time period	Site	Occurrence No.	Occurrence severity rating, HSR	Sum of HSRs of occurrences for time period, Σ HSR	Shipment distance for site for time period, D ($\times 1,000,000$ mi.)	Severity- weighted indicator, Σ HSR/D
1Q ^a 99	XYZ	abc	10	600	2.43	.00025
		abd	160			
		abe	330			
		abf	80			
		abg	20			
2Q ^b 99	XYZ	abh	40	650	3.84	.00017
		abj	140			
		abk	190			
		abl	20			
		abm	260			
3Q ^c 99	XXX	xab	40	1,120	2.93	.00038
		xac	800			
		xad	30			
		xae	160			
		xaf	80			

^a1Q = first quarter

^b2Q = second quarter

^c3Q = third quarter

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Appendix A:
P&T NOC CATEGORIES

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P&T NOC Categories

The P&T incidences selected from ORPS have a site-assigned severity category (distinct from the NTPA severity-code development) assigned and are placed into groups and subgroups. During report processing, the severity category is not changed from that reported in the ORPS. However, packaging- and transportation-related incidences were found in many of the groups and subgroups other than "Transportation," and the grouping assigned (in the NOC field of the OR, Field 15) did not describe the true nature of the occurrence as seen from the perspective of the transportation specialist.

Therefore, a system was devised for applying an NOC that would be more meaningful to transportation interests and would allow analysis of the data accumulated in line with the concerns of NTPA. A listing of the SMIP classification codes is displayed in Table A-1. This list is not an attempt to assign a cause, direct or indirect, or to evaluate the root cause. The assignment of NOC for the selected ORs provide preliminary identification of the OR's relationship to P&T issues. It provides an initial determination of *what* happened rather than *why* it occurred.

The person who searches the ORPS weekly uses this system and specific search criteria to identify those reports of interest, and the verifier assigns the new NOC code to the report before it is archived in the SMIP P&T Occurrence database. The verifier reviews the information provided in the Notification Report, particularly the Description of Occurrence, Field 16, and Description of Cause, Field 23.

To be relevant as a P&T incident, the incident must occur during preparation for transport, transport, or unloading operations. Hence, vehicular accidents that are above DOE's financial threshold for reporting will not be selected unless the accident occurred while materials or goods were being transported. Similarly, if a rail line is reported as contaminated, the incident will not be captured unless the possibility exists that packagings were transported over the rail line. Likewise, overpressurized drums will not be selected for the database unless the drums were staged for transport.

The description of the criteria on which the NOC coding is based and the specified criteria that the verifier uses to identify packaging- or transportation-related occurrences and to assign a particular code are contained in Table A-2. Furthermore, Sect. 2 of this document describes the process and criteria that are used to select occurrences as packaging- or transportation-related events.

Table A.1. SMIP NOC categories

-
1. Contamination/Release
 - 1A. Radioactive
 - 1A1. Environmental
 - 1A2. Personnel
 - 1A3. Equipment
 - 1B. Hazardous Materials
 - 1B1. Environmental
 - 1B2. Personnel
 - 1B3. Equipment
 2. Packaging
 - 2A. Damaged
 - 2B. Incorrect Selection
 - 2C. Incorrect Procedures
 3. Loading, Unloading, and Storage Incident to Transport
 4. Improper Hazardous Material Characterization
 5. Shipment Preparation
 - 5A. Shipping Papers
 - 5B. Marking
 - 5C. Labeling
 - 5D. Loading and Securing
 - 5E. Placards
 - 5F. Radiation Survey
 6. Modal Safety
 - 6A. Motor or Driver Safety
 - 6B. Aircraft Safety
 - 6C. Rail Safety
 - 6D. Barge
 - 6E. Pipeline
 7. Reserved
 8. Occurrence Created by Others (non-DOE or DOE/Contractor)
 - 8A. Shipping Preparation
 - 8B. Packaging
 - 8C. Reserved
 - 8D. Vehicle or Driver Safety
 - 8E. Contamination
 - 8F. Not otherwise specified
-

Table A.2. Criteria for assignment of NOC

Code	Description
1.	<p><u>Contamination/Release:</u> Any transportation-related, vehicular, or packaging incident that results in contamination or release of radioactive or hazardous materials (as defined in the DOT regulations, Title 49, Code of Federal Regulations, Part 107-180, Hazardous Material Regulations) to the environment, personnel or equipment. This NOC is further subdivided as follows:</p> <p>1A. <u>Radioactive:</u> Only those incidents involving the contamination or release of radioactive materials:</p> <p>1A1. <u>Environmental:</u> Contamination or release of radioactive material to the environment.</p> <p>1A2. <u>Personnel:</u> Contamination of personnel by radioactive materials.</p> <p>1A3. <u>Equipment:</u> Contamination of equipment by radioactive materials.</p> <p>1B. <u>Hazardous Materials:</u> Only those incidents involving the contamination or release of hazardous materials:</p> <p>1B1. <u>Environmental:</u> Contamination or release of hazardous materials to the environment.</p> <p>1B2. <u>Personnel:</u> Contamination of personnel by hazardous materials.</p> <p>1B3. <u>Equipment:</u> Contamination of equipment by hazardous materials.</p>
2.	<p><u>Packaging:</u> has a unique role in the shipping operations since the packaging should provide containment of the hazardous, including radioactive, material being shipped under normal and, in some cases, accident conditions. Incidents that have occurred due to some aspect of packaging problems are included in this NOC. The subgroupings are:</p> <p>2A. <u>Damaged:</u> Damaged packagings may result in release of contents and deserve special consideration whether a release has occurred or not. Repairs of damaged, broken, or leaking packages is addressed at 49 CFR Part §177.854 and overpacks at §173.3(c).</p> <p>2B. <u>Selection:</u> Incidents related to incorrect selection of packaging. Such incidents may be a regulatory violation and may lead to serious consequences. Requirements and guidance for the proper selection of packaging commensurate with the hazard of the material are provided in a number of DOE Orders, DOT regulations, and NRC regulations.</p> <p>2C. <u>Procedures:</u> Incidents related to (1) procedures not adequate for packaging materials properly, (2) procedures that do not reflect the regulatory or Safety Analysis Report for Packaging (SARP) requirements</p>

Table A.2. Criteria for assignment of NOC (cont'd)

for proper packaging, or (3) not following procedures during packaging operations.

3. Loading, Unloading, or Storage Incident to Transport: Any occurrences that indicate a violation related to loading, unloading, or in-transit storage of hazardous materials. Loading for shipment and unloading after shipment should be viewed as transportation events, even though the shipper's or carrier's responsibility may have ended, respectively. Storage incident to transport is covered by DOT's regulations that require, during storage, separation and segregation of hazardous materials, handling, loading, and unloading in accord with the modal requirements (49 CFR §174, 175, 176, and 177). In addition, storage limitations for radioactive materials are specifically addressed at 49 CFR §173.446.
4. Improper Hazardous Material Characterization: Transportation- or packaging-related incidents for which there is an indication that the hazardous material (or waste) has been incorrectly classified in accordance with 49 CFR §172.101.
5. Shipment Preparation: Any incident in which the contractor, as shipper, has incorrectly marked or labeled the package, erred in the preparation of shipping papers or shipment manifest, or failed to ensure the application of a placard to a vehicle or railcar.
 - 5A. Shipping Papers: Incidents involving a violation of the requirements for correctly preparing shipping papers as found in 49 CFR §172.200. This group includes the proper classification of the hazard, the proper shipping name of the material being shipped, the certification of the shipment, and the inclusion of a 24-h emergency number. Also included would be any special forms that must accompany shipments, such as the DOE/Nuclear Regulatory Commission (NRC) Form 741, "Nuclear Material Transaction Report," which must accompany fissile material shipments.
 - 5B. Marking: Incidents involving a violation of the requirements for correctly marking a package, as found in 49 CFR §172.300.
 - 5C. Labeling: Incidents involving a violation of the requirements for correctly labeling a package, as found in 49 CFR §172.400.
 - 5D. Loading and Securing: Incidents involving a violation of the requirements for proper limitations on quantities, loading, securing, stowage, unloading, and special applications of hazard class, as found in the modal sections of 49 CFR §174, 175, 176, and 177.
 - 5E. Placards: Incidents involving a violation of the requirements for correctly placarding a vehicle, as found in 49 CFR §172.500, and for a railcar as found in §174.59.
 - 5F. Radiation Survey: Incidents involving a violation of the requirements for performing a radiation survey of packagings that are being offered for transport or performing a radiation survey of incoming packages that are marked as bearing radioactive material.

Table A.2. Criteria for assignment of NOC (cont'd)

6. Modal Safety: Incidents in this NOC must have occurred during the transport of hazardous material. However, these incidents are more specific to the requirements of the Federal Highway Department, local traffic violations, the Federal Aviation Administration, the Federal Railroad Administration, and the U.S. Coast Guard, or accidents involving DOE-owned or -operated equipment or involving injuries or damage consistent with DOT's reporting requirements.
 - 6A. Motor Vehicle or Driver Safety: Incidents occurring during the transport of hazardous material which involve a violation of any of the Federal Motor Carrier Safety Regulations, 49 CFR §350-399 (as applicable), or a violation of local traffic ordinances, or involve accidents where there was the following: (1) death, (2) injury requiring treatment away from the scene, or (3) the towing of any vehicle from the scene.
 - 6B. Aircraft Safety: Incidents involving a violation of any of the Federal Aviation Administration regulations, 14 CFR §121, 135, and 139 (as applicable), or any accident involving a DOE-owned or -operated aircraft.
 - 6C. Rail Safety: Incidents involving a violation of any of the Federal Railroad Administration regulations, 49 CFR §200-250 (as applicable), or any accident involving DOE-owned or -operated railcars or railline.
 - 6D. Barge Safety: Incidents involving a violation of any of the Coast Guard regulations, 33 CFR and 46 CFR (as applicable), or any accident involving DOE-owned or -operated barges.
 - 6E. Pipeline: Incidents involving a violation of any of the DOT regulations, 49 CFR §190-195 (as applicable), or any accident involving DOE-owned or -operated pipelines. These incidents will be selected and archived into the P&T Occurrence database, but will be reported separate from P&T incidents.
7. Reserved: Years of experience in categorizing occurrences revealed some discrepancies in the codes. This category reflects the removal of these inconsistencies from the NOC classification, maintains consistency with previous reports, and allows the addition of another criterion while maintaining Category 8 for "others."
8. Occurrence Created by Others (nonDOE or DOE/Contractor): This NOC, referred to as "others," represents violations that originated offsite of the reporting contractor. Such occurrences have been separated from those ORs that are clearly the full responsibility of the reporting group. In the development of the reports to NTPA, this procedure allows for occurrences not to be charged to the reporting Program Office, the Operations Office, or the contractor. Currently, ORPS does not make a distinction between the reporter and the violator.

Table A.2. Criteria for assignment of NOC (cont'd)

- 8A. Shipping Preparation: Incidents, created by "others," and received at the contractor's facility with one or more of the violations described in No. 5, "Shipping Preparation."
 - 8B. Packaging: Incidents, created by "others," and received at the contractor's facility with one or more of the violations described in No. 2, "Packaging."
 - 8C. Quality Assurance: Incidents, created by "others," and received at the contractor's facility with an apparent violation as described in No. 3, "Quality Assurance."
 - 8D. Vehicle or Driver Safety: Incidents, created by "others," and received at the contractor's facility with one or more of the violations described in No. 6A, "Motor Vehicle and Driver Safety."
 - 8E. Contamination: Incidents, created by "others," and received at the contractor's facility with one or more of the violations described in No. 1, "Contamination/Release."
 - 8F. Not Otherwise Specified: Any incident, created by "others," which is not covered by 8A through 8E.
-

Appendix B:
DEFINITIONS

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Accident. An event that occurs during the course of transportation (including loading, unloading and temporary storage incident to transportation) which causes injury, radioactive contamination, and/or damage to property and/or equipment. Because DOT does not distinguish between accidents or incidents, incidents covered by 49 CFR Part 171.15 are included in this designation.

Bill of Lading. A contract between the shipper and carrier for the carriage of goods from origin to destination.

Consignment. One or more packages of material presented by a site to a shipper for transport, as represented by a single bill of lading.

Crash. To undergo sudden damage or destruction on impact or as a result of a collision or other vehicle-related accident.

Event. Packaging- or transportation-related accidents or incidents that are required to be reported by DOE Order 232.1-1A or 49 CFR.

Hazardous Materials. All substances, materials, and wastes posing a danger and declared a hazard in DOT's Hazardous Materials Regulations (Title 49 CFR) and the U.S. Environmental Protection Agency (EPA) regulations (Title 40 CFR).

Hazard Significance Rating (HSR). A weighted measure of the safety, environmental, and hazard significance of an occurrence. It is the product of three factors: (1) the event consequence measure (W_{EC}) which indicates the seriousness of the event itself; (2) the hazard classification measure (W_{HC}) which indicates the relative risk to personnel and the environmental posed by the physical contents of the hazardous material involved in the event; and (3) a quantity factor (Q_H) which is used to indicate the relative amount and graded hazard of the material being transported.

Incident. An event that occurred during the course of transportation (including loading, unloading, and temporary storage incident to transportation) which had the potential to cause injury, radioactive contamination, and/or damage to property and/or equipment.

Indicator. Severity-rated occurrences normalized to indicate a rate (e.g., occurrences/mile).

Injury. A medical problem where a person requires professional medical attention.

Fatality. A death resulting from an occurrence.

Lesson Learned. A "good work practice" or innovative approach that is identified and shared, or an adverse work practice or experience that is shared to avoid recurrence.

Material. Any item, nonhazardous or hazardous, including hazardous substances and hazardous and mixed wastes or articles that require transportation to, from, or between DOE facilities and

for which DOE pays for or reimburses transportation charges. This transportation may include transport within a pipeline.

Metric. Standard actions or steps taken or events occurring with the intent of improving safety which allows comparison with other P&T operations (e.g., safe P&T operations).

Normalization. Averaging of data by a common element to show similarities and produce standardized output.

Occurrence. An event or a condition that adversely affects, or may adversely affect, DOE or contractor personnel, the public, property, the environment, or DOE's mission. Events or conditions meeting the criteria threshold identified in DOE M 232.1-1A are occurrences. (Transportation occurrences are incidents related to the transportation of DOE materials, including hazardous materials, hazardous substances, and hazardous wastes by vehicular, vessel, air, or rail mode. Packaging occurrences are incidents related to the packaging of DOE materials, including hazardous materials, hazardous substances, and hazardous wastes.)

Occurrence Report. A documented evaluation of an event or condition that is prepared in sufficient detail to enable the reader to assess its significance, consequences, or implications and to evaluate the actions being proposed or used to correct the condition or to avoid recurrence.

Offsite. Any area within or outside a DOE site to which the public has free and unlimited access.

Onsite. Any area within the boundaries of a DOE site or facility that is fenced or otherwise access-controlled.

Package. A packaging plus its contents.

Packaging. The assembly of components necessary to contain and transport hazardous material. It may also be the act of placing hazardous material into the assembly of components necessary to contain and transport that hazardous material.

Performance Measure. A quantifiable goal for improving safety (e.g., reduce indicator by x% by next quarter).

Pipeline. All parts of an onshore pipeline facility through which hazardous liquid moves including, but not limited to, line pipe, valves, and other appurtenances connected to line pipe, pumping units, fabricated assemblies associated with pumping units, metering and delivery stations, and fabricated assemblies therein, and breakout tanks.

Resource Conservation and Recovery Act (RCRA). A hazardous waste listed by RCRA, regulated under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), and enforced by the EPA.

Repetitive Factor. The number of times that a given type of event occurred at a DOE site, or results from activities at a DOE site, after a site issued a notification report to the ORPS of a previously occurring similar event and identified corrective actions.

Repetitive Significance Rating (RSF). The product of the HSR and repetitive factor.

Severity rating. A measure of hazard and risk associated with an occurrence based upon the SMIP criteria of (1) hazard classification, (2) safety/environmental significance, (3) Stakeholder and publicity importance, and (4) quantity factor. The assignment of a rating allows the hazard significance of an occurrence to be quantified and compared with other packaging- and/or transportation-related occurrences.

Severity-weighted. A hazardous material-involved occurrence that has been evaluated to determine the actual risk posed by the event, consisting of HSR, RSF, or SPR.

Shipment. Any offsite transportation of any materials, objects, or equipment that involves activities such as packaging, loading, marking and labeling and placarding, and, where applicable, cargo securement, preparation of shipping documents, and tendering of the package to the carrier or transporter.

Site. An area that contains a DOE facility or facilities, which is either owned or leased by DOE or the U.S. federal government. The property may be divided by public rights-of-way.

Stakeholder and Publicity Significance Rating (SPR). An indicator of the potential impact of an occurrence on actual or potential stakeholder or publicity response to the occurrence.

Transfer. Any onsite transportation of materials, objects, or equipment, other than intrabuilding movements, involving activities such as packaging, loading, securing, marking, labeling, placarding, cargo security, and documentation, as appropriate, in addition to the actual movement of the material by any transport vehicle.

Transportation. Shipment of materials from one point to another using a transport vehicle.

Waste. Materials or objects designated as waste, including LLW, high-level waste (HLW), TRU, MW, and RCRA waste.

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