DGP/19-IP/12
27/10/03

DANGEROUS GOODS PANEL (DGP)

NINETEENTH MEETING

Montreal, 27 October to 7 November 2003

DISCUSSION OF THE NEW REQUIREMENTS IN THE 13TH REVISED EDITION OF THE UN MODEL REGULATIONS

Report of the Washington Meeting

— — — — — — — —

(13 pages)
DGP.19.IP.012.en.wpd

Transport of Infectious Substances by Air after January 2005: Discussion of the New Requirements in the 13th Revised Edition of the UN Model Regulations

Washington DC 8-9 September 2003

Report of the Meeting

1. The Center for Disease Control and Prevention (CDC), Office of Health and Safety sponsored this meeting which comprised a broad spectrum of participants including government transport regulators, public health professionals, safety organizations, professionals, airline industry representatives, airline pilots, shipping companies, packaging suppliers, and other interested stakeholders to discuss the transport of infectious substances. The meeting focused on the transport of infectious substances as outlined in the 13th revised edition of the UN Model Regulations.

2. Ms. Judith Code, serving as the moderator for the first day of the session, opened the meeting and welcomed all attendees. She provided a brief overview of the two-day agenda, outlining a broad spectrum of speakers intended to cover the various interests and viewpoints on the subject. She also announced that electronic copies of the presentations will be distributed via email by Dr. Nesby-O'Dell to all attendees following the meeting.

3. Dr. William Raub, US Department of Health and Human Services (HHS) provided an introduction to the role of the CDC and HHS. The HHS considers two of the Department's five strategic themes to be directly related to the transport of infectious organisms. One theme being the prevention of bio-terrorism, during which he discussed the roles of different agencies under the Select Agent Rule (i.e., CDC for agents affecting humans and USDA for agents affecting animals). The second theme relates to acquiring new knowledge about potential bio-terrorism agents. A high priority is placed on identifying new molecular targets for diagnosis, drug development, and vaccines. Dr. Raub also explained the public health implications related to the efficient, safe and unencumbered transport of infectious substances that is critical to identifying outbreak diseases such as SARS and the development of treatments for infectious diseases.

4. Mr. Bob Richard, US DOT/RSPA discussed the US DOT International Standard Coordinators role in representing the US in development of international dangerous goods standards. He outlined the UN Model Regulation development structure and how that is then incorporated into the ICAO Technical Instructions, IMDG Code and national regulations. The changes to the 13th revised edition of the UN Model Regulation relating to infectious substances were presented with a brief explanation of the issues that the UN Transport of Dangerous Goods Sub-Committee considered in developing the comprehensively revised requirements. He explained the development of the new Category A and B designations and their corresponding assignments to P620 and P650. The P650 instruction was intended to be an inclusive set of requirements for shippers including medical personnel and patients that are not normally in the business of transporting dangerous goods. The intent during development of the requirements was to

simplify the instruction, but it is realized that there is still a required level of professional judgment necessary for the proper classification of the material. There was much discussion by the group related to P650 and the applicable training associated with ensuring the persons preparing these packages are aware of how to properly classify Category A and B substances. Mr. Richard clarified that P650 states that when packed and marked in accordance with P650, the material is not subject to any other requirements of the Regulations. This would include not being subject to the training requirements. However, P650 is intended to address the training issue by identifying that clear instructions must be provided by the packaging manufacturer and subsequent distributors to the shipper to enable the package to be properly prepared. Mr. Richard indicated that additional requirements may be necessary for the air mode and that he expected that the conference would afford the opportunity to exchange the views of various groups (e.g. pilots, airlines, express carriers, shippers, health professionals) regarding the adoption of the 13th revised edition infectious substances requirements in the ICAO TI.

5. Mr. Tom Abbott, US Director of Sales and Marketing Saf-T-Pak, presented a "real-world" view of the challenges involved with packaging and transporting infectious substances. From his perspective, the largest change coming from the US rulemaking HM-226 involved changes to requirements for diagnostic specimens. He stated that prior to this rulemaking, 10% of specimens were regulated, while 100% are regulated by the rulemaking. This significantly affects shippers by making most mailers current being used now obsolete. Additionally, the US Postal Service regulations are now harmonized with the ICAO TI requirements. While most transport regulations are now harmonized, there remain questions for many shippers concerning the applicability of the 95-kPa pressure differential, training, and the air-eligibility mark. This generated much discussion on the necessity for 95-kPa and the air-eligible mark. Mr. Andy Altemos, HMT Associates, identified that the 95-kPa was developed to address the pressure differential the package would experience in an unpressurized cabin at 60,000ft, with a safety factor of 1.5. While there were various views on the air-eligibility mark it was decided that this meeting was not the proper forum to discuss it's appropriateness in the regulations.

6. Dr. Nicoletta Previsani, Biosafety and Biosecurity Program World Health Organization (WHO), provided the group an overview of WHO. The WHO is a public health agency made up of 191 Member States, not a regulatory agency. She discussed the Ad Hoc Working Group that developed most of the requirements that were adopted into the 13th rev edition of the UN Model Regulations. Dr. Previsani presented a flow chart showing the chain of infection - how someone can become infected. This chain follows the pathogen from exposure, route of transmission, infectious dose, and host susceptibility to eventual infection. The revised requirements are based on the risk posed in transport, where-by the 12th rev edition requirements were based on the inappropriate use of WHO Risk Groups, originally developed for work in the laboratory, and not for transport purposes. She presented a WHO guidance document detailing the 13th rev edition requirements and relative risks posed by these materials in transport. The group was requested to provide comments. Ms. Mary Cipriano, Abbott Laboratories, provided

the group a depiction of the probability an infectious substance release would lead to infection of an individual. She used an example of HIV to indicate that there is an extremely low probability that a package release would result in infection. There was a great deal of interest in Ms. Cipriano's presentation and many in the group requested that she document her discussion to demonstrate the low risk potential (See attachment-I).

7. Ms. Susan Gorsky, US DOT/RSPA, presented an explanation of the US hazardous material rulemaking process. The US regulatory process requires DOT to consider many Executive Orders and legal mandates before finalizing a change to the Hazardous Material Regulations (HMR) in Title 49 CFR. This includes a review of the potential impact on small businesses and unfunded mandates on States. Each proposed change is published in the Federal Register as a Notice of Proposed Rulemaking (NPRM) with an explanation of why the change is being proposed and requests comments. DOT is required to consider cost-benefit analysis on any proposed revision to ensure the revision can be justified when comparing the impact to improving safety and the cost to the public. She explained that RSPA strives to keep pace with international regulations to enhance international harmonization. One of the attendees expressed concern over conflicting regulations with OSHA and the need to coordinate efforts amongst government agencies that have authority to regulate infectious substances. Ms. Gorsky assured the group that DOT does coordinate with OSHA in matters that affect the two Departments and has done so previously during the development of the with HM-226 rulemaking project which aligned US regulations with the 12th edition of the UN Model Regulations.

8. Capt Wim Schuurman, International Federation of Airline Pilots Associations (IFALPA), discussed the concerns of IFALPA with the change to infectious substance requirements. IFALPA represents the interests of over 100,000 pilots globally. They promote the adoption of world-wide standards and implementation at the national level. IFALPA is structured into specialist committees staffed by volunteers with expertise in the subject matter. They fully recognize dangerous goods must travel by air and believe the current system utilizing the ICAO Annex 18 and TI has worked well in demonstrating an excellent safety record. Capt Schuurman expressed concern that the gap of regulations in the 13th rev edition between Category A and B substances is too wide. A middle classification providing additional requirements for Risk Group 2 and 3 materials seems justified. He was further concerned that the Category B requirements do not provide necessary hazard communication and emergency response information to the flight crew. They need to ensure adequate information is presented on the Notice to the Pilot in Command (NOTOC). IFALPA indicated that P650 is designed for normal conditions of transport. Under non-normal conditions such as mishandling during (un)loading, heavy turbulence and a survivable accident the package can fail. For these and other incident/accident where scenarios emergency response is needed, this can only be triggered and so performed correctly by having UN3373 on the NOTOC.

IFALPA representatives also expressed that they believe the 13th rev edition may be too simplified. They identified that pilots receive very brief training related to dangerous goods and rely on the hazard communication marking, labeling, and documentation.

IFALPA was concerned that by taking substances that were previously regulated and required full hazard communication (i.e. HIV and Hepatitis C) and under the 13th rev edition require only package markings, that a degradation of safety may be realized.

The WHO restated that they preformed a thorough risk assessment in developing the Category A and B levels and concluded that the Category B substances pose very little risk, if any, to the transport sector when packaged appropriately (e.g. triple package). They suggested that previous regulations may have been over-kill and the 13th rev edition is a better representation of the risk. The CDC urged the group to collaboratively develop a reasonable process for transporting these substances in the interest of both worker safety and public health.

9. Mr. Mike Mitchell, Covance Central Laboratories, discussed the confusion present in the shipping industry regarding the 2003-2004 ICAO TI requirements. His experience has shown that there is an inconsistency with how the airline industry is accepting the 2003-2004 requirements. This is causing fragmented transport operations for many shippers and in many cases leaving them unable to use the 2003-2004 TI classifications due to uncertainty of acceptance by the airline. The impact of frustrated shipments is a delay in diagnosis, disruption in drug development, and could destroy months or years of research due to the time constraints and lost integrity of the research samples. He believes it is necessary for the WHO, IATA, and national authorities to provide better education to the airline industry of the actual risk verses the perceived risk of these substances. The shipping industry needs global standardized regulation, acceptance by all airlines of that standard regulation, expeditious movement of time and temperature sensitive materials, and an airline understanding of the need for a partnership. Specific areas he felt requires additional clarification include; cultures and culture isolates, P620 related to the term "refrigerated", and P650 concerning positive means of closure for screw top tubes. Further, most labs believe that all bodily fluids should be in a triple-barrier package. He finished by stating it is vital that regulatory changes are kept to a minimum to assist global business in drug development and medical research.

10. Day two began with an airline industry perspective provided by Mr. Jean Abouchaar, International Air Transport Association (IATA) Cargo Regulatory and Industry Affairs. Mr. Abouchaar gave an overview of the IATA trade organization which includes approximately 270 members transporting about 98% of all air cargo. Their goal is to represent their member airlines to ensure the development of regulations that are practical, economically sound, and advance safety. The IATA Dangerous Goods Regulations was first published in 1956 and is recognized as the "field manual" for dangerous goods air shipments. The IATA DGR incorporates all legal requirements of the ICAO TI, while including some additional operator requirements. Mr. Abouchaar presented a summary of requirements in place prior to 2003, the 2003-2004 ICAO TI requirements, and the 2005 effective 13th rev edition requirements. His overview depicted IATA's belief that the pre-2003 requirements were clear and understandable, while the 2003-2004 requirements are confusing. He further considered that the current 2003-2004 requirements may not provide the same level of safety, as they appear to move all risk group 2 and 3 substances from a regulated infectious substance

classification to a significantly less regulated "diagnostic specimen" category. This had led several airlines to reassess their position on the carriage of infectious substances and diagnostic specimens. The loss of innocence resulting from the rushed introduction of the UN 2003-2004 provisions will lead to a more critical review of the 2005 provisions as provided in the UN 13th revised edition. Dr. Nesby-O'Dell responded that, from a public health perspective, it is likely that large volumes of risk group 2 and 3 substances were often being transported as diagnostic specimens. The 13th rev edition requirements were a collaborated attempt to technically evaluate these substances and properly place into the correct category based on risk during transportation. Further, many of the substances previously categorized as Risk group 3 are now included as Category A substances (at least 20 are risk group 3). She stated the 13th ed amendments provide a clearer, less confusing, and more appropriate system than previous systems.

11. Mr. Patrick Oppenheimer, FedEx Express, presented the challenges and impacts to the cargo carrier industry resulting from changes to the infectious substance transport requirements. He stated that a significant number of shipments previously identified as an infectious substances were now being reclassified to diagnostic specimens under the 2003-2004 TI requirements. He sees adoption of the 13th rev edition requirements providing a potential for simplification, decreased cost and difficulty transporting, and reduction in frustrated shipments. However, he also briefed the potential negative impacts the changes could bring about including; confusion, operator handling differences, less inspection and special handling for diagnostic specimens than the same substances previously shipped as infectious substances. A significant problem is the perception by airline employees that the level of safety has been reduced. He indicated that this could be overcome by appropriate outreach and that the draft WHO document would be a useful tool for outreach efforts. He indicated a potential problem with the diamond UN3374 marking due to employees being trained to look for diamond shaped labels and expecting the shipment to be treated as dangerous goods. He suggests either full regulation for diagnostic specimens or none at all. Since the classification is so vital to the determination of shipping requirements, he stated that the training requirements of the regulations (verses "informed" statement in P650) should apply to diagnostic specimens. A UPS representative urged the group to maintain harmonization with the 13th rev edition and maintain the diamond UN3374 marking to avoid difficulties with international multi-modal transport.

12. Ms. Judith Code, Dangerous Goods Standards-Transport Canada, provided a report of the Working Group of the ICAO Dangerous Goods Panel (DGP). She introduced the ICAO DGP members present at the meeting and outlined the specific changes proposed to the 2005-2006 ICAO TI. She identified changes to Part 2, Part 3, Part 5 and Part 7 that the DGP seemed to be in agreement with. She also identified areas for P650 that the panel intended to discuss at DGP 19. Those included recommendations to retain incident reporting, retain the air-eligible mark, provide minimum dimension for the diamond UN3374 mark, possibly add "Diagnostic Specimen" or Clinical Specimen" mark next to the diamond, over-pack mark, requiring the user to have information to justify Category B classification, and provide information on an alternative document (i.e., airway bill) that links to incident reporting. Retaining quantity limits in the ICAO TI was also

discussed and the DGP 19 will be evaluating this based on advice from WHO on whether the quantity is related to risk. Many in the group expressed a need for quantity limits, but that the inner package limits should be raised from the current requirements, while the outer limit was deemed appropriate. Many felt that an inner limit of 1 L (consistent with A81) and no inner limit for solids would be acceptable and cover their needs.

13. An open discussion session ensued to close out the meeting. Mr. Richard identified specific differences between the previous requirements in the TI and the proposed requirements consistent with the 13th revised edition of the Model Regulations and requested comment. Many of the carriers presented viewpoints that additional operator requirements were not consistent with the public health professional's assessment of the low risk posed by Category B substances.

There was significant opposition to imposing loading restrictions and the requirement for a NOTOC for diagnostic specimens as there were no requirements for a Dangerous Goods transport document for such shipments. They urged consideration of the increased cost of handling that would negate advantages to utilizing the diagnostic specimen provisions and the potential for airlines to submit operator variations indicating that they would not carry Category B infectious substances as diagnostic specimens. While the pilots recommended that a NOTOC be required, there was very little support from any other participants. The airlines and express carriers did not support the NOTOC on the basis that it would add an additional burden with extremely minimal safety benefit. One participant indicated that emergency responders already impose universal precautions through the use of protective gear that would minimize the need for advance notification. Many felt that the handler was the one that was most at risk and that proper training and the package markings would be sufficient to minimize handler exposures. The group further discussed the necessity for a minimum size for the outer package, with many in the group indicating at least one side should be at least 100 mm in two dimensions to allow for the necessary information on the outer package and prevent damage during handling operations. Several health care representatives indicated that a minimum dimension of 100 mm on each side would preclude the use of long thin packagings that are typically placed in mail slot and boxes.

The airlines suggested that additional requirements should not be added on to the UN requirements for the TI because it would only serve to create additional burden, the opportunity for enforcement violations and increase the probability that certain carriers would file variations. Public health representatives indicated that the regulations should be geared toward minimizing carrier variations to improve the smooth and seamless transport of diagnostic and clinical specimens. The representative from IATA fully endorsed this statement but noted that experience has shown that there was a direct correlation between variations filed and complications brought up by Regulations: the more complicated or difficult the Regulations become the more State or Operator variations were to be expected. Education and training could help alleviate the problem but, he considered the ultimate goal should be to simplify the regulatory requirements.

14. Dr. Nesby-O'Dell, Centers for Disease Control and Prevention (CDC), moderated the

concluding session. She thanked everyone for their participation and emphasized the need for collaboration. She reiterated concerns about the use of laboratory risk criteria when evaluating the hazards associated with transporting infectious substances. She highlighted that the "Risk Group" classification was developed for the direct manipulation of biological agents in the laboratory environment. Therefore, CDC appreciated efforts to properly evaluate the hazards of infectious substances based on risk within the transport environment. CDC feels the 13th UN Model Regulations provides an appropriate two-tiered, hazard classification system that is consistent with the risk posed by the transport of infectious substances. The new regulation provides a clear, less confusing, and more appropriate system than the previous system. CDC believes the transport risk-based classification approach will result in a higher level of safety and compliance. Dr. Nesby also addressed worker safety. She referenced the Category B packing standards, emphasizing that the diamond UN 3373 marking provides direct hazard communication to workers. She indicated that CDC will work with DOT and others to develop educational and outreach materials. Dr. Nesby concluded with a reference to the recent SARS outbreak and the difficult movement of diagnostic specimens. She stressed that inappropriate decisions continue to have adverse consequences on both domestic and global public health.

15. The following provides a general observation of the meeting and additional comments by topics.

General Observations:

- There was overall support for the multi-model harmonization of national and international regulations governing the transport of infectious substances.
- It was recognized that infectious substance regulations can only be effective when input is received from government officials, experts within the health industry, safety industry and the aviation industry.
- Air operators were encouraged by members of the health and safety industries to adopt the final harmonized regulations to expedite movement of these goods.
- It was noted that some issues have to go back to UN to ensure inter-model harmony and some can be resolved at ICAO DGP.
- It was emphasized that outreach was critical to the understanding of the new requirements and their successful implementation.
- It was also recognized that consideration must be given to both real and perceived risk in any awareness programs designed to explain the new regulatory text on the transport of infectious substances.

Additional Comments by Topic:

(1) Classification:

- Animal agents: Several individuals recommended a classification review of animal agents (Ref: Category A vs. B). There was concern on the appropriate location of several non-zoonotic agents appearing in the Category A list.

(2) Packaging Standards

- Triple package : There was significant discussion on the minimal difference between triple packaging standards for Category A verses Category B agents. Afterwards,

participants appeared to have increased confidence in the package integrity for Category B agents.

- Size: Several members of the group suggested minimal dimensions for package, marking (labels) and text, to facilitate safe processing during transport and promote readability.
- Quantity limits: The group supported the maintenance of quantity limits for P650, suggesting an increase of inner package limits for liquids and maintenance of outer pack limits.
- Package integrity: Drop test features of P620 and P650 were discussed. Several participants indicated the need for a rigid secondary or outer package for P650, to increase stress resistance during transport. There was also a request to investigate the integrity of new glue sealed secondary containers, when packed on dry ice. Another participant suggested the use of a puncture test on secondary containers.
- Markings: Several participants commented that the diamond UN 3373 marking will imply that packages require special handling. Therefore, considerable outreach will be necessary to educate workers on new regulatory requirements. There was also a suggestion to add the term Diagnostic/Clinical Specimen under the UN 3373 annotation on P650 packages. Participants agreed that the increased integrity of newer packaging reduced the need for the "package orientation" marking.

(3) Documentation: There was significant discussion on the NOTOC for P650 verses alternate documentation, such as an Airway Bill.

- IFALPA requested a NOTOC to facilitate appropriate emergency response by air crew and transport workers.
- Many participants felt the NOTOC was not necessary because P650 packages provide direct hazard communication on the package and pilots are notified of all P620 packages which contain Category A infectious substances.
- Disadvantages to adopting full regulation of P650: Inappropriately promotes the "perception" that P650 packages pose a significant risk to passengers, air crew and transport workers; may increase reluctance to transport due to concerns of increased liability; may limit geographic distribution and delay shipments; may increase cost and thereby increase the likelihood of undeclared shipment and non-compliance.

(4) Instructions/Training: Clear instructions must be provided to enable the shipper to properly categorize and prepare package for shipment. However, this should not be costly nor involve a prolonged review of non-applicable materials. CDC will work with DOT and others to develop educational and outreach materials. CDC will also engage OSHA to address hazard communication, standard (universal) precautions, and remediation concerns.

(5) Exceptions: Participants indicated that exceptions should be afforded for certain items that were considered not to pose a risk during transport, that otherwise would require them to be subject to the regulations. These included: Blood Spots, Organs and Tissue and Proficiency Testing.

- Blood Spots: Participants discussed dried blood spots specimens and current packing requirements (double layer envelope) during transport. The group agreed these items posed minimal risk and current packaging methods are appropriate for transport.
- Organs and Tissue: The group requested that human organs be considered for an exception in P620.

• Proficiency Test (PT): These are controlled test samples that are sent to diagnostic laboratories, to test their ability to accurately identify the agent. Since these tests are sent as unknown samples, it would be counter productive to include an itemized agent list. Public health and medical officials suggested the continued exception for these items as outlined in current U.S. DOT regulations.

(6) Operators requirements: Concerns were raised about how new regulations will affect the interline transfer from operators prohibited from carrying dangerous goods to operators that do accept dangerous goods. The discussion alluded to potential interruption of transport.

• DOT officials emphasized the need for incident reporting to monitor the adequacy of the new regulations.

(7) Miscellaneous: Participants commented on the need to insure unified regulations among different federal agencies and multi-modes of transport. Concern was raised about potential disconnects between DOT, CDC, OSHA and USPS transport regulations. Both DOT and CDC indicated that federal agencies will work together to ensure unification of U.S. transport regulations.

Getting Real About the Risks of Transporting Infectious Substances

Mary L. Cipriano

The following was put together to cover information provided as part of a discussion on the relative risks, e.g., "aerosols of infectious materials," that shipment of infectious materials could pose during airline transport. It occurred at the CDC Transport meeting in Washington, DC, on September 8, 2003.
In order to make it a stand-alone document that can be used by the airline industry to better explain these risks to their personnel, I included some additional information that addressed questions that had been posed to me on this subject.
The effort was made to translate the scientific information available into terms that would be easier to understand for the non-scientist.

What is "Acceptable Risk"?

There are major misconceptions about the perceived versus actual risks of transporting infectious agents. The primary areas of misconceptions lie in knowing what microorganisms can and cannot do; and, understanding how aerosols can be generated and the actual risks that they pose.
Before talking about these areas, it's important to understand the actual risk levels of events in our life so that we can place the risk of infection due to infectious materials in transport in its proper perspective. Car accidents kill about 50,000 people in the US annually, so the risk level is about 1.6×10^{-5}. According to AirSafe.com, the risk of a fatal event in airline travel is about 3.3×10^{-7}, if one looks at the rates of fatal events in major North American and European carriers since 1970. Most people think nothing of hopping into their car or onto an airplane to get where they are going, so the level of this risk is "acceptable."

What Organisms Can and Cannot Do.

Microorganisms do not have the ability to jump and attack or crawl away, much as television commercials would like you to believe. Microorganisms require special conditions for growth. Bacteria or fungi that are typically found in water or soil, may grow in the environment, provided that the other conditions, like temperature and available nutrients are appropriate. Infectious organisms require very specialized conditions. Those that cause infections in human, generally require a temperature of around 37 degrees C, and must actually get inside certain tissues to grow. For example, Hepatitis B virus infects the liver; tuberculosis infects the lungs. These infectious agents cannot grow outside of a living person or animal, except under very specialized laboratory conditions. These agents do not "grow" in refrigerated or frozen clinical specimens or blood, which is one of the reasons why there are differing risk associated with cultures versus clinical specimens.

99.95% of Infectious Organisms Can't Penetrate Intact Skin

Intact skin is an effective barrier against almost all microorganisms. There are very few agents that have the ability to penetrate intact skin. *Leptospira* is one of those rare agents.
Bloodborne pathogens such as Hepatitis B and HIV pose a risk to non-intact skin, provided that there is an adequate concentration of material and exposure time. What exactly is non-intact skin? Skin that is scratched, abraded, cut, or may be affected by skin conditions such as eczema, psoriasis, rashes, or acne, could be compromised. Even if infectious material should come into contact with non-intact skin, immediate washing with soap and water can eliminate the material and risk of infection. Where access to soap and water may not be readily accessible, antiseptic hand wipes to help remove the material can be used, until the person can get to a sink.
Over 90% of the exposure incidents that result in infection to bloodborne agents like HIV or HBV involve a contaminated sharp. Fortunately, this is not a significant issue for transport. Based on

the incidents reported, most transport exposure incidents occurred to individuals who were cleaning up material that had leaked. These did not result in any infections. The use of waterproof gloves can effectively break this route of transmission. It's important to note that many of the packages involved were not packaged correctly.

Respiratory Transmission and "Aerosol" Issues

The most misunderstood area of transmission is where aerosolized infectious substances are involved. This is made even more confusing because it actually could involve 3 different modes of transmission: respiratory, mucous membrane and / or non-intact skin.

It's important to understand how these aerosols can be created, and what role the particle size plays in how infectious materials can be transmitted.

Aerosol Generation

Although viruses and bacteria are extremely small, a few microns in size or less, they are huge compared to gases. They cannot evaporate like gases or volatile organic compounds because they are larger in size and do not have the chemical structure that allows them to "vaporize".

In order to generate an aerosol, force must be applied to a liquid. In laboratories, nebulizers, sonicators, homogenizers, etc. are used to effectively generate aerosols.

In the airline transport situation, that source of "force or power" is lacking. Normal ventilation does not provide adequate force. Spillage/leakage does not generate enough aerosols either, which is discussed below.

People, however, are very effective aerosol generators. Coughing, sneezing and even talking can generate aerosols. For example, one sneeze can generate 2×10^6 viable particles! If that person has tuberculosis, then someone within about a 5 feet perimeter can inhale the aerosolized particles and potentially become infected. In the case of TB, infection of the lungs occur when aerosolized infectious particles of less than 5 microns in size, are breathed into the alveoli, the tiny cells in the lung where actual gas exchange takes place.

Amazingly, under conditions of light exercise, 95% of 10-micron particles and 80% of 5-micron particles that are inhaled are trapped in the nose. The mucous lining in the nasal area and the thoracic region, trap particles of all sizes and help to minimize the chance for those infectious particles to make it into the alveoli. Particles that are larger than 10 microns are more likely to settle out and will not remain floating in the air for any length of time, so they do not pose respiratory risks.

Packages, even if leaking, are not a significant source of aerosols. Liquids, falling 10 cm or less, produce no detectable aerosols. Based on studies, if 5 mls of liquid containing 1.2×10^9 (1,200,000,000) organisms is dripped slowly from a height of 15.2 cm (6 inches), a 2 minute sample pulled about 43 cm (17 inches) away from the spill detected 95.34 organisms/m^3 or 2.7 organisms/ft^3. (Kenny and Sabel, 1968. Dimmick et al., 1973)

To look at a more practical example, assume that a clinical sample leaks. Assume that the concentration of the virus in the sample is about 1000 organisms per ml in a 5 ml sample. (The average concentration of HIV in a sample is about 1000 viruses per ml.) If one calculates the estimated concentration in the immediate area, it's about 0.000079 orgs/m^3, or 7.9×10^{-7} orgs/m^3. If you had a sample that contained a similar amount of an organism that can be transmitted by air, such as influenza with an infectious dose of 800, the probability of a person inhaling a sufficient dose (800 viruses) of the organism is less than 1 in a billion or 1×10^{-9}!

The reality is:

Getting Real About the Risks of Transporting Infectious Substances
Mary L. Cipriano

- That leaking containers do not generate any appreciable aerosols.
- People are generally sitting next to the material being transported, i.e., within a foot of the spilled material, so the actual concentration that a passenger or crew member would be exposed to would have to be divided by the total area of the cargo/cabin.
- Many airplanes have 20-30 air changes per hour (ACH) in the cabin. 20 ACH can reduce the level of airborne contaminant by 90% in 7 minutes and 99.9% in 21 minutes.
- Some airplanes that have HEPA filters are 99.97% effective in filtering out particles of 0.3 microns in size. They are more effective, virtually 100% effective, at filtering out smaller and larger particles because of the structure of the HEPA.

There are few ways, other than from people or an explosion, to generate a significant aerosol from infectious materials.

What About Lyophilized or Dried Materials?
Lyophilized cultures are generally in a pellet. Although there may be some particles that break free when the vial is broken open, most of the material remains in the pelleted form. This material is not like the specially treated anthrax material that was engineered to be a certain particle size and treated in a way that made it very easy to disperse in the air.
Because of the low humidity on board an aircraft, it is possible for a liquid to dry, leaving a solid on the surface. Again, there is nothing that would occur on board a flight to cause the material to be pulled off of the surface in particles small enough to pose an airborne risk. Think of a blood droplet and how difficult it is to be removed from a surface.

What About Agents Like SARS?
SARS and other cold viruses are most effectively spread by droplets or contact with contaminated material. Droplets are generally larger than 10 microns in size. Usually they are visible. The droplets are ejected from someone who is sneezing or coughing. If they end up in someone's face, or on a surface or object that someone touches and then they touch their eyes or mouth, these organisms can cause an infection. How is this different from respirable agents? In the first place the dose of the organism is higher because it's a larger drop. The organisms enter the body through mucous membrane tissues, not lungs.
While this is a potential risk from passengers, a package cannot generate droplets and eject them, so they do not pose a transport risk.

Bottom Line
The generation of sufficient aerosolized particles of the appropriate respirable size requires specialized equipment and significant force applied. This cannot typically occur under transport conditions.
The risk of infection from potentially leaking packages of infectious agents or clinical specimens in transport is a risk that is extremely low and certainly should be "acceptable", since it is far lower than the risk of a fatality due to automobile or airline travel .

Mary Cipriano, MBA, RBP, CBSP, is the Manager of Biosafety for Abbott Diagnostics Division. She is a former President of the American Biological Safety Association (ABSA) and currently serves as ABSA's representative to the UN Subcommittee on the Transport of Dangerous Goods.