Gentlemen:

In transcribing the Committee Comments that comprise the Report on Comments (ROC), there were two items inadvertently omitted:

Committee Comment 77-24 (Log #CC25): The following Annex item was omitted:

A.7.2.2.1 The technique of inerting or enriching a potentially flammable atmosphere to mitigate the risk of a fire or explosion associated with a static electric discharge is well known. If inerting or enrichment is used to relax the guidelines established in this Recommended Practice for reducing static electric charge generation or accumulation or to eliminate spark promoters, the design, operation, and testing of the inerting or enrichment system must provide an equivalent level of risk mitigation. The design, operation, testing, and maintenance of such systems should address the following issues:

(1) Ensuring a reliable gas supply. Considerations include the following:
   (a) Providing a back-up gas supply
   (b) Anticipating credible high demand scenarios to ensure an adequate volume of gas is available to accommodate, for example, simultaneous start-up of multiple pieces of equipment or simultaneous rapid temperature change in multiple fixed roof storage tanks due to a rain event, either of which can result in a demand for inert gas that is greater than available supply

(2) System availability commensurate with the risk. Considerations should include:
   (a) Alarms for low gas pressure and high gas flowrate
   (b) Flow meters to monitor gas flowrate
   (c) Automatic controls, including interlocks to bring equipment to a safe state in the event of a failure or to initiate supply of the back-up gas supply
   (d) Inspection, testing, and maintenance

(3) Written contingency plans to ensure the safety of the facility should failures occur or for planned shutdown of the inerting or enrichment system.
Committee Comment 77-35 (Log #CC44): Paragraph 12.1.4.3 was improperly transcribed; it should read as follows:

12.1.4.3* Specific Recommendations for Large Conductive Floating Roof Tanks and Fixed Roof Tanks with Internal Floating Covers. For all liquids, an initial flow velocity of 1 m/s should be maintained at all times while the roof or cover is landed, regardless of depth of liquid above the inlet connection. Flow velocity can be increased when the roof or cover becomes buoyant. At this time, the flammable atmosphere will be shielded from the potentials developing during filling by the floating roof or cover, provided it is made from conductive material and is properly grounded.

My apologies for the errors.

rpb/

cc
Revise text to read:

"7.2.2 Inerting.

7.2.2.1 Where an ignitable mixture is contained, such as in a processing vessel, the atmosphere can be made oxygen deficient by introducing enough inert gas (e.g., nitrogen or combustion flue gas) to make the mixture nonignitible. This technique is known as inerting. NFPA 69, Standard on Explosion Prevention Systems, contains requirements for inerting systems.

A7.2.2.1 The technique of inerting or enriching a potentially flammable atmosphere to mitigate the risk of a fire or explosion associated with a static electric discharge is well known. If inerting or enrichment is used to relax the guidelines established in this Recommended Practice for reducing static electric charge generation or accumulation or to eliminate spark promoters, the design, operation, and testing of the inerting or enrichment system must provide an equivalent level of risk mitigation. The design, operation, testing, and maintenance of such systems should address the following issues:

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   (2) System availability commensurate with the risk. Considerations should include:
      (a) Alarms for low gas pressure and high gas flowrate
      (b) Flow meters to monitor gas flowrate
      (c) Automatic controls, including interlocks to bring equipment to a safe state in the event of a failure or to initiate supply of the back-up gas supply
      (d) Inspection, testing, and maintenance
   (3) Written contingency plans to ensure the safety of the facility should failures occur or for planned shutdown of the inerting or enrichment system.

7.2.2.2 Where operations are normally conducted in an atmosphere containing a mixture above the upper flammable limit (UFL), it might be practical to introduce the inert gas only during those periods when the mixture passes through its flammable range. NFPA 69, Standard on Explosion Prevention Systems, contains requirements for inerting systems:"

Substantiation: The reference to NFPA 69 is more correctly located in 7.2.2.1.

Committee Meeting Action: Accept"
Replace the current text of Section 12.1 with the following:

****Insert Include 77_LCC44_R.doc Here****

**Substantiation:** The replacement text has been developed to harmonize with IEC document 60079-32, Explosive Atmospheres - Part 32-2: Electrostatics Hazards

**Committee Meeting Action:** Accept
12.1 Storage Tanks.

12.1.1 General. Liquid flowing into a tank can carry a static electric charge that will accumulate in the tank. This charge can be detected as a potential above the surface of the liquid in the tank. The maximum surface potential attained depends on the charge density of the incoming liquid and the dimensions of the tank. The precautions in this section regarding fill rates and flow velocities should be taken where an ignitible atmosphere can be present in the tank. In general, a properly inerted tank will not need to follow the flow velocity guidelines in Section 12.1.

A.12.1.1 For background information regarding fill rates and flow velocities, see the following:
For guidance about inerting of tanks and about "padding" of tanks with fuel gas, see Chapter 7, Deflagration Prevention by Oxidant Concentration Reduction, of NFPA 69, Standard on Explosion Prevention Systems.

12.1.2 Classification of Storage Tanks. For the purpose of Section 12.1, storage tanks are classified according to their diameter and capacity, as shown in Table 12.1.2.

Table 12.1.2 Classification of Storage Tanks

<table>
<thead>
<tr>
<th></th>
<th>All vertical axis cylindrical tanks and all rectangular tanks whose length-to-width ratio is ≤ 1.5</th>
<th>All horizontal axis cylindrical tanks and all rectangular tanks whose length-to-width ratio is &gt;1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large tanks</td>
<td>D &gt; 10 m</td>
<td>capacity &gt;500 m³ (125,000 gal)</td>
</tr>
<tr>
<td>Medium tanks</td>
<td>1.3 m &lt; D ≤ 10 m</td>
<td>2 m³ (500 gal) &lt; capacity ≤ 500 m³ (500 &lt; capacity ≤ 125,000 gal)</td>
</tr>
<tr>
<td>Small tanks</td>
<td>D ≤ 1.3 m</td>
<td>capacity ≤ 2 m³ (500 gal)</td>
</tr>
</tbody>
</table>

D = diameter of cylindrical tanks, m  
(for rectangular tanks D = 2(LW/N)¹⁄²)

L = maximum linear dimension of non-cylindrical rectangular cross-section tank, m

W = minimum linear dimension of non-cylindrical tank rectangular cross-section tank, m

d = inlet fill line diameter, m

v = inlet liquid flow velocity, m/s

N = 1 for tank lengths <2 m
N = (L/2)¹⁄² for tank lengths ≥ 2 m and ≤ 4.6 m
N = 1.5 for tank lengths > 4.6 m

12.1.3 For the purpose of Section 12.1, conductive tanks are considered to be those vessels having less than 1 megohm resistance to ground.

12.1.4 Large Conductive Tanks

12.1.4.1 For all liquids (from nonconductive to conductive), the following precautions should be taken:

(1) The tank and all associated equipment such as piping, pumps, and filters, should be grounded.
(2) Personnel entering or working near tank openings should be grounded.

(3) Splash filling should be avoided.

(4) For low conductivity liquids, follow the guidelines given in Table 12.1.4.4

12.1.4.2 Specific Recommendations for Large Conductive Fixed Roof Tanks. For nonconductive liquids, the following additional precautions should be taken:

1. Locate high static electric charge-generating elements, such as pumps and filters, a suitable residence time upstream of the tank inlet. (See Section 10.5.2.1.)

2. For uncontaminated single-phase liquids, restrict the inlet flow velocity to 1 m/s until the fill pipe has been submerged to a depth of twice the inlet pipe diameter. Fill rate may then be increased up to 7 m/s.

3. For multi-phase or contaminated liquids and where it cannot be ensured that water bottoms will not be disturbed, restrict the inlet flow velocity to 1 m/s during the entire fill cycle.

4. Use of a centrally-located inlet pipe that extends to within 150 mm of the bottom of the tank is recommended. A horizontal tee is recommended at the discharge for bottom fill connections.

5. Minimize accumulation of water and sediment in the tank.

6. For multi-stage loading, liquids should be transferred to the tank in increasing order of density.

7. In all cases, the maximum flow velocity should not exceed 7 m/s.

12.1.4.3* Specific Recommendations for Large Conductive Floating Roof Tanks and Fixed Roof Tanks with Internal Floating Covers. For all liquids, an initial flow velocity to 1 m/s should be maintained at all times while the roof or cover is landed, regardless of depth of liquid above the inlet connection. Flow velocity can be increased when the roof or cover becomes buoyant. At this time, the flammable atmosphere will be shielded from the potentials developing during filling by the floating roof or cover, provided it is made from conductive material and is properly grounded.

A.12.1.4.3 Floating roof storage tanks are inherently safe, provided that the floating roof is bonded to the tank shell. Bonding typically is achieved by shunts between the floating roof or cover and the wall of the tank. The shunts are installed for lightning protection, but they also provide protection from static electric charges that could be generated. If the floating roof is landed on its supports, charge accumulation in the surface of the liquid can occur, and the precautions for a fixed roof tank should be followed. If an internal floating roof tank is not adequately ventilated, flammable vapor can accumulate between the floating roof and the fixed roof.

12.1.4.4 Summary of flow velocities. Table 12.1.4.4 summarizes the flow velocity restrictions for large tanks.

Table 12.1.4.4 Summary of Precautions for filling large conductive tanks with low conductivity liquids

<table>
<thead>
<tr>
<th>Precautions</th>
<th>Applicability to tank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With floating roof or internal cover</td>
</tr>
<tr>
<td>Keep flow velocities below 1 m/s</td>
<td>Essential until the roof or cover is afloat</td>
</tr>
<tr>
<td>Keep flow velocities below 7 m/s</td>
<td>Not essential when the roof or cover is afloat</td>
</tr>
</tbody>
</table>

NOTE A flow rate limit will often be needed to avoid damaging the roof by too rapid movement.
Essential until the roof or cover is afloat

Ensure an adequate residence time between strong charge generators (e.g. microfilters) and the tank

NOTE The residence time can be calculated using a velocity of 1 m/s in this instance.

Ensure an adequate residence time between strong charge generators (e.g. microfilters) and the tank

Essential until the roof or cover is afloat

Avoid disturbing water bottoms with incoming product, entrained air or by blowing out lines with gas

Essential until the roof or cover is afloat

Avoid charging low density liquids into tanks containing substantially higher density liquids (see 7.3.2.1.1)

Unnecessary

Recommended as far as practicable. If unavoidable keep the flow velocity below 1 m/s (see row 1 of this table)

### 12.1.5 Medium-sized fixed conductive tanks

#### 12.1.5.1 Precautions for all types of liquid:

1. Follow the recommendations in 12.1.4.1.
2. Maintain flow velocities within the limits 12.1.5.3.
3. Do not clear lines with air or other gas unless it is certain that the operation will not overpressure the equipment.

#### 12.1.5.2 Additional precautions for low conductivity liquids:

1. Provide sufficient residence time for charge relaxation between high charging elements (e.g., filters) and the tank inlet, as recommended in Table 12.1.4.4.
2. The level of water in the bottom of the tank should be kept at least two pipe diameters below the inlet.
3. The inlet should be designed to minimize jetting of highly charged product to the surface and to minimize the disturbance of water bottoms or sediment. For example, use a dip pipe for overhead filling or a horizontal tee for bottom side entry filling.
4. Splash filling should be avoided by bottom filling or by using an inlet pipe extending close to the tank bottom or by bottom. A fill pipe directed towards the inner wall of the tank can be used where the process requires top filling. In such cases, flow velocity should not exceed the lesser of 2 m/s or 50% of the flow velocity determined from the allowable velocity limit (see 12.1.5.3) and the pipe discharge should be at least 200 mm above the maximum fill level.

#### 12.1.5.3 Additional Flow Velocity and Flow Rate Limitations for Medium-Sized Fixed Roof Tanks

**12.1.5.3.1** To prevent dangerous accumulation of static electric charge, flow velocity must be limited through a relaxation region upstream of the tank. This region consists of a run of piping through which the liquid has a residence time equal to the lesser of 30 seconds or 3 relaxation times. Relaxation time should be based on that liquid having the lowest possible conductivity that might be handled. The 30 seconds criterion should be adopted where the lowest value of conductivity is not known.

**12.1.5.3.2.** To ensure that the velocity limits are met throughout the relaxation region, it is necessary only to ensure that they are met through the most critical section, which is that section having the smallest pipe diameter in an unbranched system. If the section having the smallest diameter is less than 5 m long and is only one nominal pipe size less than the section having the next smallest diameter, then the latter can be taken as the critical one.

**12.1.5.3.3** For branched systems (e.g. a large feeder line that divides into smaller lines, such that the upstream pipe segments feed several tanks while downstream sections each feed just one tank), the critical section is the one with the highest value of $F_s/d_s^3$, where $F_s$ is the highest possible flow rate through the
segment and $d_s$ is the diameter of the pipe in the segment.

### 12.1.6 Limitations for Medium-sized Fixed Roof Tanks.

**12.1.6.1** Allowable flow velocities depend on the conductivity of the liquid being transferred and the size and geometry of the tank into which the liquids are transferred. For medium and low conductivity liquids, the initial flow velocity should not exceed 1 m/s until the fill pipe outlet is submerged to a depth of two pipe diameters.

**12.1.6.2** After the low initial filling rate period or where such a period is not needed, a maximum flow can be established in accordance with the following:

1. For conductive liquids and for single-phase medium conductivity liquids, a maximum flow velocity of 7 m/s is recommended.
2. For liquids with contaminants and for two-phase medium or low conductivity liquids, a maximum flow velocity of 1 m/s is recommended.

**12.1.6.3** For uncontaminated, single-phase low conductivity liquids, the following applies

1. For vertical-axis cylindrical tanks and for rectangular tanks of near-square cross section, the maximum flow velocity should be the lesser of 7 m/s or $0.7(D/d)^{1/2}$ m/s, where $D$ is the diameter of a cylindrical tank, in meters, and $d$ is the diameter of the inlet fill line, also in meters. For rectangular tanks, $D = 2(LW/N)^{1/2}$.
2. For horizontal-axis cylindrical tanks and for rectangular tanks having $L/W \leq 1.5$, the maximum velocity should be:
   
   (a) 0.5 X $N/d$ for top loading and for bottom loading with a central conductor
   (b) 0.38 X $N/d$ for bottom loading without a central conductor

where $N$ is the factor described in Table 12.1.2 and $d$ is the diameter of the inlet fill line, in meters.

**12.1.6.3.1** When filling multiple tanks through a branched line, the critical section might occur at a location that feeds more than one tank. In this case, the maximum velocity in the critical section can be increased by a factor $N_s^{1/2}$ from the value given in 12.1.4.3(1) above, where $N_s$ is the ratio of the maximum flow rate through the critical segment to the flow rate into the tank.

### 12.1.7 Grounding.

**12.1.7.1** Storage tanks for nonconductive liquids should be grounded. Storage tanks on grade-level foundations are considered inherently grounded, regardless of the type of foundation (e.g., concrete, sand, or asphalt).

**12.1.7.2** For tanks on elevated foundations or supports, the resistance to ground can be as high as $10^6$ ohms and still be considered adequately grounded for purposes of dissipation of static electric charges, but the resistance should be verified. The addition of grounding rods and similar grounding systems will not reduce the hazard associated with static electric charges in the liquid.

### 12.1.8 Spark Promoters.

**12.1.8.1** A tank gauging rod, high-level sensor, or other conductive device that projects downward into the vapor space of a tank can provide a location for static electric discharge between the device and the rising liquid; therefore, these devices should meet the following criteria:

1. They should be bonded securely and directly downward to the bottom of the tank by a conductive cable or rod to eliminate a spark gap or should be installed in a gauging well that is bonded to the tank.
2. They should be inspected periodically to ensure that the bonding system has not become detached.

**12.1.8.2** If tank fixtures are nonconductive, the potential for sparking does not exist, and no specific measures are needed. Devices that are mounted to the sidewall of the tank (e.g., level switches or temperature probes) and project a short distance into the tank might not pose a static electric discharge hazard. These situations should be evaluated on an individual basis.

### 12.1.9 Tank Mixers.

In-tank jet mixing or high-velocity agitator mixing can stir up water and debris and cause splashing at the surface that can generate static electric charges. If an ignitable mixture exists at the
surface, ignition is possible. For these reasons, surface splashing should be minimized. Gas blanketing or inerting can be employed to eliminate the ignition hazard.

12.1.10 Gas Agitation.

12.1.10.1 Air, steam, or other gases should not be used for agitation because they can produce high levels of charge in liquids, mists, or foams. In addition, air agitation can create an ignitable atmosphere in the vapor space of the tank. If gas agitation is unavoidable, the vapor space should be purged prior to mixing and the process should be started slowly to ensure that static electric charge does not accumulate faster than it can dissipate.

12.1.10.2 It should be noted that special precautions need to be taken to prevent agitation with air because it can dilute any initial inerting. Similarly, while agitation with an inert gas can eventually result in an inert vapor space, the buildup of a static electric charge due to the agitation process can result in a spark and ignition before inerting of the tank vapor space is achieved. A waiting time should be observed prior to any gauging or sampling activities.

12.1.11 Coated and Lined Tanks. The presence of internal coatings or linings in grounded metal tanks can generally be neglected, provided that one of the following criteria applies:

1. The coating or lining has a volume resistivity equal to or lower than 10^9 ohm-m.
2. Thickness of a painted coating does not exceed 50 μm (2 mils).
3. The liquid is conductive and is always in contact with ground, for example, a grounded dip tube or grounded metal valve.

12.1.11.1 Metal tanks with nonconductive coatings or linings that do not meet the criteria of 12.1.11(1) or 12.1.11(2) should be treated as nonconductive tanks. Regardless of the coating or lining thickness or resistivity, the tank should be bonded to the filling system.

12.1.12 Tanks Constructed of Nonconductive Materials. Tanks constructed of nonconductive materials are not permitted for storage of Class I, Class II, and Class IIIA liquids, except under special circumstances, as outlined in Subsection 21.4 of NFPA 30, Flammable and Combustible Liquids Code. (See Section 13.8 for design and use recommendations.)