Information and recommendations for paramedics and doctors at the site

- Patients whose clothing or skin is contaminated with solid acid anhydrides or their dusts can cause secondary contamination of rescue and medical personnel by direct contact.
- Acid anhydrides and their dusts and vapor are irritating when they come in contact with the eyes, skin, and upper respiratory tract causing coughing, sore throat and wheezing. Obstruction of the airways and respiratory distress with chest pain and dyspnea may occur. Skin and pulmonary sensitization is possible.
- Ingestion of acid anhydrides can cause irritation to the lips, mouth, throat, esophagus, and stomach.
- Immediate decontamination (first removal of solid acid anhydrides, thereafter extensive flushing of contaminated eyes, skin, and hair) is crucial.
- There is no antidote to be administered to counteract the effects of acid anhydrides. Treatment consists of supportive measures.

1. Substance information

Maleic anhydride (C₄H₂O₃), CAS 108-31-6
Synonyms: cis-butenedioic anhydride, 2,5-furandione, maleic acid anhydride.
At room temperature maleic anhydride is a white crystalline solid with an acrid odor. Maleic anhydride is soluble in water, acetone, ethyl acetate, chloroform, and benzene. Vapor pressure is 25 Pa at 25 °C and flash point 102 °C. In presence of water maleic anhydride hydrolyzes to maleic acid.
Use of maleic anhydride includes the manufacture of polyester and alkyd coating resins, fumaric and tartaric acids and maleic hydrazide, a herbicide.

Phthalic anhydride (C₈H₄O₃), CAS 85-44-9
Synonyms: 1,3-isobenzofurandione, 1,2-benzenedicarboxylic anhydride, phthalic acid anhydride.
At room temperature, phthalic anhydride appears as white crystalline needles with a characteristic, suffocating odor. Phthalic anhydride is soluble in in alcohol; slightly soluble in ether and water. Vapor pressure is < 0.3 Pa at 20 °C and flash point 152 °C. In presence of water phthalic anhydride converts to phthalic acid.
Phthalic anhydride is widely used in organic syntheses for the manufacture of many resins, polyesters, dyes, pharmaceuticals, plasticizers, and fungicides.

2. Routes of exposure

Inhalation
Inhalation of dust and vapor is a relevant route of exposure. Acid anhydrides’ irritant properties do not generally provide adequate warning of hazardous concentrations for acute exposures. Sensitized, allergic individuals may react to very low concentrations of acid anhydrides.

Skin/eye contact
Most exposures to acid anhydrides occur by skin contact. Direct contact with solid acid anhydrides or dusts on eyes or skin causes irritation.

Ingestion
Ingestion of acid anhydrides can cause irritation to the lips, mouth, throat, esophagus, and stomach.
3. Acute health effects

Respiratory

Acid anhydrides exposure usually causes coughing, sore throat and wheezing. Inhalation may result in obstruction of the airways and respiratory distress with chest pain and dyspnea. Several cases of occupational asthma have been reported.

Dermal

Irritation, redness and pain of the skin and mucous membranes may be caused by contact with acid anhydrides. Skin sensitization with occasional urticaria and eczematous response may occur.

Ocular

Eye irritation with burning discomfort, spasmodic blinking or involuntary closing of the eyelids, redness, and tearing may be caused by contact with acid anhydrides.

Gastrointestinal

Abdominal pain, nausea, and vomiting may occur. In cases of ingestion, irritation can involve the entire intestinal tract.

Dose-effect relationships

<table>
<thead>
<tr>
<th>Maleic anhydride concentration</th>
<th>Effect</th>
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</thead>
<tbody>
<tr>
<td>0.4 mg/m³</td>
<td>TLV-TWA (USA, NIOSH)</td>
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<tr>
<td>1.0 mg/m³</td>
<td>Odor threshold</td>
</tr>
<tr>
<td>1.5 mg/m³</td>
<td>Mucous membrane irritation</td>
</tr>
<tr>
<td>2.5 mg/m³</td>
<td>Extremely irritating</td>
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<tr>
<td>10 mg/m³</td>
<td>IDLH (USA, NIOSH)</td>
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</table>

<table>
<thead>
<tr>
<th>Phthalic anhydride concentration</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.32 mg/m³</td>
<td>Odor threshold</td>
</tr>
<tr>
<td>6 mg/m³</td>
<td>TLV_TWA (USA; NIOSH)</td>
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<tr>
<td>25 mg/m³</td>
<td>Mucous membrane irritation</td>
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<tr>
<td>30 mg/m³</td>
<td>Conjunctivitis</td>
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<tr>
<td>60 mg/m³</td>
<td>IDLH (UUS, NIOSH)</td>
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</tbody>
</table>

4. Actions

Rescuer self-protection

If the zone which has to be entered by the rescuer is suspected of containing acid anhydride dusts or vapors, pressure-demand, self-contained breathing apparatus and chemical-protective clothing shall be worn; do not use equipment that is contaminated itself. Patients whose clothing or skin is contaminated with acid anhydrides can cause secondary contamination of rescue and medical personnel by direct contact.

Patient recovery

Patients should be removed from the contaminated zone immediately. If patients can walk, they should walk. Patients who are unable to walk may be removed on backboards or stretchers; if these are not available, carefully carry or drag patients to safety.

Immediate priorities must follow the “A, B, C’s” of resuscitation.

Decontamination

Patients exposed only to acid anhydride dusts or vapors who have no evidence of skin or eye irritation do not need decontamination. All others require decontamination.

Patients who are able and cooperative may assist with their own decontamination. If the exposure involved solid acid anhydrides and dusts and if clothing is contaminated, remove and double-bag the clothing.

If any solid acid anhydrides or dusts are present on the patient's skin, hair or clothes, brush it away before flushing. Protect yourself and the patient's eyes.
Assure that exposed or irritated eyes have been irrigated with plain water or saline for at least 15 minutes, and that the pH of the conjunctival fluid has returned to normal (7.0). If not, continue eye irrigation during other basic care and transport. If eye irrigation is impaired by blepharospasm, one to two drops of oxybuprocaine 0.4% may be instilled into affected eyes to allow adequate irrigation. Remove contact lenses if present and easily removable without additional trauma to the eye.

Then, assure that exposed skin and hair have been flushed with plain water for at least 15 minutes. If not, continue flushing during other basic care and transport. Protect eyes during flushing of skin and hair.

Initial treatment

Therapy will be empiric; there is no antidote to be administered to counteract the effects of acid anhydrides.

All patients potentially exposed to an airborne acid anhydrides concentration of 1.5/30 mg/m³ or more should take 8 puffs of beclomethasone (800 µg beclomethasone dipropionate) from a metered dose inhaler.

Establishment of intravenous access.

If exposure concentration is 3.0/60 mg/m³ or greater, intravenous administration of 1.0 g methylprednisolone (or an equivalent steroid dose) is recommended.

Note: Efficacy of corticosteroid administration has not yet been proven in controlled clinical studies.

If inhalation exposure has occurred, humidified air or oxygen should be provided. If signs of hypoxemia are present, humidified supplemental oxygen should be administered.

Intubation of the trachea should be considered in cases of respiratory compromise. When the patient’s condition precludes endotracheal intubation, perform cricothyrotomy if equipped and trained to do so.

Patients with bronchospasm should be treated as follows:

a) Aerolized β₂-selective adrenergic agonist, e.g. 4 puffs of terbutaline, or salbutamol, or fenoterol from a metered dose inhaler (1 puff usually contains 0.25 mg terbutaline sulfate, or 0.1 mg salbutamol, or 0.2 mg fenoterol, respectively); may be repeated once after 10 min.

If inhalation is not possible, terbutaline sulfate (0.25-0.5 mg) subcutaneously or salbutamol (0.2-0.4 mg over 15 min) intravenously.

b) If a) is not effective or insufficient: theophylline (5 mg/kg body weight intravenously over 20-30 min).

c) If a) and b) are not effective or insufficient: 2 puffs of epinephrine (0.4 mg per puff) from a metered dose inhaler; may be repeated after 5 min.

If acid anhydrides were in contact with the skin, chemical burns may result; treat as thermal burns: adequate fluid resuscitation and administration of analgesics, maintenance of the body temperature, covering of the burn with a sterile pad or clean sheet.

After eye exposure, irritation may result; apply supportive measures. Consult an ophthalmologist.
In case of ingestion of acid anhydrides, do not induce emesis; apply supportive measures.

**Patients with an exposure concentration of 1.5 mg/m³ maleic anhydride or more or 30 mg/m³ phthalic anhydride or more or with ingestion of acid anhydrides as well as patients without available exposure measurements but suspected of being exposed to concentrations of 1.5 mg/m³ maleic anhydride or more or 30 mg/m³ phthalic anhydride or more should be transferred to a hospital/emergency department.**

**Patient release/**

**follow-up instructions**

**Asymptomatic patients** exposed to an airborne concentration of less than 0.4 mg/m³ maleic anhydride or 6 mg/m³ phthalic anhydride as well as patients who have a normal examination and no signs or symptoms of toxicity after observation for 8 hours may be discharged in the following circumstances:

a) The evaluating physician is experienced in the evaluation of individuals with acid anhydrides or irritant dusts exposure.

b) Information and recommendations for patients with follow-up instructions are provided verbally and in writing. Patients are advised to seek medical care promptly if symptoms develop or recur.

c) The physician is comfortable that the patient understands the health effects of acid anhydrides and the provided follow-up instructions.

d) Site physician is notified, so that the patient may be contacted at regular intervals in the 24-hour period following release.

e) Heavy physical work should be precluded for up to 24 hours.

f) Exposure to cigarette smoke should be avoided for 72 hours; the smoke may worsen the condition of the lungs.

Patients who have serious skin or eye injuries should be reexamined in 24 hours.

In this document BASF has made a diligent effort to ensure the accuracy and currency of the information presented but makes no claim that the document comprehensively addresses all possible situations related to this topic. This document is intended as an additional resource for paramedics and doctors at the site in assessing the condition and managing the treatment of patients exposed to acid anhydrides. It is not, however, a substitute for the professional judgement of a paramedic or a doctor and must be interpreted in the light of specific information regarding the patient available to such a paramedic or doctor and in conjunction with other sources of authority.