Post-Emergency, Multi-Hazard Health Risk Assessment in Chemical Disasters
PEC

Deliverable D.D.1

Report on Acute Health Impact Assessment

ECHO/SUB/2015-713844-PREV11 - PEC: Post-Emergency, multi-hazard health risk assessment in Chemical disasters
Project co-funded by ECHO - Humanitarian Aid and Civil Protection

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1. EXECUTIVE SUMMARY

The objective of the studies described in this document was to determine the applicability of the integrated model proposed in the PEC project for the evaluation of health impacts of acute exposure to representative hazardous chemicals (benzene and acrylonitrile) in the population affected by a hypothetical industrial disaster. The expected health effects of the incident are determined here considering both the workers present inside the industrial facility and the general population affected by the incident in proximity of the industrial area.

Acute (short-term) health effects of the chemicals released into the atmosphere are examined for each individual industrial plant item damaged during the incident. The effects are evaluated according to clinical toxicology criteria in terms of intensity and magnitude considering (i) type and magnitude of clinical symptoms (i.e. local effects such cutaneous, ocular or pulmonary irritation, and systemic syndromes) and the total number of subjects (worker and the general population) likely affected because of exposure to benzene or acrylonitrile. The predicted toxic responses are evaluated in relation to traditional reference parameters such as the Acute Exposure Guideline Levels (AEGLs) and, in addition, are ranked according to increasing levels of acute toxicity manifested as “toxidromes” (respiratory, neurological, cardiovascular) reflecting the constellation of clinical clues typical of the poison of interest.

Results indicate that the model proposed in PEC can be valuably used to predict and quantify the short-term health consequences likely resulting from incidental exposure of the population to hazardous chemicals after a natural or anthropic disaster involving a chemical plant. The methodological approach used in this study would also support caregivers and emergency personnel by providing early indication on the occurrence of defined clinical syndromes, so that informed evaluation of patients and appropriate treatment can be initiated accordingly.

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2. SHORT DESCRIPTION OF THE FICTIONAL INCIDENT SETTING.

In our model, quantities of benzene and acrylonitrile are assumed to be stored in one of the chemical plants (here indicated as Plant A) in the fictitious industrial area involved in the simulated catastrophic incident.

Characteristics of the population living in the area of the disaster have been derived from known demographic indicators of the municipality of interest, as detailed in previous Deliverables.

The study population consists of 200,000 inhabitants (48% male and 52% female), the population density being about 1,300 people/km^2 in the urban area and 250 people/km^2 in the semi-rural area. The population includes (i) local residents and (ii) workers affected inside industrial plants.

Adults (aged 19-65 years) are 65 % of the total population. Minors (children aged 18 or younger) and older people (subjects aged 65 and over) are respectively 16 % and 19 % of the total population.

The population density was originally divided into three different categories to represent subjects living in (i) the area surrounding the industrial facility (population density: 500 persons/km^2), (ii) the most populated urban area, 8000 persons/km^2), and (iii) a sub-urban area (3000 persons/ km^2).

The average distances from the industrial area have been defined as 500 m, 3-5 km, and 8-10 km for the next inhabited, most populated urban and sub-urban areas, respectively.

It is assumed for simplicity, that the spatial distribution of the population living at different distances from the fictitious industrial area is homogeneous in both the urban and semi-rural areas.

3. METHODOLOGY USED FOR THE EVALUATION OF HEALTH IMPACTS

A standard protocol is used to characterize and quantify toxic responses to benzene and acrylonitrile according to environmental data obtained in Task C, namely atmospheric dispersion of the chemicals of interest, predicted environmental concentrations, and consequent population exposure profiles.

As a preliminary step, published data on chemical incidents involving benzene or acrylonitrile, and case reports of acute poisoning and short-term accidental exposure to these chemicals were reviewed and evaluated to derive a consistent framework regarding medical toxicological aspects, pathophysiology and dose-response relationships.

Severity and magnitude of the predicted effects are expressed in terms of numbers of persons affected, overall morbidity (non-disabling and disabling) and short-term mortality, assuming a standard 1-hr post-incident exposure duration.

3.1 Traditional evaluation approach.

Atmospheric concentrations of benzene and acrylonitrile possibly associated with acute toxic response were initially evaluated based on traditional parameters such as Acute Exposure Guideline Levels (AEGLs). AEGLs can be used to estimate the concentrations at which most people—including sensitive individuals such as old, sick, or very young people—will begin to experience health effects if they are exposed to a given hazardous chemical for a specific length of time (duration).

Other existing guidelines, namely the Emergency Response Planning Guidelines (ERPGs), the inventory of the U.S. Department of Energy on Temporary Emergency Exposure Limits for Chemicals (TEEL), and the NIOSH/OSHA Immediately Dangerous to Life and Health limits (IDLHs) were also considered as basic references to examine the health impacts (see below).

Occupational exposure limits were also considered as reference parameters for evaluating the likely impact of benzene and acrylonitrile exposures in workers.

Notably, there are some limitations regarding the predictive value of these guidelines when used to assess medical emergency situations due to accidental industrial chemical release. For example, in assessing the health consequences of the incident, the latter is considered as a simplified cause-effect chain of events. Classification of responses to acute chemical exposure is generic, not considering the type of the expected clinical syndromes, which is in fact of crucial importance to determine the type of medical intervention required. Furthermore, limited attention is posed in the existing standard guidelines to the ample variations in severe toxicity or lethality outcomes occurring in sensitive population sub-groups such as children with asthma or older adults suffering from chronic respiratory diseases.

For these reasons, the practical applicability of AEGLs and similar guidelines as a reference for medical response planning in chemical emergencies is questionable. It is widely accepted that these guidelines should not be used indiscriminately but primarily used by persons with expertise in community emergency response as planning tools for assessing the adequacy of incident prevention and containment measures undertaken in cases of hazardous chemical release.

3.2 Syndromic evaluation approach.

Based on these concepts, a refined syndromic characterization approach is used in our study to better define the health outcomes of the incident and improve the accuracy of their classification. Specifically, the type and severity of toxic effects are defined in our evaluation model by criteria considering, in addition to standard reference values, our evaluation model considers weight-of-evidence-based clinical indicators as well as the mode of action (mechanisms of toxicity and critical target organs) typical of the chemicals of interest when absorbed at high doses.

The advantages offered by a syndromic analysis are considerable. In the evaluation of casualties during a complex industrial incident, the medical response personnel will benefit from placing the effects of the chemicals involved into groups with similar properties so that the severity and potential consequences of the exposure can be rapidly and accurately assessed. In other words, differing from the traditionally used reference indicators such as ERPGs, IDLHs, TEEL etc., a syndromic analysis combining available scientific information, medical experience and expert judgement is more focused on the complex framework of disease entities and clinical outcomes that can realistically be expected at a given interval of doses and exposure levels.

As shown in BOX 1, the Triage Model Outcome used in our study is based on increasing levels of symptom severity and disability resulting from chemical exposure, starting from discomfort, minor, rapidly reversible health effects, then disabling (e.g. escape impairing) or otherwise serious effects, life-threatening effects, up to the lethal effect thresholds.

BOX 1: Triage Model Outcome Used for the Evaluation of Health Impacts

Tier	**Response, level of disability**	**Requirements for Emergency Healthcare**
1	Discomfort, minor, rapidly reversible local or systemic effects	*Can be managed at the pre-hospital level*
2	Disabling (e.g. escape impairing) or otherwise serious effects	*Require hospitalization and supportive treatment*
3	Life-threatening effects	*Require prompt hospitalization and intensive care support*
4	Lethal effect threshold	*Effects require on site stabilization and resuscitation measures*

Tiers of response, i.e., the emergency healthcare requirements related to the severity of manifestations and clinical outcomes are also indicated.

On this basis, the predicted health impacts of the incident are consistently classified considering the following parameters: (i) the severity of toxic end-points and outcomes, (ii) the symptomatology (from which appropriate plans of emergency medical intervention can be decided), and the magnitude of impacts (number of persons affected).

Children and subjects aged 65 yr or over are considered as separate sub-groups because the health impact of the incident in these sub-groups may be more severe compared to the adult population. There is no direct information about the susceptibility of children and elderly people to acute toxic effects of benzene and acrylonitrile after inhalation exposure, although data from isolated report suggest children being more sensitive than adults to acute toxicity of acrylonitrile.

On the other hand, physiological considerations would indicate greater propensity of children

and old people to suffer from effects of benzene or acrylonitrile after acute exposure. Because of more rapid respiration rates, absorption of aerosolized or gaseous toxins is often more extensive in children than in adults. Greater skin surface and permeability, immature detoxification systems and higher metabolic rate are additional factors that may contribute to increased sensitivity of children to toxic insult. The child's skin has less keratinization, theoretically allowing irritants to cause greater local injury. Furthermore, immature motor skills may make it less likely that children will remove themselves from a dangerous situation.

Regarding older adults, the significant prevalence of chronic respiratory disorders in the elderly clearly will increase individual susceptibility to inhalation of chemical irritants such as benzene and acrylonitrile.

In the evaluation model used in the study it is assumed that (i) no coexisting injury (trauma, burns, bleeding, wounds, bone or joint damage etc.) occurs in victims suffering from effects of the chemical incident and (ii) the estimated health outcomes were not influenced by medical intervention and healthcare resources employed in emergency response to disaster.

4. ACUTE TOXICITY PROFILE OF THE MODEL HAZARDOUS CHEMICALS

Sources of the data summarized in this section include major textbooks of clinical toxicology (True & Dreisbach Handbook of Poisoning, 2001; Ford et al: Clinical Toxicology, 2001; Ellenhorn & Barceloux, Medical Toxicology, 1988; Dart, Medical Toxicology 2004; Goldfrank: Goldfrank's Toxicologic Emergencies, 2006), relevant published review (Kales & Christiani, 2004; Tommassoni et al. 2015), and reference publications such as the OECD Guidance Document on Chemical Accidents (OECD 1994), and the US National Research Council Document on Acute Exposure Guideline Levels for Selected Airborne Chemicals (2014).

4.1 BENZENE

Relevant toxicological parameters of acute human inhalation exposure to benzene are summarized in BOX 2.

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BOX 2. Reference toxicological indicators of acute inhalation exposure to benzene in humans.

- Emerging Response Planning Guidelines for Benzene, ERPG (Source: AIHA - Emergency Response Planning Committee):

- ERPG-1: **50 ppm**.
- ERPG-2: **150 ppm**
- ERPG-3: **1,000 ppm**

Note:

ERPG-1: maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or perceiving a clearly defined objectionable odor.

ERPG-2: maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action

ERPG-3: maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

- Acute Exposure Guideline Levels (AEGLs)*: the data shown below are expressed in ppm and refer to benzene exposures lasting from 10 minutes to 8 hours (Source: http://www.epa.gov/oppt/aegl/)

	10 minutes	**30 minutes**	**60 minutes**	**4 hours**	**8 hours**
AEGL-1	130	73	52	18	9.0
AEGL-2	2,000	1,100	800	400	200

AEGL-3	-	5,600	4,000	2,000	990

Note

AEGL-1: is the airborne concentration (expressed as ppm (parts per million) or mg/m^3 (milligrams per cubic meter)) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic no sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2: is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long–lasting adverse health effects or an impaired ability to escape.

AEGL-3: is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening effects or death.

- Immediately Dangerous to Life (IDLH) concentration: 500 ppm **(**NIOSH, 2014) **(.**

Note

The lethal concentration level is largely dependent on the duration of exposure ranging from 3,000 ppm (0.5-1 h exposure) up to 19,000-20,000 ppm for a very short exposure (5-10 min). Inhalation of 1,500 ppm benzene for 60 minutes can induce serious symptoms.

- NIOSH Recommended Exposure Limits (REL): 0.1 ppm TWA, 1 ppm STEL

- OSHA Permissible Exposure Limits (PEL)

Time Weighted Average Limit (TWA): 1 ppm (3.2 mg/m^3)

Short-term Exposure Limit (STEL): 5 ppm (16 mg/m^3)

- ACGIH Occupational Exposure Limits:

Time Weighted Average Limit (TWA): 0.5 ppm (1.6 mg/m^3)

Short-Term Exposure Limit (STEL): 2.5 ppm (8 mg/m^3)

- Odor threshold: 1.5 ppm (ATSDR 2007)

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Benzene is rapidly and almost completely absorbed by inhalation. Systemic absorption can also occur by dermal contact. Lipophilic properties of benzene facilitate rapid transfer across alveolar membranes in the respiratory tract and passage to the brain tissue.

Absorption of large amounts of benzene causes pronounced, almost immediate central nervous system depression. The principal manifestation of severe acute poisoning is coma. Symptoms from mild exposure are dizziness, weakness, euphoria, headache, nausea. Vomiting, tightness of the chest, and staggering. If exposure is more severe, symptoms progress to visual blurring,

tremors, shallow and rapid respiration, paralysis, unconsciousness, and convulsions. Violent excitement or delirium may precede unconsciousness.

Ventricular irregularities including fibrillation may also develop in subjects exposed to high concentrations of benzene. This is a serious complication which is believed to reflect a process of solvent-induced sensitization of the myocardium to effects of endogenous catecholamines, a condition likely facilitated by the presence of stress and anxiety.

In acute poisoning, death may result from asphyxiation, cardiovascular collapse and dysrhythmias, occurring up to 3 days after initial exposure.

Rapid progression of symptoms and lack or response to the patient's removal from contaminated air indicate poor outcome.

In acute fatalities, the post-mortem findings include petechial hemorrhages, kidney and liver damage and congestion of all organs.

From the overall evaluation of the available data on (i) reported effects of benzene in acute human poisoning, (ii) mechanisms of benzene toxicity in acute overdosage, and (iii) acute effects described in animals experiments conducted under controlled conditions, concentration-response relationships have been defined (BOX 3) and applied in this study as an "evidence-based" reference guide for determining the acute effects of inhalation exposure to benzene in the distinct situations considered in our simulated incident.

BOX 3. Correlation of Ambient Air Levels and Acute Effects of Benzene in Humans

Benzene concentration (ppm)	Symptoms and Clinical Presentation
1	No appreciable effects. 1 ppm benzene is the reference value for permissible occupational exposure limit, TWA (OSHA)
2.5	No appreciable effects. 2.5 ppm benzene is the reference value for permissible short-term exposure limit in occupational setting (ACGIH), and a concentration immediately above the olfactory threshold.
5	5 ppm benzene is the short-term exposure limit (STEL, 15 min exposure) indicated by OSHA. No appreciable effects observed in subjects exposed for a short period of time.
10	Past occupational standard limit (ACGIH)
25	Mild local effects (e.g. skin, eye, pulmonary irritation) expected in susceptible individuals
50	Threshold for mild, transient systemic alterations expected in individuals exposed for up to 1 hr; nausea, drowsiness, mild headache, peculiar chemical taste, fatigue, psychological reaction to olfactory stimuli
100	Pronounced drowsiness, dizziness, headache, initial mental status alterations (euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation
300	Excitatory symptoms followed by pronounced drowsiness, staggering, weakness. Impaired ability to take protective action in individuals expose for up to 1 hr
800	Cardiac sensitisation possibly manifested by tightness of the chest in susceptible individuals (e.g. pre-existing CV disease), blurring vision

1000	Threshold for life threatening effects in most individuals exposed for 1 up to 1 hr. Cardiac sensitisation, arrhythmias, CNS depression, loss of consciousness, shallow and rapid respiration, haemorrhagic pneumonitis, reduced blood cell count, lethality in most susceptible individuals
4000	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary oedema, lethality

4.2 ACRYLONITRILE

Relevant toxicological parameters of acute human inhalation exposure to acrylonitrile are reported in BOX 4.

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BOX 4. Acute inhalation toxicity of acrylonitrile in humans. Reference indicators.

- Emerging Response Planning Guidelines for Acrylonitrile, ERPG (Source: AIHA - Emergency Response Planning Committee, http://www.kas-bmu.de/links/ERP-erpglevels.pdf):

- ERPG-1: **10 ppm**.
- ERPG-2: **35 ppm**
- ERPG-3: **75 ppm**

- Acute Exposure Guideline Levels of acrylonitrile (AEGLs)*: the data shown below are expressed in ppm and refer to acrylonitrile exposures lasting from 10 minutes to 8 hours (Source: http://www.epa.gov/oppt/aegl/)

	10 minutes	**30 minutes**	**60 minutes**	**4 hours**	**8 hours**
AEGL-1	4.6	4.6	4.6	4.6	4.6
AEGL-2	290	110	57	16	8.6
AEGL-3	480	180	100	35	19

- Immediately Dangerous to Life concentration value (IDLH): 60 ppm, based on acute inhalation toxicity data in humans (NIOSH 2016).

- NIOSH REL: 1 ppm TWA, 10 ppm 15-minute CEILING [skin]

- Current OSHA PEL: 2 ppm TWA, 10 ppm 15-minute CEILING [skin]

- ACGIH Occupational Exposure Limits:

Time Weighted Average Limit (TWA): 2 ppm (4.3 mg/m^3)

Short-Term Exposure Limit (STEL): 2.5 ppm (12.5 mg/m^3)

- Average olfactory threshold: 21 ppm corresponding to 47 mg/m^3 (ATSDR 1990)

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Acrylonitrile is a cyanide releasing substance occurring as a colorless liquid with a pungent, onion- or garlic-like odor. Various industrial accidents involving acrylonitrile have been reported (IMPEL, 2009).

Acrylonitrile is easily absorbed from the lung. The majority of clinical cases of acrylonitrile poisoning have resulted from inhalation. In rats, the average lethal concentration (LC50) of acrylonitrile is 922 mg/m^3 (approximately 420 ppm). The lowest adverse-effect exposure level referred to acute respiratory irritation was estimated to be 43 mg/m^3 (around 20 ppm).

Death was shown to occur after massive acute exposure in children. Clinical reports indicated that children are more susceptible than adults to acute toxic and lethal effects of acrylonitrile compared absorbed at high concentrations.

Symptoms vary according to the intensity and duration of exposure. Short-term inhalation of large quantities causes nausea, vomiting, weakness, headache and hepatic alterations (jaundice). Larger amounts cause immediate unconsciousness.

People exposed by inhalation to high levels of acrylonitrile usually develop symptoms similar to cyanide poisoning.

Syndromes associated with acute of acrylonitrile poisoning can be classified as shown below:

- *Neurological*: limb weakness, labored and irregular breathing, headache, dizziness and impaired judgment, cyanosis, collapse, convulsions and hallucinations. Weakness and paralysis have been described in animal models.
- *Cardiovascular*: collapse, cyanosis, tachycardia.
- *Gastrointestinal hepatic*: nausea, vomiting. Autonomic cholinergic symptoms (e.g. salivation) and mild jaundice rapidly subsiding with the ending of exposure
- *Respiratory*: irritation of the nose and throat and a feeling of fullness in the chest. Irritation of skin, conjunctiva and the upper respiratory tract was frequently reported in workers exposed to acrylonitrile.
- *Renal*: kidney irritation, glycosuria and proteinuria have been reported
- *Dermal, ocular, mucous membranes*: local skin irritation, conjunctiva irritation, intolerable itching and redness. Acute dermal exposure to high concentrations of acrylonitrile may cause severe burns to the skin.

From the overall evaluation of the available data on (i) reported effects of acrylonitrile in acute human poisoning, (ii) mechanisms of acrylonitrile toxicity in acute overdosage, and (iii) acute effects described in animals experiments conducted under controlled conditions, concentration-response relationships have been defined (BOX 5) and applied in this study as an "evidence-based" reference guide for determining the acute effects of inhalation exposure to acrylonitrile in the distinct situations considered in our simulated incident

From the available data on clinical effects of acrylonitrile and the known mode of action of this

agent in human overdosage, a prospectus of dose-response relationships was defined as an "evidence-based" reference guide applicable to cases of acute inhalation exposure, such as those considered in our simulated incident (BOX 5).

BOX 5: Correlation of Ambient Air Levels and Acute Effects of Acrylonitrile in Humans

Acrylonitrile concentration (ppm)	Symptoms and Clinical Presentation
1	No appreciable health effects. Recommended occupational exposure limit, TWA-8hr (NIOSH)
2.5	No appreciable health effects. A 2-ppm concentration is the permissible TWA exposure limit (OSHA, ACGHI)
5	No appreciable health effects
10	No appreciable alterations expected in short-time exposures. A 10-ppm concentration is the ceiling (15-min) limit for skin irritation (OSHA, NIOSH) and the threshold below which no adverse systemic effects or mild effects are likely to develop in subjects exposed for up to 1 hr
25	Olfactory threshold; mild skin and mucous membrane irritation, CNS irritability
50	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with strong odor perception
100	Intense mucous membrane irritation, dermal burn. Systemic symptoms including salivation, lacrimation, weakness, and mild headache
200	Renal function changes (proteinuria), skin redness, irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort
400	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects may cause lethality in susceptible individuals
800	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality may result from exposure for up to 4 hrs
4000	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects in individuals exposed for 5-15 min.

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5. HEALTH IMPACT EVALUATION OF THE DAMAGE OF INDUSTRIAL PLANT ITEMS CAUSING RELEASE OF BENZENE

Acute health effects of benzene are examined in relation to damage of each individual benzene-containing item present in the industrial Plant A. The predicted effects have been determined assuming exposure to a wide range of benzene air concentrations and the occurrence of associated symptoms of increasing severity as indicate in BOX 3.

Health impacts are presented as the number and distribution of expected casualties and the type and severity of symptoms observed.

In the following sections, the acute effects likely observed in the simulated incident scenarios of interest will be described considering both the workers present in Plant A during the incident and the general population living in the territory at various distances from the affected industrial facility.

5.1 WORKERS

5.1.1 Primary Fractionator – Gas Phase

In this plant item, the benzene in gaseous phase is stored in combination with other gases representing 10% in volume of the overall mixture. Thus, the total amount of benzene in gas phase present in the item is calculated as: Volume of interest (514) X % of volume (0.1) which is 51.4 m^3.

Table A1 summarizes the health effects that could be observed in workers present in Plant A following catastrophic damage of the primary fractionator for an incident occurring during the winter season.

In the worksite area, a large proportion of subjects would develop toxic changes due to benzene exposure, with manifestations ranging from local symptoms (e.g. dermal and ocular irritation) to possible lethality secondary to severe neurological and cardiac failures.

Benzene-induced cardiac alterations could be exacerbated in susceptible individuals, for example in subjects with pre-existing cardiovascular disorders or as a consequence of intense stress caused by the incident.

In summer (Table A2), the severity and magnitude of the health damage caused by benzene in workers would probably be similar to that estimated in the winter incident with a large proportion of workers experiencing serious symptoms that would require prompt admission to hospital or even on-site stabilization and resuscitation measures to prevent lethal outcome.

5.1.2 Item: Virgin Naphtha Storage Tanks. Liquid Phase

This section describes health effects that could be observed in workers present in Plant A due to catastrophic damage of the Virgin Naphtha Storage Tank and consequent instantaneous release of all the benzene in liquid phase stored in the item.

Table A3 summarizes the observable health impacts of the incident occurring in the summer scenario. The large majority of workers present in the Plant A area at the time of the incident would be exposed to benzene concentrations below the established thresholds of human toxicity. A small fraction of workers (n. 18 subjects, i.e. less than 10% of total workforce) would develop mild or moderate clinical manifestations. Hospital admission would be required only in 3

individuals exposed to benzene levels of 300 ppm or lower (Table A3).

Notably, damage to the Virgin Naphtha Storage Tank from an incident occurring in the winter season would have milder health consequences compared to those in the summer scenario. No workers in Plant A would be exposed to benzene levels exceeding 2.5 ppm, thus well below the short-term occupational exposure limit (5 ppm) proposed by OSHA.

5.1.3 Primary Fractionator Storage Tanks – Liquid Phase.

Tables A4 and A5 show the health effects that could be observed in workers following damage of the primary fractionator of Plant A resulting in instantaneous release of all the benzene in liquid phase stored in the item.

In the summer season scenario (Table A4), approximately 80 workers present in Plant A at the time of the incident are expected to be exposed to benzene concentrations below the established thresholds of human toxicity and consequently would develop no toxic symptoms.

Almost all the remaining workers would present mild or moderate manifestations. A total of 11 workers exposed to high benzene levels (300 up to 4,000 ppm) would be seriously affected and develop symptoms likely requiring intensive care support and resuscitation measures.

A similar impact would be observed in the winter season scenario (Table A5). A total of 87 workers present in Plant A at the time of the incident would develop no toxic symptoms. Mild or moderate manifestations would be seen in 188 subjects, and 16 workers exposed to high benzene levels (300 up to 4,000 ppm) would experience symptoms requiring prompt stabilization and resuscitation measures.

5.1.4 Heavy Gasoline Stripper – Gas Phase.

Catastrophic damage of the Heavy Gasoline Stripper of Plant A would cause instantaneous release of all the benzene in gaseous phase stored in the item. The entire amount of benzene in gaseous phase would be released into the environment from the pressurized heavy gasoline stripper tank in 1 minute with a release rate of 439 g/s.

The estimated health impacts on workers present in Plant A for an incident occurring in summer or during the winter season are reported in Table A6 and Table A7, respectively.

In an incident occurring in summer (Table A6), approximately 130 workers in Plant A would be exposed to benzene at concentrations below the established thresholds of human toxicity. Therefore, no toxic symptoms would be expected to develop in these workers. Mild or moderate clinical manifestations would be observed in 71 workers, primarily dermal and eye irritation. Admission to hospital would be required for a total of 17 workers suffering from moderate neurological symptoms and pulmonary irritation due to benzene exposure at levels up to 800 ppm.

Similar distribution of toxic symptoms would be observed in a winter incident (Table A7). In this scenario, however, a higher number of workers would be severely affected, requiring either admission to hospital (n. 47 subjects) or intensive care support (10 subjects).

Changes not requiring hospitalization such as mild dermal or mucosal irritation and transient headache, nausea or drowsiness would be observed in 90 workers.

It is estimated that 75 workers in Plant A would be exposed to benzene levels below the thresholds of human toxicity being therefore asymptomatic.

5.1.5 Heavy Gasoline Stripper – Liquid Phase.

Tables A8 and A9 summarize short-term health effects that are likely to be observed in workers present in plant A after accidental damage of the heavy gasoline stripper tank causing instantaneous release of all the benzene in liquid phase stored in item.

In summer (Table A8), almost all workers involved in the incident (n. 163 subjects) would require no medical assistance as benzene exposure in these workers is expected not to exceed occupational threshold limits. Approximately 10 workers would suffer from transient systemic manifestations and mild cutaneous or ocular irritation that could easily be managed at the pre-hospital level. Hospital admission would be required in three cases.

Similar distribution of acute health impacts would be observed in an incident occurring in the winter season (Table A9). No medical assistance would be required in the majority of workers. Mild cutaneous/ocular irritation and transient systemic changes not requiring hospital admission would be observed in approximately 30 subjects. System symptoms requiring hospitalization would likely develop in 6 workers.

5.1.6 Debutanizer – Gas Phase.

Damage of the Debutanizer of Plant A will cause instantaneous release of all the benzene in gaseous phase stored in the item.

Table A10 summarizes the expected health changes observable in workers present in Plant A immediately after an incident occurring during the summer season. More than 100 subjects would develop symptoms caused by benzene exposure, with manifestations ranging from local irritation (dermal and ocular) to severe changes and possible lethality. About 50 workers should be admitted to hospital because of acute benzene toxicity and 9 workers would require intensive care assistance and on-site resuscitation measures. Approximately 60 workers would be exposed to benzene at concentration levels lower than occupational exposure limits and therefore would probably develop no appreciable clinical manifestations.

After an incident occurring in winter, the data of benzene dispersed into ambient air in the Plant A area suggest similar or even worse acute health impacts in exposed workers (Table A11). Up to 63 workers would necessitate medical assistance at the hospital level and an additional group of 30 workers would require intensive care support. No toxic symptoms can be expected in 50 subjects. About 40 workers would develop mild symptoms not requiring hospitalization.

5.1.7 Debutanizer – Liquid Phase.

In this incident scenario, the catastrophic damage of the Debutanizer tank of Plant A causes instantaneous release of all the benzene in liquid phase stored in the item.

Table A12 summarizes the health impacts that is likely be observed in workers during an incident occurring in the summer season. Approximately 70 workers present in the Plant A area at the time of the incident would probably develop no symptoms because the concentrations of benzene dispersed into ambient air would remain below the thresholds limit of human toxicity.

A considerable fraction of exposed workers (n. 53) would require hospitalization for treatment of nervous system and/or respiratory tract alterations. In 3 subjects, on site resuscitation measures would be necessary to prevent lethal outcomes.

A similar distribution of acute health impacts results from application of the model to a simulated incident occurring in the winter season (Table A13).

5.1.8 Quench Column Tank – Liquid Phase

In this scenario, it is assumed that catastrophic damage of the Quench Column Tank in Plant A will cause instantaneous release of all the benzene in liquid phase stored in the item.

Tables A14 and A15 summarize the predicted health impacts in workers involved in an incident occurring in the summer season or the winter season, respectively.

Results indicate mild clinical effects. The large majority of workers would present no medical problems or limited changes that could easily be managed at the pre-hospital level.

Medical assistance at hospital would be necessary for no more than 9-10 workers suffering from moderate neurological or respiratory symptoms.

5.1.9 Other Items. Liquid Phase

Calculations of the health impacts due to accidental damage of the other items present in Plant A indicate toxicological changes comparable or less severe than those described above for the Quench Column Tank. This would be observed in both the summer and winter season scenarios.

Tables A16 and A17 and Tables A18-A21 summarize the impacts of a fictional incident damaging the Cracking Gasoline Unit Buffer Tank and the Cracking Gasoline Tanks, respectively.

5.2 GENERAL POPULATION

This section describes the predicted acute health impacts expected in the general population following an incident causing release of benzene stored in gas phase, as a consequence of damage of individual items in Plant A.

The results indicate that serious health effects can be expected in this scenarios, as shown in Tables B1 (Primary Fractionator, summer) and B2 (Primary Fractionator, winter), Tables B3 (Heavy Gasoline Stripper, winter) and B4 (Heavy Gasoline Stripper, summer), Tables B5 (Debutanizer, winter) and B6 (Debutanizer, summer).

The worst health consequences would result from events causing damage of plant items in which benzene is stored in gas phase, with involvement of a large number of subjects (most adults, but also children and elderly people). Some of these subjects would develop clinical symptoms requiring admission to hospital.

Damage of items in which benzene is stored in liquid phase is expected to have less-serious health impacts compared to the gas phase. Examples of incidents occurring in summer or in the winter season are shown in Tables B7-B10 considering the effects due to damage of items containing benzene in liquid phase, namely Debutanizer (Tables B7 and B8) and Cracking Gasoline Tank (Tables B9 and B10).

5.3 BENZENE. COMMENTS ON RESULTS

The data obtained confirm that the model proposed in the PEC project is applicable as a valuable tool to predict the acute health impacts of an industrial chemical incident and determine how these impacts would differ according to the particular plant component damaged by the incident.

The amounts of benzene released into the environment would cause severe health alterations in a large proportion of the workers present in the industrial plant during the incident.

Residents in the area adjacent to the industrial site would suffer from less intense toxicity

compared to workers.

The population living in the territory in proximity of the industrial facility would be exposed to excessive benzene concentrations, although lower than those measured inside the industrial plant, with benzene levels progressively decreasing at increasing distances from the affected plant. However, the overall consequences of the disaster in the general population would likely be serious given the large number of subjects involved and the presence of susceptible individuals such as children and older adults. Particular subjects at risk would be asthmatic children and elderly people suffering from COPD or other chronic respiratory diseases that typically are exacerbated by exposure to chemical irritants.

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6. HEALTH IMPACT EVALUATION OF THE DAMAGE OF INDUSTRIAL PLANT ITEMS CAUSING RELEASE OF ACRYLONITRILE.

The predicted short-term health effects of acrylonitrile are described here using a scheme identical to that adopted for benzene. The impacts are assessed in relation to each individual item damaged by the incident in Plant A, considering ambient air acrylonitrile levels associated with clinical outcomes and syndromes of increasing severity as shown in BOX 5.

Workers affected inside the industrial plant and the general population are examined in separate paragraphs.

6.1 WORKES

6.1.1. Acrylonitrile Storage Tank

In this incident scenario, the catastrophic damage of the Acrylonitrile Storage Tank in Plant A is assumed to cause instantaneous release of all the acrylonitrile in liquid phase stored in the item.

Table C1 summarizes the health impacts likely observed in workers for an incident occurring during the winter season. No toxic symptoms are expected to develop in workers exposed to acrylonitrile concentrations of 5 ppm or lower (a total of 125 subjects).

A group of 34 workers would be symptomatic primarily showing changes such as mild irritation of skin and mucous membranes that can be managed at the pre-hospital level.

A fraction of 7 workers would develop more serious alterations (either local or systemic) requiring admission to hospital. In no case, the toxic effects of acrylamide would be so pronounced to require intensive care support.

A similar distribution of acute health impacts would result from an incident occurring in the summer season (Table C2).

6.1.2. Unit Buffer Vessel

This section describes health effects that are likely to be observed in workers present in Plant A as a consequence of catastrophic damage of the Unit Buffer Vessel and consequent instantaneous release of all the acrylonitrile in liquid phase stored in the item. Table C3 summarizes the effects of an incident occurring in the winter scenario. The large majority of workers present in the Plant A area at the time of the incident would be exposed to acrylonitrile concentrations below the established thresholds of human toxicity. A group of 27 workers would experience mild alterations not requiring medical assistance at hospital. Hospital admission would be required in 6 individuals exposed to acrylonitrile at concentration levels up to 200 ppm (Table C3).

A similar distribution of acute health impacts would result from a simulated incident occurring in the summer season (Table C4).

6.1.3. Elastomer Production Reactor

Catastrophic damage of the Elastomer Production Reactor of Plant A would cause instantaneous release of all the acrylonitrile in liquid phase stored in the item. The estimated health impacts on workers present in Plant A for an incident occurring in winter or during the summer season are reported in Table C5 and Table C6, respectively.

In the incident occurring in winter (Table C5), a group of approximately 100 workers present in

Plant A would manifest no toxic symptoms while mild or moderate changes, primarily local irritation, would be observed in 70 workers.

Admission to hospital would be required in a total of 27 workers exposed to acrylonitrile at concentrations up to 200 ppm.

Four workers can be expected to develop serious alterations requiring intensive care support.

A similar distribution of acute health impacts due to damage of the Elastomer Production Reactor would be observed an incident occurring in the summer season (Table C6).

6.1.4. Stripping Column

In this simulated incident, it is assumed that catastrophic damage of the Stripping Column in Plant A causes instantaneous release of all the acrylonitrile in liquid phase stored in the item.

Tables C7 and C8 summarize the predicted health effects observed in workers considering an incident occurring in winter or in the summer season, respectively.

The results obtained in the winter scenario indicate no medical problems seen in the majority of workers involved in the incident.

Minor local effects such as skin or eye irritation would be observed in 29 workers. Hospitalization would be required in 6 workers showing moderate local or systemic symptoms (Table C7).

A similar distribution of acute health impacts would be caused by damage to the Stripping Column following an incident occurring in the summer season (Table C8).

6.2 GENERAL POPULATION

The data regarding the general population (Tables D1-D8) support the conclusion that that a large number of individuals would be exposed to the acrylonitrile released from the damaged plant. However, in this incident scenario the estimated health impacts seem to be negligible, with most people exposed to acrylonitrile concentrations considerably lower than those considered in the ERP Guidelines**.** In some incident scenarios, for example incidents involving the Elastomer Production Reactor (Tables D5 and D6), a small number of subjects are expected to develop mild local symptoms such as irritation of skin, mucous membranes and conjunctiva. In no case admission to hospital would be necessary.

7. HEALTH IMPACTS FROM DAMAGE OF MULTIPLE PLANT ITEMS

In this study, the health effects of a simulated industrial disaster have also been examined assuming simultaneous catastrophic damage of multiple items in Plant A.

As expected, an incident causing multiple item damage was shown to induce human health impacts more deleterious, in terms of number and distribution of casualties, compared to incidents in which only one single item is involved.

The clinical alterations caused by benzene or acrylonitrile in workers and the general population during incidents associated with multiple item damage are presented in Tables E1-E8 and Tables E9-E16 for benzene and acrylonitrile, respectively.

The results clearly indicate that the adverse effects of benzene and acrylonitrile differ in their magnitude and distribution depending to the type and number of the items involved in combination.

Apparently, the dissimilar impacts are primarily due to differences in the quantities and physical characteristics (gas or liquid phase) of the chemicals stored in the items.

8. HEALTH IMPACT MAPS

Maps of health impact on the general population and plant workers are reported for each plant item in the PEC Web-GIS (http://egeos-test.eucentre.it/PEC_webgis/web/home). Impact on human health is reported in different tables displayed which can be activated just clicking on a point of the map.

The tables provide the number of people disaggregated by gender and class ages and the number of the plant workers (if the area clicked is within the plant boundaries) who are exposed to the toxic compounds along with the health impact associated in terms of clinical manifestation and tiered emergency intervention (i.e. level of disability) as shown by way of example in Figure 1.

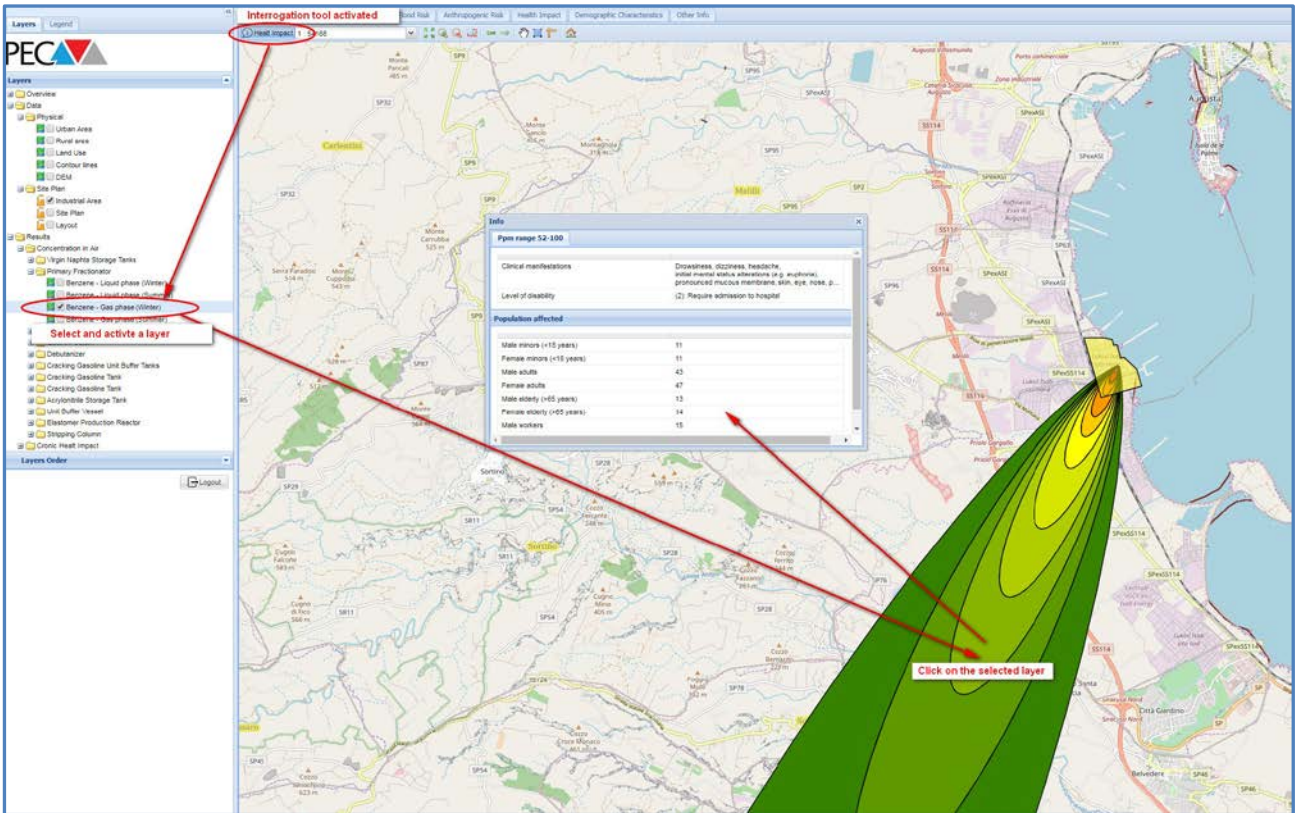

Figure 1: Health impact map and table

9. CONCLUSIONS

Accidental release of benzene or acrylonitrile from an industrial chemical plant having the characteristics modeled in this project would cause immediate health alterations in a substantial number of people. Both the workers present in the plant during the incident and the general population living in proximity of the plant would be seriously involved.

The results obtained support the conclusion that the model developed in this study may represent a valid general tool to characterize health outcomes associated with industrial chemical incidents.

Symptomatology and magnitude of health impacts can be predicted for each plant component and item damaged by the incident based on the estimated ambient air concentrations of the chemicals of interest.

In particular, the intensity of clinical effects, the number of casualties and their distribution in the exposed population can be quantified according to standard variables such as:

- Number and characteristics of the plant items damaged during the incident;
- Physical status (liquid or gas phase) of the chemicals stored in the industrial facility;
- Toxicological profile of these chemicals;
- Meteorological conditions existing at the time of the incident;
- Distance of the vulnerable territory areas from the source of chemical release.

After validation, the model developed in this project may be used for several purposes, for example ranking the technological components of a given industrial plant in terms of risk index, considering the estimated population health impacts resulting from accidental damage.

In addition, the model may provide rapid estimates of the human health effects that can be expected in a defined incident scenario. This could be useful to determine healthcare needs and ensure targeted emergency intervention under circumstances in which information from field studies is not available.

10. LIST OF TABLES

Table A1. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Primary Fractionator", gas phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	25 (20 M, 5 F)	No medical problems	
1-2.5	11 (9 M, 2 F)	No medical problems	
2.5-5	10 (8 M, 2 F)	No medical problems	
5-10	11 (9 M, 2 F)	No medical problems	
10-25	17 (14 M, 3 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	17 (14 M, 3 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	19 (15 M, 4 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	61 (29 M, 12 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	68 (54 M, 13 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	9 (7 M, 2 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	26 (21 M, 5 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	8 (7 M, 1 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A2. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Primary Fractionator", gas phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	28 (23 M, 5 F)	No medical problems	-
1-2.5	14 (11 M, 3 F)	No medical problems	-
2.5-5	12 (10 M, 2 F)	No medical problems	-
5-10	14 (11 M, 3 F)	No medical problems	-
10-25	24 (19 M, 5 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	27 (22 M, 5 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	51 (41 M, 10 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	67 (54 M, 13 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	22 (17 M, 5 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	3 (2 M, 1 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	8 (6 M, 2 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	3 (2 M, 1 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A3. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Virgin Naphtha Storage Tanks", liquid phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	69 (55 M, 14 F)	No medical problems	-
1-2.5	80 (64 M, 16 F)	No medical problems	-
2.5-5	36 (29 M, 7 F)	No medical problems	-
5-10	19 (15 M, 4 F)	No medical problems	-
10-25	11 (9 M, 2 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	4 (3 M, 2 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	2 (1 M, 1 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	1 M	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A4. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Virgin Naphtha Storage Tanks", liquid phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	60 (48 M, 12 F)	No medical problems	-
1-2.5	67 (54 M, 13 F)	No medical problems	-
2.5-5	50 (40 M, 10 F)	No medical problems	-
5-10	26 (21 M, 5 F)	No medical problems	-
10-25	16 (13 M, 3 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	5 (4 M, 1 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	2 (2 M, 0 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	2 (1 M, 1 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	1 (1 M, 0 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	0 (0 M, 0 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	0 (0 M, 0 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	0 (0 M, 0 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A5. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Primary Fractionator", liquid phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	34 (27 M, 7 F)	No medical problems	-
1-2.5	18 (14 M, 4 F)	No medical problems	-
2.5-5	16 (13 M, 3 F)	No medical problems	-
5-10	19 (15 M, 4 F)	No medical problems	-
10-25	37 (30 M, 7 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	66 (53 M, 13 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	43 (34 M, 9 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	32 (26 M, 6 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	10 (68M, 2 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	1 (1 M, 0 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	4 (3 M, 1 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	1 (1 M, 0 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A6. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Primary Fractionator", liquid phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	32 (26 M, 6 F)	No medical problems	-
1-2.5	17 (14 M, 3 F)	No medical problems	-
2.5-5	16 (12 M, 4 F)	No medical problems	-
5-10	20 (16 M, 4 F)	No medical problems	-
10-25	41 (33 M, 8 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	64 (51 M, 13 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	31 (25 M, 6 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	23 (19 M, 5 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	8 (6 M, 2 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	1 (1 M, 0 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	3 (2 M, 1 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	1 (1 M, 0 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Bix 1.

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Table A7. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Heavy Gasoline Stripper", gas phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	28 (22 M, 6 F)	No medical problems	-
1-2.5	15 (12 M, 3 F)	No medical problems	-
2.5-5	14 (11 M, 3 F)	No medical problems	-
5-10	18 (14 M, 4 F)	No medical problems	-
10-25	39 (31 M, 8 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	51 (41 M, 10 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	27 (22 M, 5 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	20 (16 M, 4 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	6 (5 M, 1 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	1 (1M, 0 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	2 (2 M, 0 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	1 (1 M, 0 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A8. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Heavy Gasoline Stripper", liquid phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	48 (38 M, 10 F)	No medical problems	-
1-2.5	41 (33 M, 8 F)	No medical problems	-
2.5-5	47 (38 M, 9 F)	No medical problems	-
5-10	27 (22 M, 5 F)	No medical problems	-
10-25	16 (13 M, 3 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	6 (5 M, 1 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	2 (2 M, 0 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	1 (1 M, 0 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A9. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Heavy Gasoline Stripper", liquid phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	43 (35 M, 9 F)	No medical problems	-
1-2.5	32 (26 M, 6 F)	No medical problems	-
2.5-5	45 (36 M, 9 F)	No medical problems	-
5-10	36 (29 M, 7 F)	No medical problems	-
10-25	23 (18 M, 5 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	8 (6 M, 2 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	4 (3 M, 1 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	2 (2 M, 0 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A10. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Debutanizer", gas phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	24 (19 M, 5 F)	No medical problems	
1-2.5	13 (10 M, 3 F)	No medical problems	
2.5-5	12 (10 M, 2 F)	No medical problems	
5-10	16 (13 M, 3 F)	No medical problems	
10-25	25 (20 M, 5 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	27 (22 M, 5 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	25 (20 M, 5 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	19 (15 M, 4 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	6 (54M, 1 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	2 (2 M, 0 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	1 (1 M, 0 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A11. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Debutanizer", gas phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	20 (16 M, 4 F)	No medical problems	
1-2.5	10 (8 M, 2 F)	No medical problems	
2.5-5	9 (7 M, 2 F)	No medical problems	
5-10	11 (9 M, 3 F)	No medical problems	
10-25	18 (14 M, 4 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	19 (15 M, 4 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	19 (15 M, 4 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	44 (35 M, 9 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	19 (15 M, 4 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	2 (2 M, 0 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	7 (6 M, 1 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	2 (1 M, 0 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A12. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Debutanizer", liquid phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	26 (21 M, 5 F)	No medical problems	-
1-2.5	14 (11 M, 3 F)	No medical problems	-
2.5-5	13 (10 M, 3 F)	No medical problems	-
5-10	16 (13 M, 3 F)	No medical problems	-
10-25	25 (20 M, 5 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	28 (22 M, 6 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	25 (20 M, 5 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	19 (15 M, 4 F)	Pronounced drowsiness preceded by Excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	6 (5 M, 1 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	1 (1 M, 0 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	3 (2 M, 1 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A13. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Debutanizer", liquid phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	25 (20 M, 5 F)	No medical problems	-
1-2.5	13 (10 M, 3 F)	No medical problems	-
2.5-5	12 (10 M, 2 F)	No medical problems	-
5-10	15 (12 M, 3 F)	No medical problems	-
10-25	24 (19 M, 5 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	23 (18 M, 5 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	29 (23 M, 6 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	25 (20 M, 5 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	8 (6 M, 2 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	1 (1 M, 0 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	3 (2 M, 1 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	1 (1 M, 0 F)	As above, rapid deterioration and loss of physiological function, lethality	**4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A14. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Quench Column Tank", liquid phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	38 (30 M, 8 F)	No medical problems	-
1-2.5	26 (21 M, 5F)	No medical problems	-
2.5-5	29 (23 M, 6 F)	No medical problems	-
5-10	41 (33 M, 8 F)	No medical problems	-
10-25	30 (24 M, 6F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	11 (9 M, 2 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	5 (4 M, 1 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	4 (3 M, 1 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	1 (1 M, 0 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A15. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Quench Column Tank", liquid phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	36 (29 M, 7 F)	No medical problems	-
1-2.5	22 (18 M, 4 F)	No medical problems	-
2.5-5	25 (20 M, 5 F)	No medical problems	-
5-10	36 (29 M, 7 F)	No medical problems	-
10-25	42 (34 M, 8 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	15 (12 M, 3 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	6 (5 M, 1 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	5 (4 M, 1 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	1 (1 M, 0 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	--	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A16. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Cracking Gasoline Unit Buffer Tank", liquid phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	37 (30 M, 7 F)	No medical problems	-
1-2.5	18 (15 M, 3 F)	No medical problems	-
2.5-5	20 (16 M, 4 F)	No medical problems	-
5-10	17 (14 M, 3 F)	No medical problems	-
10-25	10 (8 M, 2 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	4 (3 M, 1 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	1 (1 M, 0 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	1 (1 M, 0 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A17. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Cracking Gasoline Unit Buffer Tank", liquid phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	35 (28 M, 7 F)	No medical problems	-
1-2.5	17 (14 M, 3 F)	No medical problems	-
2.5-5	15 (12 M, 3 F)	No medical problems	-
5-10	22 (18 M, 4 F)	No medical problems	-
10-25	16 (13 M, 3 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	5 (4 M, 1 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	2 (2 M, 0 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	1 (1 M, 0 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A18. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Cracking Gasoline Tank", liquid phase, in Plant A. Incident Occurring in Summer.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	115 (92 M, 23 F)	No medical problems	-
1-2.5	98 (78 M, 20 F)	No medical problems	-
2.5-5	36 (29 M, 7 F)	No medical problems	-
5-10	19 (15 M, 4 F)	No medical problems	-
10-25	11 (9 M, 2 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	4 (3 M, 1 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	2 (2 M, 0 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	1 (1 M, 0 F)	Pronounced drowsiness preceded by Excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A19. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Cracking Gasoline Tank", liquid phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	97 (77 M, 20 F)	No medical problems	-
1-2.5	101 (81 M, 20 F)	No medical problems	-
2.5-5	46 (36 M, 10 F)	No medical problems	-
5-10	24 (19 M, 5 F)	No medical problems	-
10-25	15 (12M, 2 3)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	5 (4 M, 1 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	2 (2 M, 0 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	1 (1 M, 0 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A20. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Cracking Gasoline Tank 2", liquid phase, in Plant A. Incident Occurring in Summer**.**

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	100 (80 M, 20 F)	No medical problems	-
1-2.5	83 (67 M, 16 F)	No medical problems	-
2.5-5	38 (30 M, 8 F)	No medical problems	-
5-10	20 (16 M, 4 F)	No medical problems	-
10-25	12 (10 M, 2 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	4 (3 M, 1 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	1 (1 M, 0 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	1 (1 M, 0 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table A21. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Damage of the Item "Cracking Gasoline Tank 2", liquid phase, in Plant A. Incident Occurring in Winter.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	86 (69M, 17 F)	No medical problems	-
1-2.5	76 (61 M, 15 F)	No medical problems	-
2.5-5	52 (42 M, 10 F)	No medical problems	-
5-10	27 (22 M, 5 F)	No medical problems	-
10-25	16 (13 M, 3 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	6 (5 M, 1 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	2 (2 M, 0 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	(**2):** Require admission to hospital
100-300	1 (1 M, 0 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	(**2):** Require admission to hospital
300-800	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B1. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Primary Fractionator", gas phase, in Plant A. Incident Occurring in Winter.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	7,111	2,219 M 2,404 F	546 M 592 F	648 M 703 F	No medical problems	
1-2.5	4,905	2,530 M 1,658 F	546 M 592 F	648 M 447 F	No medical problems	
2.5-5	2,563	799 M 866 F	197 M 213 F	233 M 253 F	No medical problems	
5-10	1,430	446 M 483 F	110 M 119 F	130 M 141 F	No medical problems	
10-25	884	276 M 299 F	68 M 73 F	80 M 87 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	312	97 M 105 F	24 M 26 F	28 M 31 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	137	43 M 46 F	10 M 11 F	12 M 13 F	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	78	24 M 26 F	6 M 6 F	7 M 8 F	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shozn in Bix 1.

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Table B2. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Primary Fractionator", gas phase, in Plant A. Incident Occurring in Summer.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	10,062	3,139 M 3,401 F	773 M 837 F	917 M 994 F	No medical problems	
1-2.5	2,565	800 M 867 F	197 M 213 F	234 M 253 F	No medical problems	
2.5-5	884	276 M 299 F	68 M 73 F	80 M 87 F	No medical problems	
5-10	452	141 M 153 F	35 M 37 F	41 M 44 F	No medical problems	
10-25	273	85 M 92 F	21 M 23 F	25 M 27 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	88	27 M 30 F	7 M 7 F	8 M 9 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	20	6 M 7 F	1 M 2 F	2 M 2 F	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B3. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Heavy Gasoline Stripper", gas phase, in Plant A. Incident Occurring in Winter**.**

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0,1-1	8,229	2,567 M 2,781 F	632 M 684 F	750 M 813 F	No medical problems	
1-2.5	763	238 M 258 F	58 M 65 F	69 M 75 F	No medical problems	
2.5-5	260	81 M 88 F	20 M 21 F	23 M 25 F	No medical problems	
5-10	128	40 M 43 F	10 M 10 F	11 M 12 F	No medical problems	
10-25	65	20 M 22 F	5 M 5 F	6 M 6 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	4	1 M 1 F	-	1 M 1 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	-	-	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B4. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Heavy Gasoline Stripper", gas phase, in Plant A. Incident Occurring in Summer.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	3,372	1,052 M 1,140 F	259 M 280 F	307 M 333 F	No medical problems	
1-2.5	236	73 M 80 F	18 M 19 F	25 M 23 F	No medical problems	
2.5-5	73	23 M 25 F	5 M 6 F	6 M 7 F	No medical problems	
5-10	22	7 M 8 F	2 M 2 F	2 M 2 F	No medical problems	
10-25	-	-	-	-	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	-	-	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B5. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Debutanizer", gas phase, in Plant A. Incident Occurring in Winter.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	9,794	3,056 M 3,310 F	752 M 815 F	893 M 967 F	No medical problems	
1-2.5	2,226	694 M 752 F	171 M 185 F	203 M 220 F	No medical problems	
2.5-5	768	239 M 259 F	59 M 64 F	70 M 76 F	No medical problems	
5-10	393	122 M 133 F	30 M 32 F	36 M 39 F	No medical problems	
10-25	238	74 M 80 F	18 M 20 F	22 M 23 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	79	25 M 27 F	6 M 6 F	7 M 8 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	31	9 M 10 F	2 M 2 F	3 M 3 F	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	7	2 M 3 F	-	1 M 1 F	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B6. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Debutanizer", gas phase, in Plant A. Incident Occurring in Summer.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	7,730	2,412 M 2,613 F	593 M 643 F	705 M 764 F	No medical problems	
1-2.5	708	221 M 239 F	54 M 59 F	64 M 70 F	No medical problems	
2.5-5	241	75 M 81 F	18 M 20 F	22 M 24 F	No medical problems	
5-10	119	37 M 40 F	9 M 10 F	11 M 12 F	No medical problems	
10-25	66	21 M 22 F	5 M 5 F	6 M 7 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	14	4 M 5 F	1 M 1 F	1 M 1 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	-	-	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B7. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Debutanizer", liquid phase, in Plant A. Incident Occurring in Winter.

Benzene concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	8,915	2,781 M 3,013 F	685 M 742 F	813 M 881 F	No medical problems	
1-2.5	959	299 M 324 F	74 M 80 F	87 M 95 F	No medical problems	
2.5-5	328	102 M 111 F	25 M 27 F	30 M 32 F	No medical problems	
5-10	165	52 M 56 F	13 M 14 F	15 M 16 F	No medical problems	
10-25	95	30 M 32 F	7 M 8 F	9 M 9 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	26	8 M 9 F	2 M 2 F	2 M 3 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	2	1 M 1 F	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B8. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Debutanizer", liquid phase, in Plant A. Incident Occurring in Summer.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	7,641	2,384 M 2,583 F	587 M 635 F	697 M 755 F	No medical problems	
1-2.5	697	217 M 235 F	53 M 58 F	64 M 69 F	No medical problems	
2.5-5	237	74 M 80 F	18 M 20 F	22 M 23 F	No medical problems	
5-10	117	36 M 40 F	9 M 10 F	11 M 11 F	No medical problems	
10-25	54	24 M 22 F	5 M 5 F	6 M 6 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	14	4 M 5 F	1 M 1 F	1 M 2 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	-	-	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B9. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Cracking Gasoline Tank", liquid phase, in Plant A. Incident Occurring in Winter.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	908	283 M 307 F	70 M 75 F	83 M 89 F	No medical problems	
1-2.5	16	5 M 5 F	1 M 1 F	2 M 2 F	No medical problems	
2.5-5	-	-	-	-	No medical problems	
5-10	-	-	-	-	No medical problems	
10-25	-	-	-	-	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	-	-	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table B10. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Damage to the Item "Cracking Gasoline Tank", liquid phase, in Plant A. Incident Occurring in Summer.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	743	231 M 251 F	57 M 62 F	68 M 73 F	No medical problems	
1-2.5	14	4 M 5 F	1 M 1 F	1 M 1 F	No medical problems	
2.5-5	-	-	-	-	No medical problems	
5-10	-	-	-	-	No medical problems	
10-25	-	-	-	-	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	-	-	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures

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1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table C1. Health Impact in Workers Exposed to Acrylonitrile Following Accidental Damage of the Item "Acrylonitrile Storage Tank", in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	84 (67 M, 17 F)	No medical problems	-
1-2.5	60 (48 M, 12 F)	No medical problems	-
2.5-5	41 (33 M, 8 F)	No medical problems	-
5-10	21 (17 M, 4 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	13 (10 M, 3 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	4 (3 M, 1 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	2 (1 M, 1 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	1 (1 M, 0 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table C2. Health Impact in Workers Exposed to Acrylonitrile Following Accidental Damage of the Item "Acrylonitrile Storage Tank", in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	93 (74 M, 19 F)	No medical problems	-
1-2.5	65 (52 M, 13 F)	No medical problems	-
2.5-5	30 (24 M, 6 F)	No medical problems	-
5-10	15 (12 M, 3 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	9 (7 M, 2 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	3 (2 M, 1 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	1 (1 M, 0 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	1 (1 M, 0 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table C3. Health Impact in Workers Exposed to Acrylonitrile Following Accidental Damage of the Item "Unit Buffer Vessel", in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	74 (60 M, 14 F)	No medical problems	-
1-2.5	46 (37 M, 9 F)	No medical problems	-
2.5-5	33 (27 M, 6 F)	No medical problems	-
5-10	17 (14 M, 3 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	10 (8 M, 2 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	4 (3 M, 1 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	1 (1 M, 0 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	1 (1 M, 0 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table C4. Health Impact in Workers Exposed to Acrylonitrile Following Accidental Damage of the Item "Unit Buffer Vessel", in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	79 (63 M, 16 F)	No medical problems	-
1-2.5	51 (41 M, 10 F)	No medical problems	-
2.5-5	24 (19 M, 5 F)	No medical problems	-
5-10	12 (10 M, 2 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	7 (6 M, 1 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	2 (2 M, 0 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	1 (1 M, 0 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table C5. Health Impact in Workers Exposed to Acrylonitrile Following Accidental Damage of the Item "Elastomer Production Reactor", in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	53 (42 M, 11 F)	No medical problems	-
1-2.5	26 (21 M, 5 F)	No medical problems	-
2.5-5	22 (18 M, 4 F)	No medical problems	-
5-10	27 (22 M, 5 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	43 (35 M, 8 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	16 (3 M, 3 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	7 (6 M, 1 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	4 (3 M, 1 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	2 (2 M, 0 F)	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	1 (1 M, 0 F)	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	1 (1 M, 0 F)	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table C6. Health Impact in Workers Exposed to Acrylonitrile Following Accidental Damage of the Item "Elastomer Production Reactor", in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	56 (45 M, 11 F)	No medical problems	-
1-2.5	27 (22 M, 5 F)	No medical problems	-
2.5-5	23 (18 M, 5 F)	No medical problems	-
5-10	34 (27 M, 7 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	33 (27 M, 6 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	12 (10 M, 2 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	5 (4 M, 1 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	3 (2 M, 1 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	1 (1 M, 0 F)	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	1 (1 M, 0 F)	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table C7. Health Impact in Workers Exposed to Acrylonitrile Following Accidental Damage of the Item "Stripping Column", in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	48 (38 M, 10 F)	No medical problems	-
1-2.5	23 (19 M, 4 F)	No medical problems	-
2.5-5	26 (21 M, 5 F)	No medical problems	-
5-10	18 (14 M, 4 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	11 (9 M, 2 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	4 (3 M, 1 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	1 (1 M, 0 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	1 (1 M, 0 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table C8. Health Impact in Workers Exposed to Acrylonitrile Following Accidental Damage of the Item "Stripping Column", in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	49 (39 M, 10 F)	No medical problems	-
1-2.5	26 (21 M, 5 F)	No medical problems	-
2.5-5	25 (20 M, 5 F)	No medical problems	-
5-10	13 (10 M, 3 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	8 (6 M, 2 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	3 (2 M, 1 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	1 (1 M, 0 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	1 (1 M, 0 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table D1. Health Impact in the General Population Exposed to Acrylonitrile Following Accidental Damage to the Item "Acrylonitrile Storage Tank" in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	810	253 M 274 F	62 M 67 F	80 M 80 F	No medical problems	
1-2.5	30	9 M 10 F	2 M 2 F	3 M 3 F	No medical problems	
2.5-5	-	-	-	-	No medical problems	
5-10	-	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table D2. Health Impact in the General Population Exposed to Acrylonitrile Following Accidental Damage to the Item "Acrylonitrile Storage Tank" in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	574	179 M 194 F	44 M 48 F	52 M 57 F	No medical problems	
1-2.5	11	3 M 4 F	1 M 1 F	1 M 1 F	No medical problems	
2.5-5	-	-	-	-	No medical problems	
5-10	-	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table D3. Health Impact in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Item "Unit Buffer Vessel" in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	656	205 M 222 F	50 M 55 F	60 M 65 F	No medical problems	
1-2.5	26	8 M 9 F	2 M 2 F	2 M 3 F	No medical problems	
2.5-5	-	-	-	-	No medical problems	
5-10	-	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table D4. Health Impact in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Item "Unit Buffer Vessel" in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	465	145 M 157 F	36 M 39 F	42 M 46 F	No medical problems	
1-2.5	10	3 M 3 F	1 M 1 F	1 M 1 F	No medical problems	
2.5-5	-	-	-	-	No medical problems	
5-10	-	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table D5. Health Impact in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Item "Elastomer Production Reactor" in Plant A. Incident Occurring in Winter**.**

Acrylonitrile concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	2,946	919 M 996 F	226 M 245 F	269 M 291 F	No medical problems	
1-2.5	203	863 M 68 F	16 M 20 F	18 M 28 F	No medical problems	
2.5-5	63	20 M 22 F	5 M 5 F	6 M 6 F	No medical problems	
5-10	25	8 M 8 F	2 M 2 F	2 M 2 F	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	1	1 M			Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table D6. Health Impact in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Item "Elastomer Production Reactor" in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	2,138	667 M 723 F	164 M 178 F	195 M 211 F	No medical problems	
1-2.5	144	45 M 49 F	11 M 12 F	13 M 14 F	No medical problems	
2.5-5	42	13 M 14 F	3 M 4 F	4 M 4 F	No medical problems	
5-10	10	3 M 4 F	1 M 1 F	1 M 1 F	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table D7. Health Impact in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Item "Stripping Column" in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0,1-1	700	218 M 237 F	54 M 58 F	64 M 69 F	No medical problems	
1-2.5	40	13 M 14 F	3 M 3 F	4 M 4 F	No medical problems	
2.5-5	4	1 M 2 F	-	0 M 1 F	No medical problems	
5-10	-	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table D8. Health Impact in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Item "Stripping Column" in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	503	157 M 170 F	39 M 42 F	46 M 50 F	No medical problems	
1-2.5	24	8 M 8 F	2 M 2 F	2 M 2 F	No medical problems	
2.5-5	-	-	-	-	No medical problems	
5-10	-	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E1. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Simultaneous Damage of the Items "Virgin Naphtha Storage Tanks", "Cracking Gasoline Buffer Tanks", and "Cracking Gasoline Tank" (all liquid phase), in Plant A. Incident Occurring in Summer.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	49 (39 M, 10 F)	No medical problems	-
1-2.5	80 (64 M, 16 F)	No medical problems	-
2.5-5	74 (59 M, 15 F)	No medical problems	-
5-10	54 (43 M, 11 F)	No medical problems	-
10-25	36 (29 M, 7 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	11 (9 M, 2 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	5 (4 M, 1 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	4 M (3 M, 0 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2):** Require admission to hospital
300-800	1 (1 M, 0 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E2. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Simultaneous Damage of Items "Virgin Naphtha Storage Tanks", "Cracking Gasoline Buffer Tanks", and "Cracking Gasoline Tank" (all liquid phase), in Plant A. Incident Occurring in Winter.

Concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	44 (35 M, 9 F)	No medical problems	-
1-2.5	51 (41 M, 10 F)	No medical problems	-
2.5-5	74 (59 M, 15 F)	No medical problems	-
5-10	54 (43 M, 11 F)	No medical problems	-
10-25	70 (56 M, 14 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	49 (39 M, 10 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	16 (13 M, 3 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	7 M (6 M, 1 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2):** Require admission to hospital
300-800	5 (4 M, 1 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	**1 (1 M, 0 F)**	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

Table E3. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Simultaneous Damage of Items "Virgin Naphtha Storage Tanks", "Cracking Gasoline Unit Buffer Tanks", and "Cracking Gasoline Tank" (all liquid phase), in Plant A. Incident Occurring in Summer.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	943	294 M 318 F	72 M 78 F	86 M 93 F	No medical problems	
1-2.5	54	17 M 18 F	4 M 4 F	5 M 3 F	No medical problems	
2.5-5	7	2 M 1 F	1 M 1 F	1 M 1 F	No medical problems	
5-10	-	-	-	-	No medical problems	
10-25	-	-	-	-	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	-	-	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures

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> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E4. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Simultaneous Damage of Items "Virgin Naphtha Storage Tanks", "Cracking Gasoline Unit Buffer Tanks", and "Cracking Gasoline Tank" (all liquid phase), in Plant A. Incident Occurring in Winter.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1.1	1,309	408 M 442 F	100 M 109 F	119 M 129 F	No medical problems	
1-2.5	93	29 M 31 F	7 M 8 F	8 M 9 F	No medical problems	
2.5-5	24	8 M 7 F	2 M 2 F	2 M 2 F	No medical problems	
5-10	2	1 M 1 F	-	-	No medical problems	
10-25	-	-	-	-	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	-	-	-	-	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures

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> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E5. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Simultaneous Damage of Items "Primary Fractionator", "Heavy Gasoline Stripper", and "Debutanizer" (all gas phase), in Plant A. Incident Occurring in Summer.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	5 (4 M, 1 F)	No medical problems	-
1-2.5	11 (9 M, 2 F)	No medical problems	-
2.5-5	10 (8 M, 2 F)	No medical problems	-
5-10	11 (9 M, 2 F)	No medical problems	-
10-25	20 (16 M, 4 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	24 (19 M, 5 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	53 (42 M, 11 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	90 M (72 M, 18 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2):** Require admission to hospital
300-800	29 (23 M, 6 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	13 (2 M, 1 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	11 (9 M, 2 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	4 (3 M, 1 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E6. Health Impact of the Simulated Incident in Workers Exposed to Benzene Following Simultaneous Damage of Items "Primary Fractionator", "Heavy Gasoline Stripper", and "Debutanizer" (all gas phase), in Plant A. Incident Occurring in Winter.

Concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	19 (15 M, 4 F)	No medical problems	-
1-2.5	9 (7 M, 2 F)	No medical problems	-
2.5-5	8 (6 M, 2 F)	No medical problems	-
5-10	9 (7 M, 2 F)	No medical problems	-
10-25	14 (11 M, 3 F)	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	14 (11 M, 3 F)	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	16 (13 M, 3 F)	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	66 M (53 M, 13 F)	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2):** Require admission to hospital
300-800	84 (67 M, 17 F)	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	10 (8 M, 2 F)	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	36 (29 M, 7 F)	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures
> 4,000	11 (9 M, 2 F)	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E7. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Simultaneous Damage of Items "Primary Fractionator", "Heavy Gasoline Stripper" and "Debutanizer" (all gas phase), in Plant A. Incident Occurring in Summer.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	10,063	3,139 M 3,401 F	773 M 837 F	918 M 994 F	No medical problems	
1-2.5	2,566	801 M 867 F	197 M 213 F	234 M 254 F	No medical problems	
2.5-5	866	270 M 293 F	66 M 73 F	79 M 86 F	No medical problems	
5-10	458	143 M 155 F	35 M 38 F	42 M 45 F	No medical problems	
10-25	294	92 M 99 F	23 M 24 F	27 M 29 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	86	27 M 29 F	7 M 7 F	8 M 8 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	27	8 M 9 F	2 M 2 F	2 M 3 F	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	-	-	-	-	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures

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> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E8. Health Impact of the Simulated Incident in the General Population Exposed to Benzene Following Simultaneous Damage of Items "Primary Fractionator", "Heavy Gasoline Stripper", and "Debutanizer" (all gas phase), in Plant A. Incident Occurring in Winter.

Benzene concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	7,111	2,219 M 2,403 F	546 M 592 F	649 M 703 F	No medical problems	
1-2.5	4,906	1,531 M 1,658 F	377 M 408 F	447 M 485 F	No medical problems	
2.5-5	2,539	792 M 858 F	195 M 211 F	231 M 251 F	No medical problems	
5-10	1,434	447 M 485 F	110 M 119 F	131 M 142 F	No medical problems	
10-25	909	283 M 307 F	70 M 76 F	83 M 90 F	Mild skin and ocular irritation	**(1):** Can be managed at the pre-hospital level
25-52	301	94 M 102 F	23 M 25 F	27 M 30 F	Transient systemic alterations, primarily nausea, mild drowsiness and headache	**(1):** Can be managed at the pre-hospital level
52-100	148	46 M 50 F	11 M 12 F	14 M 15 F	Drowsiness, dizziness, headache, initial mental status alterations (e.g. euphoria), pronounced mucous membrane, skin, eye, nose, pulmonary irritation	**(2):** Require admission to hospital
100-300	89	28 M 30 F	7 M 7 F	8 M 9 F	Pronounced drowsiness preceded by excitatory symptoms, staggering, weakness, impaired ability to take protective action	**(2)**: Require admission to hospital
300-800	-	-	-	-	Excitatory symptoms followed drowsiness, staggering, impaired ability to take protective action, palpitations, tightness of the chest, blurring vision	**(3):** Require prompt hospitalization and intensive care support in subjects presenting neurological and cardiac alterations
800-1,000	-	-	-	-	CNS depression, loss of consciousness, arrhythmias, shallow and rapid respiration, signs of pneumonitis, lethality in the most susceptible individuals	**(4):** Require on site stabilization and resuscitation measures
1,000-4,000	-	-	-	-	Severe CNS depression, coma, paralysis, convulsions, non-cardiogenic pulmonary edema, lethality	**(4):** Require on site stabilization and resuscitation measures

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> 4,000	-	-	-	-	As above, rapid deterioration and loss of physiological function, lethality	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table ***E9.*** Health Impact of the Simulated Incident in Workers Exposed to Acrylonitrile Following Simultaneous Damage of the Items "Acrylonitrile Storage Tank", "Unit Buffer Vessel", and "Stripping Column" in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	79 (63 M, 16 F)	No medical problems	-
1-2.5	48 (38 M, 10 F)	No medical problems	-
2.5-5	44 (35 M, 9 F)	No medical problems	-
5-10	35 (28 M, 7 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	29 (23 M, 6 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	8 (6 M, 2 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	4 (3 M, 1 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	2 (2 M, 0 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	1 (1 M, 0 F)	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E10. Health Impact of the Simulated Incident in Workers Exposed to Acrylonitrile Following Simultaneous Damage of the Items "Acrylonitrile Storage Tank", "Unit Buffer Vessel", and "Stripping Column" in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	**Number of workers involved**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	72 (57 M, 14 F)	No medical problems	-
1-2.5	44 (35 M, 9 F)	No medical problems	-
2.5-5	39 (31 M, 8 F)	No medical problems	-
5-10	42 (34 M, 8 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	39 (31 M, 8 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	11 (9 M, 2 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	5 (4 M, 1 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	3 (2 M, 1 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	1 (1 M, 0 F)	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E11. Health Impact of the Simulated Incident in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Items "Acrylonitrile Storage Tank", "Unit Buffer Vessel", and "Stripping Column" in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	652	204 M 220 F	50 M 54 F	60 M 64 F	No medical problems	
1-2.5	26	8 M 9 F	2 M 2 F	2 M 3 F	No medical problems	
2.5-5	5	2 M 2 F	-	0 M 1 F	No medical problems	
5-10	-	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E12. Health Impact of the Simulated Incident in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Items "Acrylonitrile Storage Tank", "Unit Buffer Vessel", and "Stripping Column" in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	894	279 M 302 F	69 M 74 F	82 M 88 F	No medical problems	
1-2.5	41	13 M 14 F	3 M 3 F	4 M 4 F	No medical problems	
2.5-5	18	6 M 6 F	1 M 1 F	2 M 2 F	No medical problems	
5-10	-	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E13. Health Impact of the Simulated Incident in Workers Exposed to Acrylonitrile Following Simultaneous Damage of the Items "Acrylonitrile Storage Tank", "Unit Buffer Vessel", and "Elastomer Production Reactor" in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	75 (60 M, 15 F)	No medical problems	-
1-2.5	35 (28 M, 7 F)	No medical problems	-
2.5-5	26 (21 M, 5 F)	No medical problems	-
5-10	45 (36 M, 9 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	17 (14 M, 3 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	8 (6 M, 2 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	4 (3 M, 1 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	2 (2 M, 0 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	1 (1 M, 0 F)	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E14. Health Impact of the Simulated Incident in Workers Exposed to Acrylonitrile Following Simultaneous Damage of the Items "Acrylonitrile Storage Tank", "Unit Buffer Vessel", and "Elastomer Production Reactor" in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	Number of workers involved	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	70 (56 M, 14 F)	No medical problems	-
1-2.5	34 (27 M, 7 F)	No medical problems	-
2.5-5	24 (19 M, 5 F)	No medical problems	-
5-10	30 (24 M, 6 F)	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	55 (44 M, 11 F)	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	23 (18 M, 5 F)	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	10 (8 M, 2 F)	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	(**2):** Require admission to hospital
100-200	6 (5 M, 1 F)	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	(**2):** Require admission to hospital
200-400	3 (2 M, 1 F)	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	1 (1 M, 0 F)	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	1 (1 M, 0 F)	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table E15. Health Impact of the Simulated Incident in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Items "Acrylonitrile Storage Tank", "Unit Buffer Vessel", and "Elastomer Production Reactor" in Plant A. Incident Occurring in Summer.

Acrylonitrile concentration (ppm)	**Number of subjects involved**	**Adults**	**Children (< 18 years)**	**Elderly (> 65 years)**	**Clinical manifestations**	**Level of disability* (Tier and emergency intervention)**
0.1-1	2,140	668 M 723 F	164 M 178 F	195 M 211 F	No medical problems	
1-2.5	144	45 M 49 F	11 M 12 F	13 M 14 F	No medical problems	
2.5-5	42	13 M 14 F	3 M 4 F	4 M 4 F	No medical problems	
5-10	10	-	-	-	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	-	-	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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Table. E16. Health Impact of the Simulated Incident in the General Population Exposed to Acrylonitrile Following Accidental Damage of the Items "Acrylonitrile Storage Tank", "Unit Buffer Vessel", and "Elastomer Production Reactor" in Plant A. Incident Occurring in Winter.

Acrylonitrile concentration (ppm)	Number of subjects involved	Adults	Children (< 18 years)	Elderly (> 65 years)	Clinical manifestations	Level of disability* (Tier and emergency intervention)
0.1-1	2,949	920 M 997 F	226 M 245 F	269 M 291 F	No medical problems	
1-2.5	203	63 M 69 F	16 M 17 F	18 M 20 F	No medical problems	
2.5-5	63	20 M 22 F	5 M 5 F	6 M 6 F	No medical problems	
5-10	25	8 M 8 F	2 M 2 F	2 M 2 F	Initial dermal and mucous membrane irritation in susceptible individuals	**(1):** Can be managed at the pre-hospital level
10-25	1	1 M	-	-	Mild skin, ocular irritation, CNS irritability	**(1):** Can be managed at the pre-hospital level
25-52	-	-	-	-	Moderate skin irritation, strong eye and pulmonary irritation, nausea, light headedness, behavioral reactions associated with odor perception	**(2):** Require admission to hospital
52-100	-	-	-	-	Intense mucous membrane irritation, dermal burn. Autonomic symptoms including salivation, lacrimation, weakness, and mild headache	**(2):** Require admission to hospital
100-200	-	-	-	-	Skin redness, renal function changes (proteinuria), irregular breathing, weakness, dizziness, headache, flushing, vomiting, chest discomfort	**(2):** Require admission to hospital
200-400	-	-	-	-	Hepatic dysfunction with malaise and jaundice, respiratory depression and other cyanide-like effects. Possible lethality in susceptible individuals	**(3):** Require prompt hospitalization and intensive care support
400-800	-	-	-	-	As above with symptoms developing early after initial exposure	**(3):** Require prompt hospitalization and intensive care support
800-4,000	-	-	-	-	Hallucinations, unconsciousness, severe respiratory depression cyanosis, drop in blood pressure, lethality after exposure for up to 4 hrs	**(4):** Require on site stabilization and resuscitation measures
> 4,000	-	-	-	-	Coma, convulsions, asphyxia, cardiovascular collapse. Lethal effects after 5-15 min exposure.	**(4):** Require on site stabilization and resuscitation measures

* Syndromic patterns & level of disability classified as shown in Box 1.

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