UK Health Security Agency

Sulphuric acid

Incident management

This document provides information needed for response to a chemical incident, such as physicochemical properties, health effects and decontamination advice.

Thank you for visiting the compendium of chemical hazards. Please take our short survey to help us make improvements.

Contents

Main points

General

Sulphuric acid is a colourless, odourless, oily liquid at room temperature.

Although sulphuric acid is non-flammable, reactions may cause fire or explosion. Reacts violently with bases and is corrosive to most common metals.

When heated, sulphuric acid releases toxic and irritating oxides of sulphur fumes to decomposition.

Health

Corrosive by inhalation, ingestion, eye contact and skin contact.

Inhalation causes irritation of eyes and nose, with sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia, and confusion.

Ingestion can cause immediate pain, with burning in the mouth, throat and stomach; in severe cases, extensive areas of the gastrointestinal tract may be involved.

Dermal exposure causes pain, blistering, ulceration, and penetrating necrosis.

Eye exposure can cause pain, watering, conjunctivitis, oedema, and photophobia.

Casualty decontamination at the scene

Sulphuric acid mist and liquid are corrosive. Therefore, following disrobe, improvised wet decontamination should be considered.

Environment

Inform the Environment Agency where appropriate and avoid release into the environment.

Hazard identification

Table 1a. Standard (UK) dangerous goods emergency action codes for sulphuric acid, with more than 51% acid

UN		1830	Sulphuric acid with more than 51% acid	
EAC		2P	Use fine water spray. Wear chemical protective clothing with liquid tight connections for whole body in combination with breathing apparatus [note 1]. Where there is an immediate threat to people, spillages and decontamination run-off may be washed to drains with large quantities of water [note 2]. Substance can be violently or explosively reactive.	
APP		-	-	
Hazards	**Class**	8	Corrosive substance	
	Sub-risks	-	-	
HIN		80	Corrosive or slightly corrosive material	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1a

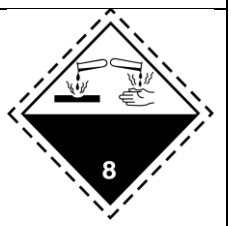
Note 1: Chemical protective clothing with liquid tight connections for whole body (Type 3) conforming to the relevant standards such as BS 8428 or EN 14605 in combination with breathing apparatus conforming to BS EN 137.

Note 2: In such cases due care must be exercised to avoid unnecessary pollution of surface and groundwaters and wherever possible control measures such as the sealing of drains should be employed.

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List' 2023 (viewed on 07 October 2024)

Table 1b. Standard (UK) dangerous goods emergency action codes for sulphuric acid, fuming

UN		1831	Sulphuric acid, fuming	
EAC		4WE	Use dry agent, water must not be allowed to come into contact with substance. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [note 1]. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters. Substance can be violently or explosively reactive. There may be a public safety hazard outside the immediate area of the incident [note 2].	
APP		B	Gas-tight chemical protective suit in combination with breathing apparatus [note 3].	
Hazards	**Class**	8	Corrosive substance	
	Sub-risks	6.1	Toxic substance	
HIN		X886	Highly corrosive substance, toxic which reacts dangerously with water	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1b

Note 1: Chemical protective clothing with liquid tight connections for whole body (Type 3) conforming to the relevant standards such as BS 8428 or EN 14605 in combination with breathing apparatus conforming to BS EN 137.

Note 2 People should be warned to stay indoors with all doors and windows closed, preferably in rooms upstairs and facing away from the incident. Ignition sources should be eliminated and

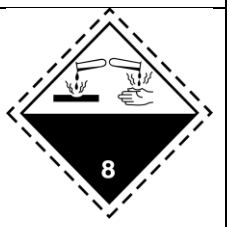
ventilation stopped. Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250 m away from the incident.

Note 3. Chemical protective clothing should be gas-tight conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137.

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List' 2023 (viewed on 07 October 2024)

Table 1c. Standard (UK) dangerous goods emergency action codes for sulphuric acid, spent

UN		1832	Sulphuric acid, spent	
EAC		2W	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [note 1]. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface groundwaters. Substance can be violently or explosively reactive.	
APP		-	-	
Hazards	**Class**	8	Corrosive substance	
	Sub-risks	-	-	
HIN		80	Corrosive or slightly corrosive material	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

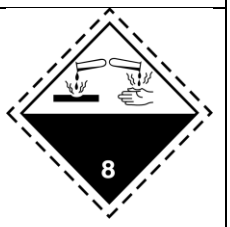
Notes to Table 1c

Note 1: Chemical protective clothing with liquid tight connections for whole body (Type 3) conforming to the relevant standards such as BS 8428 or EN 14605 in combination with breathing apparatus conforming to BS EN 137.

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List' 2023 (viewed on 07 October 2024)

Table 1d. Standard (UK) dangerous goods emergency action codes for sulphuric acid, with not more than 51% acid or battery fluid acid

UN		2796	Sulphuric acid, with not more than 51% acid or battery fluid, acid	
EAC		2R	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [note 1]. Where there is an immediate threat to people, spillages and decontamination run-off may be washed to drains with large quantities of water [note 2].	
APP		-	-	
Hazards	**Class**	8	Corrosive substance	
	Sub-risks	-	-	
HIN		80	Corrosive or slightly corrosive material	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1d

Note 1: Chemical protective clothing with liquid tight connections for whole body (Type 3) conforming to the relevant standards such as BS 8428 or EN 14605 in combination with breathing apparatus conforming to BS EN 137.

Note 2: In such cases due care must be exercised to avoid unnecessary pollution of surface and groundwaters and wherever possible control measures such as the sealing of drains should be employed.

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List' 2023 (viewed on 07 October 2024)

Table 2a. The GB classification, labelling and packaging (CLP) regulation for sulphuric acid

Hazard class and category	Skin Corr. 1A	Skin corrosion, category 1A	
Hazard statement	H314	Causes severe skin burns and eye damage	
Signal words	DANGER		

Table 2b. Specific concentration limits for sulphuric acid

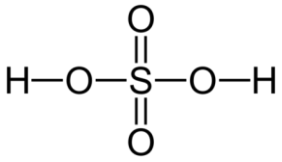
Concentration	**Hazard class and category**	**Hazard statement**	
C ≥ 15%	Skin Corr. 1A	H314	Causes severe skin burns and eye damage
5% ≤ C < 15%	Skin Irrit. 2	H315	Causes skin irritation
5% ≤ C < 15%	Eye Irrit. 2	H319	Causes serious eye irritation

References

The Health and Safety Executive (HSE). 'GB CLP Regulation' (viewed 07 October 2024).

Physicochemical properties

Table 3. Physicochemical properties

CAS number	7664-93-9
Molecular weight	98
Formula	H_2SO_4
Common synonyms	Sulfuric acid, oil of vitriol, oleum, sulphur oxoacid
State at room temperature	Colourless oily Liquid
Volatility	Non-volatile at 20°C
Specific gravity	1.8 (water = 1) 3.4 (air = 1)
Flammability	Non-flammable, reactions may cause fire or explosion
Lower explosive limit	-
Upper explosive limit	-
Water solubility	Miscible with water
Reactivity	Sulphuric acid is a strong oxidiser. Reacts with combustible and reducing materials and organic materials generating fire and explosion hazards. Reacts violently with water generating heat and fire or explosion hazard. Attacks many plastics.
Reaction or degradation products	Releases toxic and corrosive oxides of sulphur fumes when heated to decomposition. Strong acid that reacts violently with bases and is corrosive to most common metals forming a flammable/explosive gas
Odour	Odourless
Structure	

References

International Programme on Chemical Safety. 'International Chemical Safety Card entry for Sulphuric acid'. ICSC 0362, 2016. World Health Organization: Geneva. (viewed on 07 October 2024)

PubChem Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information; 2024-. 'PubChem Compound Summary for CID 1118, Sulfuric Acid' (viewed 07 October 2024)

Reported effect levels from authoritative sources

Table 4. Exposure to the skin and eyes

%	Signs and symptoms	Reference
5-15	Skin irritation and serious eye irritation	a
>15	Severe skin burns and eye damage	a

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values.

References

The Health and Safety Executive (HSE). 'GB CLP Regulation' (viewed 11 November 2024).

Published emergency response guidelines

Table 4. Interim exposure guideline levels (AEGLs)

	Concentration mg/m^3				
	10 minutes	**30 minutes**	**60 minutes**	**4 hours**	**8 hours**
AEGL-1 [note 1]	0.2	0.2	0.2	0.2	0.2
AEGL-2 [note 2]	8.7	8.7	8.7	8.7	8.7
AEGL-3 [note 3]	270	200	160	110	93

Notes to Table 4

Note 1: Level of the chemical in air at or above which the general population could experience notable discomfort.

Note 2: Level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape.

Note 3: Level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

References

US Environmental Protection Agency (EPA) 'Acute Exposure Guideline Levels' (viewed 07 October 2024)

Exposure standards, guidelines or regulations

Table 5. Occupational standards for sulphuric acid mist [note 1]

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m^3	ppm	mg/m^3
WEL	-	0.05	-	-

Note 1: The mist is defined as the thoracic fraction.

Abbreviations

WEL = workplace exposure limit.
LTEL = long-term exposure limit.
STEL = short-term exposure limit.

References

Health and Safety Executive. 'EH40/2005 Workplace Exposure Limits . Fourth Edition' 2020 (viewed on 07 October 2024)

Table 6. Public health standards and guidelines

Drinking water standard	No value specified
WHO guideline for drinking water quality	No value specified
UK indoor air quality guideline	No value specified
WHO indoor air quality guideline	No value specified
WHO air quality guideline	No value specified

Health effects

Corrosive by inhalation, ingestion, eye contact and skin contact.

Table 7. Signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Irritation of eyes and nose with sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia, and confusion. Chemical pneumonitis, tachypnoea, dyspnoea, and stridor due to laryngeal oedema may follow. Pulmonary oedema with increasing breathlessness, wheeze, hypoxia, and cyanosis may take up to 36 hours to develop. Optic neuropathy has been reported following both acute and chronic inhalation. In serious cases, corrosive damage to the mucous membranes of both the upper and lower respiratory tract occurs. Severe inhalation injuries may result in persistent hoarseness, pulmonary fibrosis, and chronic obstructive pulmonary disease. Prolonged exposure may result in systemic effects.
Ingestion	Ingestion of corrosives can cause immediate pain with burning in the mouth, throat, and stomach. This may be followed by abdominal pain, vomiting, haematemesis and dyspnoea. Pain and oedema may make swallowing difficult, causing drooling. Haemorrhagic or hypovolaemic shock and airway obstruction from laryngeal and/or epiglottic oedema are features of severe cases. Stridor and respiratory complications (including pneumonitis, pulmonary oedema, ARDS, and pulmonary necrosis) can develop following aspiration of corrosive materials. The presence of oropharyngeal burns does not correlate well with the presence of oesophageal injuries, but generally more extensive oral burns are associated with multiple site involvement. Gastric or oesophageal perforation may occur in the early stages of severe cases. Stricture formation is a potential late complication, usually occurring between 2 weeks and 2 months post exposure, although it may not be clinically apparent for several

Route	Signs and symptoms
	years. Severe injury can cause pyloric stenosis and a small, scarred, immobile stomach. Acids tend to damage the stomach with ulceration, necrosis, haemorrhage, and perforation. However, in severe cases, extensive areas of the gastrointestinal tract may be involved. Systemic features following corrosive ingestion may include hypovolaemic shock, metabolic acidosis, hypoxia, respiratory failure, acute renal failure, severe electrolyte imbalances, haemolysis and disseminated intravascular coagulation (DIC).
Eyes	Pain, watering, conjunctivitis, oedema, and photophobia may occur. Acidic and alkaline solutions may cause corneal burns and limbal ischaemia (whitening/blanching around the edge of the cornea where it meets the sclera). Aerosols sprayed directly into the eye may cause corneal damage.
Dermal	Acids generally produce rapid symptoms. Symptoms are more likely to occur following direct contact with solid or liquid corrosive materials although features can also occur via contact with corrosive gases and fumes. Acids may cause pain, blistering, ulceration, and necrosis. These burns may be self-limiting and superficial with the destruction of the surface epithelium and sub mucosa forming a leathery crust which limits the spread of the product. Large or prolonged exposure may result in systemic effects.

References

National Poisons Information Service TOXBASE ‘Sulphuric acid’ 2019. (viewed on 07 October 2024)

National Poisons Information Service TOXBASE. ‘Corrosives – inhalation’ 2020 (viewed on 07 October 2024)

National Poisons Information Service TOXBASE. ‘Corrosives – ingestion’ 2022 (viewed on 07 October 2024)

National Poisons Information Service TOXBASE. ‘Skin decontamination – corrosives’ 2020 (viewed on 07 October 2024)

National Poisons Information Service TOXBASE. ‘Chemicals splashed or sprayed into the eyes’ 2020 (viewed on 07 October 2024)

Decontamination at the scene

Chemical specific advice

The approach used for decontamination at the scene will depend upon the incident, location of the casualties and the chemicals involved. Therefore, a risk assessment should be conducted to decide on the most appropriate method of decontamination.

Sulphuric acid liquid and vapour are corrosive. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details on wet decontamination).

People who are processed through improvised decontamination should subsequently be moved to a safe location, triaged and subject to health and scientific advice. Based on the outcome of the assessment, they may require further decontamination.

Emergency services and public health professionals can obtain further advice from the UK Health Security Agency (UKHSA) Radiation, Chemicals, Climate and Environmental Hazards Directorate using the 24- hour chemical hotline number: 0344 892 0555.

Disrobe

The disrobe process is highly effective at reducing exposure to HAZMAT/CBRN material when performed within 15 minutes of exposure.

Therefore, disrobe must be considered the primary action following evacuation from a contaminated area.

Where possible, disrobing should be conducted at the scene and by the casualty themselves. Disrobing should be systematic to prevent transfer of contaminant from clothing to skin. Clothing should not be pulled over the head if possible.

Clothing stuck to the casualty by the contaminant should not be forcefully removed, as this risks causing further harm.

Consideration should be given to ensuring the welfare and dignity of casualties as far as possible. Immediately after decontamination the opportunity should be provided to dry and dress in clean robes or clothes.

Improvised decontamination

Improvised decontamination is an immediate method of decontamination prior to the use of specialised resources. This should be performed on all contaminated casualties unless medical advice is received to the contrary. Improvised dry decontamination should be considered for an incident involving chemicals unless the agent appears to be corrosive or caustic.

Unprotected first responders and members of the public should not approach casualties incapacitated by exposure to administer improvised decontamination, as they may be exposed to contaminants and become a casualty themselves.

Important note: Improvised decontamination should continue until a more structured intervention, such as an Interim Operational Response is conducted, or Specialist Operational Response are present.

Improvised dry decontamination

Any available dry absorbent material can be used such as kitchen towel, paper tissues (for example blue roll) and clean cloth.

Exposed skin surfaces should be blotted first and then rubbed, starting with the face, head, and neck, and moving down and away from the body.

Blotting and rubbing should not be too aggressive, as it could drive contamination further into the skin.

Casualties should also blow their nose to remove contaminants from the nasal cavities.

All waste material arising from decontamination should be left in situ, and ideally bagged, for disposal at a later stage.

Improvised wet decontamination

Wet decontamination should be used if contamination with a caustic chemical substance is suspected.

Water should only be used for decontamination where casualty signs and symptoms are consistent with exposure to caustic or corrosive substances such as acids or alkalis.

Wet decontamination may be performed using copious amounts of water from any available source such as taps, showers, water bottles, fixed installation hose-reels and sprinklers to gently rinse the affected skin. Other natural sources of water may be considered unless this creates greater risks to the individuals affected. Wet wipes or baby wipes may be used as an effective alternative.

Improvised decontamination should not involve overly aggressive methods to remove contamination as this could further damage affected tissues and drive the contamination further into the skin.

Where appropriate, seek professional advice on how to dispose of contaminated water and prevent run-off going into the water system.

Additional notes

Following improvised decontamination, remain cautious and observe for signs and symptoms in the decontaminated person and in unprotected staff.

If water is used to decontaminate casualties this may be contaminated, and therefore hazardous, and a potential source of further contamination spread.

All materials (paper tissues and so on) used in this process may also be contaminated and, where possible, should not be used on new casualties.

The risk from hypothermia should be considered when disrobe and any form of wet decontamination is carried out.

People who are contaminated should not eat, drink or smoke before or during the decontamination process and should avoid touching their face.

When vulnerable people are affected by a hazardous substance, they may need additional support to remove themselves, their clothing or the substance.

Casualties should remain in the area and should not leave to seek care at a hospital, as this presents a contamination risk. Further care will be administered on site by the appropriate emergency services.

Interim wet decontamination

Interim decontamination is the use of standard Fire and Rescue Service equipment to provide a planned and structured decontamination process prior to the availability of purpose-designed decontamination equipment.

Decontamination at the scene references

Home Office. 'Initial operational response to a CBRN incident.' Version 2.0 July 2015 (viewed on 07 October 2024)

NHS England. 'Emergency Preparedness, Resilience and Response (EPRR): Guidance for the initial management of self-presenters from incidents involving hazardous materials.' February 2019 (viewed on 07 October 2024)

JESIP. 'Initial Operational Response (IOR) to Incidents Suspected to Involve Hazardous Substances or CBRN Materials' June 2024 (viewed on 07 October 2024)

Clinical decontamination and first aid

Clinical decontamination is the process where trained healthcare professionals, using purpose-designed decontamination equipment, treat contaminated persons individually.

Detailed information on clinical management can be found on TOXBASE.

Important notes

Once body surface contaminants have been removed or if your patient was exposed by ingestion or inhalation, the risk that secondary care givers may become contaminated is very low. Secondary carers should wear standard hospital PPE as a precaution against secondary contamination from vomit and body fluids.

If the patient has not been decontaminated following surface contamination, secondary carers must wear appropriate NHS PPE for chemical exposure to avoid contaminating themselves.

The area should be well ventilated.

For comprehensive clinical advice consult TOXBASE directly.

Clinical decontamination following surface contamination

Avoid contaminating yourself.

Carry out decontamination after resuscitation. This should be performed in a well-ventilated area, preferably with its own ventilation system.

Contaminated clothing should be removed, double-bagged, sealed and stored safely.

Decontaminate open wounds first and avoid contamination of unexposed skin. Any particulate matter adherent to skin should be removed and the patient washed with copious amounts of water under low pressure for at least 10 to 15 minutes, or until pH of skin is normal (pH of the skin is 4.5 to 6 although it may be closer to 7 in children, or after irrigation). The earlier irrigation begins, the greater the benefit.

Pay special attention to skin folds, fingernails and ears.

Dermal exposure

Decontaminate (as above) the patient following surface contamination.

Recheck pH of affected areas after a period of 15 to 20 minutes and repeat irrigation if abnormal. Burns with strong solutions may require irrigation for several hours or more. Attention should be paid to avoiding hypothermia during prolonged irrigation with cool fluids. Once the pH is normal and stabilised, treat as per a thermal injury.

Burns totalling more than 15% of body surface area in adults (>10% in children) will require standard fluid resuscitation as for thermal burns.

Moderate/severe chemical burns should be reviewed by a burns specialist.

Other supportive measures as indicated by the patient's clinical condition.

Ocular exposure

Remove contact lenses if present.

Anaesthetise the eye with a topical local anaesthetic (for example, oxybuprocaine, amethocaine or similar). However, do not delay irrigation if local anaesthetic is not immediately available.

Immediately irrigate the affected eye thoroughly with 1,000mL 0.9% saline or equivalent crystalloid (for example, by an infusion bag with a giving set) for a minimum of 10 to 15 minutes irrespective of initial conjunctival pH. A Morgan Lens may be used if anaesthetic has been given.

Aim for a neutral conjunctival pH of 7 to 7.2. The conjunctivae may be tested with indicator paper. Retest at 15 to 30 minutes after irrigation and use further irrigation if necessary.

Any particles lodges in the conjunctival recesses should be removed.

Repeated instillation of local anaesthetics may reduce discomfort and help more thorough decontamination. However, prolonged use of concentrated local anaesthetics is damaging to the cornea.

Patients with corneal damage, those who have been exposed to strong acids or alkalis and those whose symptoms do not resolve rapidly should be discussed urgently with an ophthalmologist.

Other supportive measures as indicated by the patient's clinical condition.

Ingestion

Maintain airway and establish haemodynamic stability.

In severely affected patients, especially those with tachypnoea, stridor or upper airway damage, critical care input is essential with urgent assessment of the airway. A supraglottic-epiglottic burn with erythema and oedema is usually a sign that further oedema will occur that may lead to airway obstruction.

Children are at increased risk of airway obstruction.

Do not attempt gastric lavage. Do not give neutralising chemicals as heat produced during neutralisation reactions may increase injury.

Monitor vital signs and cardiac rhythm; check the capillary blood glucose.

Check and record pupil size.

Perform a 12-lead ECG in all patients who require assessment.

Other supportive measures as indicated by the patient's clinical condition.

Inhalation

Maintain a clear airway and ensure adequate ventilation.

Administer oxygen to achieve adequate oxygenation.

In severely affected patients, especially those with tachypnoea, stridor or upper airway damage, critical care input is essential with urgent assessment of the airway. A supraglottic-epiglottic burn with erythema and oedema is usually a sign that further oedema will occur that may lead to airway obstruction.

Children are at increased risk of airway obstruction.

Monitor vital signs and check capillary blood glucose.

Check and record pupil size.

Perform a 12-lead ECG in all patients who require assessment.

Other supportive measures as indicated by the patient's clinical condition.

Clinical decontamination and first aid references

National Poisons Information Service TOXBASE 'Sulphuric acid' 2019. (viewed on 07 October 2024)

National Poisons Information Service TOXBASE. 'Corrosives – inhalation' 2020 (viewed on 07 October 2024)

National Poisons Information Service TOXBASE. 'Corrosives – ingestion' 2022 (viewed on 07 October 2024)

National Poisons Information Service TOXBASE. 'Skin decontamination – corrosives' 2020 (viewed on 07 October 2024)

National Poisons Information Service TOXBASE. 'Chemicals splashed or sprayed into the eyes' 2020 (viewed on 07 October 2024)

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

This document from the UKHSA Radiation, Chemicals and Environment Directorate reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

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