NOSB NATIONAL LIST
FILE CHECKLIST

CROPS

MATERIAL NAME: Pheromones

CATEGORY: Synthetic **Complete?:** _____

✓ **NOSB Database Form**

✓ **References**

✓ **MSDS (or equivalent)**

_____ **Date file mailed out:** 1/17/95

✓ **TAP Reviews from:** _____

Joe Kovach

Bruce Spencer

_____

_____ **Supplemental Information:**

MISSING INFORMATION: _____

NOSB/NATIONAL LIST COMMENT FORM/BALLOT

Use this page to write down comments and questions regarding the data presented in the file of this National List material. Also record your planned opinion/vote to save time at the meeting on the National List.

Name of Material Pheromones

Type of Use: V **Crops;** ____ **Livestock;** ____ **Processing**

TAP Review by:

1. Joe Kovach
2. Bruce Spencer
3. ____

Comments/Questions:

My Opinion/Vote is:

Signature _____ **Date** _____

USDA/TAP REVIEWER COMMENT FORM

Use this page or an equivalent to write down comments and summarize your evaluation regarding the data presented in the file of this potential National List material. Attach additional sheets if you wish.

This file is due back to us within 30 days of: Due: MAR 01 1995

Name of Material: Pheromones

Reviewer Name: Joe Kovach

Is this substance Natural or Synthetic? Explain (if appropriate)

Synthetic.

Please comment on the accuracy of the information in the file:

It Looks pretty accurate to me.

This material should be added to the National List as:

✓ **Synthetic Allowed** ____ **Prohibited Natural**

or, ____ **This material does not belong on the National List because:**

Are there any restrictions or limitations that should be placed on this material by use or application on the National List?

No - I believe pheromones fit in w/ an organic philosophy. Even though they are synthetic they really do not kill anything.

Any additional comments or references?

No

Signature Joyce Kovach **Date** 3/8/95

ORGANIC FOOD PRODUCTION ACT/NATIONAL LIST SECTIONS

USDA/TAP REVIEWER COMMENT FORM

Use this page or an equivalent to write down comments and summarize your evaluation regarding the data presented in the file of this potential National List material. Attach additional sheets if you wish.

This file is due back to us within 30 days of: Due MAR 01 1995

Name of Material: Pheromones

Reviewer Name: Bruce Spencer

Is this substance Natural or Synthetic? Explain (if appropriate)
Synthetic

Please comment on the accuracy of the information in the file:
Complete + Accurate

This material should be added to the National List as:

X **Synthetic Allowed** ____ **Prohibited Natural**

or, ____ **This material does not belong on the National List because:**

Are there any restrictions or limitations that should be placed on this material by use or application on the National List?
Disposal requirements, ~~NO~~

Any additional comments or references?

Signature Bruce Spencer **Date** 3-6-95

ORGANIC FOOD PRODUCTION ACT/NATIONAL LIST SECTIONS

NOSB Materials Database

Identification

Common Name **Pheromones** **Chemical Name** Various

Other Names Sex Pheromones, Checkmate, Isomate-M, Biolure, Grandlure

Code #: CAS Various **Code #: Other**

N. L. Category Synthetic Allowed

Chemistry

Composition Synthetic insect hormones. **Family** Semiochemical

Properties Multi chemical properties dependent upon nature of source.

How Made Scent of a female insect is synthesized and is placed in a plastic tube that allows pheromones to be slowly released over time on cardboard traps or sticky traps to attract an insect of the opposite sex.

Use/Action

Type of Use Crops

Use(s) pest control
Behavioral stimulus

Action Lures insects to traps.baits containing insecticides. Mating disruption: pheromone permeates environment making it difficult for males to locate females.

Combinations

Status

OFPA 2118(c)1(B)i

N. L. Restriction

EPA, FDA, etc Registration

Directions

Safety Guidelines Use adequate ventilation

State Differences

Historical status Allowed by a wide majority of certification groups.

Internationl status OCIA: allowed; EU & CODEX & IFOAM all ok

NOSB Materials Database

OFPA Criteria

2119(m)1:chem. inter. Avoid: oxygen and strong oxidizing agents. -Carbon oxides formed when burned.

2119(m)2: toxicity No information available at this time.

2119(m)3:manufacture Traps should be positioned in field to prevent exposure of crop to chemical contamination from pheromone.

2119(m)4:humans -Use gloves
-Avoid skin contact
-Avoid inhalation of vapors or mist

2119(m)5: biology -Disrupts mating patterns of males of target species. Does not affect other species.

2119(m)6:alternatives Trap crops, sugar or feeding attractant traps, colored sticky traps, botanicals. Alternatives are very species specific and for some species there are none.

2119(m)7:compatible Compatible with sustainable agriculture goals.

References

Olkowski, W, S. Daar, H. Olkowski. 1991. Common Sense Pest Control. Conneticut. Tauton Press. pgs. 143-144.

AgriSense: 4230 W. Swift St. Suite 106 Fresno, CA 415-856-9500
Atomegric Chemicals: 222 Sherwood Ave Farmingdale, NY 516-694-9000

& see attached.

PHEROMONES REFERENCES

AU: Pickett,-J.A.; Pye,-B.J.; Wadhams,-L.J.; Woodcock,-C.M.; Campbell,-C.A.M.
TI: Potential applications of semiochemicals in aphid control.
SO: Monograph-Br-Crop-Prot-Counc. Surrey : The Council. 1992. (51) p. 29-33.
CN: DNAL SB599.B73

AU: Dawson,-G.W.; Griffiths,-D.C.; Merritt,-L.A.; Mudd,-A.; Pickett,-J.A.; Wadhams,-L.J.; Woodcock,-C.M.
TI: Aphid semiochemicals--a review, and recent advances on the sex pheromone.
SO: J-Chem-Ecol. New York, N.Y. : Plenum Press. Nov 1990. v. 16 (11) p. 3019-3030.
CN: DNAL QD415.A1J6
AB: The alarm pheromones are known for many species of aphids, and methods of using the synthetic pheromone to improve control of aphids by contact insecticides and biological agents have been devised. Highly active analogs have been prepared and plant-derived synergists identified. Strategies for biotechnological production of aphid semiochemicals are described. Further studies on the production, perception, and interspecific attraction of the pheromone components are described and possible uses for the sex pheromone are discussed.

AU: Currie,-R.W.; Winston,-M.L.; Slessor,-K.N.; Mayer,-D.F.
TI: Effect of synthetic queen mandibular pheromone sprays on pollination of fruit crops by honey bees (Hymenoptera: Apidae).
SO: J-Econ-Entomol. Lanham, Md. : Entomological Society of America. Aug 1992. v. 85 (4) p. 1293-1299.
CN: DNAL 421-J822
AB: Three different concentrations of honey bee, Apis mellifera L., queen mandibular pheromone were applied to 0.4-ha blocks of apple, Malus domestica Borkh, and pear, Pyrus communis L., by air-blast sprayer. Concentrations of 1,000 queen equivalents (QEQ) (AI)/ha increased the number of honey bees foraging both apple and pear under a wide range of environmental conditions, orchard management systems, and geographical locations. Bee activity on plots sprayed with pheromone concentrations of 0.1 or 10 QEQ (AI)/ha did not differ significantly from controls. The pheromone was most effective on the day of application and declined to the level of control plots by the third day.

AU: Pickett,-J.A.
TI: Pheromones: Will their promise in insect pest control ever be achieved.
SO: Bull-Entomol-Res. London : Commonwealth Agricultural Bureaux International. Sept 1991. v. 81 (3) p. 229-232.
CN: DNAL 421-B87

AU: Ferguson,-A.W.; Williams,-I.H.
TI: Deposition and longevity of oviposition-deterring pheronome int he cabbage seed weevil.
SO: Physiol-Entomol. Oxford : Blackwell Scientific Publications. Mar 1991. v. 16 (1) p. 27-33.
CN: DNAL QL461.P5

AU: Dennehy,-T.J.; Hoffman,-C.J.; Nyrop,-J.P.; Saunders,-M.C.
TI: Development of low-sray, biological and pheromone approaches for control of grape berry moth, Endopiza viteana Clemens, in the eastern United States.
SO: Monitoring and integrated management of arthropod pests of small fruit crops / editors N.J. Bostainian, L.T. Wilson and T.J. Dennehy. Andover, Hampshire : Intercept, c1990. p. 261-282.
CN: DNAL SB608.F8M6

AU: Horak,-A.; Hrdy,-I.; Konecny,-K.; Vrkoc,-J.
TI: Effect of substrate formulation on the efficacy of the pea moth, Cydia nigricana, sex pheromone lures.
SO: Entomol-Exp-Appl. Dordrecht : Kluwer Academic Publishers. Dec 1, 1989. v. 53 (2) p. 125-131.
CN: DNAL 421-EN895

AU: Pickett,-J.A.
TI: Production of behaviour-controlling chemicals by crop plants.

SO: Philos-Trans-R-Soc-Lond-Ser-B-Biol-Sci. London : The Society. Sept 12, 1985. v. 310 (1144) p. 235-239.
CN: DNAL 501-L84PB

AU: Bajikar,-M.R.; Sarode,-S.V.
TI: Future of pheromones in plant protection.
SO: Plant protection in the year 2000 AD : proceedings of the seminar held at New Delhi, December 20-22, 1984 / [ed. of publications, G.S. Venkataraman]. New Delhi : Indian National Sci. Acad., 1986. p129-.
CN: DNAL SB950.A2P55

AU: Chadha,-M.S.
TI: Trends in the application of natural products in plant protection.
SO: Plant protection in the year 2000 AD : proceedings of the seminar held at New Delhi, December 20-22, 1984 / [ed. of publications, G.S. Venkataraman]. New Delhi : Indian National Sci. Academy, 1986. p. 25-34.
CN: DNAL SB950.A2P55

AU: Lewis,-W.J.; Nordlund,-D.A.
TI: Behavior-modifying chemicals to enhance natural enemy effectiveness.
SO: Biological control in agricultural IPM systems / edited by Marjorie A. Hoy, Donald C. Herzog. Orlando, Fla. : Academic Press, 1985. p. 89-101.
CN: DNAL SB933.3.B548

AU: Campion,-D.G.; McVeigh,-E.M.
TI: Controlling insect pests with pheromones.
SO: Span-Prog-Agric. Foston : J.G.R. Stevens. 1984. v. 27 (3) p. 100-102, 138, 140, 143. ill.
CN: DNAL 464.8-SP2

AU: McBride,-J.
TI: Pheromones--decoding insects' chemical communication.
SO: Agric-Res-U-S-Dep-Agric-Res-Serv. Washington, D.C. : The Administration. Oct 1984. v. 32 (13) p8-12
CN: DNAL 1.98-AG84

AU: McLaughlin,-J.R.; Mitchell,-E.R.
TI: Practical development of pheromones in Heliothis management.
SO: Proceedings of the International Workshop on Heliothis Management, ICRISAT Center, Patancheru, India, 15-20 November 1981 / editors W. Reed and V. Kumble. Andhra Pradesh, India : International Crops Research Institute for the Semi-Arid Tropics, 1982. p. 309-318. ill.
CN: DNAL SB945.H27I5-1981

AU: Klassen,-W.; Ridgway,-R.L.; Inscoe,-M.
TI: Chemical attractants in integrated pest management programs Pheromones, insect pests, agricultural crops, livestock, forest trees, wood.
SO: Insect suppression with controlled release pheromone systems / editors, Agis F. Kydonieus, Morton Beroza. Boca Raton, Fla. : CRC Press, 1982. p. 13-130.
CN: DNAL SB933.5.I48-v.-1

AU: Shorey,-H-H
TI: Application of pheromones for manipulating insect pests of agricultural crops
SO: In Proceedings of the International Symposium on Insect Pheromones and Their Applications, 1976 (Pub. 1977), p. 97-108. Ref.
CN: DNAL SB933.5.I5-1976

AU: Yang,-S-L; Zettler,-F-W
TI: Effects of alarm pheromones [of Aphis craccivora or Myzus persicae] on aphid [Aphis craccivora] probing behavior and virus transmission efficiency [Cowpeas]
SO: Plant-Dis-Rep, Nov 1975, 59 (11): 902-905. Ref.
CN: DNAL 1.9-P69P

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

FERMONE

IDENTITY (As Used on Label and List)	Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.
Stirrup® M	

Section I

Manufacturer's Name Fermone Corporation Inc	Emergency Telephone Number (602) 254-7946
Address (Number, Street, City, State, and ZIP Code) 1700 North 7th Ave., Suite 100	Telephone Number for Information (602) 254-7946
Phoenix, AZ 85007	Date Prepared 1/16/89
DOT SHIPPING AND HAZARD CLASSIFICATION: Non-Hazardous UN -	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
none				

Section III — Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O = 1)	1.025-1.0
Vapor Pressure (mm Hg.)	N/A	Melting Point	N/A
Vapor Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water
Miscible in water.

Appearance and Odor
off-white, mild paint-like odor.

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
>210° F (closed cup)		N/A	N/A

Extinguishing Media
Water, CO_2, dry chemical, foam

Special Fire Fighting Procedures
None

Unusual Fire and Explosion Hazards
None

The MSDS information is accurate to the best of our knowledge, however, Fermone does not assume any legal responsibility for reliance upon same.

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid: None
	Stable	X	

Incompatibility (*Materials to Avoid*)

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur	X	

Section VI — Health Hazard Data

Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
		X	X

Health Hazards (*Acute and Chronic*)

Oral LD_{50}: > 5000 mg/kg (rat)

Dermal LD_{50}: > 2000 mg/kg (rabbit)

Chronic Effects - not known

Carcinogenicity:	NTP?	IARC Monographs?	OSHA Regulated?

Signs and Symptoms of Exposure
Irritation of eyes, skin, gastrointestinal tract.

Medical Conditions Generally Aggravated by Exposure
None

Emergency and First Aid Procedures
If in eyes: flush with copious amounts of water. If on skin - wash with soap & water.

Obtain medical attention if irritation persists. If ingested - consult physician.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
Remove people from contaminated area. Avoid contamination of streams and sewers. Contain area of spill and absorb material onto clay, sand, or other absorbent material.

Waste Disposal Method
Dispose of unused pesticide, spray rinsate, or mixture in accordance with federal, state, and local government authorities.

Precautions to Be Taken in Handling and Storing
Store in cool area, avoid open flames and other sources of ignition.

Other Precautions

Section VIII — Control Measures

Respiratory Protection (*Specify Type*)
None

Ventilation		
	Local Exhaust	Special
	Mechanical (*General*)	Other

Protective Gloves	Eye Protection
Chemical resistant - rubber	Safety glasses

Other Protective Clothing or Equipment
Wear impervious clothing.

Work/Hygienic Practices
Wash contaminated clothing

MATERIAL SAFETY DATA SHEET

CONSEP®

213 S.W. Columbia, Bend, Oregon U.S.A. 97702-1013
EMERGENCY PHONE NUMBER: (503) 388-3688

SECTION I

TRADE NAME:	**CheckMate® CM**
SYNONYMS:	Codlure, Codlemone
REGULATORY LICENSE:	EPA Registration No. 56336-13
CHEMICAL FAMILY:	Unsaturated Aliphatic Ester

SECTION II – COMPONENTS

PRINCIPAL COMPONENT(S)	CAS NO.	CHEMICAL FORMULA
E,E,-8,10-Dodecadien-1-ol	33956-49-9	$C_{12}H_{22}O_2$

None of the ingredients of this material meet the definition of "Hazardous Chemical" given in OSHA Hazard Communication Regulation 29 CFR 1910.1200(c). The information on this form is furnished as a customer service.

SECTION III – PHYSICAL DATA

BOILING POINT (°C)	Not Applicable for dispenser.	MELTING POINT	29 °C for pheromone. Not established for whole dispenser.
VAPOR PRESSURE (20 °C)	(20 °C, mm Hg): Not established for dispenser.	VAPOR DENSITY (AIR=1)	> 1 for pheromone.
SOLUBILITY IN WATER	Insoluble in water for pheromone and dispenser.	SPECIFIC GRAVITY (H2O=1)	Not established for dispenser.
SPECIFIC GRAVITY (H2O=1)	Not established for dispenser.	APPEARANCE AND ODOR	Plastic devices; mild, fruity odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method Used)	FLAMMABLE LIMITS (% by Volume in Air)	LEL	UEL
Not established.	Not established.	Not established.	Not established.

EXTINGUISHING MEDIA:	Dry Chemical, Foam, Carbon Dioxide (CO_2)
SPECIAL FIRE FIGHTING PROCEDURES:	Evacuate area of all unnecessary personnel. Use standard fire fighting procedures.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Carbon oxides formed when burned.

SECTION V - HEALTH HAZARD DATA

TOXICITY DATA

None of the ingredients of this material meet the definition of "Hazardous Chemical" given in OSHA Hazard Communication Regulation 29 CFR 1910.1200(c). The information on this form is furnished as a customer service.

For pheromone ingredient:

LD_{50}, Oral, Rat:	> 5050 mg/kg
LD_{50}, Dermal, Rabbit:	> 2050 mg/kg
LD_{50}, Intratrachael, Rat:	> 2.50 ml/animal (>5 mg/L)
Eye Irritation, Rabbit:	Minimally irritating.
Skin Irritation, Rabbit:	Moderately irritating.
Ames Mutation Assay:	Negative.

EFFECTS OF OVEREXPOSURE

EYE CONTACT:	Pheromone is minimally irritating. Avoid contact with eyes when in contact with dispenser membrane.
SKIN CONTACT:	Pheromone is moderately irritating. Avoid contact with skin when in contact with dispenser membrane.
INHALATION:	Avoid breathing vapors when in confined areas.
INGESTION:	Due to product form, ingestion is not considered likely.
CHRONIC:	Long-term studies have not been done on the concentrated active ingredient, however, no adverse effects expected.

SECTION V - EMERGENCY FIRST AID PROCEDURES

EYE CONTACT:	Flush with plenty of water for at least 15 minutes. If irritation develops, call a physician.
SKIN CONTACT:	Wash with soap and water. If irritation develops, call a physician.
INHALATION:	Remove from exposure. If illness or adverse symptoms develop, call a physician. Due to product form, such exposure is unlikely.
INGESTION:	Due to product form, such exposure is unlikely.

RECOMMENDED EXPOSURE LIMITS:	None established.
LISTED AS CARCINOGEN BY NTP, IARC, OR OSHA:	No.
OTHER HEALTH EFFECTS:	No known adverse effects expected.
HEALTH HAZARD CATEGORIES:	EPA Toxicity Category: III - CAUTION.

SECTION VI - REACTIVITY DATA

STABILITY:	Pheromone is sensitive to heat and light.
INCOMPATIBILITY:	Pheromone to strong oxidizing agents.
HAZARDOUS DECOMPOSITION PRODUCTS:	Carbon oxides formed when burned.
HAZARDOUS POLYMERIZATION:	Will not occur.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

Solid spills can be swept up. Keep out of water sources or sewers.

ENVIRONMENTAL HAZARDS/ WASTE DISPOSAL:

Incinerate or otherwise manage at an RCRA permitted waste management facility. Dispose of in accordance with local, state, and federal regulations.

USED DISPENSERS AND CONTAINER DISPOSAL:

Used dispensers should be wrapped in newspaper, placed in garbage bag and discarded in trash. Do not reuse box or bag containers. Discard in trash.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:	Not generally required under normal use conditions.
PROTECTIVE GLOVES:	Use waterproof gloves when handling dispensers.
EYE PROTECTION:	Not generally required under normal use conditions.
OTHER PROTECTIVE EQUIPMENT:	Use protective garments to prevent excessive skin contact.
VENTILATION:	Use adequate ventilation.
NOTE:	Personal protection information provided in this Section is based upon label information as to normal uses and conditions. Where special or unusual uses or conditions exist, it is suggested that the expert assistance of an industrial hygienist or other qualified professional be sought.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE, ETC.

Wear protective equipment described in Section VIII, if exposure conditions warrant. Keep containers closed. Wash hands after handling. Launder contaminated clothing before reuse. Do not allow product to contaminate water sources, food or feed.

SECTION X - REGULATORY INFORMATION

Consep, Inc. is unaware of any local, state or federal regulations which define the active ingredient as hazardous.

As of the preparation date, this product did not contain a chemical or chemicals subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

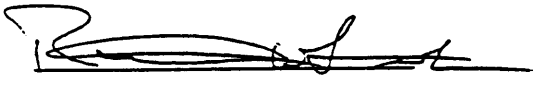
While this information and recommendations set forth are believed to be accurate as of the date hereof, Consep, Inc. makes no warranty with respect hereto and disclaims all liability from reliance thereon.

Date: 12/7/94

Supersedes: 11/22/94

Name: Richard W. Fresh

Title: Regulatory Affairs

Signature: 

chckm

INSECTS THAT CAN'T SMELL DON'T MATE

R.S. BERGER and D.A. RIDER

ENTOMOLOGISTS have long recognized the ability of insects to use a sensitive olfactory sensory system to detect odors from volatile chemicals. Current research in the Alabama Agricultural Experiment Station is seeking ways to block or jam this sensory system to disrupt the reproductive cycle of certain economically damaging insect pests.

By absorbing special chemicals known as sex pheromones from the air into their antennae and recognizing these as unique markers, insects can distinguish potential mates from many other species in the field and continue their reproductive cycle. Auburn researchers were the first in the world to identify and chemically synthesize sex pheromone of an economically damaging insect pest (the cabbage looper). Current research is underway to use the sex pheromone in combination with other chemicals to jam reproductive signals of this frequent pest of vegetable crops and occasionally of soybeans and cotton.

Researchers first tried to block the ability of male cabbage loopers to detect sex pheromone by synthesizing chemical compounds that contain characteristics of both the toxic part in three insecticides and the specific portion of the sex pheromone. The rationale was that these compounds would be carried to the same site in the nerve cells where the pheromone molecule is recognized by the insect. The 'toxic tail' would then jam the important components that must act to transmit the necessary information to the brain of the insect. Although the toxic principle of each of the three different insecticides was explored, none was effective.

A second group of compounds was copied from chemicals known to occur in certain plants that have been used as spices and in folk medicine. These are 'hot' when chewed, cause a numbing in the mouth, and have been used to relieve the pain of toothache and bronchitis. These compounds, known as isobutylamides, were made to imitate the structure of the pheromone molecule, but they were also ineffective.

A third group of compounds, known as thiol-inhibitors, specifically N-butylmaleimide, which chemically binds to certain sulphur-containing substances, was used. Research by others had shown that the ability of insects to taste could be blocked with mercury-containing compounds that are known to react with sulphur. N-butylmaleimide was dispersed as a vapor in much the same way sex pheromones are distributed in the air, providing dramatic initial results.

An oscilloscope was used to monitor treated insects. Typically when antennae of male cabbage loopers were stimulated by pheromone vapor, blips showed up on the oscilloscope, much like heart beats show up when patients are monitored in a hospital. After exposure to the thiol-inhibiting vapor, male cabbage loopers showed no blips on the monitor.

If the antenna shows no response, does this mean the insect can no longer smell? Apparently it cannot. Insects that were exposed to doses of the chemical sufficient to abolish essentially all electrical response in the antennae were unable to locate a source of synthetic pheromone when placed downwind from it in a wind tunnel. Normally about 80% of males will fly directly to the source when placed in the plume of pheromone.

The final test was to determine if blockage of an insect's antennae impaired its ability to locate and mate with a suitable partner. Single pairs of cabbage looper moths were placed in cages with a potted collard plant. Either the male or the female of each pair was treated with a dose of chemical sufficient to block their antennae. The results of these studies are listed in the table. Treatment of males completely destroyed their ability to locate females and mate with them, resulting in no viable eggs being produced.

Further studies are currently underway to develop practical means for getting the chemical to males in the field. The feasibility of combining the inhibitor with sex pheromone in a lure that would result in males picking up the chemical as they follow the plume of pheromone is being investigated.

EFFECT OF N-BUTYLMALEIMIDE ON MATING OF CABBAGE LOOPER MOTHS

Treatment	Pairs producing fertile eggs
	Pct
Control	81
Males treated	0
Females treated	100

Male cabbage looper scanning the air with its antennae.

Berger is Professor and Rider is a former Graduate Student in Zoology-Entomology.

Tiny worm-like nematodes have just migrated out of the body of a dead termite and are seeking a new host. Infective juvenile nematodes enter an insect host through its body openings. Once inside, they feed on the insect and release toxic bacteria that produce lethal blood poisoning.
(Photo courtesy George Poinar.)

These infectious juvenile nematodes have mutualistic beneficial relationships with the bacteria *Xenorhabdus nematophilus* and *X. luminescens*, which they carry in their gut. Once inside the host, the bacteria are released from the anus of the nematode and multiply rapidly in the host's bloodstream. The insect host dies within 24 hours from blood poisoning caused by the bacteria, and the nematodes continue to use the bacteria as a food source within the insect's body.

Formulations. Mass production of nematodes has resulted in a number of commercial products containing 13 infective nematodes. These are mixed with water and are applied as drenches or sprays to the soil or other moist environments. The major factor limiting wider use of parasitic nematode species is the lack of a formulation that allows nematodes to survive for long periods under adverse—particularly dry—conditions. Additives that could solve this problem are now being researched. Encapsulation processes whereby nematodes are enclosed in a gelatin-like material have recently been developed. New developments in mass-rearing will probably lower production costs so nematodes will be even more commercially feasible.

Safety. After extensive toxicological testing, these nematodes and their bacteria have been found to be nontoxic to humans, animals and other nontarget organisms.

Uses and Application. At their present stage of development, parasitic nematodes are most effective when applied to moist soil to kill insects in the ground or in plant containers, or when injected into holes bored by insects in trees. Because commercial nematode species cannot survive naturally in dry environments, current formulations are not effective when sprayed on the leaves of plants. Nematodes applied this way quickly desiccate and die before finding a host.

Steinernema carpocapsae, the most widely available commercial nematode, has been shown to infect and kill about 300 species of insects in 17 families of Coleoptera (beetles), 9 families of Diptera (flies), 5 families of Heteroptera (bugs), 4 families of Homoptera (aphids, scales, mealybugs, whiteflies), 8 families of Lepidoptera (caterpillars), 1 family of Neuroptera (lacewings) and 5 families of Orthoptera (grasshoppers, crickets). With an organism that has such a wide host range, it may be necessary to devise baits, carriers and other delivery systems that ensure the nematode attacks the target pest selectively.

The same nematode has been shown to attack subterreanean termites (*Reticulitermes* spp.) in laboratory cultures. A product called SAF-T-Shield™, which contains *S. carpocapsae* as its chief ingredient, is now marketed to control these termites. However, field testing of this and other nematode products against subterranean termites is still underway. A number of private termite companies have been using the nematodes for several years and report success; however, data from controlled studies of treatments applied to structures is needed before scientifically accurate assessments of nematode effectiveness can be made.

Parasitic nematodes have been shown to kill many horticultural and agricultural insect species in laboratory tests; however, when applied to plants or soil in field experiments, *S. carpocapsae* was effective in controlling only a few plant-boring insects, including carpenterworms (moths of the family Sesiidae) in figs, oak and other trees, and the wood-boring larvae of the western poplar clearwing moth (*Prionoxystus robinae*) in birches and willows in California. In these cases, the nematodes were mixed with water and pumped directly into the hole made by the borer, using either an oil-can applicator or a hand-operated plastic spray bottle. The nematodes can also be applied wit traditional spraying equipment.

Another *Steinernema* species has been found effective in controlling a borer of currants in Australia; when used in conjunction with one or more species of *Heterorhabditis*, it has also been successful in controlling a few soil-inhabiting insects. *Steinernema* and *Heterorhabditis* are effective against root weevils such as the black vine weevil (*Otiorhynchus sulcatus*) and the strawberry root weevil (*O. ovatus*). (For application procedures in containerized soil, see p. 395.) Commercial cranberry growers have controlled the strawberry root weevil in cranberry bogs through aerial applications of nematodes. In lawns, nematodes have controlled white grubs such as the Japanese beetle (see p. 538), other beetles, cutworms and mole crickets.

PHEROMONES AND OTHER SEMIOCHEMICALS

Various pheromone products have had a great impact on pest control to date and offer great promise for the future. Pheromones are chemicals s

creted and emitted by an organism that elicit responses in other individuals of the same species. The insect sex pheromones are the most widely known, probably because they have enjoyed good press and have captured the interest of the public. Large-scale detection programs for the gypsy moth that use sticky cardboard traps baited with their sex pheromones familiarized the public in many areas of the country with this new class of chemicals for manipulating pest populations.

There are other types of pheromones and related substances with potential for insect control. These include alarm pheromones, aggregation pheromones, food attractants, food stimulants and various repellents, deterrents and arrestants. In fact, pheromones are only one of at least three classes of chemicals called semiochemicals (see the sidebar at right) that are used by organisms to communicate with other species and the inanimate environment.

Awareness of the importance of semiochemicals is still relatively new, but research in this area may have a great impact on world affairs if it continues to grow and mature. After all, if human sex pheromones can influence human behavior just as insect sex pheromones affect insects—and there is now good evidence of this in humans as well as in other mammals --then a whole range of other classes of pheromones and semiochemicals may also be affecting humans without our being aware of it. This means that a whole new set of substances awaits discovery, industrial use and market exploitation.

Pheromones Used in Insect Control

The ability to synthesize insect pheromones in the laboratory has given rise to the seductive vision of total, species-specific pest control in a bottle. If we sound skeptical, it is not because we doubt the usefulness of these materials in pest control programs. It scarcely seems unwise to put too much faith in a chemical control that is used repeatedly and in isolation. The likelihood of insect resistance or tolerance is too great. It is obvious to us that the value of these materials is as a complement to programs that integrate many strategies to make the habitat less desirable for pests.

Mode of Action. Insects can communicate via chemical stimuli produced in their bodies and emitted into the air. They detect these compounds by way of their chemoreceptors which detect messenger compounds at extremely low concentrations. Once a chemical message is detected, it may trigger a specific behavior or development process. Most pheromones currently used in pest control are synthetic versions of natural insect chemical compounds, chiefly sex pheromones, aggregation pheromones or feeding attractants.

Formulations. Pheromones are used as lures to attract insects to traps or baits containing insecticides. The most commonly used pheromones are the attractant chemicals that one insect gender uses to attract the other. For example, a pheromone secreted by female moths is placed in a trap to capture males of the same species (or vice versa). The chemical attractant is usually impregnated into or enclosed within a rubber or plastic lure or hollow tube that slowly releases the pheromone over a period of days or weeks. Sometimes several pheromones are combined in the lure. The lures are then placed in cardboard or plastic traps (see the drawing on p. 144) that use an adhesive-coated surface or funnel-shaped entrance to capture the target insect.

Uses and Application. Pheromone traps are used to monitor for the presence of pests, as control tools to capture insects, as confusants to disrupt insect mating and as lures to attract insects to insecticidal baits. Currently, the most important use of pheromones is as detection and monitoring tools. They make it possible to look for pests with a "chemical searchlight" that points out where and when the pest is occurring so other measures can be brought to bear on the pest and its environment. An excellent example is the use of traps in cockroach management.

Cockroach traps, now a common product, were virtually unknown 20 years ago. These traps use a food attractant together with an adhesive inside a box or triangle-shaped cardboard container designed to be thrown away after it fills with cockroaches. (We discuss this tool further in Chapter 14 on cockroach management.) The trap tells you where the roaches are most concentrated and

Definitions of Various Classes of Chemical-Releasing Stimuli[a]

Semiochemical: A substance produced by an organism or inanimate object that elicits a response in another organism.

Pheromone: A substance produced by an organism that elicits a response in another individual of the same species.

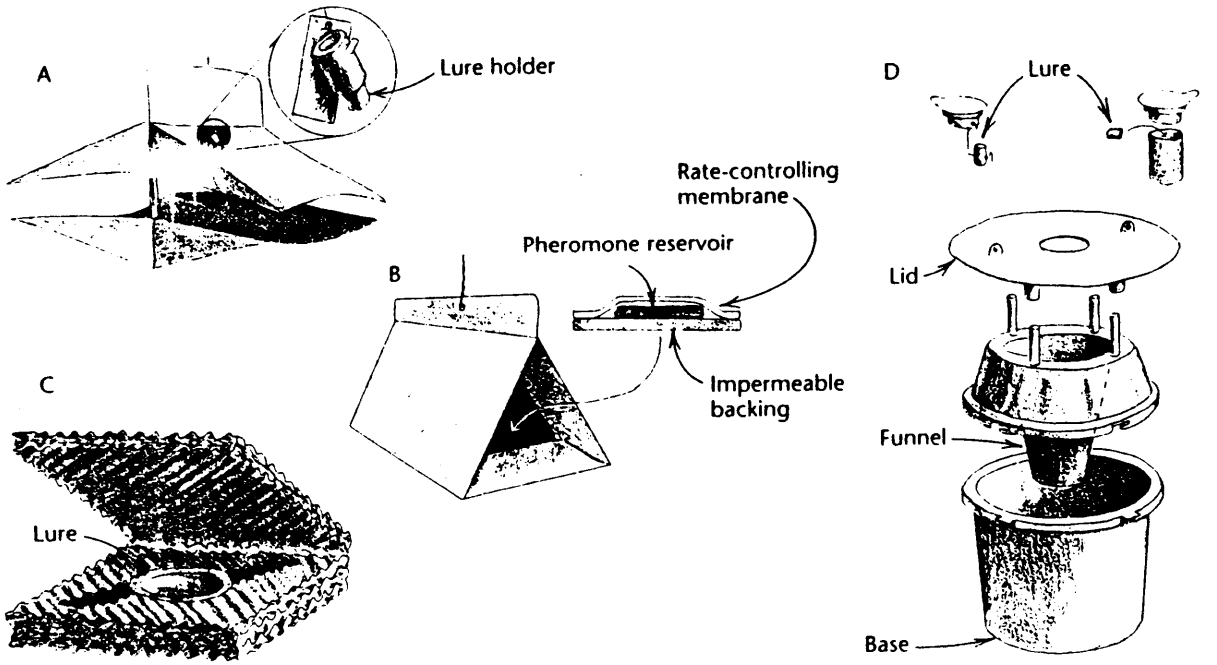
Allelochemic: A substance produced by an organism that elicits a response in an individual of a different species.

- **Allomone:** A type of allelochemic that favors the emitter over the receiver.
- **Kairomone:** A type of allelochemic that favors the receiver over the emitter.
- **Synomone:** A type of allelochemic that favors both emitter and receiver.

Apneumone: A substance produced by a nonliving thing that elicits a response from a living organism.

[a] From Nordlund, D. A., et al.,1981.

Pheromone Lures and Traps
Pheromones are impregnated in lures that slowly release the active ingredients over a period of days or weeks. Lures are placed in a variety of traps designed to attract specific groups of insects. Trap styles include wing traps (A), delta traps (B, which also shows a cross section of the Biolure™ pheromone dispenser), square cardboard traps (C) and funnel traps (D).

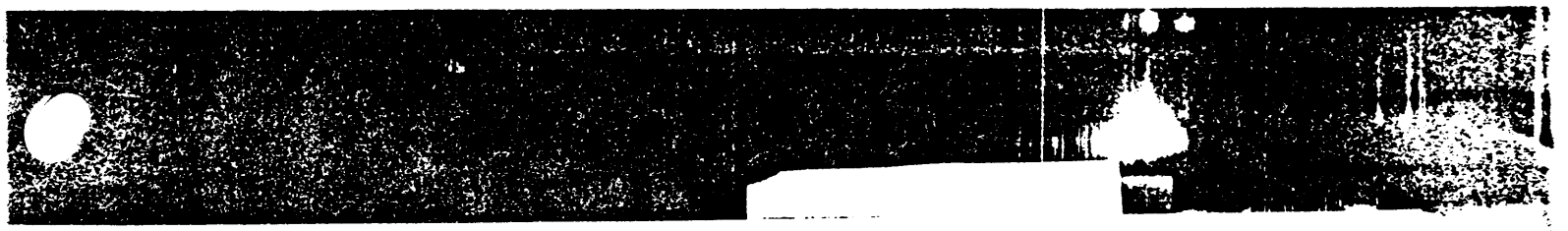


whether your control efforts are working or not. Despite advertisements that suggest differently, the traps are not a method of control. Certainly the roaches "check in but don't check out," but they don't all check in. Such traps have not been shown to be useful for control in field tests against large populations.

Different pheromone-baited traps also attract a large variety of other pest species indoors and in the garden. We mention these species in the appropriate sections of this book, including the discussions of stored-product pests in Chapter 14 and pests of lawns and ornamental plants in Part 8. But some general cautions about using pheromone-baited traps are in order here.

First, the synthesized materials are usually not perfect replicas of the natural product. Because the substances that insects and plants manufacture themselves are so complex, it is extremely difficult to copy them exactly. This means that the natural pheromones emitted by the living organism "out-compete" the human products in attractiveness to other members of the same species. The pulsed timing of the normal release and the need for a target with normal behaviors (a live partner) are also factors that make attractant traps less than effective in some species. Thus, what works on a very small scale, for example in one fruit tree in a back yard, may not necessarily be successful on a larger scale, such as in a suburban lot or small home orchard. In the latter situations, it may be difficult to provide an artificial scent in a trap that is as powerful as that emitted by live members of the same pest species.

Second, there is always the possibility that you will attract a pest into the area that was not already there, or attract it in greater numbers than would otherwise have been present. Thus, strategies have to be applied to limit drawing pests to an area, especially small-scale plantings. To do this, you must place the traps around the perimeter of the area being sampled, attaching the traps to plants that would not normally be attacked by the pest. For example, a codling-moth trap should be placed on a linden or elm tree, because these trees lack the fruit on which the moth normally lays its eggs. Apple or walnut trees, of which the moth is a pest, would be bad choices because traps set in them may attract more moth



than they can catch. In such cases, the traps would actually exacerbate the pest problem.

The important exception to the above is the use of pheromone confusant systems. These are hollow plastic fibers that contain a pheromone sex attractant distributed en masse over many acres, usually by aircraft. Results to date have been very promising in large-scale agriculture and forestry against the pink bollworm *(Pectinophora gossypiella)*, the tomato pinworm *(Keiferia lycopersicella)*, the artichoke plume moth *(Platyptilia carduidactyla)* and the western pine shoot borer *(Eucosma sonomana)*. The same approach has also been used against the gypsy moth *(Lymantria [=Porthetria] dispar)*.

A slightly different type of pheromone system combines an aggregation stimulant, or a bio-irritant, and a conventional pesticide. The irritant encourages the pest insect to travel farther; the insect is thereby exposed to higher dosages of the insecticide than it would be without the stimulant. This system has proven effective against the boll weevil *(Anthonomus grandis)* and two tobacco and cotton pests, *Heliothis virescens* and *H. zea*, which are also vegetable pests in home gardens. This approach offers the potential for the reduction of the amount of insecticide applied to various crops.

Although most pheromone trap systems have been developed for the larger agricultural pest control market, they may also find use in home gardens. But gardeners troubled with agricultural pest problems on a small scale will have to do their own experimentation. In Table 8.7 on p. 146, we provide a list of insects that are susceptible to pheromone attractants that are commercially available as we go to press. If you see your pest on this list, write to one of the producers of the substance that attracts the pest to see whether the product can be made available to you or a local distributor. Major pheromone producers [illegible] under "Insect Management: Identification and Monitoring" on pp. 681-682. These producers can also provide information about techniques for trap placement and frequency of trap replacement.

A few pheromones attract an entire insect family instead of just one species or a few members of a single genus. For example, the pheromone that attracts the ash borer *(Podosesia syringae)* also attracts other members of the same family, the Sesiidae (Lepidoptera). If your pest is not on the list but another pest in the same genus is, the pheromone that works against it may also work against your pest.

INSECT GROWTH REGULATORS

Insect growth regulators (IGRs) are the insect hormones (or their synthetic mimics) that govern an insect's maturation processes and other vital functions. IGRs are sometimes referred to as third-generation insecticides. The first generation consisted of stomach poisons such as arsenic compounds. The second generation included the commonly used organochlorines, organophosphates and carbamates. The third generation, the IGRs, are the newest compounds on the scene, and there are great hopes for this class of pesticide, with its promise of selectivity of target pests and safety to nontarget organisms.

Insects, like other animals, can be viewed as biochemical factories, with each of their various glands producing specific compounds. These compounds function in reproduction, coordination of the nervous system, tissue protection and repair, molting and metamorphosis. Insects, like many other forms of life, are biochemically similar to humans and other mammals in certain ways, but differ significantly in other ways. The search for less-toxic insecticides has focused on substances such as IGRs that affect biochemical processes unique to arthropods, so that the potential negative effects on humans and other mammals are minimized.

This motivation, coupled with adequate research support, has so far facilitated the exploitation of two classes of important insect hormones: ecdysone, which is responsible for insect molting, and juvenile hormones (JH) that prevent metamorphosis (the change from larva to adult). Scientists have mapped the biochemical pathways involved in their production and their impact on target tissues. Of the two, the juvenile hormones have received more commercial attention. The application of a natural JH and its synthetic mimics to juvenile insects in many orders arrests their development enough so that they cannot complete their life cycles and either die at an immature stage, or mature into sterile adults.

Formulations. Available IGRs are formulated as liquid concentrates or as aerosol sprays or foggers. The concentrates can be mixed and applied with standard spray equipment.

Safety. Because mammals do not molt or metamorphose as insects do, the chemical compounds in IGRs are unlikely to affect them. The LD_{50} of methoprene, the most widely used IGR, is greater than 34,000 mg/kg, indicating its wide margin of safety to humans and other mammals. In addition, the relatively narrow range of species affected by a given IGR results in low or zero toxicity to beneficial insects.

Uses. At least [illegible] IGRs have been registered: the JH analogs methoprene, hydroprene, kinoprene and fenoxycarb, and the chitin inhibitor diflubenzuron. Table 8.8 on p. 147 lists the targets affected by these IGRs. Other materials are under development, so additional products can be expected.

Methoprene. Methoprene impedes insect maturation, causing sterility and death before insects can mature. Thus, like most JHs, it is useful only on insects such as fleas that are pests when adults, but whose immature stages are not pestiferous. Metho-

Table 8.7
Insects Susceptible to Commercially Available Pheromones

Common Name	Scientific Name	Common Name	Scientific Name
Coleoptera		fall armyworm	*Spodoptera frugiperda*
boll weevil	*Anthonomus grandis*	false codling moth	*Argyroploce leucotreta*
Japanese beetle	*Popillia japonica*	filbert leafroller	*Archips rosana*
khapra beetle	*Trogoderma granarium*	filbert worm	*Melissopus latiferreanus*
smaller European elm bark beetle	*Scolytus multistriatus*	fruit tree leafroller	*Archips argyrospila*
		fruit tree tortrix	*A. podana*
spruce bark beetle	*Ips typographus*	grape berrymoth	*Endopiza viteana*
		greater peachtree borer	*Synanthedon exitiosa*
Diptera		gypsy moth	*Lymantria dispar*
apple maggot	*Rhagoletis pomonella*	Indianmeal moth	*Plodia interpunctella*
black cherry fruit fly	*R. fausta*	lesser appleworm	*Graphiolitha prunivora*
cherry fruit fly	*R. cingulata*	lesser peachtree borer	*Synanthedon pictipes*
Mediterranean fruit fly	*Ceratitis capitata*	lilac borer	*Podosesia syringae*
red plum maggot	*Grapholita funebrana*	Mediterranean flour moth	*Anagasta kuehniella*
tentiform leafminer	*Lithocolletis blancardella*	Nantucket pine tip moth	*Rhyacionia frustrana*
walnut husk fly	*R. completa*	navel orangeworm	*Amyelois transitella*
		oblique-banded leafroller	*Choristoneura rosaceana*
Homoptera		omnivorous leafroller	*Platynota stultana*
California red scale	*Aonidiella aurantii*	orange tortrix	*Argyrotaenia citrana*
citrus mealybug	*Planococcus citri*	oriental fruit moth	*Graphiolitha molesta*
comstock mealybug	*Pseudococcus comstocki*	peach twig borer	*Anarsia lineatella*
San Jose scale	*Quadraspidiotus perniciosus*	pink bollworm	*Pectinophora gossypoiella*
		plum fruit moth	*Cydia funebrana*
Lepidoptera		potato tubermoth	*Phthorimaea operculella*
alfalfa looper	*Autographa californica*	redbanded leafroller	*Argyrotaenia velutinana*
angoumois grain moth	*Sitrotroga cerealella*	rhododendron borer	*Synanthedon rhododendri*
artichoke plume moth	*Platyptilia carduidactyla*		
ash borer	*Podosesia syringae*	smaller tea tortrix	*Adoxophyes fasciata*
bagworm	*Thyridopteryx ephemeraeformis*	soybean looper	*Pseudoplusia includens*
		spiny rollworm	*Earias insulana*
beet armyworm	*Spodoptera exigua*	spotted tentiform leafminer	*Phyllonorycter blancardella*
black cutworm	*Agrotis ipsilon*		
bollworm/corn earworm	*Heliothis zea*	spruce budworm	*Choristoneura fumiferana*
		strawberry crown moth	*Synanthedon bibionipennis*
cabbage looper	*Trichoplusia ni*		
codling moth	*Cydia pomonella*	sugarcane borer	*Diatraea saccharalis*
common armyworm	*Pseudaletia unipuncta*	summer fruit tortrix	*Adoxophyes orana*
cranberry girdler	*Chrysoteuchia topiaria*	sunflower headmoth	*Homoeosoma electellum*
diamondback moth	*Plutella xylostella*	threelined leafroller	*Pandemis limitata*
dogwood borer	*Synanthedon scitula*	tobacco budworm	*Heliothis virescens*
Douglas-fir cone moth	*Barbara colfaxiana*	tomato pinworm	*Keiferia lycopersicella*
Egyptian cotton leafworm	*Spodoptera littoralis*	tufted apple budmoth	*Platynota idaeusalis*
European corn borer	*Ostrinia nubilalis*	variegated cutworm	*Peridroma saucia*
European grape vine moth	*Lobesia botrana*	variegated leafroller	*Platynota flavedana*
European pineshoot moth	*Rhyacionia buoliana*		

1 - PRODUCT IDENTIFICATION

PRODUCT NAME: POTASSIUM PERMANGANATE
FORMULA: KMNO4 FORMULA WT: 158.04
CAS NO.: 07722-64-7 NIOSH/RTECS NO.: SD6475000
COMMON SYNONYMS: PERMANGANIC ACID, POTASSIUM SALT
PRODUCT CODES: 3228,3227,3232
EFFECTIVE: 11/25/86 REVISION #03

PRECAUTIONARY LABELLING BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 2 MODERATE
FLAMMABILITY - 0 NONE
REACTIVITY - 3 SEVERE (OXIDIZER)
CONTACT - 2 MODERATE
HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT
SAFETY GLASSES; LAB COAT; VENT HOOD; PROPER GLOVES

PRECAUTIONARY LABEL STATEMENTS
DANGER CAUSES IRRITATION HARMFUL IF SWALLOWED OR INHALED
STRONG OXIDIZER - CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE
KEEP FROM CONTACT WITH CLOTHING AND OTHER COMBUSTIBLE MATERIALS.
DO NOT STORE NEAR COMBUSTIBLE MATERIALS.
KEEP IN TIGHTLY CLOSED CONTAINER.
WASH THOROUGHLY AFTER HANDLING. IN CASE OF FIRE, SOAK WITH WATER. IN CASE OF SPILL, SWEEP UP AND REMOVE. FLUSH SPILL AREA WITH WATER.
SAF-T-DATA(TM) STORAGE COLOR CODE: YELLOW (REACTIVE)

2 - HAZARDOUS COMPONENTS

COMPONENT	%	CAS NO.
POTASSIUM PERMANGANATE	90-100	7722-64-7

3 - PHYSICAL DATA

BOILING POINT: N/A VAPOR PRESSURE(MM HG): N/A

MELTING POINT: 150 C (302 F) DECOMPOSES VAPOR DENSITY(AIR=1): 5.40

SPECIFIC GRAVITY: 2.70 (H2O=1) EVAPORATION RATE: N/A (BUTYL ACETATE=1)

SOLUBILITY(H2O): MODERATE (1 TO 10 %) % VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: DARK PURPLE TO BRONZE CRYSTALS WITH NO ODOR.

4 - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (CLOSED CUP N/A NFPA 704M RATING: 1-0-0 OXY
FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA: USE WATER SPRAY.

SPECIAL FIRE-FIGHTING PROCEDURES
FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

UNUSUAL FIRE & EXPLOSION HAZARDS
STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE.

5 - HEALTH HAZARD DATA

PEL AND TEL VALUES ARE LISTED FOR MANGANESE.

THRESHOLD LIMIT VALUE (TLV/TWA): 5 MG/M3 (PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 5 MG/M3 (PPM)

TOXICITY: LD50 (ORAL-RAT)(MG/KG) - 1090
LD50 (SCU-MOUSE)(MG/KG) - 500

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE
EXCESSIVE INHALATION OF DUST IS IRRITATING AND MAY BE SEVERELY DAMAGING TO RESPIRATORY PASSAGES AND/OR LUNGS.
CONTACT WITH SKIN OR EYES MAY CAUSE SEVERE IRRITATION OR BURNS.
SUBSTANCE IS READILY ABSORBED THROUGH THE SKIN.
INGESTION MAY CAUSE NAUSEA, VOMITING, GASTROINTESTINAL IRRITATION, AND BURNS TO MOUTH AND THROAT.
PROLONGED INHALATION OF MANGANESE IN THE FORM OF ITS INORGANIC COMPOUNDS MAY CAUSE MANGANISM.

TARGET ORGANS: RESPIRATORY SYSTEM, CENTRAL NERVOUS SYSTEM, BLOOD, KIDNEYS

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: DAMAGED SKIN

ROUTES OF ENTRY: INGESTION, INHALATION

EMERGENCY AND FIRST AID PROCEDURES
CALL A PHYSICIAN.

IF SWALLOWED, DO NOT INDUCE VOMITING; IF CONSCIOUS, GIVE LARGE AMOUNTS OF WATER. FOLLOW WITH DILUTED VINEGAR, FRUIT JUICE OR WHITES OF EGGS, BEATEN WITH WATER.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES.

PEL AND TLV LISTED DENOTE CEILING LIMIT.

6 - REACTIVITY DATA

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT

INCOMPATIBLES: ORGANIC MATERIALS, COMBUSTIBLE MATERIALS, STRONG REDUCING AGENTS, STRONG ACIDS, PEROXIDES, ALCOHOLS, CHEMICALLY ACTIVE METALS

7 - SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING.

KEEP COMBUSTIBLES (WOOD, PAPER, OIL, ETC.) AWAY FROM SPILLED MATERIAL. WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

EPA HAZARDOUS WASTE NUMBER: D001 (IGNITABLE WASTE)

8 - PROTECTIVE EQUIPMENT

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION

RESPIRATORY PROTECTION: NONE REQUIRED WHERE ADEQUATE VENTILATION CONDITIONS EXIST. IF AIRBORNE CONCENTRATION EXCEEDS TLV, A DUST/MIST RESPIRATOR IS RECOMMENDED. IF CONCENTRATION EXCEEDS CAPACITY OF RESPIRATOR, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, UNIFORM, BUTYL RUBBER GLOVES ARE RECOMMENDED.

9 - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA(TM) STORAGE COLOR CODE: YELLOW (REACTIVE)

SPECIAL PRECAUTIONS
KEEP CONTAINER TIGHTLY CLOSED. STORE SEPARATELY AND AWAY FROM FLAMMABLE AND COMBUSTIBLE MATERIALS.

10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME POTASSIUM PERMANGANATE
HAZARD CLASS OXIDIZER
UN/NA UN1490
LABELS OXIDIZER
REPORTABLE QUANTITY 100 LBS.

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME POTASSIUM PERMANGANATE
HAZARD CLASS 5.1
UN/NA UN1490
LABELS OXIDIZING AGENT