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BATES SOLAR INDUSTRIAL- PROCESS-HEAT APPLICATION

ENVIRONMENTAL-IMPACT ASSESSMENT

DOE CONTRACT NO.

DE-FC03-79CS30312

(UNCLASSIFIED)

SUBMITTED TO: UNITED STATES
DEPARTMENT OF ENERGY/SAN

BY: BATES CONTAINER, INC.
6433 DAVIS BLVD.
FORT WORTH, TEXAS 76180

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BDM/A--80-025-TR

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BATES SOLAR INDUSTRIAL PROCESS
STEAM APPLICATION
ENVIRONMENTAL IMPACT ASSESSMENT

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FOREWORD

This document, Bates Solar Industrial Process Steam Application Environmental Impact Assessment (BDM/A-80-025-TR) is submitted by The BDM Corporation, 1801 Randolph Rd. S.D., Albuquerque, New Mexico 87106. It is prepared for the Department of Energy (DOE), San Francisco, California.

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CHAPTER I INTRODUCTION

Bates Container, Inc. and its prime subcontractor, The BDM Corporation, have been awarded a contract by the Department of Energy, San Francisco Operations Office in the Agricultural and Industrial Process Heat Division, to design a solar industrial process heat system. Bates is a corrugated box manufacturer which has designed and is proposing to install 34,440 square feet of linear parabolic trough solar collectors at its new corrugator plant. The parabolic collectors will generate the thermal energy required (approximately 5,500 lbs/hr of steam) to supply the corrugator. The solar system will satisfy the average daily demand of the corrugator and will operate in parallel with the fossil fuel boiler which will supply supplemental steam when necessary. A schematic of the system is presented in figure I-1.

This environmental assessment has been completed as required by the Statement of Work for Phase I of the Bates Solar Industrial Process Heat (SIPH) Project. The purpose of this assessment was to investigate the impacts of the solar energy system on the existing environment and to determine whether or not a more detailed environmental impact statement is needed.

The environmental assessment of the Bates SIPH system is based on actual operational data obtained on the collector, fluid, and heat transport system and on Department of Energy test data contained in Hazardous Properties and Environmental Effects of Materials Used in Solar Heating and Cooling (SHAC) Technologies: Interim Handbook, U.S. Department of Energy, Washington D.C. DOE/EV-0028. The actual operational data on the system were collected by the BDM Corporation, which maintains a solar test facility (STF) at its Albuquerque office. The collector, fluid, and heat transport system have undergone 1 year of testing at the BDM STF.

A description of the design of the solar energy system and its application is contained in the following sections. Also included is a discussion of the location of the new plant in Fort Worth, Texas, and of its surrounding environment. Impacts on the environment are discussed in detail, and alternatives to the solar industrial process steam retrofit application are offered.

Figure I-1. Schematic of Bates Solar Industrial Process Steam System

CHAPTER II

APPLICATION DESCRIPTION

Bates Container, Inc. is a rapidly growing organization involved in the production of cardboard containers. The current Bates facility, shown in figure II-1, is located in North Richland Hills, an industrial suburb of Fort Worth, Texas. Bates has expanded their facilities to include a cardboard corrugation fabrication facility to supply the cardboard stock required for the manufacture of the various containers which they produce. Previously the raw stock was purchased from outside suppliers. Construction of the corrugation facility is complete and the corrugation assembly has been purchased. The corrugator facility began operation in late 1980.

Bates is considering a solar industrial process steam retrofit application for several reasons. The location in Ft. Worth, Texas, places the corrugation facility within the sunbelt and provides a very high level of direct normal solar radiation. The positive matchup between the workload and the available solar energy is ideal for solar power applications. Also, positive correlation between energy demand and solar availability has eliminated the requirement for thermal energy storage in conjunction with the solar energy system. With the increasing costs and future uncertainties of fossil fuels, solar energy may prove itself more economic.

Figure II-1. Aerial View of Bates Container, Incorporated Plant

CHAPTER III

SOLAR SYSTEM DESCRIPTION

The solar energy system uses linear parabolic trough (LPT) concentrators to provide thermal energy to a nonfired steam generating unit which produces the requisite steam for the corrugator. This steam will be provided in parallel with the fossil fuel boiler which will provide supplementary steam when necessary. The LPT is the T-700 (fabricated by Solar Kinetics, Inc., of Dallas, Texas) with a 7-foot aperture. The collector array will be located on available land south of the Bates Facility. The design incorporates a total of 34,440 square feet of aperture in one array directly to the south of the new building, as shown in figure III-1. With the available insolation in the Dallas/Ft. Worth area, this size array will produce the hourly requisite 5,500 pounds of steam.

The solar collector system has been designed to withstand the extremes of weather in the Ft. Worth area and to comply with the Dallas Ft. Worth Building Code. The following design criteria were used:

- (1) 25 PSF wind load (100 MPH, survival condition from building code with collector stowed)
- (2) 40 MPH wind (Operational condition with collector in any attitude)
- (3) Structure Weight Loads (Collector system plus support structure)
- (4) 0 to 100°F Temperature Conditions

Figure III-1. Location of Bates Solar Project Collector Arrays

CHAPTER IV

LOCATION OF THE PROPOSED PROJECT

The existing Bates plant is located on State Highway 1938 in North Richland Hills, Texas, about 15 miles northeast of downtown Ft. Worth. The exact address is 6433 Davis Blvd., Ft. Worth, Texas 76180.

The present factory, warehouse, and office facility are located on the north end of the property. They are bounded on the north by the Southwestern Railroad track, on the west by a railroad siding, and on the east by Davis Blvd. The new 167 feet X 455 feet corrugator facility was built south of the present factory. The railroad siding will extend inside the new facility to aid in the transportation of the cardboard product.

Figure IV-1 is a zoning map provided by the city of North Richland Hills which indicates the zoning around the Bates Container plant. As can be seen from the zoning map, no conflicting land use is present. The land where the corrugation facility is being built is zoned for industrial use. Its neighboring industry to the west is a lumber company. The south side of the facility will be next to residential and local retail-zoned property. Across Davis Blvd. to the east, the land is zoned for commercial and neighborhood retail. Residential homes and schools, both elementary and junior high, are within a mile radius of the Bates facility. Less than a mile to the southwest of the Bates property is the Fort Worth Christian College. The Mangham Airport is located about a mile southeast of Bates. Figure IV-2 is a street map showing major facilities in the surrounding area, schools, colleges, and retail areas.

Figure IV-1. North Richland Hills Zoning Map

1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9	14.0	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	15.0	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	16.0	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7	17.8	17.9	18.0	18.1	18.2	18.3	18.4	18.5	18.6	18.7	18.8	18.9	19.0	19.1	19.2	19.3	19.4	19.5	19.6	19.7	19.8	19.9	20.0	20.1	20.2	20.3	20.4	20.5	20.6	20.7	20.8	20.9	21.0	21.1	21.2	21.3	21.4	21.5	21.6	21.7	21.8	21.9	22.0	22.1	22.2	22.3	22.4	22.5	22.6	22.7	22.8	22.9	23.0	23.1	23.2	23.3	23.4	23.5	23.6	23.7	23.8	23.9	24.0	24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.8	24.9	25.0	25.1	25.2	25.3	25.4	25.5	25.6	25.7	25.8	25.9	26.0	26.1	26.2	26.3	26.4	26.5	26.6	26.7	26.8	26.9	27.0	27.1	27.2	27.3	27.4	27.5	27.6	27.7	27.8	27.9	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	28.9	29.0	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	29.9	30.0	30.1	30.2	30.3	30.4	30.5	30.6	30.7	30.8	30.9	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.8	31.9	32.0	32.1	32.2	32.3	32.4	32.5	32.6	32.7	32.8	32.9	33.0	33.1	33.2	33.3	33.4	33.5	33.6	33.7	33.8	33.9	34.0	34.1	34.2	34.3	34.4	34.5	34.6	34.7	34.8	34.9	35.0	35.1	35.2	35.3	35.4	35.5	35.6	35.7	35.8	35.9	36.0	36.1	36.2	36.3	36.4	36.5	36.6	36.7	36.8	36.9	37.0	37.1	37.2	37.3	37.4	37.5	37.6	37.7	37.8	37.9	38.0	38.1	38.2	38.3	38.4	38.5	38.6	38.7	38.8	38.9	39.0	39.1	39.2	39.3	39.4	39.5	39.6	39.7	39.8	39.9	40.0	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	41.0	41.1	41.2	41.3	41.4	41.5	41.6	41.7	41.8	41.9	42.0	42.1	42.2	42.3	42.4	42.5	42.6	42.7	42.8	42.9	43.0	43.1	43.2	43.3	43.4	43.5	43.6	43.7	43.8	43.9	44.0	44.1	44.2	44.3	44.4	44.5	44.6	44.7	44.8	44.9	45.0	45.1	45.2	45.3	45.4	45.5	45.6	45.7	45.8	45.9	46.0	46.1	46.2	46.3	46.4	46.5	46.6	46.7	46.8	46.9	47.0	47.1	47.2	47.3	47.4	47.5	47.6	47.7	47.8	47.9	48.0	48.1	48.2	48.3	48.4	48.5	48.6	48.7	48.8	48.9	49.0	49.1	49.2	49.3	49.4	49.5	49.6	49.7	49.8	49.9	50.0	50.1	50.2	50.3	50.4	50.5	50.6	50.7	50.8	50.9	51.0	51.1	51.2	51.3	51.4	51.5	51.6	51.7	51.8	51.9	52.0	52.1	52.2	52.3	52.4	52.5	52.6	52.7	52.8	52.9	53.0	53.1	53.2	53.3	53.4	53.5	53.6	53.7	53.8	53.9	54.0	54.1	54.2	54.3	54.4	54.5	54.6	54.7	54.8	54.9	55.0	55.1	55.2	55.3	55.4	55.5	55.6	55.7	55.8	55.9	56.0	56.1	56.2	56.3	56.4	56.5	56.6	56.7	56.8	56.9	57.0	57.1	57.2	57.3	57.4	57.5	57.6	57.7	57.8	57.9	58.0	58.1	58.2	58.3	58.4	58.5	58.6	58.7	58.8	58.9	59.0	59.1	59.2	59.3	59.4	59.5	59.6	59.7	59.8	59.9	60.0	60.1	60.2	60.3	60.4	60.5	60.6	60.7	60.8	60.9	61.0	61.1	61.2	61.3	61.4	61.5	61.6	61.7	61.8	61.9	62.0	62.1	62.2	62.3	62.4	62.5	62.6	62.7	62.8	62.9	63.0	63.1	63.2	63.3	63.4	63.5	63.6	63.7	63.8	63.9	64.0	64.1	64.2	64.3	64.4	64.5	64.6	64.7	64.8	64.9	65.0	65.1	65.2	65.3	65.4	65.5	65.6	65.7	65.8	65.9	66.0	66.1	66.2	66.3	66.4	66.5	66.6	66.7	66.8	66.9	67.0	67.1	67.2	67.3	67.4	67.5	67.6	67.7	67.8	67.9	68.0	68.1	68.2	68.3	68.4	68.5	68.6	68.7	68.8	68.9	69.0	69.1	69.2	69.3	69.4	69.5	69.6	69.7	69.8	69.9	70.0	70.1	70.2	70.3	70.4	70.5	70.6	70.7	70.8	70.9	71.0	71.1	71.2	71.3	71.4	71.5	71.6	71.7	71.8	71.9	72.0	72.1	72.2	72.3	72.4	72.5	72.6	72.7	72.8	72.9	73.0	73.1	73.2	73.3	73.4	73.5	73.6	73.7	73.8	73.9	74.0	74.1	74.2	74.3	74.4	74.5	74.6	74.7	74.8	74.9	75.0	75.1	75.2	75.3	75.4	75.5	75.6	75.7	75.8	75.9	76.0	76.1	76.2	76.3	76.4	76.5	76.6	76.7	76.8	76.9	77.0	77.1	77.2	77.3	77.4	77.5	77.6	77.7	77.8	77.9	78.0	78.1	78.2	78.3	78.4	78.5	78.6	78.7	78.8	78.9	79.0	79.1	79.2	79.3	79.4	79.5	79.6	79.7	79.8	79.9	80.0	80.1	80.2	80.3	80.4	80.5	80.6	80.7	80.8	80.9	81.0	81.1	81.2	81.3	81.4	81.5	81.6	81.7	81.8	81.9	82.0	82.1	82.2	82.3	82.4	82.5	82.6	82.7	82.8	82.9	83.0	83.1	83.2	83.3	83.4	83.5	83.6	83.7	83.8	83.9	84.0	84.1	84.2	84.3	84.4	84.5	84.6	84.7	84.8	84.9	85.0	85.1	85.2	85.3	85.4	85.5	85.6	85.7	85.8	85.9	86.0	86.1	86.2	86.3	86.4	86.5	86.6	86.7	86.8	86.9	87.0	87.1	87.2	87.3	87.4	87.5	87.6	87.7	87.8	87.9	88.0	88.1	88.2	88.3	88.4	88.5	88.6	88.7	88.8	88.9	89.0	89.1	89.2	89.3	89.4	89.5	89.6	89.7	89.8	89.9	90.0	90.1	90.2	90.3	90.4	90.5	90.6	90.7	90.8	90.9	91.0	91.1	91.2	91.3	91.4	91.5	91.6	91.7	91.8	91.9	92.0	92.1	92.2	92.3	92.4	92.5	92.6	92.7	92.8	92.9	93.0	93.1	93.2	93.3	93.4	93.5	93.6	93.7	93.8	93.9	94.0	94.1	94.2	94.3	94.4	94.5	94.6	94.7	94.8	94.9	95.0	95.1	95.2	95.3	95.4	95.5	95.6	95.7	95.8	95.9	96.0	96.1	96.2	96.3	96.4	96.5	96.6	96.7	96.8	96.9	97.0	97.1	97.2	97.3	97.4	97.5	97.6	97.7	97.8	97.9	98.0	98.1	98.2	98.3	98.4	98.5	98.6	98.7	98.8	98.9	99.0	99.1	99.2	99.3	99.4	99.5	99.6	99.7	99.8	99.9	100.0	100.1	100.2	100.3	100.4	100.5	100.6	100.7	100.8	100.9	101.0	101.1	101.2	101.3	101.4	101.5	101.6	101.7	101.8	101.9	102.0	102.1	102.2	102.3	102.4	102.5	102.6	102.7	102.8	102.9	103.0	103.1	103.2	103.3	103.4	103.5	103.6	103.7	103.8	103.9	104.0	104.1	104.2	104.3	104.4	104.5	104.6	104.7	104.8	104.9	105.0	105.1	105.2	105.3	105.4	105.5	105.6	105.7	105.8	105.9	106.0	106.1	106.2	106.3	106.4	106.5	106.6	106.7	106.8	106.9	107.0	107.1	107.2	107.3	107.4	107.5	107.6	107.7	107.8	107.9	108.0	108.1	108.2	108.3	108.4	108.5	108.6	108.7	108.8	108.9	109.0	109.1	109.2	109.3	109.4	109.5	109.6	109.7	109.8	109.9	110.0	110.1	110.2	110.3	110.4	110.5	110.6	110.7	110.8	110.9	111.0	111.1	111.2	111.3	111.4	111.5	111.6	111.7	111.8	111.9	112.0	112.1	112.2	112.3	112.4	112.5	112.6	112.7	112.8	112.9	113.0	113.1	113.2	113.3	113.4	113.5	113.6	113.7	113.8	113.9	114.0	114.1	114.2	114.3	114.4	114.5	114.6	114.7	114.8	114.9	115.0	115.1	115.2	115.3	115.4	115.5	115.6	115.7	115.8	115.9	116.0	116.1	116.2	116.3	116.4	116.5	116.6	116.7	116.8	116.9	117.0	117.1	117.2	117.3	117.4	117.5	117.6	117.7	117.8	117.9	118.0	118.1	118.2	118.3	118.4	118.5	118.6	118.7	118.8	118.9	119.0	119.1	119.2	119.3	119.4	119.5	119.6	119.7	119.8	119.9	120.0	120.1	120.2	120.3	120.4	120.5	120.6	120.7	120.8	120.9	121.0	121.1	121.2	121.3	121.4	121.5	121.6	121.7	121.8	121.9	122.0	122.1	122.2	122.3	122.4	122.5	122.6	122.7	122.8	122.9	123.0	123.1	123.2	123.3	123.4	123.5	123.6	123.7	123.8	123.9	124.0	124.1	124.2	124.3	124.4	124.5	124.6	124.7	124.8	124.9	125.0	125.1	125.2	125.3	125.4	125.5	125.6	125.7	125.8	125.9	126.0	126.1	126.2	126.3	126.4	126.5	126.6	126.7	126.8	126.9	127.0	127.1	127.2	127.3	127.4	127.5	127.6	127.7	127.8	127.9	128.0	128.1	128.2	128.3	128.4	128.5	128.6	128.7	128.8	128.9	129.0	129.1	129.2	129.3	129.4	129.5	129.6	129.7	129.8	129.9	130.0	130.1	130.2	130.3	130.4	130.5	130.6	130.7	130.8	130.9	131.0	131.1	131.2	131.3	131.4	131.5	131.6	131.7	131.8	131.9	132.0	132.1	132.2	132.3	132.4	132.5	132.6	132.7	132.8	132.9	133.0	133.1	133.2	133.3	133.4	133.5	133.6	133.7	133.8	133.9	134.0	134.1	134.2	134.3	134.4	134.5	134.6	134.7	134.8	134.9	135.0	135.1	135.2	1
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CHAPTER V

EXISTING ENVIRONMENT

A. GENERAL

The location of Bates Container, Inc. in Fort Worth, Texas has the advantage of the excellent solar environment typical of southwestern United States. Fort Worth is located in north-central Texas about 250 miles north of the Gulf of Mexico near the boundary between two major climatic zones. The western climate is a semi-arid steppe, and the eastern climate is warm, temperate, with rainy winters and hot, dry summers. The mean afternoon high temperatures vary from about 55°F in midwinter to about 93°F in midsummer. During the winter, occasional days are encountered when the temperature remains below freezing all day. The annual minimum temperatures encountered are in the range 15° to 20°F. Summer temperatures as high as 110°F are rare. Ft. Worth has 2405 heating degree days per year.

Throughout the year, rainfall occurs more frequently during the night. Usually periods of rainy weather last for only a day or two, and are followed by several days with fair skies. A large part of the annual precipitation averaging 32 inches results from thunderstorm activity, with occasional heavy rainfall over brief periods. Greatest amounts of rain occur during the months of April and May. Hail falls on about two or three days a year, ordinarily with only slight damage. Snowfall is rare, with a measurable fall occurring only once in an average year.

Relatively severe weather is a part of the Fort Worth climate. Thunderstorms occur commonly from April through October, with peak activity in May. Convective thunderstorms are likely to occur in the afternoon and early evening during this time; the remainder are associated with frontal systems. Tornadoes are not uncommon in Texas and are accepted as a normal environmental hazard. Most tornadoes occur in April, May, and June during the warm hours of the day. Hurricanes are very rare in Fort Worth. Prevailing winds are strong (10-20 mph) but high winds (40 mph) are unusual.

B. EXISTING ENVIRONMENT

The site of the Bates Container plant lies within the transition zone between the Blackland Prairie and the Eastern Cross Timbers Region that runs roughly in a north-south direction through the Dallas-Fort Worth area. The terrain can be characterized as being slightly rolling with steeper topography immediately adjacent to the upper reaches of the streams which drain the area and giving way to alluvial plains in low-lying areas near the Trinity River.

1. Vegetation

The Eastern Cross Timbers Region is on the Woodbine Formation and is characterized by slightly rolling terrain and sandy soils, with forests of scrub oak and hickory. The dominant vegetation is little bluestem grass, blackjack oak, and post oak. The Eastern Cross Timbers extend southward from the Red River through eastern Denton County and along the Dallas-Tarrant County boundary, thence spottily through Johnson County into Hill County. Due primarily to agricultural development over the years, this natural forest ecology is only sparsely in evidence today.

The Blackland Prairie is an almost treeless area comprising 11,500,000 acres of East Central Texas extending southwesterly from the Red River to Bexar County. The area is underlain primarily by the Eagle Ford Formation with soil of the Houston Black, Houston, and Austin series with smaller areas of Bell, Lewisville, Sumter, and Eddy soils. The native vegetation consists of bunch and short grasses. The main species are little and big bluestem, grama, Indian, buffalo, and three-awn grasses. In places, scattered mesquite trees, cacti, and small shrubs form a thick cover. Hackberry, pecan, and elm occur in stream bottoms. Again, the natural vegetation of this region has been substantially altered by the presence of agricultural production and urbanization.

2. Wildlife

As in most developing urban areas, wildlife is limited to smaller species which can adapt to man's encroachments. Mourning doves, squirrels, bobwhites, cottontails, opossums, skunks, beaver, armadillos,

raccoon, and a sparse population of white-tailed deer reside in the less developed areas. Waterfowl such as the green-winged teal, mallard, scaup, and coot frequent the periodically flooded areas and widened portions of streams in the area. Numerous birds such as red-tailed hawk, marsh hawk, American kestrel, redwing blackbird, starling, crow, grackle, killdeer, robin, junco, goldfinch, bluejay, cardinal, and a variety of sparrows occur in the area.

3. Fisheries

The intermittent nature of streams in the area limit fish and aquatic life. A moderate population of fish, such as minnows, including carp, exist in reaches of the streams. A low population of game fish such as largemouth bass and channel catfish may occupy the deeper pools.

4. Threatened or Endangered Species

There are no threatened or endangered species in the area.

C. ARCHAEOLOGIC/HISTORIC SITES

No archaeologic or historic sites were uncovered during excavations for the present facilities. No evidence of archaeologic materials was found when test borings were made in the area of the proposed solar collector field.

CHAPTER VI

ENVIRONMENTAL IMPACTS

A. INTRODUCTION

There are several potential impacts predicted on the environment, the neighboring community, and the employees of the plant by the proposed solar energy system. Although they are not drastic effects, they have been considered and are discussed. These potential impacts on the environment include solar collector glare, employee contact and disposal of the heat transfer fluid, and the aesthetic appearance of the array.

These potential impacts are summarized in table VI-1. The environmental impacts of each subsystem will be discussed in this section.

B. COLLECTOR/RECEIVER SUBSYSTEM

Concentrating solar collector systems are often perceived to have the potential for creating both hazardous and nuisance reflection exposure to workers, visitors, and/or people in the neighborhood of the systems. Possible hazards include both direct exposure of people and secondary effects such as creating fires or hot surfaces. In addition, concentrated or reflected sunlight may affect pilots, automobile drivers, and neighbors to the extent that accidents might occur. These problems are not expected to occur as a result of the Bates SIPH system.

The collector proposed for the Bates plant is the SKI T-700 parabolic trough concentrating solar collector. The parabolic collector is constructed of aluminum components using a monocoque design with an aircraft-grade aluminum skin stretched over precision-machined, cast aluminum bulkheads. A picture of the T-700 located the BDM Solar Test Facility is shown in figure VI-1. The T-700 LPT collects all direct normal radiation and focuses it on the receiver tube. This collector has a focal length of 22.4 inches, and there are no reflection hazards beyond

TABLE VI-1. MAJOR ENVIRONMENTAL IMPACTS SUMMARY

<u>SUBSYSTEM</u>	<u>COMPONENTS</u>	<u>IMPACTS</u>	<u>RATING</u>	<u>ASSESSMENT</u>
COLLECTOR/RECEIVER	7 FT APERTURE ALUMINUM LPT BLACK CHROME STEEL RECEIVER TUBE	GLARE AESTHETICS	MINOR ADVERSE MINOR BENEFICIAL	FOCUSED ON RECEIVER CLEAN DESIGN
COLLECTOR MOUNTING STRUCTURE	OPEN WEB - STEEL JOISTS	AESTHETICS LAND USE	MINOR BENEFICIAL MINOR BENEFICIAL	ROOF-MOUNTED INTEGRAL WITH EXISTING STRUCTURE - COMPLIES WITH DFW BUILD- ING CODE
COLLECTOR WASH WATER AND DETERGENT	NON-IONIC BIODEGRADABLE SURFACTANT	WATER QUALITY	MINOR ADVERSE	GENTLE, BIODEGRADABLE
FLUID/HEAT TRANSPORT	MEDIUM - THERMINOL-60	TOXICITY/ DISPOSAL	MINOR ADVERSE	EXCELLENT PROPERTIES, RELATIVELY NONTOXIC, BIODEGRADABLE EXISTING DISPOSAL METHODS RESISTANT TO LEAKS
	PIPE - MILD STEEL - WELDED JOINTS	CONTAINMENT	MINOR BENEFICIAL	NONWICKING, NONTOXIC
	INSULATION - FIBERGLASS AND CERAMIC FIBER PUMPS AND VALVES	WICKING FLUID SPILLS	MINOR ADVERSE MINOR ADVERSE	CONTROL AND ISOLATION OF INDIVIDUAL COLLECTORS
STEAM GENERATION	NONFIRED BOILER, HEAT EXCHANGER	NONE	N/A	NO IMPACT
MASTER CONTROL	ELECTRICAL CONTROLS AND MONITORING EQUIPMENT	NONE	N/A	NO IMPACT
SOCIO-ECONOMIC	PLANT EMPLOYEES	VARYING WORKING HOURS	MINOR BENEFICIAL	SCHEDULE SHIFTS AROUND SOLAR NOON, 6 DAY WORK WEEK
	LOCATION	LAND USE	MINOR BENEFICIAL	COMPATIBLE LAND USE ZONING

Figure VI-1. T-700 LPT at the BDM STF

the focal point. Diffuse sunlight is reflected but poses no hazard. The back of the collectors are nonreflective.

As in any environment, fire would not be a desirable occurrence. The actions that have been described in the Safety Analysis include the use of ultraviolet fire sensors and dry chemical extinguishment apparatus. These should provide adequate protection. The situation of the solar array in an industrial area rather than in a wooded or undeveloped area implies negligible impact on the existing environment.

Glare from a malfunctioning array or side glare along the long axis will pose a low hazard. Studies of the health and safety hazards associated with solar concentrating systems performed by Sandia Laboratories have shown that "we are reasonably able to predict the thermal chorio-retinal maximum permissible exposure levels from a single source solar spectrum radiation. These calculations provide information strongly suggesting that in many cases, exposure of personnel who are not near the focus and or alignment point for blink-response exposures present a low hazard for biological damage in most cases no worse than direct viewing of the sun."¹

Observation experiments of the reflectivity of the SKI collectors currently in place at the BDM Solar Test Facility have been conducted to assess reflection hazards. The BDM STF is located on a major trafficway and within a quarter mile of the Albuquerque International Airport. No adverse effects have been caused to pilots or drivers due to collector glare. The FAA was consulted on the placement of approximately 6000 square feet of aperture of linear parabolic troughs in the roof of the BDM/TAC office building in Albuquerque and no objections were voiced. If the decision is made to proceed with phase II construction of the Bates SIPH system, the FAA regional office in Dallas will be contacted to review the system. Figure VI-2 shows the SKI collector in tracking mode

¹Lawrence L. Young III, "Health and Safety Hazards Associated with Solar Concentrating Systems". Solar Energy Vol. 22, p. 329-333.

Figure VI-2. Reflection Observation (Collectors in Operation - Pointed at Observer at 160 Yds.)

facing the observer. The observation experiments resulted in the conclusion that there are no reflection hazards beyond the focal point of the collector.

The manufacturer's recommended cleaning procedures will be used to clean the collector mirror surfaces. SKI recommends the use of de-ionized water and a non-ionic, biodegradable surfactant as a detergent (Turgitol-15-5-9 Union Carbide, or Triton Series, Rohm Hass). The detergent is biodegradable, non-corrosive with a neutral pH and is the most gentle which can be used. Collector wash water will be disposed of as normal run-off.

C. COLLECTOR MOUNTING LOCATION

The assessment of the impact of a ground mounted collector system considers effects on land use, soils, topography, flora and fauna. The use of land for an industrial energy generation purpose, especially in a solar application with its silent and clean, nonpolluting operation is consistent with zoning of the land as an industrial area and represents no impact. No changes of the local topography are associated with the installation of the solar system. In the southwest area of the Bates facility, land has been previously cleared as part of the Bates facility expansion and access road construction. A slight slope as well as drainage channels to facilitate drainage will be provided at the collector site. Soils in the region are extremely clayey even at the surface so that clearing activity that has been mentioned above in the southwest area, has resulted in a very flat, hard surface that may be subject to dust and erosion. Bates' original plan was to plant grass in all unpaved areas. With the installation of a solar system, all areas around and under the mirror arrays will have a ground cover and gravel surfacing with drainage to hold down dust and eliminate erosion.

The solar system will affect the native vegetation consistent with the zoning and present use of the area for industrial activity.

D. FLUID HEAT TRANSPORT SUBSYSTEM

1. Introduction

The primary environmental concerns occur in examining the properties of the heat transfer fluid and the heat transport subsystem. The toxicity of the fluid and fluid vapors at ambient or elevated temperatures, the potential damage caused by leaks or fluid spills to the environment, and methods of disposing of fluid and solid wastes are key concerns.

The thermal working fluid selected to be circulated through the solar system is Therminol-60, made by the Monsanto Chemical Company. Reasons for its selection are its low cost, excellent fluidic properties, and chemical stability in the operating range of -60 to 600°F. This is partly because it is a synthetic product so that its chemical composition is more controllable than crude oil cuts. The operating temperature for the Bates SIPH is 500°F, well within the range of the fluid. A complete description of the properties of Therminol-66 taken from the manufacturers literature is provided below.

In the DOE Hazardous Properties and Environment Effects Handbook, the following information is provided to assess Therminol-66. T-66 is a heat transfer fluid (also manufactured by Monsanto) with composition and properties similar to T-60.

- (1) Chemical composition - mixture of terphenyls. No sulfur, nitrogen, halogen, or metals were detected.
- (2) Thermal stability, degradation and thermoxidative stability - stable at 450°F; Stagnation Test-0.04% liquid weight loss due to outgassing after aging at 450°F for 7 days. Decomposition products - hydrogen 82%, methane 2%, ethane 1%, water 15%.
- (3) Toxic properties - classified as an irritant - outgassing products practically non-toxic.
- (4) Recommended waste disposal - Fluid: recycling, burning, or discarding at local service stations. Solid: utilize current methods for common solid urban refuse disposal.

2. Fluid Properties

Designed as a heat transfer medium, Therminol-60 has excellent stability at temperatures below 600°F with degradation of about 1 percent per year (2500-hour year at $T_{avg} = 500^{\circ}\text{F}$). A summary of its properties is shown in figure VI-3. Freezing is not a problem because of its -90°F pour point and the relatively high winter design (99% level) temperature of 20°F at Fort Worth, Texas, where Bates is located. The auto ignition temperature of 835°F (445.8°C) is well above the operating temperature of the Bates SIPH and provides a wide margin of safety.

Therminol-60 (T-60) is a polyaromatic compound with an operating range of -60°F (-51.1°C) to 600°F (315°C) and a pour point of -90°F (-67.8°C). It is used extensively for moderate temperature nonpressurized thermal applications. It offers good viscosity characteristics (pumpable to -60°F (-51.1°C)) and a high specific heat and thermal conductivity.

3. Toxicity

Therminol-60 is virtually non-toxic based on acute oral and skin absorption studies and poses no special handling problems. A toxicity statement from the manufacturer is included in the appendix. T-60 is not absorbed through unbroken skin but can be mildly irritating to the skin on prolonged contact or to the eyes. The manufacturer recommends washing the skin with soap and water as soon as possible after contact or immediate flushing of the eye upon exposure. Standard safety showers and eye wash basins will be provided for use in the event of exposure.

The vapors from T-60 are non-toxic but may cause discomfort when coming off heated fluid. This will not pose a problem in the Bates application because the fluid is used in a closed system with the expansion tank vent trapped to condense any vapors. There is no vapor exposure problem when transferring T-60 from its container into the system. Standard industrial precautions will be used when handling T-60.

4. Spills and Disposal

The heat transport subsystem will contain approximately 1100 gallons of T-60. T-60 is readily biodegradable. In a semi-continuous

Composition	Polyaromatic Compounds
Appearance	Light yellow liquid
Odor	Faint, aromatic
Pour Point	-90°F. (-67.8°C.)
Density @ 75°F.	8.33 lbs./gal.
Flash Point, coc.	310°F. (154°C.)
Fire Point, coc.	320°F. (160°C.)
AIT	835°F. (445.8°C.)
Coefficient of Expansion	0.00082 cc/cc/°C.
Boiling Range:	
10%	550°F. (288°C.)
90%	741°F. (394°C.)
Average Molecular Weight	250

Figure VI-3. Typical Properties

activated sludge test at a feed rate of 5 mg., 56% of T-60 disappeared within 24 hours. The biodegradability of T-60 greatly minimizes any environmental hazard and simplifies the disposal process. In the event of a spill or leak, the design of the HTS incorporates two control features to minimize the amount of fluid loss, environmental damage, and safety hazards.

Experience at the BDM STF indicates that if a leak in the system should occur, the temperature of T-60 will decrease rapidly from its operating temperature by approximately 200°F before hitting the ground. This decrease in temperature and the nonreactive gravel ground cover of the Bates plant reduce the possibility of a hazard.

Spills can be cleaned up by the use of sorbents, dispersants, trough-collectors or separation vessels such as septic tanks or holding tanks which would contain the spilled fluid for a period of time with a digestant to allow the biological degradation to take place. The fluid could then be disposed of as sewage. The trough collectors for fluid spills need not be isolated from rainwater collection. Flushing the piping system of the heat transfer fluid for cleaning reasons will be eliminated because of the use of a continuous filtration system. The anticipated life expectancy of Therminol-60 is 30 years, which eliminates the need for periodic fluid changes.

Eventually the Therminol-60 will need to be disposed. The fluid can be reclaimed by distillation, filtration, and separation processes; or it can be disposed of by mixing it with boiler fuel and burning it as such. The DOE handbook recommends recycling and burning waste oils as the most desirable disposal technique. In one experiment cited by DOE, burning waste oil in a power plant did not violate EPA or the state of Maryland's air quality control limits. An alternative method is to discard the waste oil at local service stations. DOE recommends that current methods for disposing of urban refuse should be used for disposal of solid wastes such as filters.

Therminol-60, as well as other heat transfer fluids, will eventually oxidize and degrade when exposed to the atmosphere; therefore an

overflow tank has been incorporated into the HTS design and will be pressurized with commercial-grade nitrogen to act as a blanket to the fluid, preventing outside air from contacting it. Nitrogen is used because of its inert characteristics, low cost, and commercial availability. The pressure will be regulated both at the nitrogen supply and also on the tank as a gas bleed-off when the fluid is expanding. Pressure for the incoming nitrogen will be kept at 30 psig to insure a positive pressure when the system is thermally at a minimum. A pressure relief valve will be used to vent the nitrogen gas as the fluid expands.

The ullage system is also functional in removing contaminants from the fluid through condensation. Noncondensable vapors will be automatically vented to the atmosphere with the nitrogen each day as the fluid is heated and expanded. The outgassing products of T-60 are practically nontoxic, as described above.

A fluid maintenance unit composed of a filtration device will be placed in parallel with the main supply (cold) line. A continuous bleed-off of a small percentage of the flow will be filtered to remove sludge formation. Filters will be disposed of as recommended in the DOE handbook using existing urban solid waste disposal methods.

5. Piping Insulation and Valves

The balance of the heat transfer subsystem comprises all piping, insulation, pumps, and related components. Mild steel was selected for the piping system because of its cost, weldability, availability, and adaptability to valving and couplers. Welded joints increase reliability by minimizing possible leaks.

The insulation selected for the valves and fittings section of the piping system is foam-glass. The insulation has a temperature limit of 2400°F and will be covered by an aluminum jacket for safety. Experiments conducted at the BDM STF have demonstrated the Cerablanket non-wicking properties, thus minimizing fire hazards in case of a fluid leak. For the straight pipe section of the piping system, where no leaks are expected, regular fiberglass insulation will be used.

E. OTHER IMPACTS

The use of solar energy in this commercial industrial area will not only prove its success as an alternative energy source; it also minimizes the burning of hydrocarbon fuels. This reduces the air pollutants (carbon monoxide, particulates, sulfur oxides, nitrogen oxides, unburned hydrocarbons) commonly associated with burning of fossil fuels.

The noise level produced by the pumps and the collector system will be negligible compared to other processes in the area, such as the corrugator facility and the nearby railroad system. Because the area is a developed commercial area, flora and fauna will not be additionally affected. The geology will not be affected beyond the surface grading in preparation for the collector field which has already been completed as part of the facility expansion. Neither the geology or the hydrology will be negatively affected by the piers to be drilled for the collector since immediate refilling with reinforced concrete will be done.

Working hours for Bates plant employees may be adjusted to take advantage of the available solar energy. It is proposed to modify plant operations to a 6- or 7-day week with work shifts scheduled symmetrically about solar noon on a seasonal basis. During the summer, when solar noon occurs around 1:25 p.m. because of daylight savings time, a delayed shift (9 a.m. to 6 p.m.) may be used to ensure afternoon collection of solar energy.

CHAPTER VII

GOVERNMENTAL COORDINATION

Coordination with the local, state, and federal Governments was carried out via documented telephone conversations with officials in the city of North Richland Hills and the state government of Texas. The proposed application was reviewed with each official to determine legislative and environmental impacts. The Building Department of the City of North Richland Hills was contacted about the zoning regulations and boundaries surrounding the Bates property. The department viewed the proposed system as compatible with existing site zoning. The zoning commission has no regulations on building height in industrial zones and they do not acknowledge solar rights. Therefore, the commission recommended to Bates that they obtain a mutual agreement with neighboring industries about their solar rights.

The Director of Division of Planning Coordination from the Office of the Governor in Austin, Texas, was contacted to determine state regulations or guidelines which existed with relation to the environmental assessment. Bates was directed to the Texas Energy and Natural Resources Advisory Board, the Air Control Board, and the Department of Water Resources to review air quality and water impacts.

All three agencies were contacted about the SIPH system. The consensus of the officials was that the solar energy system will not impact the air or the water. The Texas Energy and Natural Resources Advisory Board treats solar processes on a promotional basis instead of a regulatory basis. An officer of the board did not require Bates to obtain further approval since the solar energy system was not going to impact the air or water. He suggested that the EPA Division of the Attorney General's office in Austin might be contacted. The EPA Division also could not think of any permits applicable to the Bates Solar energy system and felt all those concerned had been contacted.

CHAPTER VIII ALTERNATIVES

The alternatives considered are summarized in figure VIII-1.

A. SOLAR SYSTEM ALTERNATIVES

If the solar system is not used to supply steam to the corrugator, Bates will continue to use the existing fossil fueled boiler unit.

The fossil fired boiler unit is sized at 350 boiler horsepower (11.72×10^6 Btu/hr) producing steam at approximately 380°F and 180 psi. This is sized to satisfy the peak steam requirement. The boiler is fitted for dual fuel firing and will burn both gas and #6 fuel oil with a conversion efficiency expected to be about 80 percent. If the solar system is used, an annual fuel consumption saving of about 7.2 million cubic feet of gas or 48,000 gallons of heavy fuel oil can be realized.

B. ALTERNATIVE HEAT TRANSFER FLUIDS

Alternative fluids such as Caloria HT43, Syltherm 800, VP-1 and Therminol-55 were considered but rejected because of degradation, high cost, operational handling, and safety. Salts were not candidates because of low operating temperatures, freezing and corrosion, and environmental problems.

C. ABOVE GROUND INSTALLATION

An alternative system would be located above the existing Bates structure. Extensive study has shown that high costs would eliminate the option for a solar sytem at this location.

<u>Alternative</u>	<u>Impact</u>	<u>Assessment</u>
1. Continued Fossil Fuel Operation	Minor-Adverse	No action on the Solar IPH would result in annual Fuel Consumption of 9.4 MCF of natural gas or 63,000 gallons of heavy fuel oil.
2. Heat Transfer Fluids:		
Caloria HT43	Major-Adverse	Low autoignition temperature-Safety hazard - crude oil cut with environmental problems, disposal and high degradation.
Syltherm-800	Minor-Adverse	High cost fluid - more appropriate for high temperature applications.
VP-1	Minor-Adverse	Operational problems due to handling.
Salts	Major-Adverse	Freezing and corrosion problems, environmental contamination and disposal - more appropriate for high temperature applications.
3. Above ground Mounted Structure	Major-Adverse	Support structure too costly for consideration.

Figure VIII-1. Alternatives Considered

CHAPTER IX

SUMMARY AND CONCLUSIONS

As a result of this environmental assessment it can be concluded that the overall benefits from the Bates SIPH system outweigh any negative environmental factors. Use of the SIPH will significantly reduce the demand for fossil fuels used by the corrugator. This will also reduce air pollutants such as carbon monoxide, particulates, sulfur oxides, nitrogen oxides, and unburned hydrocarbons. Over the 20-year life of the SIPH a significant positive impact and improvement in the environment will result.

The selection of a stable heat transfer fluid with low toxicity and biodegradable qualities minimizes environmental damage due to fluid spills, personal exposure and degradation byproducts. Control systems have been designed to isolate individual collector rows in the event of a leak, thus minimizing fluid loss. The heat transfer fluid chosen for the Bates SIPH has been in commercial use for many years and is a known substance. The fluid is biodegradable and can be reclaimed by organic purification processes or disposed of by mixing the fluid with the boiler fuel and burning it in the boiler. The collector system has an attractive, cleanly designed appearance with positive aesthetic effects, and minimal hazards due to glare.

APPENDIX
THERMINOL-60 FLUID PROPERTIES
PUBLISHED BY THE MONSANTO INDUSTRIAL CHEMICALS COMPANY

Therminol-60 is a wide range liquid phase heat transfer fluid for non-pressurized indirect heating and cooling applications from -60° to 600°F. Heat transfer fluids are intended only for indirect heating purposes. Under no circumstances should this product contact or in any way contaminate food, animal feed, food products, food packaging materials, pharmaceuticals or any items which may directly or indirectly be ultimately ingested by humans. Any contact may contaminate these items to the extent that their destruction may be required. Precautions against ignitions and fires should be taken with this product.

MONSANTO Notice: "Nothing contained herein is to be construed as a recommendation to use any product in conflict with any patent. MONSANTO MAKES NO WARRANTIES AS TO THE FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY OF ANY PRODUCT REFERRED TO, no guarantee of satisfactory results from reliance upon contained information or recommendations, and disclaims all liability for any resulting loss or damage".

Therminol-60 is virtually non-toxic based on acute oral and skin absorption studies, and poses no special handling problems. Therminol-60 is not absorbed through unbroken skin in any significant quantity, but can be mildly irritating to the skin on prolonged contact. Therminol-60 should be washed off the skin with soap and water as soon as possible after contact, and fluid soiled clothing should be laundered before reuse.

Therminol-60 may be mildly irritating if eye contact occurs. Immediate flushing of the eye with copious amounts of water will minimize eye irritation or aftereffects.

Handled like any other industrial chemical, Therminol-60 is quite safe to store and use.

Therminol-60 vapors are not toxic, but may cause discomfort if coming off of heated fluid. There is no vapor exposure problem when transferring the fluid from its shipping container to the heat transfer

system. On the other hand, vapors emitted by Therminol-60 heated to elevated temperatures may be mildly irritating upon prolonged exposure. In heat transfer installations, the fluid is used in a closed, non-pressurized system free from leaks and with the expansion tank vent trapped so as to condense any vapors. Consequently, there should be little or no opportunity for workers to come in contact with vapors.

While Therminol-60 poses no serious problems with respect to the environment, as a concerned supplier to industry, Monsanto urges the user to maintain a tight system, to correct leakage promptly, and to exercise care in the handling and disposal of this and all other such products. A tight maintenance program not only protects the environment, but keeps employees comfortable, the working area clean, and the system running smoothly.

THERMINOL® 60 FLUID
TOXICITY STATEMENT

Therminol 60 heat transfer fluid has a single oral LD₅₀ to albino rats of 13.0 g/kg and the single dermal LD₅₀ to rabbits is greater than 7.9 g/kg. This material is considered to be practically non-toxic by ingestion in single doses and by single dermal applications.

The undiluted product is a moderate irritant to intact rabbit skin (average maximum score of 4.3 on a scale of 8) and a slight irritant to rabbit eye (average maximum score of 12.0 on a scale of 110). A group of 6 male rats survived a 6-hour exposure to air near saturation with vapor of this product at room temperature. The animals exhibited no adverse signs during the exposure and a subsequent 10-day observation period.

A repeated insult patch test was conducted on 50 human subjects with the undiluted product. No visible skin changes signifying reaction to injury were observed in any of the 50 subjects. Visible skin changes suggestive of sensitivity were observed in one individual. This hypersensitive individual did not react to a 1% solution of the test material in dimethyl phthalate. In the opinion of the consulting dermatologist, this product has a potential for sensitizing susceptible individuals and should, therefore, be handled with caution. He also offered the opinion that a 1% dilution of the test material appears to be innocuous even in apparently sensitized individuals.

Groups of 30 albino rats (15 male and 15 female) were fed Therminol 60 at dietary levels of 500 ppm, 2000 ppm, and 6000 ppm for 90 days. A similar group of 30 animals served as controls. There was no untoward behavior, nor were there any deaths attributable to ingestion of the product. No statistical differences in the final body weight, food consumption or total weight gains were noted between the test and control groups. There were no outstanding differences in hematology (hematocrit, erythrocyte, hemoglobin and total and differential leukocyte count), in blood chemistry (blood urea nitrogen and fasted blood glucose concentrations, and serum alkaline phosphatase and glutamine-pyruvic transaminase activities), or in urinalysis (glucose and albumin concentrations, pH, specific gravity, and microscopic examination) between

the 6000-ppm test and control groups. There were no significant differences of platelet counts and prothrombin times between test and control animals. Treated animals did seem to show lower average coagulation times.

Following 90 days of feeding, 10 rats of each sex from both the control and 6000 ppm groups were sacrificed and given a gross examination. At that time, weights of liver, kidney, spleen, gonads, heart, and brain of each rat were determined. There were no intergroup differences in organ weights and their ratios which could be related to ingestion of the test product. There were no relevant gross findings and microscopic examination of about 30 tissues did not reveal any abnormalities.

In a separate feeding study, a group of 9 rats were fed Therminol 60 at a dietary level of 1.0%. After 2 and 4 weeks on test, 3 animals were killed and the remaining 3 were transferred to a control diet for 2 weeks, following which time they were killed. At each interval, 3 control rats also were killed. Portions of muscle, liver, fat and kidney were taken from the test and control animals and analyzed for their content of Therminol 60. Liver and kidney samples of all treated animals were essentially negative. Muscle showed a slight and fat showed a moderate accumulation of Therminol 60 during the feeding period, but the levels decreased rapidly during the 2-week post-treatment period.

Acute static toxicity tests have been conducted with fingerling rainbow trout and bluegills. The 96-hour TL_{50} values are 32 ppm and 2 ppm, respectively.

Therminol 60 is readily biodegradable. In the semi-continuous activated sludge test at a feed rate of 5 mg, the disappearance in 24 hours was 56%.

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August 8, 1973