

*Kathy* EXHIBIT 3  
11/16 M. WISE 1990

PYRANOL™ COMPOSITIONS

GENERAL ELECTRIC COMPANY  
 1932 - 1976

\* GE Specification - 1488, 1467, 1470, A1383B. (1497 = A1383B), A50P55..  
 # ASTM D 2283 Type ( ), Annual Book of Standards, Vol. 10.03.  
 1242, 1254, 1260 - Aroclor™ PCB mixtures - Monsanto Chemical  
 T<sub>3</sub>CB - tri- & tetra-chlorobenzenes - Hooker Chemical  
 Sn<sub>4</sub> - tin tetraphenyl - Hooker Chemical(1944-1957),

EDDC - epoxide dicyclo-diepoxy carboxylate - ERL 4221, Union Carbide & Metal & Thermite Corp  
 CY-179, Ciba-Geigy

PITTSFIELD, MA

| <u>1932-NOV 1944</u><br><u>1488*</u>                                      | <u>NOV 1944-APR 1952</u><br><u>1467</u>                                   | <u>APR 1952-MAR 1963</u><br><u>1470</u>                                              | <u>MAR 1963-APR 1972</u><br><u>A1383B (B)#</u>                            |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 60% 1260<br>40% T <sub>3</sub> CB                                         | 60% 1260<br>40% T <sub>3</sub> CB<br>0.125% Sn <sub>4</sub>               | 45% 1260<br>40% T <sub>3</sub> CB<br>15% T <sub>4</sub> CB<br>0.125% Sn <sub>4</sub> | 45% 1260<br>40% T <sub>3</sub> CB<br>15% T <sub>4</sub> CB<br>0.125% EDDC |
| <u>APR 1972-NOV 1973</u><br><u>A1383B2 (F)</u>                            | <u>NOV 1973-FEB 1974</u><br><u>A50P559</u>                                | <u>JAN 1974-END</u><br><u>A1383B3 (G)</u>                                            |                                                                           |
| 45% 1254<br>40% T <sub>3</sub> CB<br>15% T <sub>4</sub> CB<br>0.125% EDDC | 65% 1254<br>23% T <sub>3</sub> CB<br>12% T <sub>4</sub> CB<br>0.125% EDDC | 60% 1254<br>40% T <sub>3</sub> CB<br>0.125% EDDC                                     |                                                                           |

ROME, GA

| <u>1953 - 1963</u><br><u>1470</u>                                                    | <u>1963 - 1965</u><br><u>A1383B (B)</u>                                   | <u>1965 - 1970</u><br><u>A50P524 (C)</u>                                  | <u>SEP 1969 - OCT 1970</u><br><u>A1383B (B)</u>                           |
|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 45% 1260<br>40% T <sub>3</sub> CB<br>15% T <sub>3</sub> CB<br>0.125% Sn <sub>4</sub> | 45% 1260<br>40% T <sub>3</sub> CB<br>15% T <sub>4</sub> CB<br>0.125% EDDC | 80% 1242<br>13% T <sub>3</sub> CB<br>7% T <sub>4</sub> CB<br>0.125% EDDC  | 45% 1260<br>40% T <sub>3</sub> CB<br>15% T <sub>4</sub> CB<br>0.125% EDDC |
| <u>1970 - 1972</u><br><u>A50P559</u>                                                 | <u>1972 - 1974</u><br><u>A1383B2 (F)</u>                                  | <u>NOV 1973-FEB 1974</u><br><u>A50P559</u>                                | <u>MAR 1974-END</u><br><u>A50P570</u>                                     |
| 65% 1254<br>23% T <sub>3</sub> CB<br>12% T <sub>3</sub> CB<br>0.125% EDDC            | 45% 1254<br>40% T <sub>3</sub> CB<br>15% T <sub>4</sub> CB<br>0.125% EDDC | 65% 1254<br>23% T <sub>3</sub> CB<br>12% T <sub>4</sub> CB<br>0.125% EDDC | 40% 1254<br>60% T <sub>3</sub> CB<br>0.125% EDDC                          |

HICKORY, NC & SHREVEPORT, LA

Pyranol - never used

/3800B

tor 12-29-87

GLEP 000654

## Standard Specification for CHLORINATED AROMATIC HYDROCARBONS (ASKARELS) FOR CAPACITORS<sup>1</sup>

This standard is issued under the fixed designation D 2233; the number immediately following the designation indicates the original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last revision.

1. Scope

This specification covers synthetic non-combustible electrical insulating liquids of the chlorinated aromatic hydrocarbon type known as askarels, which are used as an electrical insulating and cooling medium in capacitors. This specification includes liquids that were previously available and are still in use in capacitors.

Insulation systems incorporating these askarels and cellulosic or other organic materials may, when arced, produce gaseous mixtures that are moderately flammable.

Askarels covered by this specification are of four types as follows:

1.1 *Type A*—Biphenyl that has been chlorinated to a content of 42 weight %.

1.2 *Type B*—Biphenyl that has been chlorinated to a chlorine content of 54 weight %.

1.3 *Type C*—A mixture of approximately 75 % Type D 2233 B and 25 % trichlorobenzene.

1.3.4 *Type D*—The same as Type A, except that the higher boiling homologs have been removed to a maximum level of 0.4 %.

**Note 1**—These statements are merely descriptions of the materials currently in common use and are not intended as part of this specification, which is based on physical and chemical properties prescribed in Table 1.

**Note 2**—Current governmental regulations prohibit the manufacture and sale of polychlorinated biphenyls (askarels). This method is being maintained for reference of those units still in service.

**Note 3**—For information on PCB's in mineral oils,

D 88 Test Method for Saybolt Viscosity<sup>2</sup>

D 92 Test Method for Flash and Fire Points by Cleveland Open Cup<sup>2</sup>

D 97 Test Method for Pour Point of Petroleum Oils<sup>2</sup>

D 664 Test Method for Neutralization Number by Potentiometric Titration<sup>2</sup>

D 877 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes<sup>2</sup>

D 923 Methods of Sampling Electrical Insulating Liquids<sup>2</sup>

D 924 Test Method for A-C Loss Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids<sup>2</sup>

D 974 Test Method for Neutralization Number by Color-Indicator Titration<sup>2</sup>

D 1169 Test Method for Specific Resistance (Resistivity) of Electrical Insulating Liquids<sup>2</sup>

D 1218 Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids<sup>2</sup>

D 1533 Test Methods for Water in Insulating Liquids (Karl Fischer Reaction Method)<sup>2</sup>

D 1810 Test Method for Specific Gravity of Askarels<sup>2</sup>

D 1820 Test Method for Hydrolyzable Chlorine Compounds in Chlorinated Aromatic Hydrocarbons (Askarels)<sup>2</sup>

D 1821 Test Method for Inorganic Chloride in Askarels<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D 21 on Electrical Insulating Liquids and Gases and the direct responsibility of Subcommittee D27.02 on Synthetic Liquids. Approved Jan. 31, 1986. Published March 1, 1986.

D 1903 Test Method for Coefficient of Thermal Expansion of Electrical Insulating Liquids of Petroleum Origin, and Askarels<sup>2</sup>

D 1936 Test Method for Thermal Stability of Chlorinated Aromatic Hydrocarbons (Askarels)<sup>2</sup>

D 2129 Test Method for Color of Chlorinated Aromatic Hydrocarbons (Askarels)<sup>2</sup>

D 4059 Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography<sup>2</sup>

### 3. Definition

3.1 *askarel*—a generic term for a group of synthetic, fire-resistant, chlorinated aromatic hydrocarbons used as electrical insulating liquids. They have a property under arcing conditions such that any gases produced will consist predominantly of noncombustible hydrogen chloride with lesser amounts of combustible gases.

ride with lesser amounts of combustible gases.

### 4. Detail Requirements

4.1 Askarels for use in capacitors shall conform to the requirements prescribed in Table 1.

**Note 4**—Since October 1971 askarel produced in the United States for use in capacitors has conformed to Type D as shown in Table 1. Materials previously available are still in use in the field.

**Note 5**—These materials sometimes contain additives whose presence may interfere with the chemical tests prescribed in Table 1. Unless it is known that no additives are present, results of the chemical tests may be misleading.

### 5. Sampling and Test Methods

5.1 The material shall be sampled in accordance with Methods D 923 and tests shall be conducted in accordance with the methods of test listed in Table 1.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, Pa. 19103.



TABLE 1. Detail Requirements for Askarels for Classifications

| Property                              | Type A                | Type B                | Type C                | Type D <sup>e</sup>   | ASTM Test Method <sup>g</sup> |
|---------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------------------|
| Viscosity, mPa·s at 100°C and 1 kHz   | 0.01                  | 0.01                  | 0.01                  | 0.01                  | D 974, D 644                  |
| Acidity, mEq/L                        | 50                    | 50                    | 150                   | 40                    | D 2129                        |
| Acidity, mEq/L                        | 0.05                  | 0.05                  | 0.05                  | 0.05                  | (visual)                      |
| Acidity, mEq/L                        | 4.7 to 4.9            | 4.15 to 4.35          | 4.1 to 4.6            | 4.80 to 4.95          | D 1821                        |
| Dielectric breakdown voltage, min. kV | 35                    | 35                    | 35                    | 35                    | D 924                         |
| Dielectric breakdown voltage, max. kV | 35                    | 35                    | 35                    | 35                    | D 877                         |
| Dielectric loss, max. ppm             | 0.5                   | 1.0                   | 1.0                   | 0.5                   | D 92                          |
| Dielectric loss, max. ppm             | 1.6240 to 1.6260      | 1.6370 to 1.6390      | 1.6305 to 1.6315      | 1.6215 to 1.6235      | D 1820                        |
| Dielectric loss, max. ppm             | 500 x 10 <sup>6</sup> | 500 x 10 <sup>6</sup> | 500 x 10 <sup>6</sup> | 500 x 10 <sup>6</sup> | D 97                          |
| Dielectric loss, max. ppm             | 1.381 to 1.392        | 1.495 to 1.505        | 1.525 to 1.535        | 1.562 to 1.572        | D 1218                        |
| Dielectric loss, max. ppm             | 25/15.5°C             | 65/15.5°C             | 15.5/15.5°C           | 25/15.5°C             | D 1169                        |
| Dielectric loss, max. ppm             | 0.00064               | 0.00066               | 0.00070               | 0.00068               | D 1810                        |
| Dielectric loss, max. ppm             | 0.4                   | 0.5                   | 0.5                   | 0.4                   | D 1903                        |
| Dielectric loss, max. ppm             | 12 to 92 at 37.8°C    | 44 to 48 at 98.9°C    | 70 to 82 at 37.8°C    | 71 to 81 at 37.8°C    | D 1936                        |
| Dielectric loss, max. ppm             | 35                    | 35                    | 35                    | 35                    | D 88                          |
| Dielectric loss, max. ppm             |                       |                       |                       |                       | D 1533                        |

<sup>g</sup>When testing for fire points, pseudo-flash may be observed; it differs considerably from the flash obtained on combustible materials and is not indicative of a fire hazard.

<sup>h</sup>These are approximate values included for information only.

<sup>i</sup>These are approximate values included for information only.

<sup>j</sup>These are approximate values included for information only.

<sup>k</sup>These are approximate values included for information only.

## Standard Specification for CHLORINATED AROMATIC HYDROCARBONS (ASKARELS) FOR TRANSFORMERS<sup>1</sup>

This standard is issued under the fixed designation D 2283; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (<sup>ε</sup>) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers synthetic non-flammable electrical insulating liquids of the chlorinated aromatic hydrocarbon-type known as askarels, which are used as an insulating and cooling medium in liquid-filled transformers. This specification includes liquids that were previously available and are still in use in apparatus.

1.2 Askarels covered by this specification are of various types, having components in weight percent in accordance with Table 1.

NOTE 1—The components and the respective percentages given are descriptive of the materials currently in common use and are not intended as part of this specification, which is based on physical and chemical properties.

NOTE 2—Types A through G are PCB type askarels previously available and still in use in the field. Recently Type H, a non-PCB askarel, was introduced as a retrofit and replacement.

NOTE 3—Current governmental regulations prohibit the manufacture and sale of polychlorinated biphenyls (PCBs). This method serves as a reference for all askarels, PCB and non-PCB.

### 2. Applicable Documents

#### 2.1 ASTM Standards:

- D88 Test Method for Saybolt Viscosity<sup>2</sup>
- D92 Test Method for Flash and Fire Points by Cleveland Open Cup<sup>3</sup>
- D97 Test Method for Pour Point of Petroleum Oils<sup>4</sup>
- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)<sup>5</sup>
- D664 Test Method for Neutralization Num-

ber by Potentiometric Titration<sup>7</sup>

D877 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes<sup>7</sup>

D923 Methods of Sampling Electrical Insulating Liquids<sup>2</sup>

D924 Test Method for A-C Loss Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids<sup>2</sup>

D974 Test Method for Neutralization Number by Color-Indicator Titration<sup>7</sup>

D1169 Test Method for Specific Resistance (Resistivity) of Electrical Insulating Liquids<sup>7</sup>

D1218 Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids<sup>7</sup>

D1533 Test Method for Water in Insulating Liquids (Karl Fischer Reaction Method)<sup>7</sup>

D1701 Test Method for Scavenger Content of Askarels<sup>2</sup>

D1810 Test Method for Specific Gravity of Askarels<sup>2</sup>

D1821 Test Method for Inorganic Chlorides in Askarels<sup>2</sup>

D1903 Test Method for Coefficient of Thermal Expansion of Electrical Insulating Liquids of Petroleum Origin, and Askarels<sup>2</sup>

D2129 Test Method for Color of Chlorinated Aromatic Hydrocarbons (Askarels)<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D-27 on Electrical Insulating Liquids and Gases and is the direct responsibility of Subcommittee D27.02 on Synthetics.

Current edition approved Jan. 31, 1988. Published Mar 1988. Originally published as D 2283 - 64.1. Last previous edition D 2283 - 82 (1985)<sup>ε</sup>.

### 3. Definition

3.1 *askarel*—a generic term for a group of synthetic, fire-resistant, chlorinated aromatic hydrocarbons used as electrical insulating liquids. They have a property under arcing conditions such that any gases produced will consist predominantly of noncombustible hydrogen chloride with lesser amounts of combustible gases.

### 4. Detail Requirements

4.1 Askarels for use in transformers shall conform to the requirements prescribed in Table 2.

Note 4—If more convenient, a measurement of dissipation factor may be made by Test Method D 924 in place of the resistivity measurement. Theoretical considerations indicate and experiment confirms that a strong statistical correlation exists between the dissipation factor and resistivity; however, other factors modify in practice the precise relationship predicted by theory. A dissipation factor at 60 Hz and 100°C that is not in excess of 15 % shall be considered satisfactory.

### 5. Sampling and Test Methods

5.1 The material shall be sampled in accordance with Methods D 923, and tests shall be conducted in accordance with the methods of test listed in Table 2.

TABLE 1 Askarels Components in Weight Percent

| Components                           | Type A       | Type B         | Type C         | Type D       | Type E       | Type F         | Type G         | Type H <sup>a</sup> |
|--------------------------------------|--------------|----------------|----------------|--------------|--------------|----------------|----------------|---------------------|
| Hexachlorobiphenyl <sup>a</sup>      | 60           | 45             |                | 70           |              | 45             | 60             |                     |
| Pentachlorobiphenyl <sup>b</sup>     |              |                |                |              | 100          |                |                |                     |
| Trichlorobiphenyl <sup>c</sup>       |              |                | 80             |              |              |                |                |                     |
| Trichlorobenzene <sup>d</sup>        | 40           |                |                | 30           |              |                | 40             |                     |
| Tri-tetra blend <sup>e</sup>         |              | 55             | 20             |              |              | 55             |                | 100                 |
| Phenoxypropene oxide <sup>f</sup>    | 0.18 to 0.22 |                |                | 0.18 to 0.22 | 0.18 to 0.22 |                |                |                     |
| Diepoxide type compound <sup>g</sup> |              | 0.115 to 0.135 | 0.115 to 0.135 |              |              | 0.115 to 0.135 | 0.115 to 0.135 | 0.10 to 0.25        |

<sup>a</sup> Biphenyl chlorinated to a chlorine content of 60 weight %.

<sup>b</sup> Biphenyl chlorinated to a chlorine content of 54 weight %.

<sup>c</sup> Biphenyl chlorinated to a chlorine content of 42 weight %.

<sup>d</sup> A mixture of isomers of trichlorobenzene.

<sup>e</sup> A mixture of isomers of trichlorobenzene and tetrachlorobenzene.

<sup>f</sup> Glycidyl phenylether.

<sup>g</sup> 3,4-Epoxy-cyclohexylmethyl 3,4-epoxycyclohexane carboxylate.

<sup>h</sup> Non-PCB contains no chlorinated biphenyls.

TABLE 2 Detail Requirements for Askarels for Transformers

| Property                                                                            | Type A                 | Type B                 | Type C                 | Type D                 | Type E                 | Type F                 | Type G                 | Type H <sup>a</sup>    | ASTM Test Method |
|-------------------------------------------------------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------|
| Acidity, mg KOH/g, max                                                              | 0.014                  | 0.014                  | 0.014                  | 0.014                  | 0.014                  | 0.014                  | 0.014                  | 0.014                  | D 974            |
| Color, APHA, max                                                                    | 150                    | 150                    | 150                    | 150                    | 150                    | 150                    | 150                    | 150                    | D 664            |
| Condition                                                                           | clear                  | clear                  | clear                  | clear                  | clear                  | clear                  | clear                  | clear                  | D 212            |
| Chlorides, inorganic, ppm max                                                       | 0.1                    | 0.1                    | 0.1                    | 0.1                    | 0.1                    | 0.1                    | 0.1                    | 0.1                    | D 182            |
| Relative permittivity at 100°C and 1 kHz                                            | 3.7 to 4.0             | 3.8 to 4.3             | 4.4 to 4.9             | 4.3 to 4.6             | 4.7 to 4.9             | 4.5 to 4.9             | 4.3 to 4.6             | 4.5 to 4.7             | D 924            |
| Dielectric breakdown voltage min, kV                                                | 35                     | 35                     | 35                     | 35                     | 35                     | 35                     | 35                     | 35                     | D 877            |
| Fire point <sup>a</sup>                                                             | none to boiling        | none to boiling        | none to boiling        | none to boiling        | none to boiling        | none to boiling        | none to boiling        | none to boiling        | D 92             |
| Pour point, max, °C                                                                 | -32                    | -44                    | -30                    | -30                    | -14                    | -42                    | -38                    | -20                    | D 97             |
| Refractive index, 25°C                                                              | 1.6130 to 1.6154       | 1.6068 to 1.6088       | 1.6146 to 1.6166       | 1.6163 to 1.6193       | 1.6240 to 1.6260       | 1.6060 to 1.6070       | 1.6110 to 1.6120       | 1.5760 to 1.5780       | D 121            |
| Resistivity at 100°C, 5 V/mil, d.c. <sup>b</sup> min, Ω-cm                          | 100 × 10 <sup>10</sup> | 100 × 10 <sup>10</sup> | 100 × 10 <sup>10</sup> | 100 × 10 <sup>10</sup> | 100 × 10 <sup>10</sup> | 100 × 10 <sup>10</sup> | 100 × 10 <sup>10</sup> | 100 × 10 <sup>10</sup> | D 116            |
| Scavenger content, %:                                                               |                        |                        |                        |                        |                        |                        |                        |                        | D 170            |
| Phenoxypropene oxide                                                                | 0.18 to 0.22           |                        |                        | 0.18 to 0.22           | 0.18 to 0.22           |                        |                        |                        |                  |
| Diepoxide type compound                                                             |                        | 0.115 to 0.135         | 0.115 to 0.135         |                        |                        | 0.115 to 0.135         | 0.115 to 0.135         | 0.10 to 0.25           |                  |
| Specific gravity, 15.5/15.5°C                                                       | 1.560 to 1.568         | 1.560 to 1.571         | 1.412 to 1.425         | 1.518 to 1.528         | 1.381 to 1.392         | 1.515 to 1.525         | 1.502 to 1.517         | 1.381 to 1.392         | D 181            |
| Viscosity, Saybolt Universal, s at 37.8°C (100°F)                                   | 52 to 56               | 41 to 45               | 50 to 55               | 56 to 61               | 82 to 92               | 39 to 43               | 44 to 48               | 31 to 41               | D 88             |
| Coefficient of thermal expansion, <sup>c</sup> cm <sup>3</sup> /cm <sup>3</sup> /°C | 0.0007                 | 0.0007                 | 0.0007                 | 0.0007                 | 0.0007                 | 0.0007                 | 0.0007                 | 0.0007                 | D 190            |
| Water content max, ppm                                                              | 30                     | 30                     | 30                     | 30                     | 30                     | 30                     | 30                     | 30                     | D 153            |

<sup>a</sup> When testing for fire point, a pseudo flash may be observed; it differs noticeably from the flash obtained for combustible materials and is not indicative of a fire hazard.

<sup>b</sup> See Note 4.

<sup>c</sup> These are approximate values included for information only.

<sup>d</sup> These designations refer to the methods referenced in Section 2.

<sup>e</sup> Non-PCB contains no chlorinated biphenyls.

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# ASKAREL\*TRADE NAMES

AROCLOR  
ASBESTOL  
CLOPHEN  
CHLOREXTOL  
CHLORINOL  
CLORPHEN  
DIACLOR  
DK, INCLOR, FENCLO  
DYKANOL  
ELEMEX  
EUCAREL  
HYVOL  
INERTEEN  
KANECHLOR  
N-3  
NO-FLAMOL  
PHENOCLO  
PYDRAUL  
PYROCLOR  
PYRALENE  
PYRANOL  
SAF-T-KUHL  
SANTOTHERM  
THERMINOL

MONSANTO CO.  
AMERICAN CORP.  
BAYER (GERMANY)  
ALLIS CHALMERS  
SPRAGUE  
JARD  
SANGAMO ELECT.  
CAFFARO (ITALY)  
CORNELL DUBILIER  
MCGRAW EDISON  
  
AEROVOX  
WESTINGHOUSE HOUSE  
MITSUBISHI (JAPAN)  
NIAGARA TRANSFORMER  
WAGNER ELECTRIC  
PRODELEC (FRANCE)  
  
PRODELEC (FRANCE)  
GENERAL ELECTRIC  
KUHLMAN ELECTRIC  
MITSUBISHI (JAPAN)

\*GENERIC NAME FOR PCB

A&ESO PROPRIETARY INFORMATION

RDP/GE/040184 (3)

5/29/84  
9AF

GEF 000658