EA02025

TEXAS INSTRUMENTS, INC.'S

09/10/03 LETTER TO ODI

REQUEST 10

BOX 13

PART A – G

PART A

EA02-025
TEXAS INSTRUMENTS, INC.'S

Response to NHTSA Request No. 10

August 19, 1991

Gary Baker
Texas Instruments
MS 12-32
34 Forest St.
Attleboro, MA 02703

Re: Pressure switch, automatic transmission

Dear Mr. Baker,

Enclosed you will find sheet samples of Kapton* 300HN, and 500HN, for evaluation. Unfortunately, we have not made a laminate of Kapton* and Teflon PFA in a similar construction to the 500FN131.

However, initial tests conducted last year at Du Pont Engineering Test Center in Wilmington may prove encouraging for use of Kapton* alone in this application.
I have included the results on the attached page.

Should the properties of a laminate structure prove desirable, it may be possible to explore ways of improving the fluoropolymer to polyimide bond.

If I can be of further assistance, please feel free to call me at ~~302-874-7436~~.
302 871 7426

Thanks again for your continued interest in Du Pont's Kapton* Polyimide Film.

Sincerely,
Edward C McKenzie

Edward C. McKenzie
Sales Representative

* Du Pont Registered Trademark

TI-NHTSA 017350A

August 19, 1991

AUTOMOTIVE TRANSMISSION FLUID TESTING OF KAPTON* FILM

Test conducted using Dexron ATF, off shelf, soak tests at 300 degrees F.

	CONTROL	1000HRS
ELONG (%)		
300HN	67.4	50.3
200FN919	71.1	66.1
MODULUS (psi)		
300HN	373724	431564
200FN919	298726	258870
TENSILE (psi)		
300HN	30647	29156
200FN919	24714	19401

SWELL: essentially no change after 1000 hrs.

1. Control points are average of 5 data points.
2. All test points are average of 3 data points.
3. Additional info regarding test procedures is available on request.
3. This information is offered without charge as a service to customers, is based on our testing and experience and is believed to be reliable. Hoever, Du Pont Company makes no gaurentee as to results achieved by others and assumes no obligation or liability in connection with the use of this information, which is intended for use by persons with technical skills and at their own discretion and risk. Determination of product suitability is the responsibility of the user.

ROUTE TO [redacted]

TEXAS INSTRUMENTS
ATTLEBORO, MASSACHUSETTS

REPORT OF DISCREPANT IN-PROCESS MATERIAL

No. 002173

DWG NO. & NAME	REV.	INSPECTOR	DATE	Mfg. Supervision Review
192241 (Kapton Tape)			3-31-92	6 #
SOURCE: Dupont Kapton	DEVICE: 5215	PROD. CODE: 060	QUANTITY: 2 Rolls [redacted]	

ITEM	ATTRIBUTE/REQUIREMENT	ACTUAL	SMSP	AC	RE	JOBP
	Workmanship (Dents, nicks or ragged not allowed)	Rolls are dented / damaged	2	-	2	2
		4/24/92				

MAT'L/PROD. CONTROL

☐ CHECK INVENTORY AT (LOCATION)
☐ PARTS/MATERIAL IN SHORT SUPPLY

PRIORITY ☐1 ☐2 ☒3

COMMENTS:

PLANNER: SIGNATURE DATE 3-31-92

MRB ENGINEERING DISPOSITION

☒ RETURN TO SUPPLIER
☐ REWORK AT TI
☐ SORT AT TI
☐ SCRAP
☐ DEVIATE (UAI)

COMMENTS: RTS Dupont

MRB SIGNATURES	DATE
PURCHASING	
MFG ENG	4/6/92
QA ENG	4/3/92
MS MGR	
DE MGR	
QA MGR	4/3/92

NOTE — IF DISP. OTHER THAN RTS - MRB CORRECTIVE ACTION MUST BE COMPLETED

REWORK PROCEDURE: (MFG./ENG.)

MH159612

ESTIMATED TIME ______

REWORK COMPLETE ON

BY

ACTUAL STD. HOURS

GOOD PCS. REMAINING

INSPECTION AFTER REWORK	SMSP	AC	RE	JOBP	INSPECTOR	DATE	QPA ENG. (Signature required if rej.)

MRB CORRECTIVE ACTION

TI
— CHANGE DRAWING/SPEC (OPINION MUST BE ATTACHED) ☐
— USE ENCLOSED SAMPLES AS ACCEPTABLE VISUAL STANDARDS ☐
— OTHER (EXPLAIN) ☒

SUPPLIER
— PROVIDE CORRECTIVE ACTION WITH FORMAL RESPONSE ☐
— SUBMIT INSPECTION DATA WITH FUTURE SHIPMENTS ☐
— CONDUCT CAPABILITY STUDY AND SUBMIT TO ENGINEERING ☐
— OTHER (EXPLAIN) ☐

COMMENTS:
T.I. evaluating use of plastic cores vs. cardboard s/A plan -

RECEIVING INSPECTION

RI SEQUENCE NO.	DISP. CODE	AREA	LOCATION
9933	RTS	P	Dock

REJECT VALIDATION: INITIAL DATE 4-15

SUPPLIER NOTIFIED: INITIAL DATE

ACTION TAKEN TO PREVENT RECURRENCE:

PROCUREMENT ASSURANCE

DO NOT WRITE BELOW THIS LINE

☒ FOR INFO ONLY - SUPPLIER
☐ EXTERNAL C.A.R.
☐ FOR INFO ONLY - INTERNAL
☐ INTERNAL C.A.R.
☐

SIGNATURE 4-16-92 DATE

FORM 20475

DAMAGED ROLLS (WORK)

TI-NHTSA 017352

ROUTE TO ______ Walt Sutton | Hyperlinks | [redacted]

TEXAS INSTRUMENTS — ATTLEBORO, MASSACHUSETTS

REPORT OF DISCREPANT IN-PROCESS MATERIAL

No. 002175

DWG NO. & NAME	REV.	INSPECTOR	DATE	Mfg. Supervision Review
27125-1 (Roll Strip)		[illegible]	4-14-92	46.4 #

SOURCE	DEVICE	PROD. CODE	QUANTITY
Dupont Kapton	5025	060	Rolls Rolls

ITEM	ATTRIBUTE/REQUIREMENT	ACTUAL	SAMP	AC	RE	NO. DEF
	Workmanship (Dents, Rips or jagged edges not allowed)	Rolls are dented & damaged	2	-	2	2

MAT'L/PROD. CONTROL 4/24/92

☐ CHECK INVENTORY AT (LOCATION)
☐ PARTS/MATERIAL IN SHORT SUPPLY

PRIORITY ☐1 ☐2 ☒3

COMMENTS:

PLANNER: SIGNATURE: Joe [illegible] DATE: 3-31-92

MRB ENGINEERING DISPOSITION

☒ RETURN TO SUPPLIER
☐ REWORK AT TI
☐ SORT AT TI
☐ SCRAP
☐ DEVIATE (U A I)

COMMENTS: RTS Dupont

MRB SIGNATURES	DATE
PURCHASING	
MFG ENG. [signature]	4/6/92
QRA ENG. [signature]	4/6/92
MK MGR.	
DV MGR.	
QRA [signature] for Andy [illegible]	4/9/92

NOTE — IF DISP. OTHER THAN RTS - MRB CORRECTIVE ACTION MUST BE COMPLETED

REWORK PROCEDURE: (MFG./ENG.)

MH 159609

ESTIMATED TIME ______

REWORK COMPLETE ON ______ BY ______ ACTUAL STD. HOURS ______

INSPECTION AFTER REWORK	SAMP	AC	RE	NO. DEF	INSPECTOR	DATE	QRA ENG. (Signature required if rej.)	GOOD PCS. REMAINING

MRB CORRECTIVE ACTION

TI
— CHANGE DRAWING/SPEC (CHANGE MUST BE ATTACHED) ☐
— USE ENCLOSED SAMPLES AS ACCEPTABLE VISUAL STANDARDS ☐
— OTHER (EXPLAIN) ☐

SUPPLIER
— PROVIDE CORRECTIVE ACTION WITH FORMAL RESPONSE ☒
— SUBMIT INSPECTION DATA WITH FUTURE SHIPMENTS ☐
— CONDUCT CAPABILITY STUDY AND SUBMIT TO ENGINEERING ☐
— OTHER (EXPLAIN) ☐

COMMENTS: T.I. evaluating use of plastic cores vs cardboard. c/a please.

RECEIVING INSPECTION

R SEQUENCE NO.	DISP. CODE	AREA	LOCATION	ACTION TAKEN TO PREVENT RECURRENCE
9810	RTS	P	Dock	Defects available @ R.I 4-15-92

REJECT/APPLICATION: RP 4-15 (INITIAL, DATE) SUPPLIER NOTIFIED: (INITIAL, DATE)

PROCUREMENT ASSURANCE — DO NOT WRITE BELOW THIS LINE

☒ FOR INFO ONLY - SUPPLIER
☐ EXTERNAL C.A.R.
☐ FOR INFO ONLY - INTERNAL
☐ INTERNAL C.A.R.
☐

SIGNATURE: Kim Berry DATE: 4-16-92

FORM [illegible]

WORK - DAMAGED ROLLS

TI-NHTSA 017363

TEXAS INSTRUMENTS INCORPORATED
ATTLEBORO, MASSACHUSETTS 02703

INCOMING INSPECTION NONCONFORMANCE REPORT 2444 2418 Form 2286

PART NO. & NAME	QUANTITY	# CONTAINERS	SUPPLIER NAME
27225-1 Kapton Strip	67	2	El Dupont

PURCHASE ORDER NO.	PO DWG REV	BUYER	SUPPLIER NUMBER
500011911-01-982	N	5080	171011

ITEM	ATTRIBUTE/REQUIREMENT	ACTUAL	# INSP	AC	RE	# DEF
06	Reel should be free of deformation	Coil is bent causing deformation	2	0	1	2
		See attached photo				
		6-5-92				
		7/23/92				

Evidence of attached

COMMENTS: ~~Defects were found during inspection~~

INSPECTED BY: [illegible] DATE OF REJ: [illegible]-92

III SEQUENCE NO.	III DWG REV	FILE DWG REV	ACCT. NUMBER	AREA	
9806	N	N	050-01301-060	P	6-4-92

REJECT VALIDATION INITIAL	DATE	SUPPLIER NOTIFIED INITIAL	DATE	DEF. CODE	DISP CODE	DISP. DATE	LOCATION
[illegible]	6-5	Cl MacKenzie	6-5	2D	RTS	6-17-92	Dock

PRODUCTION CONTROL

☐ CHECK INVENTORY AT (LOCATION)
☒ PARTS/MATERIAL IN SHORT SUPPLY

PRIORITY ☒1 ☐2 ☐3

COMMENTS:

PLANNER: SIGNATURE [signature] DATE

MRB ENGINEERING DISPOSITION [signature] 6/5/92

	COMMENTS:	MRB SIGNATURES	DATE
☒ RETURN TO SUPPLIER		MFG ENG	
☐ REWORK AT TI		QRA ENG	
☐ SORT AT TI		M/E MGR	
☐ SCRAP		O/E MGR	
☐ DEVIATE (U A I)		QRA MGR	6-11-92

NOTE — IF DISP. OTHER THAN RTS — MRB CORRECTIVE ACTION MUST BE COMPLETED

MRB CORRECTIVE ACTION

TI
- CHANGE DRAWING/SPEC (CSN/SCN MUST BE ATTACHED) ☐
- USE ENCLOSED SAMPLES AS ACCEPTABLE VISUAL STANDARDS ☐
- OTHER (EXPLAIN) ☐

SUPPLIER
- PROVIDE CORRECTIVE ACTION WITH FORMAL RESPONSE ☐
- SUBMIT INSPECTION DATA WITH FUTURE SHIPMENTS ☐
- CONDUCT CAPABILITY STUDY AND SUBMIT TO ENGINEERING ☐
- OTHER (EXPLAIN) ☐

COMMENTS: SAT 6-17-92 M.5 6/18/92

PROCUREMENT ASSURANCE DO NOT WRITE BELOW THIS LINE

☐ FOR INFO ONLY – SUPPLIER ☐
☐ EXTERNAL C.A.R. ☒
☐ FOR INFO ONLY – INTERNAL ☐
☐ INTERNAL C.A.R. ☐
☐ ☐

FAULT S ☒ T ☐

[signature] SIGNATURE 6-17-92 DATE

TI-NHTSA 017364

WORK – DAMAGED CARRIER

DuPont
Electronics

High Performance Films

TEFLON® Fluorocarbon Film
PFA Film Properties Bulletin

April 1992

Donald J. [illegible], Jr.
Senior Sales Representative

DuPont High Performance Films

DuPont High Performance Films
U.S. Route 23 & DuPont Road
P.O. Box [illegible]
Circleville, OH [illegible]
Tel. [illegible] fax [illegible]
Local [illegible]

Description

TEFLON® PFA film is a transparent, thermoplastic film which can be heat sealed, thermoformed, vacuum formed, heat bonded, welded, metalized, laminated—combined with dozens of other materials, and can be used as an excellent hot-melt adhesive. This wide variety of fabrication possibilities combines with the following important properties to offer a unique balance of capabilities not available in any other plastic film:

Chemical compatibility

TEFLON PFA film is chemically inert and solvent resistant to virtually all chemicals except molten alkali metals, gaseous fluorine, and certain complex halogenated compounds, such as chlorine trifluoride at elevated temperatures and pressures.

- TEFLON is the most inert of all plastics
- Low permeability to liquids, gases, moisture, and organic vapors

Electrical reliability

- Superior reliability and retention of properties over large areas of film
- High dielectric strength, over 260 kilovolts per millimeter for 0.025 mm film (6500 volts per mil for 1-mil film)
- No electric tracking, non-wettable, and noncharring
- Very low power factor and dielectric constant, only slight change over wide ranges of temperature and frequency

Wide thermal range

- Continuous service temperature: −240° to +260°C (−400° to +500°F)
- Melting range: 300° to 310°C (572° to 590°F)
- Heat sealable

Mechanical toughness

- Superior anti-stick and low frictional properties
- High resistance to impact and tearing
- Useful physical properties at cryogenic temperatures.

Long time weatherability*

- Inert to outdoor exposure
- High transmittance of ultraviolet and all but far infrared

Reliability

- PFA film contains no plasticizers or other foreign materials
- Conventional equipment and techniques can be used for processing; basic composition and properties will not be influenced
- Rigid quality control by Du Pont ensures uniform gauge, void-free film

The convenience of TEFLON flurocarbon in easy-to-use film facilitates the design and fabrication of this low friction thermoplastic for all sorts of high-performance jobs. It is transparent and can be *heat sealed*, *thermoformed*, *welded*, and *heat bonded*. Superior anti-stick properties make it an ideal release film for many applications. A *cementable* type with an invisible surface treatment is available for bonding to one or both sides with adhesives. This versatility is augmented by the superior properties of a true melt-processible fluorocarbon and by the wide choice of product dimensions available from Du Pont.

Table I. Types and gauges of Du Pont TEFLON® PFA film

Gauge	50	100	200	500	1000	2000	6000	9000
Thickness								
mils	½	1	2	5	10	20	60	90
inches	0.0005	0.001	0.002	0.005	0.010	0.020	0.060	0.090
micrometers (µm)	12.5	25	50	125	250	500	1500	2300
Approximate Area Factor								
ft²/lb	180	90	45	18	9	4.5	1.5	1
in²/lb	26,000	12,900	6,480	2,580	1,290	645	215	130
m²/kg	36	18	9	4	2	1	0.3	0.2
Type LP General Purpose	avail.	avail.	avail.	avail.	avail.	avail.	avail.	avail.
Type CLP-One Side Cementable	—	avail.	avail.	avail.	avail.	avail.	—	—

Films are available in widths from ½ inch to 48 inches. See current price list for widths by specific gauge and type.

*Type C film not recommended for outdoor use

TI-NHTSA 017356

Table II. Summary of properties of TEFLON† PFA film

	Property	Test Method	Typical Value* SI Units	Typical Value* Inch-Pound Units
MECHANICAL	Tensile Strength at break	ASTM D-882	21 N/mm²	3000 psi
	Elongation at Break	ASTM D-882	300%	
	Yield Point	ASTM D-882	12 MPa	1700 psi
	Elastic Modulus	ASTM D-882	480 MPa	70000 psi
	Impact Resistance	Du Pont pneumatic impact tester	6.2×10^4	14 in-lb/mil
	Folding Endurance (MIT)	ASTM D-2176	100,000 cycles	
	Tear Strength—Initial (Graves)	ASTM D-1004	4.90 N	500 grams
	Tear Strength—Propagating (Elmendorf)	ASTM D-1922	0.74 N	75 grams
THERMAL	Melt Point	ASTM D-3418 (DTA)	302°–310°C	575°–590°F
	Thermal Conductivity	Cenco-Fitch	0.195 W/(m • K)	1.35 Btu • in/(h • ft² • °F)
	Specific Heat	—	1172 J/(kg • K)	0.28 Btu/(lb • °F)
	Dimensional Stability	30 min @ 150°C (302°F)	MD ≈1% shrinkage TD ≈1% shrinkage	
	Oxygen Index	ASTM D-2863	95%	
ELECTRICAL	Dielectric Strength, short-time, in air @ 23°C (73°F), 6.35 mm (1/4 inch) diameter electrode, 0.79 mm (1/32 inch) radius, 60 Hz, 500 V/s rate of rise: 0.025 mm (1 mil) film	ASTM D-149 Method A	260 kV/mm	6500 V/mil
	Dielectric Constant 25°C (77°F), 100 Hz to 1 MHz	ASTM D-150	2.0	
	Dissipation Factor, 25°C (77°F), 100 Hz to 1 MHz	ASTM D-150	0.0002–0.0007	
	Volume Resistivity, −40° to 240°C (−40° to 464°F)	ASTM D-257	$>1 \times 10^{17}$ ohm • centimeter	
CHEMICAL	Moisture Absorption	—	<0.03%	
	Permeability, gas:	ASTM D-1434	cm³/(m² • 24h • atm)†	
	carbon dioxide		14×10^3	
	nitrogen		3.0×10^3	
	oxygen		8.7×10^3	
	Permeability, vapors:	ASTM E-96	g/(m² • d)	g/(100 in² • 24 h)
	water		2	0.13
	TEFLON is chemically inert and solvent resistant to virtually all chemicals except molten alkali metals, gaseous fluorine, and certain complex halogenated compounds, such as chlorine trifluoride at elevated temperatures and pressures.			
MISC.	Density	ASTM D-1505	2150 kg/m³	134 lb/ft³
	Coefficient of friction kinetic (film-to-steel)	ASTM D-1894	0.1–0.3	
	Refractive Index	ASTM D-542	1.350	
	Solar Transmission	ASTM E-424	96%	

* For 0.050 mm (2 mil) film at 25°C (77°F) unless otherwise specified

† To convert to cm³/(100 in² • 24h • atm) multiply by 0.0645

TI-NHTSA 017357

United States
Headquarters
Du Pont Electronics
Barley Mill Plaza
P.O. Box 80019
Wilmington, DE 19880-0019
Product Information: 1-800-237-4357
Ordering Information: 1-800-237-2374

Electronics Technology Center
Du Pont Electronics
14 T.W. Alexander Drive
Research Triangle Park, NC 27709
(919) 248-5000
Fax: 919-248-5550
Technical Information: 1-800-727-1399

Canada
Du Pont Canada Inc.
Du Pont Electronics
7070 Mississauga Road
Box 2200, Streetsville
Mississauga, Ontario
L5M 2H3 Canada
(416) 821-3300
Fax: 416-821-5000

Latin America
Argentina
Du Pont Argentina S.A.
Av. Eduardo Madero 1020
(1106) Buenos Aires
54-1-312-2011
Fax: 54-111-1329

Brazil
Du Pont do Brasil S.A.
Av. Presidente Kennedy, 611
09900 - Diadema
Sao Paulo - Brasil
55-11-445-3711
Fax: 55-11-445-3892

Mexico
Du Pont, S.A. de C.V.
Homero 206-10
Col. Chapultepec Morales
Mexico, D.F. 11570
525-250-8039
Fax: 525-250-3845

Venezuela
Du Pont de Venezuela C.A.
Apartado Del Este 61893
Caracas 1060-A, Venezuela
58-2-92-6022
Fax: 58-2-92-6442

Europe
Du Pont de Nemours International S.A.
P.O. Box 50
2, chemin du Pavillon
CH-1218 Le Grand-Saconnex
Geneva, Switzerland
41 (22) 717-5111
Fax: 41 (22) 717-5109

Asia Pacific
Japan
Du Pont Japan Ltd.
Du Pont Tower, Shin-Nikko Building
10-1, Toranomon 2-chome
Minato-ku, Tokyo
105 Japan
81-3-3585-5511
Fax: 81-3-3224-8863

ASEAN
Du Pont Singapore PTE Ltd.
1 Maritime Square
07-01, World Trade Centre
Singapore 0409
65-273-2244
Fax: 65-272-5055

Australia
Du Pont (Australia) Ltd.
Northside Gardens
168 Walker Street
North Sydney, NSW 2060
Australia
61-2-923-6111
Fax: 61-2-929-7217

Hong Kong/China
Du Pont Asia Pacific Ltd.
1122 New World Office Bldg
East Wing
Salisbury Road, Kowloon
Hong Kong
852-734-5345
Fax: 852-724-4458

Korea
Du Pont Korea Ltd.
9th Floor, Kyobo Bldg.
1, Chongro 1-Ka, Chongro-Ku
Seoul 110-714, Korea
82-2-721-5114
Fax: 82-2-732-6990

Taiwan
Du Pont Taiwan Ltd.
13th Floor, Hung Kuo Building
167 Tun Hwa North Road
Taipei, Taiwan 10590, R.O.C.
886-2-719-1999
Fax: 886-2-712-0444

DuPont Electronics

H-04331 (4/93) Printed in U.S.A. 220984A

PC

TEXAS INSTRUMENTS – M & C

CORRECTIVE ACTION REQUEST

THIS RESPONSE IS DUE 15 WORKDAYS AFTER RECEIPT AT YOUR FACILITY

RETURN TO:

Ken Barry MS 11-11
Texas Instruments Incorporated
34 Forest Street
Attleboro, MA 02703

DATE PREPARED: APRIL 23, 1992

E I DUPONT	27225-1/74224-1
EDWARD MCKENZIE	002173/002175

1. Do you understand the specification requirement(s) for the characteristic(s) rejected ? YES [X] NO [ ]

If no – describe concern:

RECEIVED

MAY 07 1992

PROCUREMENT ASSURANCE

If the requirement is not understood, what specific area of information needs clarification?

- TI print unclear [ ]
- TI purchase order [ ]
- Standards of acceptance [ ]
- Other – [ ]

2. Please identify the actions you have taken to contain or limit the non-conformance at your facility until a corrective action is in place. Include comments on your inventory, in-transit material, and TI inventory.

TI HAS BEEN EVALUATING A PLASTIC REPLACEMENT FOR THE CARDBOARD CORES, WHICH HAVE BEEN DAMAGED IN THE PAST. DUPONT RECEIVED THE GO AHEAD IN APRIL TO USE THE PLASTIC CORES. IT WILL TAKE APPROXIMATELY 4-6 WKS TO CLEAR WAREHOUSED INVENTORY, AND THEN ALL FUTURE ORDERS WILL BE ON PLASTIC CORES. THE PLASTIC IS MUCH STRONGER, AND SHOULD ELIMINATE FUTURE DAMAGE CAUSED DURING TRANSIT, AS WAS THE CASE IN THIS REJECTION. THERE IS NO KNOWN WAY TO PREVENT MISHANDLING DURING SHIPMENT, SO DUPONT WILL ACCEPT ~~ARE~~ FOR RETURN AND REPLACE ANY MATERIAL DAMAGED IN TRANSIT DURING THE TRANSITION.

What was the Effectivity Date of this containment action ? APRIL 14 1992

3. Has your process, machinery or operation been significantly changed since this part number was qualified by M & C ?

NO

TI-NHTSA 017359

4. Have your measurement methods or inspection equipment significantly changed since this part number was qualified by M & C ? Please state your present measurement method.

NO CHANGE. -

OPTICAL INSPECTION

5. What allowed this non-conformance to escape your facility ?

PRODUCT WAS DAMAGED IN TRANSIT - PROBABLE CAUSE: DROPPED DURING SHIPPING.

6. Other than "increased inspection," what specific action(s) will be taken to prevent the defect from recurring ?

REPLACE CARDBOARD CORES WITH STRONGER PLASTIC CORES

What was the Effectivity Date of this corrective action ? APRIL 14 '92

Have you audited or verified that the above corrective action(s) will be effective in correcting the problem ?

SHOWN EFFECTIVE IN SIMILAR SITUATIONS.

If your current process or quality system is no longer capable of meeting M & C's specifications, contact the TI Purchasing agent or Procurement Assurance Engineer .

SUPPLIER'S AGENT : EDWARD C McKENZIE (please print)

TITLE: SALES REPRESENTATIVE

DATE COMPLETED : 5/4/92

TI-NHTSA 017360

Texas Instruments INCORPORATED
MATERIALS & CONTROLS GROUP
ATTLEBORO, MA. 02703

DUNS NO.

TI-NHTSA 017361

REJECTED MATERIAL RELEASE NO. B 72413

BUYER: Agnes Cardoza 1010

PHONE: (508) 699-

The material referred to on your Purchase Order is being returned for the reason(s) indicated. Please give your return authorization No.:

TI REJECTION NO. 087745

VENDOR NUMBER	VENDOR TERMS	PAY DATE
171011		

SHIPPING MEMO

- ☐ SHIPPING ORDER ONLY NOT A PURCHASE ORDER!
- ☐ REPAIR/PROCESS - CONTACT BUYER WITH PRICE AND AVAILABILITY FOR PO.

DEBIT MEMO

- ☐ CREDIT ONLY, NO REPLACEMENT NECESSARY.
- ☒ CREDIT OUT ACCOUNT, SHIP AND REBILL FOR SATISFACTORY MATERIAL.

☒ RETURN SHIPMENT TO:

DELIVERY REQUIRED:

SHIP TO:
Ed McKenzie
E.I. Dupont Company
60140 Old Town Road
Vernon, CT 06066

CHARGE TO:

QUANTITY		PART NUMBER-SERIAL NUMBER	DESCRIPTION	ACCOUNT NUMBER	
[illegible]		97856-1	kapton strip *** very contaminated - obvious to the naked eye	60-1301-60-132	[redacted]

TI SHIPPING

APPROVED BY TRAFFIC	SHIPPED BY — DATE SHIPPED	SHIP
		☐
BILL NO./BL NO.	**CARRIER**	☐

VENDOR TRANSPORTATION INSTRUCTIONS

- ☐ This shipment is released freight collect F.O.B. origin. Any reshipments made as a result of this RMR will be F.O.B. destination freight prepaid.
- ☐ This shipment is released freight prepaid F.O.B. destination. Return shipment freight collect F.O.B. origin per routing on P.O.

CLERICAL SERVICES RELEASE

BY: Michelle Robarak DATE: 8/3/92

BUYER'S SIGNATURE

REQUESTED UTILIZATION OF MATERIAL

ROUTE TO ______

TEXAS INSTRUMENTS
ATTLEBORO, MASSACHUSETTS 02703

REPORT OF DISCREPANT IN-PROCESS MATERIAL

No. 007745

DWG NO. & NAME	MFG CERTIFIED	REV	INSPECTOR	DATE	Mfg. Supervision Review:
872251 KAPTON STRIP	☐	N	67236	5/14/92	
SOURCE: DU PONT		DEVICE: 603/645	PROD. CODE: 045	QUANTITY: 1	

ITEM	ATTRIBUTE/REQUIREMENT	ACTUAL	#INSP	AC	RE	#DEF
01	WORKMANSHIP	CONTAMINATION				
		TRAPPED BETWEEN				
		LAYERS OF KAPTON				
	6-15-92					

MAT'L/PROD. CONTROL

☐ CHECK INVENTORY AT (LOCATION) ______
☐ PARTS/MATERIAL IN SHORT SUPPLY

PRIORITY ☐ 1 ☐ 2 ☐ 3

COMMENTS:

PLANNER: | SIGNATURE | DATE

MRB ENGINEERING DISPOSITION

☒ RETURN TO SUPPLIER
☐ REWORK AT TI
☐ SORT AT TI
☐ SCRAP
☐ DEVIATE (U A I)

COMMENTS: Return sample for Notification of Defect and Formal corrective Action

MRB SIGNATURES		DATE
PURCHASING	[signature]	5/27/92
MFG ENG	[signature]	5/19/92
QRA ENG	[signature]	5/19/92
MFG MGR		
DE MGR		
QRA MGR		

NOTE — IF DISP. OTHER THAN RTS - MRB CORRECTIVE ACTION MUST BE COMPLETED

REWORK PROCEDURE: (MFG./ENG.)

ESTIMATED TIME ______

REWORK COMPLETE ON | BY | ACTUAL STD. HOURS | GOOD PCS. REMAINING

INSPECTION AFTER REWORK	#INSP	AC	RE	#DEF	INSPECTOR	DATE	QRA ENG. (Signature required if req.)

MRB CORRECTIVE ACTION

TI
— CHANGE DRAWING/SPEC (DCN/ECN MUST BE ATTACHED) ☐
— USE ENCLOSED SAMPLES AS ACCEPTABLE VISUAL STANDARDS ☐
— OTHER (EXPLAIN) ☐

SUPPLIER
— PROVIDE CORRECTIVE ACTION WITH FORMAL RESPONSE ☒
— SUBMIT INSPECTION DATA WITH FUTURE SHIPMENTS ☐
— CONDUCT CAPABILITY STUDY AND SUBMIT TO ENGINEERING ☐
— OTHER (EXPLAIN) ☐

COMMENTS:

RECEIVING INSPECTION

RI SEQUENCE NO.	INSP. CODE	AREA	LOCATION	ACTION TAKEN TO PREVENT RECURRENCE:

REJECT VALIDATION — INITIAL / DATE
SUPPLIER NOTIFIED — INITIAL / DATE

PROCUREMENT ASSURANCE — DO NOT WRITE BELOW THIS LINE

☒ FOR INFO ONLY - SUPPLIER ☐
☐ EXTERNAL C.A.R. ☐
☐ FOR INFO ONLY - INTERNAL ☐
☐ INTERNAL C.A.R. ☐
☐ ☐

[signature] 6/9/92
SIGNATURE DATE

FORM 00675

[signature]

TI-NHTSA 017382

DuPont Electronics

DuPont Company
Barley Mill Plaza
PO Box 80013
Wilmington, Delaware 19880-0013

RECEIVED

JUL 27 1992

PROCUREMENT ASSURANCE

July 21, 1992

Mr. Ken Berry, MS 11-11
TEXAS INSTRUMENTS, INC.
34 Forest Street
Attleboro, MA 02703

Dear Mr. Berry:

The Circleville manufacturing plant has completed its review of the sample returned with RDM 007746. The sample of Du Pont's Kapton® 500FN131 film (TI Part No. 27225-1) had a foreign object trapped within the film layers. The plant investigation revealed that the object was from a hydrocarbon elastomer, such as polybutylene, isoprene, or ethylene-propylene diene, transferred to the film from contact with rolls in the process or carried by the air.

As Circleville's Mike Yunker mentioned in his letter of July 7, our products undergo electronic/optical inspection to identify opaque objects and holes. An object larger than 50 mils in its largest dimension is considered a defect. The black speck returned by Texas Instruments measured 15 mils in the largest dimension, and was not considered a defect by existing standards for Kapton® FN131 film.

If you have additional questions, or if further discussion on specifications or our process is required, please call me at 203/871-7426, or we could meet at your convenience.

Sincerely,

Edward C. McKenzie

Edward C. McKenzie
Sales Representative

DU PONT

CIRCLEVILLE PLANT
P.O. Box 89
Circleville, OH 43113

CC: E.C.McKenzie,Conn.
M.T.Lewandowski,BMP191207,Wilm.

July 7, 1992

Mr. Ken Berry
Texas Instruments
Attleboro, Mass. 02703

Dear Mr. Berry:

The rewind inspection system used for Kapton* uses a laser to detect either opaque objects or holes.

The equipment includes lane identifiers and lights to assist the operator in locating the object that activated the laser.

If an opaque object is larger than 50 mils in its largest dimension it is considered a defect.

As such it is marked and flagged so that it can be removed in a subsequent operation as the film is slit to customer's orders.

The black spot returned by Texas Instruments was only 15 mils in the largest dimension, so it is not considered a defect by existing standards.

If you have any further questions about the inspection method or the definition of a defect in Kapton* film, please do not hesitate to call Ed McKenzie at 203-871-7426 or me at 614-474-0127.

Sincerely,

J. M. Yunker

TI-NHTSA 017365

:jm

BUYER RATIONALE

PART# 27225-1 REV. R P.O. 500085037

DESCRIPTION Kapton Strip DATE OUT 6-2-92

SELECTED SUPPLIER E I Dupont DATE DUE ______

	1ST QUOTE	2ND QUOTE	3RD QUOTE	4TH QUOTE
SUPPLIER	E I Dupont	Allied Optical		
ADDRESS	Wilmington	Allied Signal		
CONTACT	Delaware	Morristown N J		
PHONE	19598	07982		
DATE	6/2/92	5/18/92		
QUANTITY	1450 lbs			
PRICE	86.50/lb	94.65/lb		
QUANTITY				
PRICE				
LEADTIME				
TOOLING				

EXCEPTIONS: ______

RATIONALE & COMMENTS: E I Dupont is only approved source. In 6/92 we successfully negotiated away a 4.6% price increase that will be in effect thru 12/93. This signifies 4 yrs of no price increase from Dupont. Also, in 9/92, Dupont agreed to reduce price an additional 3.4% (was related towards GM challenge). Dupont also replaced cardboard cores that caused quality problems with plastic cores at no charge. Total cost savings annually = $20K.

SPC: ___ YES ___ NO BUYER: [signature] DATE 2-17-93

TI-NHTSA 017366

TEXAS INSTRUMENTS

Materials & Controls Group
August 6, 1992

Mr. Harry Gumm
E. I. Du Pont
Rte. 23 South
Du Pont Rd.
Circleville, OH 43113

Dear Mr. Gumm,

As agreed during our July 31 conversation, I am sending you the Kapton films from four typical brake fluid pressure switch failures. These 500 FN 131 films rupture during cycle testing at 135 C. The brake fluid tested is an after-market DOT 3 fluid, Gunk Heavy Duty Brake Fluid (Radiator Specialty Co.). Unfortunately, I am unable to supply films from the 170 C testing in which the polyimide is attacked severely.

We use three Kapton films stacked together as the switch diaphragm. I've labeled the side that contacts the brake fluid directly. The three films are rotated with respect to one another. I taped the layers together to retain the stacking and orientation.

We hope that you will help us understand what causes the rupture of these films during our cycle testing. I look forward to hearing from you. Thank you for your assistance.

Sincerely,

John E. Brennan

cc: Dave Czarn
Steve Offiler

TI-NHTSA 017367

CIRCLEVILLE PLANT
P.O. Box 89
Circleville, OH 43113

CC: R. C. McKenzie, Conn.

File E-16

August 20, 1992

Mr. John E. Brennan, Ph.D.
Texas Instruments
34 Forest Street
Attleboro, Mass. 02703

Dear Mr. Brennan:

Thanks for sending the Kapton* film from four typical brake fluid pressure switch failures. You indicated the 500FN131 films rupture during cycle testing at 135°C.

Taping the three layers of Kapton* film used to make the diaphragm in its original stacking and orientation was extremely helpful in understanding the failure.

Our initial observations of the failure indicate (1) that the film is damaged in the same location on all three layers, (2) the size of the crack in the diaphragm is about the same on all three layers. The location of the failure in all four assemblies is in the same geographical area.

Based on these observations, I think the rupture is caused by higher stresses occurring at the failure site. If you could look at your design and find anything that might cause this localized pressure, we may be able to find a solution. Some things that might be involved would be thickness tolerances of pieces used in assembly, crimping pressures, or other processing parameters that could create this condition.

If I can be of further assistance, do not hesitate calling me at (614)474-0257.

Sincerely,

Harrison V. Gumm

Harrison V. Gumm
Senior Marketing Specialist
E I du Pont de Nemours & Co., Inc.

Charting a Course for Excellence

TI-NHTSA 017368

DEVICE #8795
PROJ. #3423

MATERIAL SPECIFICATION FOR KAPTON (R) FILM | REV A | 75951 SH.1

1.0 SCOPE
THIS SPECIFICATION DEFINES MECHANICAL PROPERTY, QUALITY AND INSPECTION REQUIREMENTS FOR DUPONT TYPE 300HN, 500HN AND 500FN131 KAPTON (R) AND TEFLON (R) LAMINATED KAPTON (R) FILM SUPPLIED TO TEXAS INSTRUMENTS. THIS SPECIFICATION APPLIES WHEN IT IS REFERENCED ON THE PRINT FOR THE MATERIAL OR FINISHED COMPONENT.

2.0 TRACEABILITY
MATERIAL SUPPLIED TO THIS SPECIFICATION MUST BE TRACEABLE TO THE ORIGINAL MILL ROLL. A MILL ROLL IS DEFINED AS A ROLL THAT IS 50 - 90 INCHES WIDE AND NO LONGER THAN 10,000 FEET. FOR THE PURPOSE OF CERTIFYING STRENGTH AND ELONGATION, A NEW MILL ROLL SHOULD BE DESIGNATED AFTER ANY PROCESS CHANGES THAT MAY AFFECT THE CERTIFIED MINIMUM STRENGTH AND ELONGATION VALUES

3.0 PROCESS CHANGES
PROCESS CHANGES THAT COULD AFFECT THE STRENGTH, ULTIMATE ELONGATION, OR PHYSICAL APPEARANCE OF THE FILM MUST HAVE PRIOR REVIEW AND APPROVAL OF TEXAS INSTRUMENTS.

4.0 STRENGTH AND ELONGATION CERTIFICATION
4.1 TYPES 300HN AND 500HN KAPTON (R) FILM

TENSILE TEST SPECIMENS ARE TO BE TAKEN FROM INCREMENTS ALONG THE WIDTH OF THE ROLL INCLUDING LOCATIONS AT BOTH OUTER EDGES AND THE CENTER. A MINIMUM OF 10 SPECIMENS ARE TO BE TESTED - 1 IN THE MACHINE DIRECTION (MD) AND 1 IN THE TRANSVERSE DIRECTION (TD) FROM EACH OF 5 LOCATIONS ACROSS THE WIDTH OF THE MILL ROLL. THE CERTIFIED MINIMUM STRENGTH IS TO BE THE MINIMUM VALUE RECORDED FOR ALL OF THE TEST SPECIMENS. TENSILE TESTING IS TO BE CONDUCTED UPON START-UP OF A PRODUCTION RUN, THEN ON EVERY OTHER MILL ROLL. IT IS DUPONT'S RESPONSIBILITY TO INCREASE THE FREQUENCY OF INSPECTION IF THERE ARE PROCESS CHANGES OR OTHER FACTORS WITHIN A PRODUCTION RUN THAT MAY RESULT IN STRENGTH OR ELONGATION VALUES THAT ARE LOWER THAN THOSE CERTIFIED BY THE TEST SPECIMENS.

MINIMUM VALUES

ULTIMATE TENSIL STRENGTH	TYPE 300HN & 500HN
MACHINE DIRECTION (MD)	24000 PSI MINIMUM
TRANSVERSE DIRECTION (TD)	24000 PSI MINIMUM
ULTIMATE ELONGATION	
MACHINE DIRECTION (MD)	50% MINIMUM
TRANSVERSE DIRECTION (TD)	50% MINIMUM

TESTING TO BE CONDUCTED PER THE LATEST REVISION OF ASTM D882

DEVICE #8795
PROJ. #3423

MATERIAL SPECIFICATION FOR KAPTON (R) FILM | REV A | 75951 SH.2

4.2 TYPE 500FN131 TEFLON (R) LAMINATED KAPTON (R)
TENSILE TESTING 500FN131 FILM IS NOT REQUIRED PROVIDED THE 300HN KAPTON (R) SUBSTRATE FILM HAS BEEN TESTED AND CERTIFIED TO MEET THE MINIMUM STRENGTH AND ELONGATION VALUES. THE REASONING IS THAT

A.) THE MECHANICAL PROPERTIES OF THE 500FN131 FILM ARE DERIVED MORE FROM THE 300HN SUBSTRATE FILM RATHER THAN THE TEFLON (R) LAMINATE.

B.) THE TEFLON (R) LAMINATING PROCESS ACCORDING TO DUPONT DOES NOT NEGATIVELY AFFECT STRENGTH OR ELONGATION PROPERTIES

IT IS DUPONT'S RESPONSIBILITY TO TEST TYPE 500FN131 FILM IF EITHER

A.) THE 300HN CERTIFICATION DATA IS UNAVAILABLE OR

B.) THERE IS REASON TO BELIEVE THE LAMINATION PROCESS MAY HAVE AFFECTED THE CERTIFIED MINIMUM VALUES OF THE 300HN SUBSTRATE. IN THIS CASE IT IS ACCEPTABLE TO FIRST REMOVE THE TEFLON (R) FILM FROM THE KAPTON (R) SUBSTRATE TO GET A MORE ACCURATE AND REPEATABLE TENSILE TEST. THE MINIMUM STRENGTH AND ELONGATION VALUES FOR THE TYPE 300HN FILM SHALL APPLY.

5.0 DEFECTS (ALL FILM TYPES)
MATERIAL SUPPLIED TO THIS SPECIFICATION MUST BE 100% INSPECTED FOR DEFECTS INCLUDING BUBBLES, PINHOLES AND INCLUSIONS. THE CONTROL PLAN MUST INCLUDE A MEANS FOR PERIODICALLY VERIFING THAT THE INSPECTION EQUIPMENT IS CAPABLE OF LOCATING DEFECTS.

CRITERIA

A. INSPECTION IS REQUIRED TO DETECT HOLES AND BUBBLES IN ALL 300HN AND 500HN FILM, AS WELL AS THE 300HN USED AS THE SUBSTRATE FOR 500FN131 FILM USING AN ON LINE CAMERA INSPECTION SYSTEM. HOLES OF ANY SIZE ARE NOT ACCEPTABLE IN FINISHED PRODUCT SHIPPED TO T.I., AND THEREFORE NEEDS TO BE ADDRESSED THROUGH APPROPRIATE PREVENTION CONTROLS IN THE MANUFACTURE OF THE FILM. AS A PRACTICAL DETECTION CONTROL, THE SYSTEM MUST BE ABLE TO DETECT HOLES AND BUBBLES OF .025" OR GREATER, AND MATERIAL FOUND TO HAVE HOLES OR BUBBLES OF THIS SIZE IS NOT ACCEPTABLE.

B. INSPECTION IS REQUIRED TO DETECT INCLUSIONS OF FOREIGN MATTER IN ALL 300HN AND 500HN FILM, AS WELL AS THE 300HN USED AS THE SUBSTRATE FOR 500FN131 FILM USING AN ON LINE CAMERA INSPECTION SYSTEM. INCLUSIONS OF .025" OR GREATER MUST BE DETECTABLE BY THE SYSTEM AND ARE NOT ALLOWED IN FINISHED PRODUCT SHIPPED TO T.I.

6.0 CERTIFICATION AND DATA RETENTION
WHEN THE PRINT SPECIFIES THAT MATERIAL CERTIFICATION IS REQUIRED, THE SUPPLIER CERTIFIES THAT THE MATERIAL WAS PRODUCED IN ACCORDANCE WITH THIS SPECIFICATION.

ALL STRENGTH TEST DATA AND SPECIMENS ARE TO BE MAINTAINED BY DUPONT FOR A MINIMUM OF (5) YEARS FROM THE DATE OF MANUFACTURE.

DU PONT

CIRCLEVILLE PLANT

P.O. Box 89
Circleville, OH 43113

CC: E. C. McKenzie, Conn.

FILE E-IL

August 20, 1992

Mr. John E. Brennan, Ph.D.
Texas Instruments
34 Forest Street
Attleboro, Mass. 02703

Dear Mr. Brennan:

Thanks for sending the Kapton* film from four typical brake fluid pressure switch failures. You indicated the 300FN131 films rupture during cycle testing at 135°C.

Taping the three layers of Kapton* film used to make the diaphragm in its original stacking and orientation was extremely helpful in understanding the failure.

Our initial observations of the failure indicate (1) that the film is damaged in the same location on all three layers, (2) the size of the crack in the diaphragm is about the same on all three layers. The location of the failure in all four assemblies is in the same geographical area.

Based on these observations, I think the rupture is caused by higher stresses occurring at the failure site. If you could look at your design and find anything that might cause this localized pressure, we may be able to find a solution. Some things that might be involved would be thickness tolerances of pieces used in assembly, crimping pressures, or other processing parameters that could create this condition.

If I can be of further assistance, do not hesitate calling me at (614)474-0287.

Sincerely,

Harrison V. Gunn

Harrison V. Gunn
Senior Marketing Specialist
E I du Pont de Nemours & Co., Inc.

Charting a Course for Excellence

TI-NHTSA 017370

07.07.92 11:00 AM P01

ROUTE TO

TEXAS INSTRUMENTS

ATTLEBORO, MASSACHUSETTS 02703

REPORT OF DISCREPANT IN-PROCESS MATERIAL

No. 007745

DWG NO. & NAME		REV	LOCATION	DATE	Mfg. Supervision Review:
37225-1 KAPTON STRIP		V	67236	[illegible]	
SOURCE DU PONT	DATES 65/485	PROD. CODE 0/5	QUANTITY 1		

ITEM	ATTRIBUTE/REQUIREMENT	ACTUAL				
01	WORKMANSHIP	CONTAMINATION TRAPPED BETWEEN LAYERS OF KAPTON				
	2-15-92					

MATL/PROD. CONTROL

COMMENTS:

5 pages

TO: [redacted]

FROM: KEN BERRY FAX# 508-699-3788

509-699-3780

TI-NHTSA 017371

TEXAS INSTRUMENTS - M & C

CORRECTIVE ACTION REQUEST

THIS RESPONSE IS DUE 15 WORKDAYS AFTER RECEIPT AT YOUR FACILITY

RETURN TO:
Ken Berry MS 11-11
Texas Instruments Incorporated
34 Forest Street
Attleboro, MA 02703

DATE PREPARED:

SUPPLIER:	E.I. DUPONT	PART NUMBER:	27225-1
ATTENTION:	MIKE YUNKER	CAN/ITEM #	007745

1. Do you understand the specification requirement(s) for the characteristic(s) rejected ? YES ☐ NO ☐

If no – describe concern:

If the requirement is not understood, what specific area of information needs clarification?

- TI print unclear ☐
- TI purchase order ☐
- Standards of acceptance ☐
- Other – ☐

2. Please identify the actions you have taken to contain or limit the non-conformance at your facility until a corrective action is in place. Include comments on your inventory, in-transit material, and TI inventory.

What was the Effectivity Date of this containment action ? ____________

3. Has your process, machinery or operation been significantly changed since this part number was qualified by M & C ?

4. Have your measurement methods or inspection equipment significantly changed since this part number was qualified by M & C ? Please state your present measurement method.

5. What allowed this non-conformance to escape your facility ?

6. Other than "increased inspection," what specific action(s) will be taken to prevent the defect from recurring ?

What was the Effectivity Date of this corrective action ? ____________________

Have you audited or verified that the above corrective action(s) will be effective in correcting the problem ?

If your current process or quality system is no longer capable of meeting M & C's specifications, contact the TI Purchasing agent or Procurement Assurance Engineer.

SUPPLIER'S AGENT: ____________________ (please print) TITLE: ____________________

DATE COMPLETED: ____________________

-MSG M#= 00163526 FR=U2JB TO=SBO1 SENT=10/20/92 10:46 AM
R#=083 ST=C DIV=0050 CC=00101 BY=U2JB AT=10/20/92 10:31 AM

To: DAVID CZARN	ZARN	STEPHEN B. OFFILER	SBO1
ANDY McKENNA	SPRT	AGNES CARDOZO	ADC

From: JOHN E BRENNAN U2JB

Subj: Kapton Film Update

I talked with Harry Gumm of DuPont yesterday afternoon. He said they were cutting the samples for our testing, and that those samples would be mailed to me today. He also said that their operating procedure is to run all samples and controls at the same time. We have to decide if we want the 1000 hr samples to be run before ANY testing can be done. He felt that a complete evaluation would have the 1000 hr samples in them. I agree, and I welcome your thoughts. → 42 DAYS; (6 WEEKS)

We're pulling things together in Adv. Dev. to be prepared for the samples when they arrive. We are organizing to get the test running as soon as possible after the samples are here.

John

TI-NHTSA 017374

Harry Igumm:	1/21/93.

Delamination is not an issue. Use delaminated Kapton. Teflon has no effect on tensile/tear strength of Kapton.

Suggests doing both directions to gain as much data as possible. No Dupont data exists for preferential direction in fluids.

~~Other~~. No problem with storage after test.

Suggested Matrix

3 Fluids

2 Kapton

2 Direction

~~Strips each~~

×

3 times

×

4 ~~8~~ strips a.

3×2×2×4×3

= 144 strips.

TI-NHTSA 017375

KEITH COSTELLO
3-21-95

DU PONT

MATERIAL SAFETY DATA SHEET

E. I. DUPONT DE NEMOURS & CO
POLYMER PRODUCTS DEPARTMENT
ELECTRONICS DEPARTMENT
1007 MARKET STREET
WILMINGTON, DE 19898

TELEPHONE NUMBERS
MEDICAL EMERGENCY 800-441-3637
PRODUCT INFORMATION 800-441-7515
TRANSPORTATION EMERGENCY 800-424-9300

MATERIAL IDENTIFICATION

PRODUCT NAME	Kapton® Polyimide Film Types H, V, C09, FPC, HA, HN, HPP-A, HPP-LT, MT, PST, PST-C, VN, XC, ~~XC600~~, XFPC, 5X4M, XT
CHEMICAL NAME	Aromatic Polyimide plus up to 1% dimethyl acetamide
CAS REGISTRY NUMBER	25038-81-7
TSCA INVENTORY STATUS	All reportable ingredients are listed in the TSCA Chemical Substance Inventory.
DOT HAZARD CLASS	Not regulated
SHIPPING NAME	NA
PREPARER	C. B. Stouffer DATE August 21, 1990

HAZARDOUS COMPONENTS

		MT Types Only	C & CX Types
MATERIAL	Dimethyl acetamide	Alumina	Carbon black
CAS NO.	127-19-5	1344-28-1	1333-86-4
CONCENTRATION %	Up to 1%	35% max	30% max
OSHA PEL	10 ppm(skin)*	10mg/m³ total dust 5mg/m³-resp. dust	3.5mg/m³
ACGIH TLV	10 ppm (skin)*	10mg/m³	3.5mg/m³
DUPONT AEL	10 ppm (skin)*	NE	3.5mg/m³

*The "skin" notation serves as a reminder that exposure can result through skin absorption as well as through inhalation, and that appropriate precautions should be taken to prevent both types of exposure.

SUBSTANCES PRESENT AT A CONCENTRATION OF 0.1% OR MORE CLASSIFIED AS A CARCINOGEN BY IARC, NTP OR OSHA: None

PHYSICAL/CHEMICAL DATA

APPEARANCE	Transparent film, light amber color
ODOR	None
MELTING POINT	None
SOLUBILITY IN WATER	Insoluble
VOLATILE CONTENT	1% max
SPECIFIC GRAVITY	>1.4

FIRE AND EXPLOSION HAZARD DATA

FLASH IGNITITION TEMPERATURE NA

UNUSUAL FIRE, EXPLOSION HAZARDS Chars but does not burn in air. Kapton® will burn in an atmosphere of 100% oxygen. Static charge may build up during handling of Kapton® film.

HAZARDOUS COMBUSTION PRODUCTS Carbon monoxide.

SPECIAL FIRE FIGHTING INSTRUCTIONS Not required.

EXTINGUISHING MEDIA Water, Carbon Dioxide, Foam, Dry Chemicals.

HAZARDOUS REACTIVITY

CONDITIONS TO AVOID Temperatures above 400°C without adequate ventilation.

MATERIALS TO AVOID None known.

HAZARDOUS DECOMPOSITION PRODUCTS None under normal conditions. At temperatures above 400°C the major off-gases are carbon monoxide and carbon dioxide.

HEALTH HAZARD DATA

Read "Safety in Handling and Use" Bulletin H-72084 before using Kapton®.

ACUTE OR IMMEDIATE EFFECTS: ROUTES OF ENTRY AND SYMPTOMS

INGESTION Not a probable route of exposure.

SKIN No irritation expected. Less than 1 ppm dimethyl acetamide was extracted from film by distilled water at 40°C for 4 hours.

EYE Not a probable route of exposure. Mechanical irritation.

INHALATION Not a probable route of exposure for film. For the polymer from which this film is made, Du Pont recommends treating polymer dust as a nuisance particulate, and has established an AEL of 10 mg/m^3 total dust, the same as the TLV for nuisance particulates.

EMERGENCY FIRST AID

- Inhalation or ingestion not a probable route of exposure.
- For prolonged skin contact, wash with soap and water. In case of skin irritation, consult a physician.
- Flush eyes with water. Consult a physician.

CHRONIC EFFECTS None known.

STATE RIGHT TO KNOW LAWS

No substances on the state hazardous substances list, for the states indicated below, are used in the manufacture of products on this Material Safety Data Sheet, with the exceptions indicated. While we do not specifically analyze these products, or the raw materials used in their manufacture, for substances on various state hazardous substances lists, to the best of our knowledge the products on this Material Safety Data Sheet contain no such substances except for those specifically listed below.

SUBSTANCES ON THE PENNSYLVANIA HAZARDOUS SUBSTANCES LIST PRESENT AT A CONCENTRATION OF 1% OR MORE:
Dimethyl acetamide (1% maximum). C and XC types contain carbon black (2-30%). MT types contain alumina (35% maximum).

SUBSTANCES ON THE PENNSYLVANIA SPECIAL HAZARDOUS SUBSTANCES LIST PRESENT AT A CONCENTRATION OF 0.01% OR MORE: None known.

NON-HAZARDOUS INGREDIENTS PRESENT AT A CONCENTRATION OF 3% OR MORE REQUIRED TO BE LISTED BY PENSYLVANIA:
Polyimide film CAS 25038-81-7

WARNING: SUBSTANCES KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER: None known.

WARNING: SUBSTANCES KNOWN TO THE STATE OF CALIFORNIA TO CAUSE BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM: None known.

SUBSTANCES ON THE NEW JERSEY WORKPLACE HAZARDOUS SUBSTANCE LIST PRESENT AT A CONCENTRATION OF 1% OR MORE (0.1% FOR SUBSTANCES IDENTIFIED AS CARCINOGENS, MUTAGENS OR TERATOGENS):
Dimethyl acetamide (1% maximum). C and XC types contain carbon black (2-30%). MT types contain alumina (35% maximum).

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE None known.

PROTECTION INFORMATION

EYE Safety glasses recommended.

SKIN Gloves recommended.

VENTILATION Local exhaust for operations above 200°C.

RESPIRATOR Not required for normal processing.

DISPOSAL

SPILL, LEAK OR RELEASE Pick up to prevent slipping hazard.

WASTE DISPOSAL Landfill or incinerate in compliance with federal, state, and local regulations.

AQUATIC TOXICITY Insoluble.

STORAGE CONDITIONS Store away from flammable materials.

The information in this Material Safety Data Sheet relates only to the specific material (s) designated herein and does not relate to use in combination with any other material or in any process.

NA = Not applicable
NE = Not established
AEL = Du Pont Company's Acceptable Exposure Limit
< = New or revised information in this section when "<" is in right margin

SECTION 313 SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372:

MT types contain up to 35% alumina (1344-28-1) encapsulated in polymer.

This information must be included in all MSDSs that are copied and distributed for this material.

QUALITY MANUAL

This manual is the property of:

E.I. du Pont de Nemours, Circleville, OH

It may be freely consulted by our customers and by agreed product quality and quality systems certifying organizations.

Authorized by:

L.K. Millikin (signature)	5/14/93
L.K. Millikin Circleville Site Manager	Date
(signature)	5/14/93
R. Hutton Worldwide HPF Business Mgr. Kapton-Teflon	Date
William R. Geddie (signature)	5/13/93
W. R. Geddie Area Superintendent Finishing, Quality Control Management Representative	Date
P W Leahy (signature)	5/14/93
P. W. Leahy Quality Systems Administrator	Date

Distribution:

Copy No.	Holder
Original	ISO Clerk
1	BSI, U/L, or QSA
2	K-T Stenographer
3	Quality Systems Administrator(QSA)
4	HPF Fin & QC Area Supt.
5	Removed
6	Production Control Supervisor
7	Q.C. Laboratory Supervisor
8	HPF Mfg Area Supt.
9	Removed
10	HPF Integrated Op. Area Supt.
11	Worldwide HPF Business Mgr
12	Teflon Operations Supervisor

Revisions to Quality Manual

Date	Revision	Section	Page	Modification
8/26/91	1	All	All	General; Preassessment
10/15/92	2	1	3	Remove copies 5,9
10/15/92	2	3	6	Rev product thicknesses
10/15/92	2	3	7	Added Prod Contr. Ref
10/15/92	2	4.1	9	Removed Tech. Mgr, SS Sup Added Oper. to Day Supv Added Distribution Mgr
10/15/92	2	4.1	10	Removed Tech Mgr
10/15/92	2	4.1	11	Added Maint Supv
10/15/92	2	4.1	12	Added Int Audits to QSA
10/15/92	2	4.1.4	14	Added ref to QSP0018
10/15/92	2	4.2	16	Added QSP 0017, 0018
10/15/92	2	4.12	29	Added Tech Rep, 2nd Para.
10/15/92	2	4.13	30	Rem. repeated sentence
10/15/92	2	4.14	31	Added Mylar Prod Contr
10/15/92	2	4.15	32	Added new locations
05/06/93	3	1	2	Revised Names, Titles
05/06/93	3	1	3	Changed Titles
05/06/93	3	2	5	Added new page for Rev.
05/06/93	3	2	6	Revised page numbers
05/06/93	3	4.1	9	Drop SP-ST, Chg Name
05/06/93	3	4.1	10	Chg Title Oper Mgr
05/06/93	3	4.1	11	Chg Titles, Rev Resp.
05/06/93	3	4.1	12	Chg Titles, Rev Resp.
05/06/93	3	4.1	13	Chg Titles, Rev Resp.

Revisions to Quality Manual

Date	Revision	Section	Page	Modification
05/06/93	3	4.1	14	Chg Titles, Rev Resp.
05/06/93	3	4.1	15	Added Resp to Doc. Contr.
05/06/93	3	4.12	30	Chg'd Sr Qual Engr to Lab Supv., Auth for Disp.
05/06/93	3	4.13	31	Dropped "plant", last Para

INDEX

3.1 INTRODUCTION

The Kapton-Teflon plant at Circleville manufactures Kapton polyimide films and Teflon films. Chemically, Kapton is a polyimide polymer makeup that is the result of a polycondensation reaction. The resulting base film, type HN, is a tough aromatic polyimide film that is an exceptionally strong, heat resistant film with an excellent combination of mechanical and electrical properties. The plant makes two other general types of Kapton, type FN, which is a heat sealable grade. This product is achieved by combining type HN Kapton with Teflon FEP fluorocarbon resin, through a laminating or coating process. Type VN films exhibit the same tough polyimide properties as HN, with superior dimensional stability at elevated temperatures. Kapton films are sold in thicknesses of 0.3 mils to 11.0 mils.

Teflon films are produced from various fluorocarbon resins including FEP, PFA and Tefzel, some of which are pigmented. The pellets are melted and extruded into a Teflon film for subsequent processing in treating, laminating and slitting. In addition to the different resin types, the plant offers Teflon films in thicknesses ranging from 0.5 mils to 225.0 mils. It is sold into several markets where it is unique among plastics. It is the most chemically inert of all plastics, withstands both high and low temperature extremes, has superior electrical properties, has superior anti-stick/ low friction properties plus many more unique characteristics.

Some of the applications or markets for Kapton from the electrical and electrical industry field are: field coil insulation, substrates for flexible printed circuits, motor and generator armature slot liners, magnet wire insulation, transformer and capacitor insulation, magnetic recording and pressure-sensitive tapes, and wire and cable insulation.

A few of the applications for Teflon include a general purpose items such as Cell culture bags, plain and metallized microphone electrets and a variety of release applications; cementable films for laminated belting, high-performance pressure-sensitive tapes and protective clothing; chemical process films for tank linings, thermoformed rupture disc seals, and thick gaskets and drop-in mold liners; and aerospace composite molding release films.

3.2 Purpose

The Quality Management System as defined by this Quality Manual is applicable to all Kapton* and Teflon* production and support facilities located at the DuPont site in Circleville, OH.

This manual is intended as a general overview of the Kapton*-Teflon* Quality Management System and does not include specific information related to the actual execution of many of the Quality System features. This manual is the responsibility of the Quality Systems Administrator and is reviewed/updated at least every two years.

3.3 General References

* ISO 9002: 1987, "Quality Systems--Model for Quality Assurance in Production and Installation"
* Circleville Safety How
* Circleville General Procedures How
* Circleville Site Manufacturing Plan
* PQM Manual
* Kapton General Specification Bulletins
* Teflon General Specification Bulletins

3.4 Controlled Documents Referenced

* Kapton-Teflon Quality Manual
* Kapton-Teflon Quality System Procedures (QSP's)
* Kapton-Teflon Area Procedures (AP's)
* Kapton-Teflon Operating Procedures (OP's)
* Kapton-Teflon Standard Operating Conditions (SOC's)
* Kapton-Teflon Area Forms, Reference Charts, Decision Trees and similar forms used and described in area procedures.
* Business Services Purchasing Manual
* Business Services Quality Manual
* Mylar Production Control Manual/Procedures

4.1 MANAGEMENT RESPONSIBILITY

4.1.1 Quality Policy

The quality policy of the Kapton*-Teflon* plant is the following:

> "The Kapton*-Teflon* plant will be recognized as providing the best value to customers through quality leadership and continuous improvement in all our products and services."

R. Hutton
Worldwide HPF Business Mgr
10 May 1993

4.1.2 Organization

The basic Organization Chart of the Kapton*-Teflon* plant is as follows:

- Plant Manager
  - HPF World Wide Business Manager
    - Area Superintendents
      - Shift Supervisors
        - Operators
      - Day Supervisors
        - Laboratory Technicians
        - Technical Assistants
        - Mechanics
        - Schedulers
        - Charters
        - Operators
      - Production Engineers
      - Chemists
      - Quality Engineers
      - Area Specialists
      - Systems Support
  - Human Resources and Site Services Manager
    - Personnel Superintendent
  - Business Services and Supply Chain Manager
    - Purchasing and Contract Administration Supervisor
      - Essential Materials Accountant
    - Information Systems Supervisor
    - Distribution Manager

4.1.3 Responsibilities and Authorities

An outline of the responsibilities and authorities of the different functions on the Organization chart is as follows:

o **Plant Manager**

Has the responsibility of providing overall leadership for the plant site in order to accomplish the strategic objectives of the business served.

o **HPF Worldwide Business Mgr.**

Overall managerial responsibility for the Kapton* and Teflon* products.

Authorization of top level documents and the Quality Policy of the referenced product lines.

o **HPF Manufacturing Area Superintendent**

Overall responsibility for the manufacturing operations

Authorization of the procedures and documents relating to activity in his areas.

Responsibility for and participation in periodic Quality System reviews for their areas:
* internal reviews
* external reviews

Defines assignments of the Production Engineers, Chemist, and specialists.

Overall responsibility for area process development efforts.

Authority to accept material by concession in concert with the Process Engineer.

Overall responsibility for the Kapton-Teflon maintenance operation, including calibration of process equipment.

o **HPF Integrated Operations Area Superintendent**

Overall responsibility for Production Control.

Authorization of the procedures and documents relating to Production Control. Defines assignments of Production Control Supv, CFM Engineers and Specialists.
Responsibility for and participation in periodic Quality System reviews for Kapton-Teflon:
* internal reviews
* external reviews

4.1.3 Responsibilities and Authorities (cont'd)

o **Area Superintendent-Production and Technical-Finishing & QC**

Designated Kapton - Teflon Management Representative who, irrespective of other responsibilities, has full authority and responsibility for ensuring that the requirements of ISO 9002 are implemented and maintained.

Overall responsibility for the Kapton - Teflon Finishing operation.

Overall responsibility for the Quality Control laboratory.

Authorization of the procedures and documents relating to Finishing and Quality Control.

Responsibility for and participation in periodic Quality System reviews for specified areas:
* internal reviews
* external reviews

Defines assignments of the Production Engineers, his Supervisors, and Project Engineers

o **Production (Area) Supervisors**

Safety and Environmental in the process areas.

Provide scheduling of equipment maintenance.

Monitor and support for the plant operation, including coordinating process outage.

Oversee the supplies for the process including raw materials

Coordination of housekeeping.

o **Maintenance Supervisors**

Safety and Environmental in the maintenance areas.

Review scheduling of equipment maintenance, schedule people

Monitor and support for the plant operation

Responsible to provide resources as required to see that calibration of process equipment is completed according to procedures.

Coordination of housekeeping.

4.1.3 Responsibilities and Authorities (cont'd)

o **QC Lab Supervisor**

Administrative responsibility of the laboratory.

Maintenance of lab equipment and supplies.

Manages all raw material specifications and testing

Initiates action to dispose of non conforming product

Maintain product release system; product reviews

Customer inquiries and concerns; customer certification

o **Production Engineers/Chemist**

Routine support for the processes.

Design and revision of equipment and operating systems.

Corrective action on process upsets.

Design and follow up of Test Authorizations.

Develop and maintain standard operating conditions and procedures.

Monitoring process operation and review of process documentation.

o **Process Development Chemists/Engineers**

Design and implementation of manufacturing experiments.

Process development and support the Kapton-Teflon processes

Assist in design and revising equipment for the Kapton-Teflon processes

Develop laboratory basic data for Kapton-Teflon processes.

o **Quality System Administrator**

The monitoring and coordination of the quality system.

Ensure that the requirements of ISO 9002 are implemented and maintained, at the direction of the Management Representative, especially Internal Auditing System.

4.1.3 Responsibilities and Authorities (cont'd)

- **Project Engineers**

  Provide engineering design on process equipment for projects.

- **Senior Technical Engineer, QC**

  New and or revised product tests and equipment.

  For calibration method on equipment used to test product.

  Interlaboratory Checks and Interlaboratory Method Control

- **Production Operators**

  Perform actual work tasks for a given area of manufacturing, testing, material handling, etc.

  Operators process quality data pertaining to each phase of their particular operation.

  Make some routine quality measurements of product vs specification.

  Document and file the required processing history information for each lot.

  Cast films according to Standard Operating Conditions and Procedures.

  Obtain film samples for lab analysis.

  Document process conditions as required.

  Specific responsibilities are defined in area procedures.

- **Laboratory Technicians**

  Performance of raw material, in-process, and product analysis, as required.

  Recording results of tests and releasing product or essential ingredients per standards provided.

- **Scheduler, Production Control**

  Review orders to ensure they are stated correctly

  Notify CSC of shipment delays and document any changes.

4.1.3 Responsibilities and Authorities (cont'd)

o **Control Mechanics**

Responsible for calibration systems; for the control of inspection, measuring, and test equipment used to verify the conformance of equipment used in the processes.

Primarily responsible for installation, repairing, maintaining, and calibrating equipment.

o **Document Controllers**

Responsible for maintaining and controlling all the documents in their area of responsibility. This includes numbering, formatting, and having reviewed before expiration.

Where Document Controller is also training coordinator, responsibility also includes coordinating and maintaining operator training.

4.1.3 Responsibilities and Authorities (cont'd)

Additional responsibilities, authorities, and interrelationship of personnel managing, performing and verifying work affecting quality are defined by Job Descriptions (as maintained by Training Coordinator), documented procedures, and the communicated wishes of said personnel's direct management.

The Area Superintendent, Quality Control will serve as the Management Representative who, irrespective of other responsibilities, shall have defined authority and responsibility for ensuring that the requirements of the Quality Management System, as defined in this Quality Manual, are implemented and maintained.

4.1.4 Management Review

The Quality Management System defined in this Quality Manual will be reviewed, at least annually, to determine its continuing suitability and effectiveness. This review will include the Site Manager, the HPF Worldwide Business Mgr, senior heads of the Employee Relations and Business Services, the Management Representative, HPF Area Supts, the QSA, and others as requested. Such reviews will include an assessment of the results of vendor performance, concessions on product release, customer complaints, outstanding corrective actions, and external and internal quality audits. Records of these reviews will be kept in accordance with appropriate sections of this manual.
Additional details are in QSP 0018.

4.2 QUALITY SYSTEM

4.2.1 **Kapton*-Teflon* Quality Manual:** outlines the elements and objectives of the Plant Quality Management System and how it complies with the ISO 9002 standards.

4.2.2 **Quality System Procedures:**

- Provide the minimum features needed by Functional Areas to satisfy and comply with the elements and objectives of the Plant Quality Management System.
- Contain specific information where a uniform system has been adopted across the Functional Areas.
- Where no uniform system has been established, the Quality System Procedures will explain what the requirements are for a given feature. Functional Areas are then able to develop their own systems and will document them in Area Procedures.
- An Index of Quality System Procedures is on the next page

4.2.3 **Area Procedures:** explain in specific terms how an area satisfies those requirements detailed in the Quality System Procedures.

4.2.4 **Operating Procedures:** a step by step instruction on how to perform a specific job.

4.2.5 **Standard Operating Conditions:** a set of conditions that are used to produce a given product on a given type of equipment.

4.2.6 **Test Methods:** step by step instructions on how to run specific tests in the laboratory.

4.2.7 **Product Release Sheets:** controlled set of release standards used by the laboratory to release product.

4.2.8 **Slitting specifications, slitting charts, standard forms, flow charts:** Part of the Quality System documentation explained by Quality System Procedures or Area Procedures as needed.

QUALITY SYSTEM PROCEDURES

QSP0001	FORMAT FOR QUALITY SYSTEM PROCEDURES
QSP0002	DOCUMENT CONTROL
QSP0003	RAW MATERIAL CONTROL
QSP0004	PRODUCT IDENTIFICATION AND TRACEABILITY
QSP0005	STANDARD OPERATING SYSTEM
QSP0006	PROCESS EQUIPMENT CALIBRATION
QSP0007	LABORATORY EQUIPMENT CALIBRATION
QSP0008	CORRECTIVE ACTION
QSP0009	QUALITY RECORDS
QSP0010	INTERNAL AUDITS
QSP0011	TRAINING
QSP0012	FORMAT FOR AREA PROCEDURES
QSP0013	NONCONFORMING PRODUCT
QSP0014	TEST APPROVALS (TA's)
QSP0015	FORMAT FOR OPERATING PROCEDURES
QSP0016	EXTERNAL QUALITY AUDIT PROCEDURE
QSP0017	PRODUCT SPECIFICATION SYSTEM
QSP0018	MANAGEMENT REVIEW

4.3 CONTRACT REVIEW

Contract, as stated here, refers to an order for product placed by Marketing through a Customer Service Center (CSC), who in turn places an order with the plant. The Kapton-Teflon quality system starts with the receipt of the order from the Customer Service Center. Orders are received electronically by the plant.

Orders, are reviewed on the plant site after receipt to ensure that the requirements of the customer (CSC) are adequately stated or documented, and that the plant has the ability to meet those requirements. This review is performed by the Production Control function. If additional requirements are needed, or if the plant does not possess the ability to meet the requirements as stated, the requirements will be revised to accurately reflect the product which the customer will receive. Such revisions will be coordinated with the customer as needed.

Records of the orders and review will be maintained by Production Control in accordance with Section: 4.15 of this manual.

If a shipment date cannot be met, the CSC is notified and notice is documented.

Additional detail is given in Production Control Procedures.

4.4 DOCUMENT CONTROL

All documents and data which are used to satisfy the elements and objectives of the plant Quality Management System will be controlled. Control includes the following:

- o Review and authorization by specified individuals prior to issue
- o Pertinent copies of documents at locations where they are needed and used
- o Documented index and distribution list for each type of document
- o Removal of obsolete documents from circulation
- o Reissue of documents when a change is necessary.

Because documents are used throughout the Quality Management System, responsibilities to control documents can be found at many levels of the operation.

Document control will be administered according to QSP 0002.

4.5 PURCHASING

Purchase requisitions are initiated locally and executed as orders locally or submitted to Material and Logistics Regional Office for actual procurement. Each functional area is responsible for identifying those requirements and verifying the suitability of these materials.

Purchasing documentation includes a complete description of the item, suggested vendor, charge codes, authorizations for the purchase, and delivery information. Specification numbers are included on the order if it is for a raw material.

Vendors are selected based on their ability to supply the product as needed in a timely manner. Vendors have agreed on specifications for the materials they provide. Vendor performance is evaluated routinely. Additional details are given in the Business Services Purchasing Manual, and QSP 0003.

4.6 PURCHASER SUPPLIED PRODUCT

Currently, no materials supplied by customers are incorporated into a Kapton*-Teflon* product. If materials are provided by customers in the future, the Area receiving those materials will be required to verify, store, and maintain those materials as needed in conformance with the Quality Management System. The established controls for this material will be developed to ensure that the material provided by the customer becomes part of the product which is delivered to that customer.

4.7 PRODUCT IDENTIFICATION AND TRACEABILITY

The Kapton*-Teflon* plant maintains a system of identifying product at all stages of production such that all final products can be traced to the vendor lot numbers of the raw materials used to produce that product. Incoming materials are identified with a unique material name and number. Upon receipt of materials and during the manufacturing process, unique lot numbers are utilized or assigned to provide traceability. Once film is produced, mill roll numbers are assigned. New numbers are assigned whenever film is converted to a different product or preslit to a different size.

Since cast rolls are produced on a continuous process, tracing raw material lots or Solvent Recovery Materials is time dependent.

Additional detail is given in QSP 0004.

4.8 PROCESS CONTROL

4.8.1 General

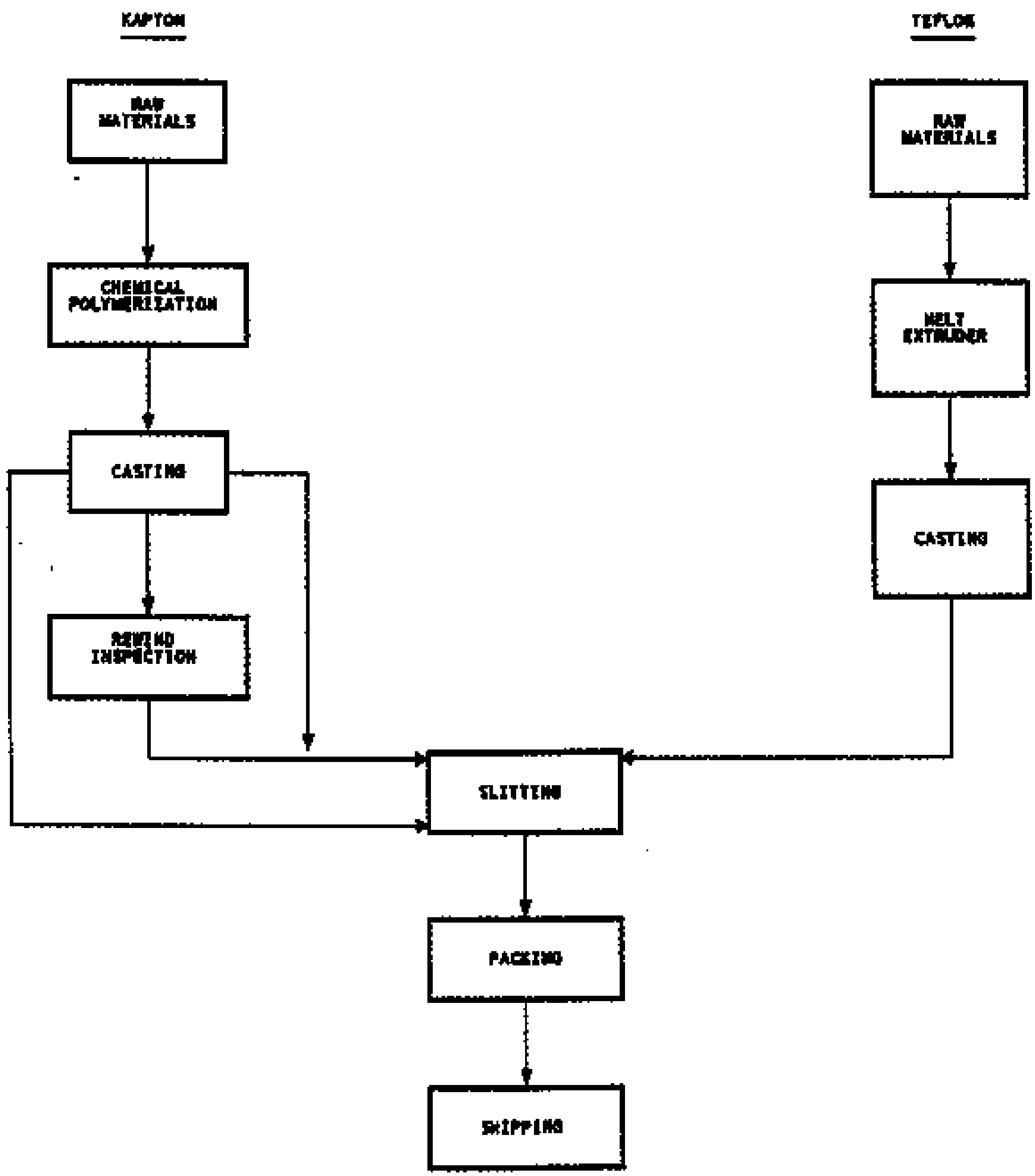
All Kapton*-Teflon* processes will be run under a state of controlled conditions. These processes are shown schematically on the following three pages. Functional areas are responsible for establishing these controlled conditions which include:

- o Production schedules, based on orders and forecasts, are communicated by Production Control to the areas. The manufacturing areas use these schedules to plan product changes.
- o Documented work instructions, Area Procedures (APs) and Operating Procedures (OPs), explain how tasks are to be performed where the lack of such instructions could significantly reduce the product's level of quality.
- o Specified operating conditions, called Standard Operating Conditions (SOCs), which describe where process parameters should be set
- o Control of process parameters to the greatest extent within specified ranges
- o Operation of the processes outside of specified ranges only after obtaining authorization
- o Routine monitoring of these processes to ensure process stability. Monitoring techniques include one or more of the following:
    - Automatic control loops
    - Manual controls
    - Computerized control systems
    - Statistical control charts
- o Additional detail is given in QSP 0005 and Area Procedures

4.8.2 New Equipment or Process

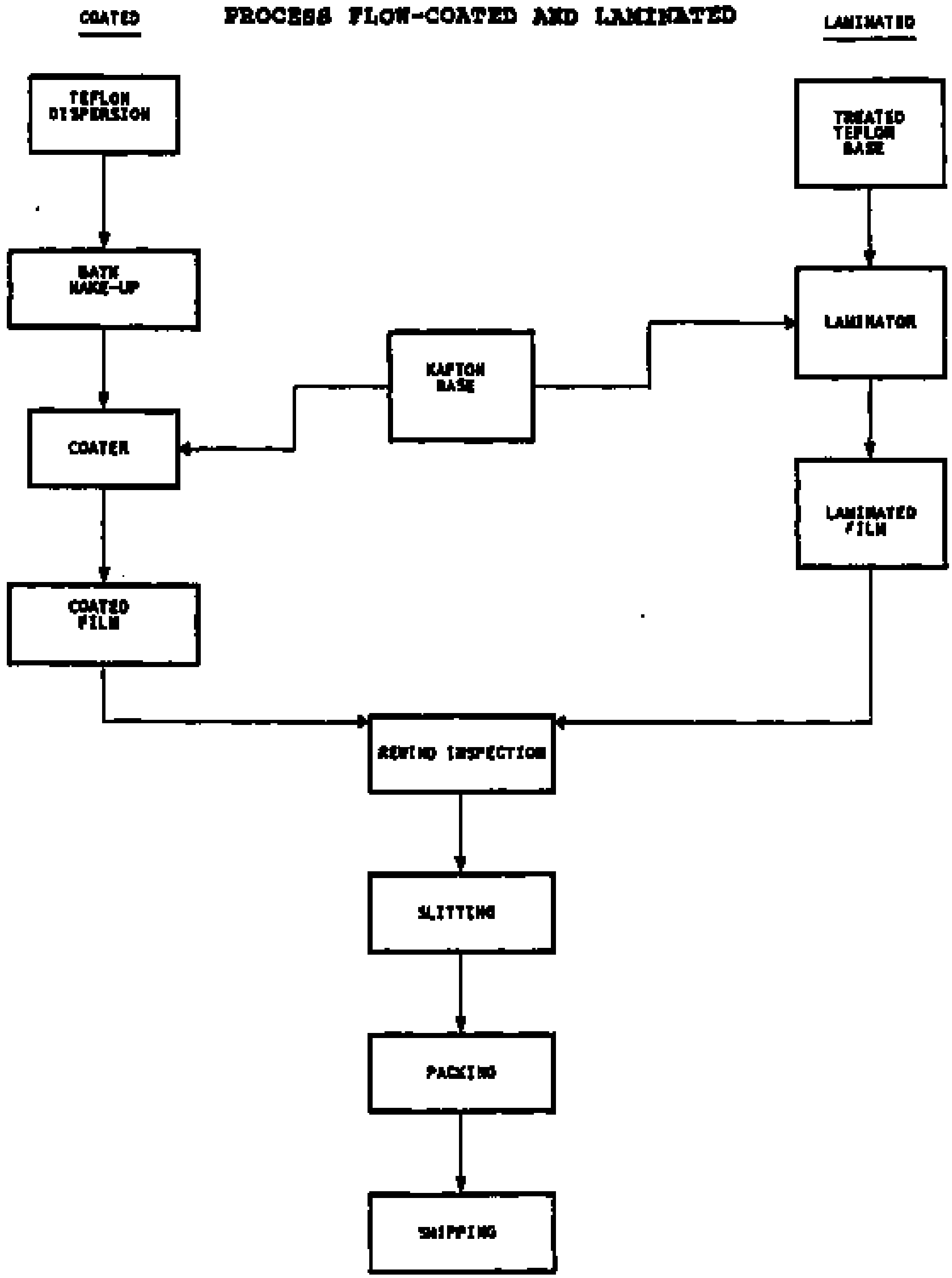
Any product manufactured on new equipment or by a new process is produced under the plant TA (Test Authorization) system. This system provides the documentation and approval system for using a non-standard process. This system is described in more detail in QSP 0014.

PROCESS FLOW-PLAIN FILM



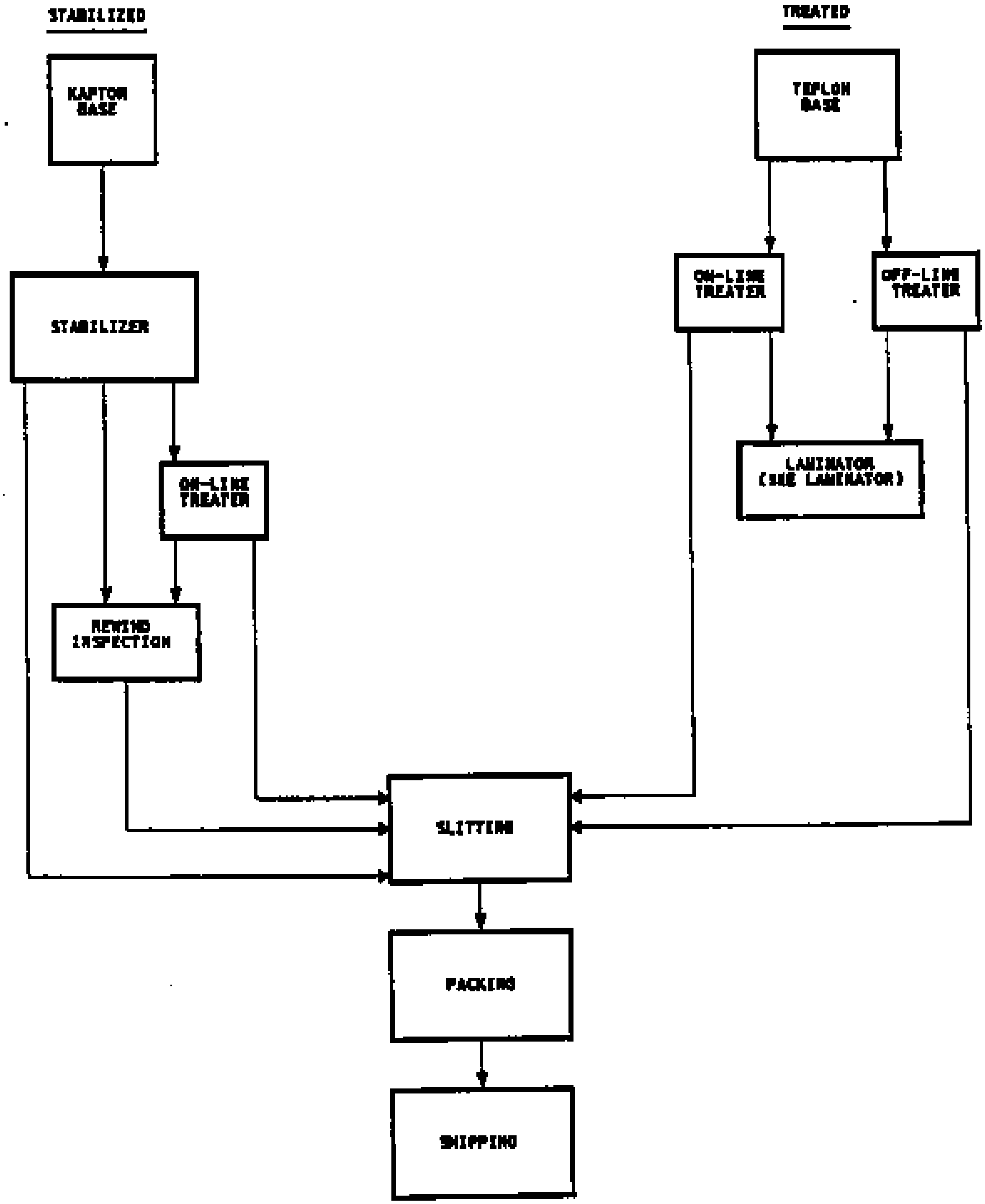
KAPTON* - TEFLON* REGISTERED TRADEMARK OF DU PONT

PROCESS FLOW-COATED AND LAMINATED



KAPTON* - TEFLON* REGISTERED TRADEMARK OF DU PONT

PROCESS FLOW - STABILIZED AND TREATED



KAPTON* - TEFLON* REGISTERED TRADEMARK OF DU PONT

4.9 INSPECTION AND TESTING

Material is inspected and/or tested at three stages in the production process: receiving (raw materials), in-process (partially converted material), post-process (fully converted material or final product). For any of these types of testing, the following information will be documented:

- o Frequency for performing the inspection or test
- o Procedure for performing the inspection or test
- o Specifications for passing/failing the inspection or test
- o Process for handling material which has passed the inspection or test
- o Process for handling material which has failed the inspection or test (see 4.12)
- o The authority for releasing product

The results of all inspections and tests will be recorded to serve as evidence that the material truly passed the appropriate test. Production areas that run tests on product in the area will be responsible to forward results to the lab for recording on appropriate lab records. Tests run in the lab will be recorded by the lab tech. Tests run in Finishing will be recorded on appropriate forms in the Finishing Area.

No materials will be completely dispatched to the next production step until all tests and inspections have been executed. If urgent production needs arise and untested materials are used in a subsequent processing step, the required tests will still be performed and those materials will be identified so as to allow for recall in the case that the materials do not pass the inspection or test.

Additional detail can be found in QSP 0003 and Quality Control Area Procedures.

4.10 INSPECTION, MEASURING, AND TEST EQUIPMENT

All equipment used to determine the disposition of the Kapton*-Teflon* materials or product will be calibrated to the required accuracy in order to ensure the ability of this equipment to measure desired material and product characteristics.

The calibration of all such equipment will be maintained regardless of whether it is owned, borrowed, or leased by any portion of the Kapton*-Teflon* plant.

Functional areas needing such equipment will identify and select equipment capable of meeting the accuracy needs. Actual calibration of this equipment will be performed by trained individuals and will include:

- A prescribed interval for calibration
- Documented calibration procedures
- Use of certified equipment which, where possible, is traceable to national standards
- Documented actions to be taken when equipment is found to be out of calibration
- Identification of the calibration status directly on, or as near as practical to, the calibrated equipment
- Records of the equipment calibration.
- Appropriate environmental conditions for calibration and usage of inspection, measuring, and test equipment

Additional detail may be found in QSP 0006 and QSP 0007, as well as in Maintenance and Quality Control Area Procedures.

4.11 INSPECTION AND TEST STATUS

Material is identified at all stages of production by the functional areas to indicate the tests which have been completed on that material and the results of those tests. The inspection authority will release product according to specifications. This is to ensure that only material which has passed inspection and test will be used in further processing. The release status of semifinished product is recorded in the PICS computer system, and is available to the areas. Mill roll tags will also carry the release status of a mill roll.

Additional information may be found in QSP 0004 and various Area Procedures.

4.12 CONTROL OF NONCONFORMING PRODUCT

Material or product which does not conform to the specifications established for passing an inspection or test will be identified as nonconforming product. This identification will be documented and the material or product will be evaluated, segregated (when practical), and disposed of through accepted channels. Various computer systems and procedures are in place to prevent inadvertently shipping non-conforming product.

Final disposition of nonconforming product resides with the QC Lab Supervisor with authority from the appropriate Technical Representative from Marketing, as required.

Nonconforming product may be:

- o Reworked to improve conformance to the pass/fail specifications
- o Retested in lab if test is suspect
- o Accepted by the customer on concession
- o Regraded and used in an alternate application
- o Rejected or scrapped

Reworked materials are tested in accordance with the requirements of Section: 4.9.

Additional detail is described in QSP 0013.

4.13 CORRECTIVE ACTION

Documented procedures are maintained by the functional areas for the following:

- o Investigating the cause of nonconforming product
- o Analyzing customer complaints and service reports to eliminate existing or potential sources of nonconformances.

Any functional area which identifies nonconforming product is responsible for developing and executing corrective actions to prevent future nonconformances. This will be done to an extent corresponding with the degree of severity and/or frequency of the nonconformance.

The initial responsibility for corrective action is in the hands of the manufacturing operators. In instances where there is an adjustment to the process which can be made, the operations area is responsible for attempting to get the process back to aim and documenting what was done. If they are not successful, or if a catastrophe occurs, the appropriate Process Engineer is notified.

Corrective actions which have been initiated will be reviewed by the area instituting them to determine their effectiveness.

Changes in procedures resulting from corrective actions will be documented by the functional areas in conformance with Section: 4.4 of this quality manual, and area document control procedures.

Additional detail may be found in QSP 0008 and various Area Procedures.

4.14 HANDLING, STORAGE, PACKAGING AND DELIVERY

Handing, storage, packaging, and delivery of materials and products will be done in accordance with documented procedures. Areas performing these tasks will be required to maintain these procedures.

Handling is conducted in a way that prevents damage or deterioration of the materials and product.

Storage facilities are secure and designed to prevent damage or deterioration of the materials and product. Functional areas receiving or dispatching material to these storage areas will stipulate appropriate methods for doing so.

The processes and equipment used to pack, preserve, and mark product are controlled by the functional areas to ensure the fulfillment of product requirements.

The Kapton*-Teflon* plant arranges for the protection of the product's quality after final inspection and test including, when required by the order, delivery to destination. Delivery is the responsibility of the Traffic function, which is part of the Mylar Production Control Organization.

Additional details are described in Area Procedures.

4.15 QUALITY RECORDS

Records are maintained to attest to the fact that materials and product actually meet their established specifications. Also, records demonstrate the proper and effective operation of the Quality Management System.

The plant and the functional areas are responsible for maintaining the quality records which they generate. Proper procedures for collecting, identifying, filing, storing, maintaining, and disposing of quality records are established. Retention times for all records are documented.

The following are guidelines of records kept with the following features of the Quality Management System:

Record	Location
o Management reviews of the Quality Management System	Quality Control Superintendent
o Contract reviews	Production Control Business Services
o Approved suppliers	Purchasing
o Corrective Action records	Area Files
o Slitting charts	Production Control
o Product identification at given production stages	Quality Control PICS
o Calibration results	Maintenance QC Lab
o Non-conforming products and materials	Production Control QC Lab
o Internal quality audits	Technical File Quality System Ad.
o Training records	Area Files

These records are stored and maintained in such a way as to prevent loss or deterioration. Also, they should be reasonably available.

Additional detail can be found in QSP 0009 and various Area Procedures.

4.16 INTERNAL QUALITY AUDITS

Internal audits are conducted by the plant in order to determine the effectiveness of the Quality Management System as well as compliance to established practices. The scope of these audits vary, but are intended to address those items which are thought to be most crucial to the quality of the product. Internal audits are conducted in each area at least twice per year. These audits are conducted by individuals independent of the work being performed, and are trained in auditing techniques.

A documented procedure is maintained which explains the audit process. The results of these audits are documented and brought to the attention of the appropriate individuals who are required to take actions in order to correct identified discrepancies.

More details of this system are described in QSP 0010.

4.17 TRAINING

Training systems are maintained by the functional areas to ensure that individuals performing work crucial to the quality of the product are appropriately instructed in the methods for performing those tasks.

These training systems include identification of the training needs, plans for the training process, and qualification of personnel. Records showing the level of qualification of certain plant personnel are maintained.

Additional details can be found in QSP 0011 and various Area Procedures.

4.18 STATISTICAL TECHNIQUES

Functional areas will maintain procedures as needed which identify and explain appropriate statistical techniques which are used to control products and processes. The following are examples of statistical techniques that are used where appropriate:

- o Shewhart Control Charts
- o Cusum Control Loops
- o Process Capability Studies

Details of where these are use are described in the appropriate Area Procedures.

FAX NO. 508-699-3153

Date 5/19/93

DUPONT

CIRCLEVILLE PLANT

P.O. Box 89
Circleville, OH 43113

Kapton*-Teflon*-SP Resin

FACSIMILE TRANSMISSION COVER SHEET

ADDRESSEE(S):

Name	Company or Department	Location
David Czarn MS 12-29	Texas Instruments	Attleboro MA

COPY:

SENDER:

Name	Business Sector	Location
Ed McKenzie	Texas Instruments	Circleville

Total Number of Pages (Including Cover Sheet) 8

SPECIAL INSTRUCTIONS/INFORMATION TO RECIPIENT:

DuPont, Circleville Kapton*-Teflon*-SP Resin Fax No. - 614-474-0680
Verification number - 614-474-0445

*** CONFIDENTIALITY NOTE ***

DuPont High Performance Films
U.S. Route 23 & DuPont Road
P.O. Box 89
Circleville, OH 43113
Tel. (614) 474-0194
Fax: (614) 474-0722

DuPont High Performance Films

May 19, 1993

Mr. David Czarn
Texas Instruments
MS 12-29
34 Forest St.
Attleboro, MA 02703

Dear Dave,

In response to your request of May 13, enclosed you will find excerpts from the Quality Manual for our manufacturing facility for Kapton® polyimide and Teflon® fluoropolymer films. Section 3.1 is an introduction with product background, and section 4.8 describes the procedures by which we control our processes. Flow charts are also included depicting the basic steps involved in the manufacture of our film products.

A few additional comments:

Thickness - Kapton® 500FN131 (TI part #27225-1) is a laminate construction of 3 mil polyimide film with 1 mil of fluoropolymer film on each side. The thickness of each web is continuously measured on line and this information is used as feedback, through a proprietary computer control system to adjust the die lip openings. The three webs are then laminated in a separate process, with point thickness of the final laminate measured to assure conformance to specifications.

Attached is a copy of statistical data recently supplied to Texas Instruments Quality Assurance, regarding 500FN131 laminate. Results were derived from thickness measurements of samples taken from all production in calendar year 1992.

Film Inspection: All laminate films are 100% inspected using a rewind inspector equipped with electronic/optical detection equipment which is used to locate and "map" pinholes, debris and other film defects. The Finishing Area uses this map to locate and remove the defect. The inspection criteria are:

Holes: any detected hole is a defect, and flagged for removal during slitting. The inspection equipment is capable of detecting holes 5 mils or larger.

"Opaque objects": inclusions, and surface contaminants. The equipment detects any opaque object down to 25 mils, and alerts the operator to its location in the web. It is removed, if possible, in the case of a surface defect. Current specifications call for any opaque object in the film, 50 mils or larger to be flagged and removed during slitting.

I hope this information will prove useful in your efforts. Although many aspects of the manufacture of Kapton® films are proprietary, I'll do my best to answer any further questions you might have.

I look forward to the visit to Attleboro on May 25. Perhaps at this time we can discuss further ways in which DuPont can assist Texas Instruments in opening markets in Japan.

Sincerely,

Edward C. McKenzie

Edward C. McKenzie
Senior Technical Service Representative

cc: D. Reifschneider

/dll
(EM.005)

3.1 INTRODUCTION

The Kapton-Teflon plant at Circleville manufactures Kapton polyimide films and Teflon films. Chemically, Kapton is a polyimide polymer makeup that is the result of a polycondensation reaction. The resulting base film, type HN, is a tough aromatic polyimide film that is an exceptionally strong, heat resistant film with an excellent combination of mechanical and electrical properties. The plant makes two other general types of Kapton, type FN, which is a heat sealable grade. This product is achieved by combining type HN Kapton with Teflon FEP fluorocarbon resin, through a laminating or coating process. Type VN films exhibit the same tough polyimide properties as HN, with superior dimensional stability at elevated temperatures. Kapton films are sold in thicknesses of 0.3 mils to 11.0 mils.

Teflon films are produced from various fluorocarbon resins including FEP, PFA and Tefzel, some of which are pigmented. The pellets are melted and extruded into a Teflon film for subsequent processing in treating, laminating and slitting. In addition to the different resin types, the plant offers Teflon films in thicknesses ranging from 0.5 mils to 225.0 mils. It is sold into several markets where it is unique among plastics. It is the most chemically inert of all plastics, withstands both high and low temperature extremes, has superior electrical properties, has superior anti-stick/ low friction properties plus many more unique characteristics.

Some of the applications or markets for Kapton from the electrical and electrical industry field are: field coil insulation, substrates for flexible printed circuits, motor and generator armature slot liners, magnet wire insulation, transformer and capacitor insulation, magnetic recording and pressure-sensitive tapes, and wire and cable insulation.

A few of the applications for Teflon include a general purpose items such as Cell culture bags, plain and metallized microphone electrets and a variety of release applications; cementable films for laminated belting, high-performance pressure-sensitive tapes and protective clothing; chemical process films for tank linings, thermoformed rupture disc seals, and thick gaskets and drop-in mold liners; and aerospace composite molding release films.

4.8 PROCESS CONTROL

4.8.1 General

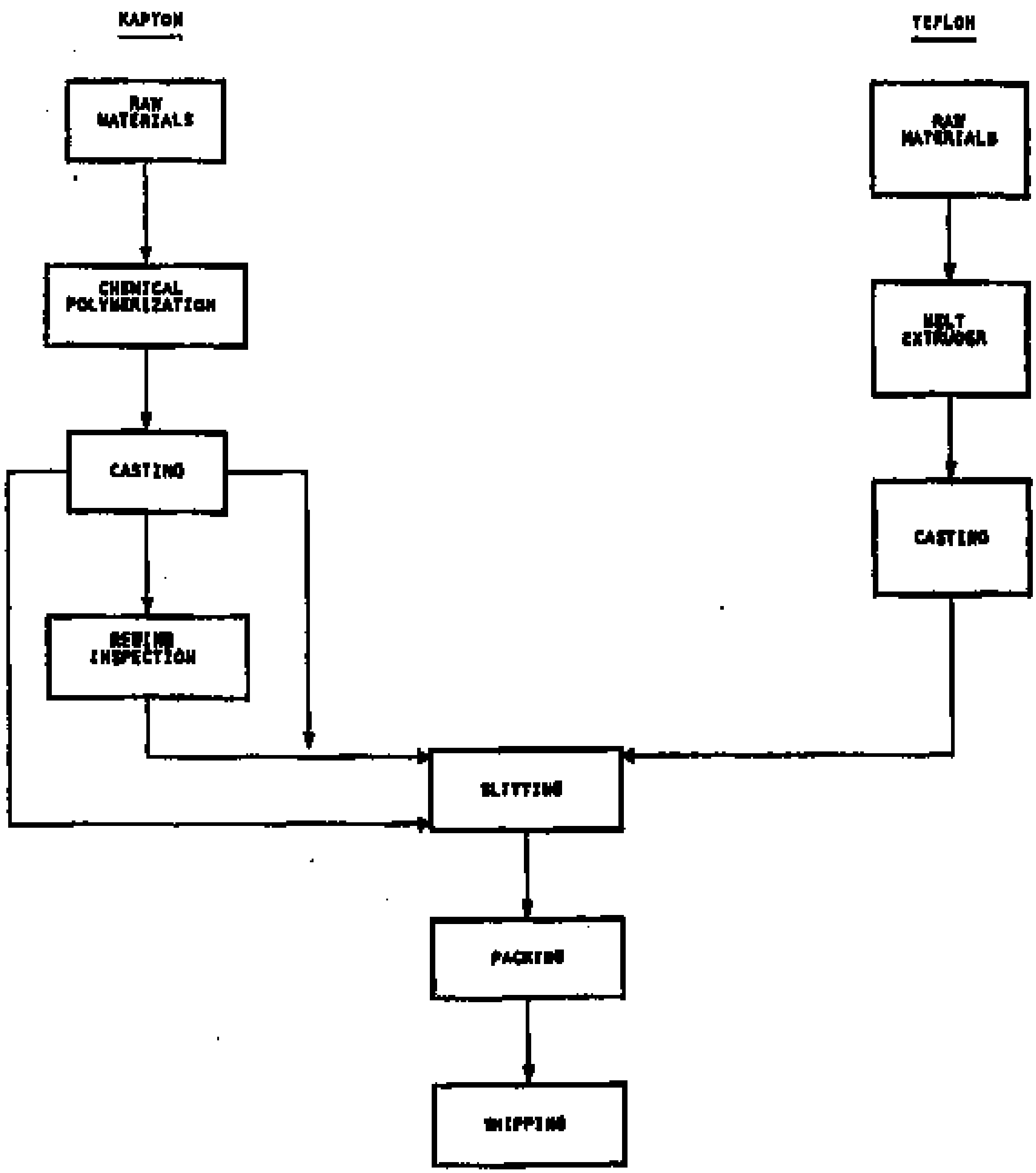
All Kapton*-Teflon* processes will be run under a state of controlled conditions. These processes are shown schematically on the following three pages. Functional areas are responsible for establishing these controlled conditions which include:

- Production schedules, based on orders and forecasts, are communicated by Production Control to the areas. The manufacturing areas use these schedules to plan product changes.
- Documented work instructions, Area Procedures (APs) and Operating Procedures (OPs), explain how tasks are to be performed where the lack of such instructions could significantly reduce the product's level of quality.
- Specified operating conditions, called Standard Operating Conditions (SOCs), which describe where process parameters should be set
- Control of process parameters to the greatest extent within specified ranges
- Operation of the processes outside of specified ranges only after obtaining authorization
- Routine monitoring of these processes to ensure process stability. Monitoring techniques include one or more of the following:
  - Automatic control loops
  - Manual controls
  - Computerized control systems
  - Statistical control charts
- Additional detail is given in QSP 0008 and Area Procedures

4.8.2 New Equipment or Process

Any product manufactured on new equipment or by a new process is produced under the plant TA (Test Authorisation) system. This system provides the documentation and approval system for using a non-standard process. This system is described in more detail in QSP 0014.

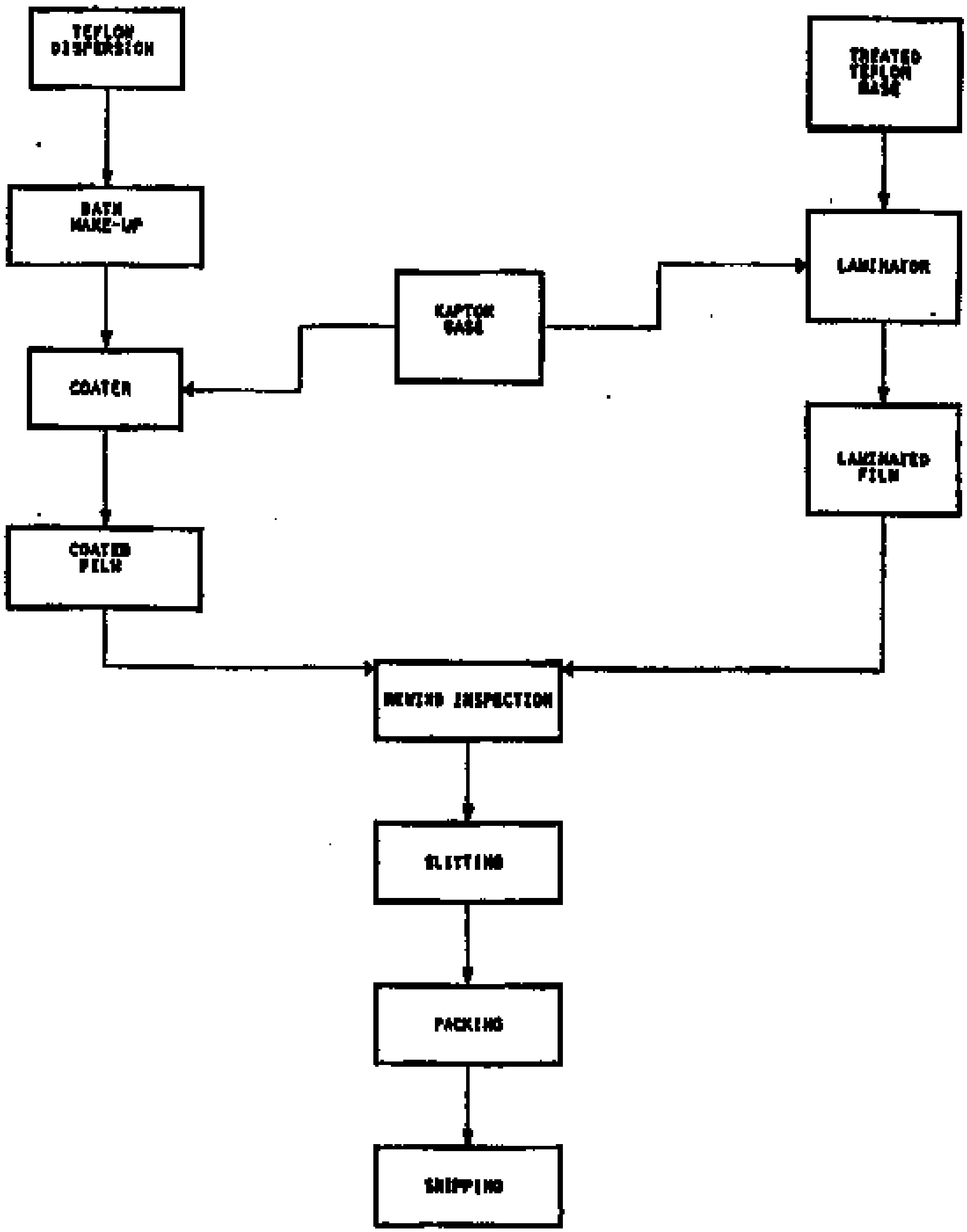
PROCESS FLOW-PLAIN FILM



TION - TEFLON* REGISTERED TRADEMARK OF DU PONT

PROCESS FLOW-COATED AND LAMINATED

COATED | LAMINATED



[illegible] - TEFLON* REGISTERED TRADEMARK OF DU PONT

5/7/93

PROCESS CAPABILITY ANALYSIS
500FN131 (TI Part No. 27223-1)
DATE: 5/5/93

WIDTH (INCHES)

	COUNT:	169			
0.001 STD	0.003613	3STD			
0.751 AVG	0.754542	AVG+3STD		USL	0.766
0.748 MIN	0.747315	AVG-3STD		LSL	0.734
0.761 MAX					
		CPU	4.171096		
		CPL	4.685318		
	>>	CPK	4.171096		

POINT THICKNESS (MILS)

	COUNT:	14			
0.080 STD	0.24	3STD			
4.890 AVG	5.13	AVG+3STD		USL	5.5
4.710 MIN	4.65	AVG-3STD		LSL	4.5
5.140 MAX					
		CPU	2.541666		
		CPL	1.625		
	>>	CPK	1.625		

USL: Upper Specification Limit
LSL: Lower Specification Limit
CPK: Process Capability Index Measure
CPU: CPK Upper
CPL: CPK Lower
STD: Standard Deviation

TI-NHTSA 017422

DuPont High Performance Films
U.S. Route [illegible] & DuPont Road
P.O. Box [illegible]
Circleville, OH [illegible]
Tel. [illegible]
Fax [illegible]

DUPONT

DuPont High Performance Films

May 19, 1993

Mr. David Czarn
Texas Instruments
MS 12-29
34 Forest St.
Attleboro, MA 02703

Dear Dave,

In response to your request of May 13, enclosed you will find excerpts from the Quality Manual for our manufacturing facility for Kapton® polyimide and Teflon® fluoropolymer films. Section 3.1 is an introduction with product background, and section 4.8 describes the procedures by which we control our processes. Flow charts are also included depicting the basic steps involved in the manufacture of our film products.

A few additional comments:

<u>Thickness</u> - Kapton® 500FN131 (TI part #27225-1) is a laminate construction of 3 mil polyimide film with 1 mil of fluoropolymer film on each side. The thickness of each web is continuously measured on line and this information is used as feedback, through a proprietary computer control system to adjust the die lip openings. The three webs are then laminated in a separate process, with point thickness of the final laminate measured to assure conformance to specifications.

Attached is a copy of statistical data recently supplied to Texas Instruments Quality Assurance, regarding 500FN131 laminate. Results were derived from thickness measurements of samples taken from all production in calendar year 1992.

<u>Film Inspection:</u> All laminate films are 100% inspected using a reeled inspector equipped with electronic/optical detection equipment which is used to locate and "map" pinholes, debris and other film defects. The Finishing Area uses this map to locate and remove the defect. The inspection criteria are:

Holes: any detected hole is a defect, and flagged for removal during slitting. The inspection equipment is capable of detecting holes 5 mils or larger.

"Opaque objects": inclusions, and surface contaminants. The equipment detects any opaque object down to 25 mils, and alerts the operator to its location in the web. It is removed, if possible, in the case of a surface defect. Current specifications call for any opaque object in the film, 50 mils or larger to be flagged and removed during slitting.

I hope this information will prove useful in your efforts. Although many aspects of the manufacture of Kapton® films are proprietary, I'll do my best to answer any further questions you might have.

I look forward to the visit to Attleboro on May 25. Perhaps at this time we can discuss further ways in which DuPont can assist Texas Instruments in opening markets in Japan.

Sincerely,

Edward C. McKenzie

Edward C. McKenzie
Senior Technical Service Representative

cc: D. Reifschneider

/all
(EM.009)

3.1 INTRODUCTION

The Kapton-Teflon plant at Circleville manufactures Kapton polyimide films and Teflon films. Chemically, Kapton is a polyimide polymer makeup that is the result of a polycondensation reaction. The resulting base film, type HN, is a tough aromatic polyimide film that is an exceptionally strong, heat resistant film with an excellent combination of mechanical and electrical properties. The plant makes two other general types of Kapton, type FN, which is a heat sealable grade. This product is achieved by combining type HN Kapton with Teflon FEP fluorocarbon resin, through a laminating or coating process. Type VN films exhibit the same tough polyimide properties as HN, with superior dimensional stability at elevated temperatures. Kapton films are sold in thicknesses of 0.3 mils to 11.0 mils.

Teflon films are produced from various fluorocarbon resins including FEP, PFA and Tefzel, some of which are pigmented. The pellets are melted and extruded into a Teflon film for subsequent processing in treating, laminating and slitting. In addition to the different resin types, the plant offers Teflon films in thicknesses ranging from 0.5 mils to 325.0 mils. It is sold into several markets where it is unique among plastics. It is the most chemically inert of all plastics, withstands both high and low temperature extremes, has superior electrical properties, has superior anti-stick/low friction properties plus many more unique characteristics.

Some of the applications or markets for Kapton from the electrical and electrical industry field are: field coil insulation, substrates for flexible printed circuits, motor and generator armature slot liners, magnet wire insulation, transformer and capacitor insulation, magnetic recording and pressure-sensitive tapes, and wire and cable insulation.

A few of the applications for Teflon include a general purpose items such as Cell culture bags, plain and metallised microphone electrets and a variety of release applications; cementable films for laminated belting, high-performance pressure-sensitive tapes and protective clothing; chemical process films for tank linings, thermoformed rupture disc seals, and thick gaskets and drop-in mold liners; and aerospace composite molding release films.

4.8 PROCESS CONTROL

4.8.1 General

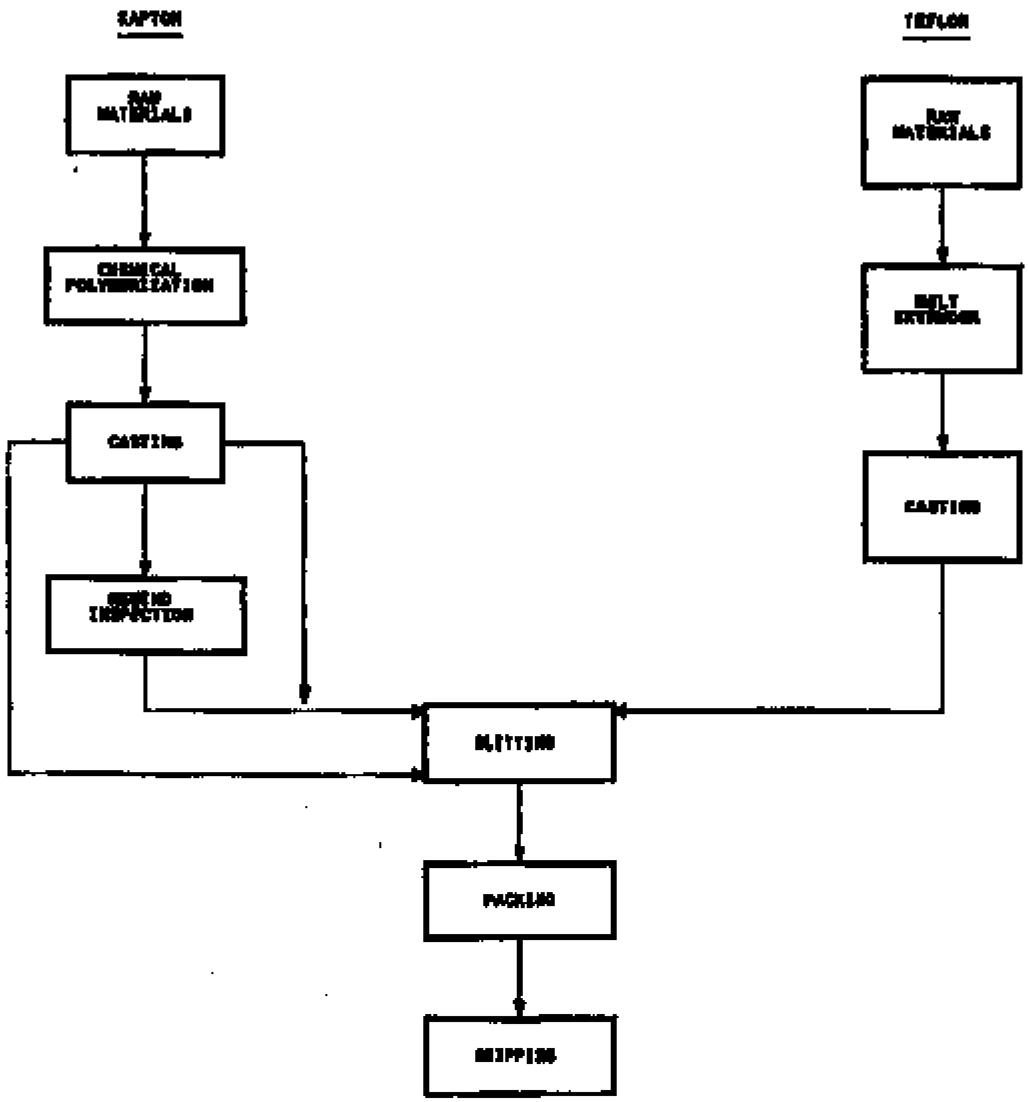
All Kapton*-Teflon* processes will be run under a state of controlled conditions. These processes are shown schematically on the following three pages. Functional areas are responsible for establishing these controlled conditions which include:

- o Production schedules, based on orders and forecasts, are communicated by Production Control to the areas. The manufacturing areas use these schedules to plan product changes.
- o Documented work instructions, Area Procedures (APs) and Operating Procedures (OPs), explain how tasks are to be performed where the lack of such instructions could significantly reduce the product's level of quality.
- o Specified operating conditions, called Standard Operating Conditions (SOCs), which describe where process parameters should be set
- o Control of process parameters to the greatest extent within specified ranges
- o Operation of the processes outside of specified ranges only after obtaining authorization
- o Routine monitoring of these processes to ensure process stability. Monitoring techniques include one or more of the following:
  - Automatic control loops
  - Manual controls
  - Computerized control systems
  - Statistical control charts
- o Additional detail is given in QSP 0005 and Area Procedures

4.8.2 New Equipment or Process

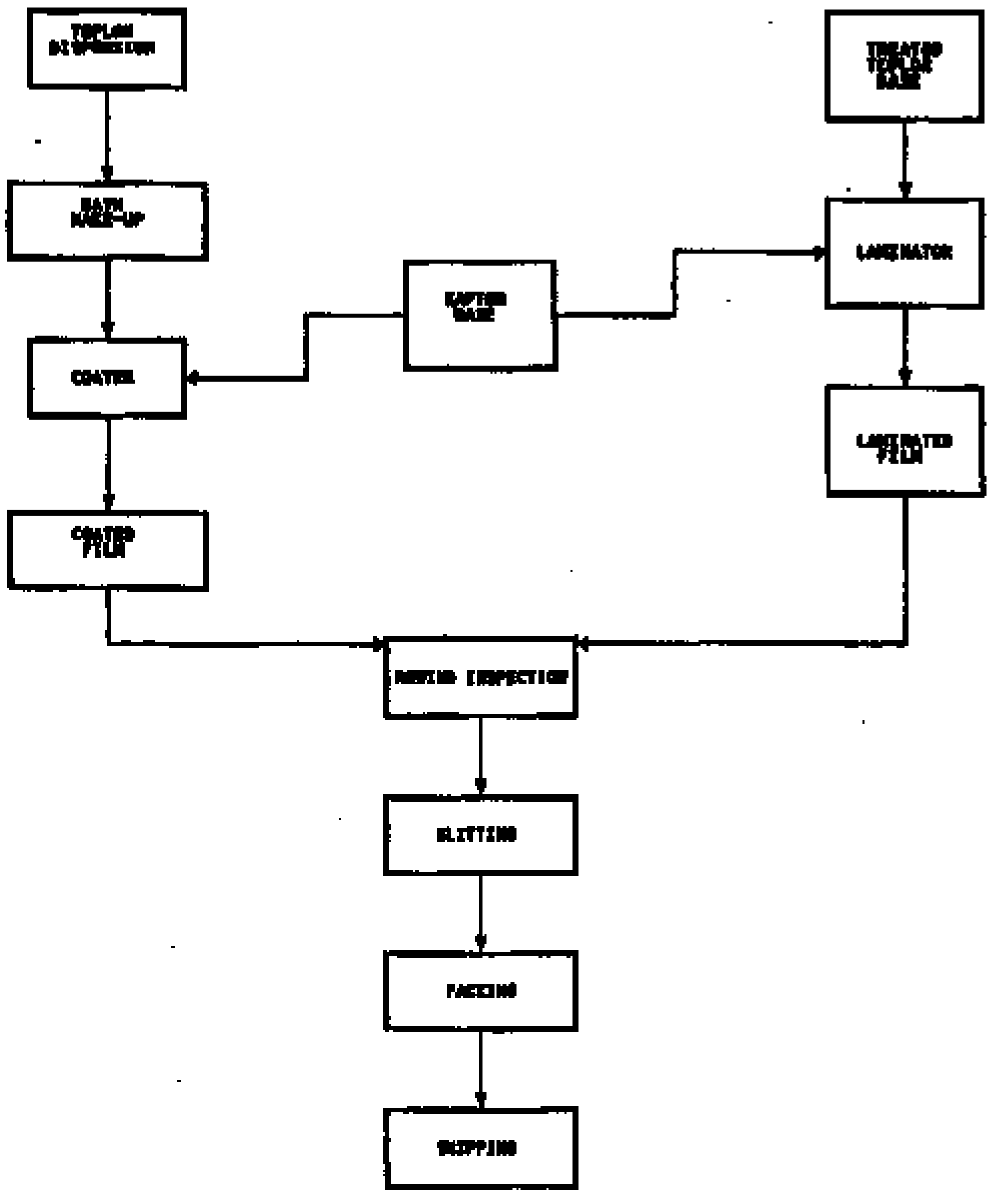
Any product manufactured on new equipment or by a new process is produced under the plant TA (Test Authorization) system. This system provides the documentation and approval system for using a non-standard process. This system is described in more detail in QSP 0014.

PROCESS FLOW-PLAIN FILM



KAPTON* - TEFLON* REGISTERED TRADEMARK OF DU PONT

PROCESS FLOW-COATED AND LAMINATED



KAPTON® - TEFLON® REGISTERED TRADEMARK OF DU PONT

PROCESS CAPABILITY ANALYSIS
300FN131 (TI Part No. 27225-1)
DATE: 5/5/93

WIDTH (INCHES)

		COUNT: 169			
0.001	STD	0.003615	3STD		
0.751	AVG	0.754542	AVG+3STD	USL	0.766
0.748	MIN	0.747315	AVG-3STD	LSL	0.734
0.761	MAX				

	CPU	4.171096
	CPL	4.688318
>>	CPK	4.171096

POINT THICKNESS (MILS)

		COUNT: 14			
0.080	STD	0.24	3STD		
4.890	AVG	5.13	AVG+3STD	USL	5.5
4.710	MIN	4.65	AVG-3STD	LSL	4.5
5.140	MAX				

	CPU	2.541666
	CPL	1.625
>>	CPK	1.625

USL: Upper Specification Limit
LSL: Lower Specification Limit
CPK: Process Capability Index Measure
CPU: CPK Upper
CPL: CPK Lower
STD: Standard Deviation

TO: ANDY MCKENNA, T.I.J.

FAX: 011-81-550-78-0331

FR: AZIZ RAHMAN, T.I.A.

FAX: 508-699-3153

PH: 508-699-1660

DT: 5/19/93

OF PAGES TO FOLLOW: 8

ANDY,

ATTACHED PLEASE FIND SOME DETAILS ON KAPTON FILM PROCESSING FROM DUPONT. PLEASE BE AWARE THAT THIS INFORMATION IS CONFIDENTIAL BETWEEN T.I. AND DUPONT. I SUGGEST THAT YOU DIGEST THIS INFO AND THEN SHARE GENERALITIES WITH NISSAN/UNISIA. ACTUAL CHEMICAL POLYMERIZATION/CASTING/EXTRUDING PROCESSES ARE PROBABLY DUPONT PROPRIETARY.

REGARDS
AZIZ.

DUPONT

FAX NO. 508-699-3153

Date 5/19/93

CIRCLEVILLE PLANT

P.O. Box 89
Circleville, OH 43113

Kapton*-Teflon*-SP Resin

FACSIMILE TRANSMISSION COVER SHEET

ADDRESSEE(S):

Name	Company or Department	Location
DAVID CZARN M.S. 12-29	TEXAS INSTRUMENTS	ATTLEBORO MA

COPY:

SENDER:

Name	Business Sector	Location
ED McKENZIE	TEXAS INSTRUMENTS	CIRCLEVILLE

Total Number of Pages (Including Cover Sheet) 8

SPECIAL INSTRUCTIONS/INFORMATION TO RECIPIENT:

DuPont, Circleville Kapton*-Teflon*-SP Resin Fax No. - 614-474-0580
Verification number - 614-474-0445

*** CONFIDENTIALITY NOTE ***

Charting a Course for Excellence

DuPont High Performance Films
U.S. Route 23 & DuPont Road
P.O. Box 89
Circleville, OH 43113
Tel. (614) 474-0784
Fax (614) 474-0722

DuPont High Performance Films

May 19, 1993

Mr. David Czarn
Texas Instruments
MS 12-27
34 Forest St.
Attleboro, MA 02703

Dear Dave,

In response to your request of May 13, enclosed you will find excerpts from the Quality Manual for our manufacturing facility for Kapton® polyimide and Teflon® fluoropolymer films. Section 3.1 is an introduction with product background, and section 4.8 describes the procedures by which we control our processes. Flow charts are also included depicting the basic steps involved in the manufacture of our film products.

A few additional comments:

Thickness - Kapton® 500FN131 (TI part #27225-1) is a laminate construction of 3 mil polyimide film with 1 mil of fluoropolymer film on each side. The thickness of each web is continuously measured on line and this information is used as feedback, through a proprietary computer control system to adjust the die lip openings. The three webs are then laminated in a separate process, with point thickness of the final laminate measured to assure conformance to specifications.

Attached is a copy of statistical data recently supplied to Texas Instruments Quality Assurance, regarding 500FN131 laminate. Results were derived from thickness measurements of samples taken from all production in calendar year 1992.

Film Inspection: All laminate films are 100% inspected using a rewind inspector equipped with electronic/optical detection equipment which is used to locate and "map" pinholes, debris and other film defects. The Finishing Area uses this map to locate and remove the defect. The inspection criteria are:

Holes: any detected hole is a defect, and flagged for removal during slitting. The inspection equipment is capable of detecting holes 5 mils or larger.

"Opaque objects": inclusions, and surface contaminate. The equipment detects any opaque object down to 25 mils, and alerts the operator to its location in the web. It is removed, if possible, in the case of a surface defect. Current specifications call for any opaque object in the film, 50 mils or larger to be flagged and removed during slitting.

TI-NHTSA 017432

I hope this information will prove useful in your efforts. Although many aspects of the manufacture of Kapton® films are proprietary, I'll do my best to answer any further questions you might have.

I look forward to the visit to Attleboro on May 25. Perhaps at this time we can discuss further ways in which DuPont can assist Texas Instruments in opening markets in Japan.

Sincerely,

Edward C. McKenzie

Edward C. McKenzie
Senior Technical Service Representative

cc: D Reifschneider

/all
(EM.005)

3.1 INTRODUCTION

The Kapton-Teflon plant at Circleville manufactures Kapton polyimide films and Teflon films. Chemically, Kapton is a polyimide polymer makeup that is the result of a polycondensation reaction. The resulting base film, type HN, is a tough aromatic polyimide film that is an exceptionally strong, heat resistant film with an excellent combination of mechanical and electrical properties. The plant makes two other general types of Kapton, type FN, which is a heat sealable grade. This product is achieved by combining type HN Kapton with Teflon FEP fluorocarbon resin, through a laminating or coating process. Type VN films exhibit the same tough polyimide properties as HN, with superior dimensional stability at elevated temperatures. Kapton films are sold in thicknessec of 0.3 mils to 11.0 mils.

Teflon films are produced from various fluorocarbon resins including FEP, PFA and Tefzel, some of which are pigmented. The pellets are melted and extruded into a Teflon film for subsequent processing in treating, laminating and slitting. In addition to the different resin types, the plant offers Teflon films in thicknesses ranging from 0.5 mils to 225.0 mils. It is sold into several markets where it is unique among plastics. It is the most chemically inert of all plastics, withstands both high and low temperature extremes, has superior electrical properties, has superior anti-stick/ low friction properties plus many more unique characteristics.

Some of the applications or markets for Kapton from the electrical and electrical industry field are: field coil insulation, substrates for flexible printed circuits, motor and generator armature slot liners, magnet wire insulation, transformer and capacitor insulation, magnetic recording and pressure-sensitive tapes, and wire and cable insulation.

A few of the applications for Teflon include a general purpose items such as Cell culture bags, plain and metallized microphone electrets and a variety of release applications; cementable films for laminated belting, high-performance pressure-sensitive tapes and protective clothing; chemical process films for tank linings, thermoformed rupture disc seals, and thick gaskets and drop-in mold liners; and aerospace composite molding release films.

4.8 PROCESS CONTROL

4.8.1 General

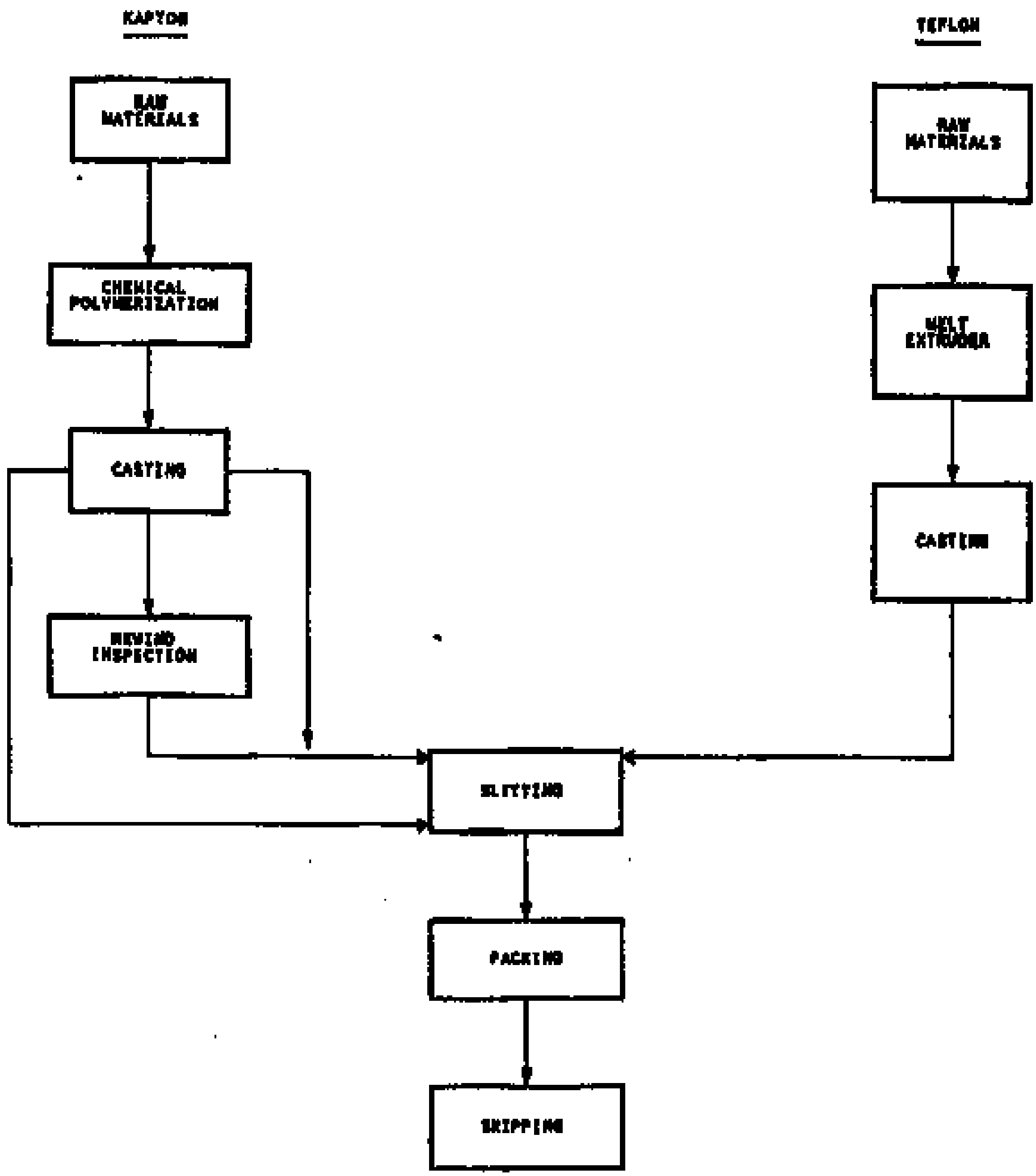
All Kapton*-Teflon* processes will be run under a state of controlled conditions. These processes are shown schematically on the following three pages. Functional areas are responsible for establishing these controlled conditions which include:

- o Production schedules, based on orders and forecasts, are communicated by Production Control to the areas. The manufacturing areas use these schedules to plan product changes.
- o Documented work instructions, Area Procedures (APs) and Operating Procedures (OPs), explain how tasks are to be performed where the lack of such instructions could significantly reduce the product's level of quality.
- o Specified operating conditions, called Standard Operating Conditions (SOCs), which describe where process parameters should be set
- o Control of process parameters to the greatest extent within specified ranges
- o Operation of the processes outside of specified ranges only after obtaining authorization
- o Routine monitoring of these processes to thereby process stability. Monitoring techniques include one or more of the following:
  - Automatic control loops
  - Manual controls
  - Computerized control systems
  - Statistical control charts
- o Additional detail is given in QSP 0005 and Area Procedures

4.8.2 New Equipment or Process

Any product manufactured on new equipment or by a new process is produced under the plant TA (Test Authorization) system. This system provides the documentation and approval system for using a non-standard process. This system is described in more detail in QSP 0014.

PROCESS FLOW-PLAIN FILM

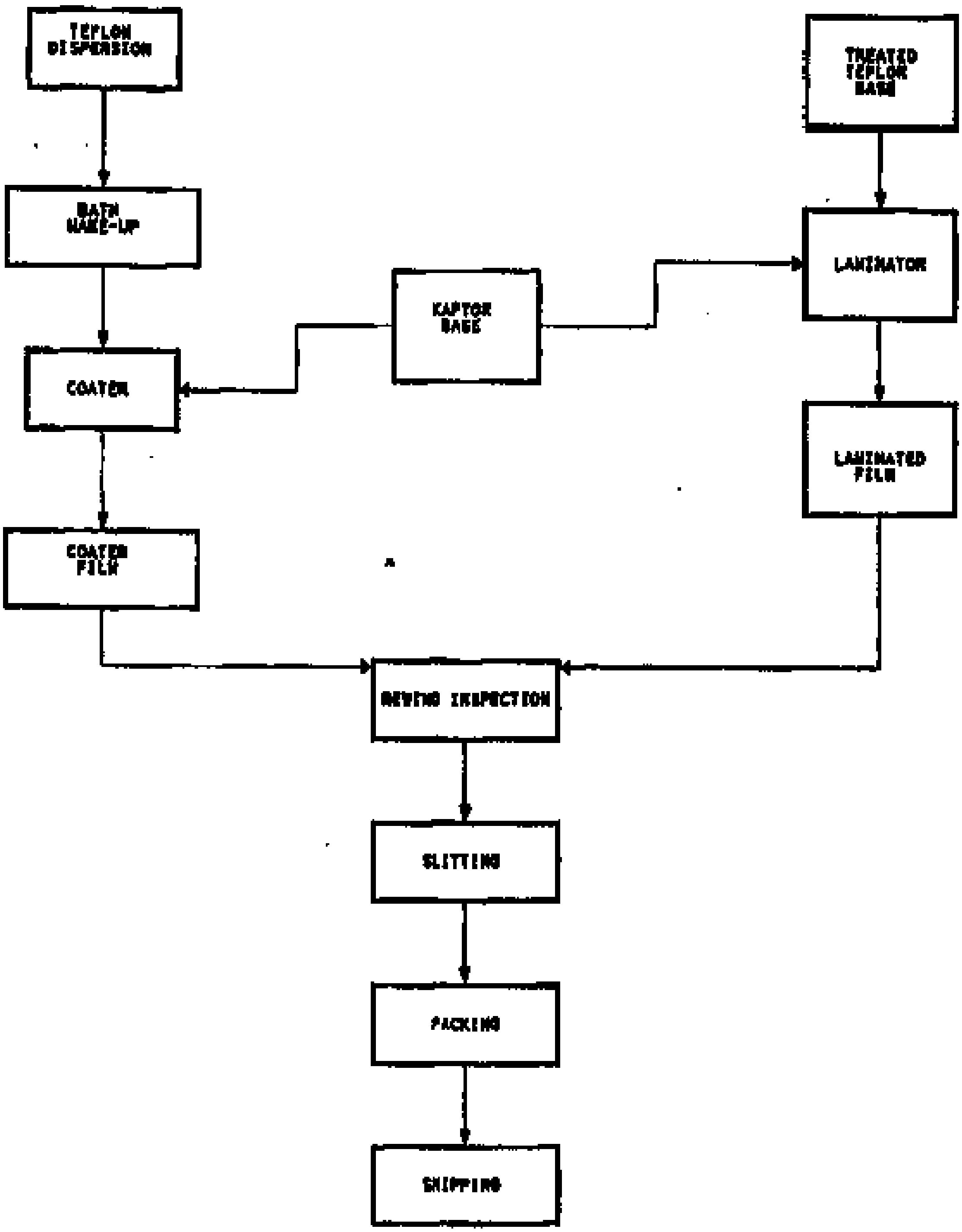


APTON* - TEFLON* REGISTERED TRADEMARK OF DU PONT

COATED

PROCESS FLOW-COATED AND LAMINATED

LAMINATED



TON - TEFLON* REGISTERED TRADEMARK OF DU PONT

5/7/93

PROCESS CAPABILITY ANALYSIS
500FN131 (TI Part No. 27225-1)
DATE: 5/5/93

WIDTH (INCHES)

		COUNT: 169				
0.001	STD	0.003613	3STD			
0.751	AVG	0.754542	AVG+3STD		USL	0.766
0.748	MIN	0.747313	AVG-3STD		LSL	0.734
0.761	MAX					
			CPU	4.171096		
			CPL	4.685318		
		>>	CPK	4.171096		

POINT THICKNESS (MILS)

		COUNT:	14			
0.080	STD	0.24	3STD			
4.890	AVG	5.13	AVG+3STD		USL	5.5
4.710	MIN	4.65	AVG-3STD		LSL	4.5
5.140	MAX					
			CPU	2.541666		
			CPL	1.625		
		>>	CPK	1.625		

USL: Upper Specification Limit
LSL: Lower Specification Limit
CPK: Process Capability Index Measure
CPU: CPK Upper
CPL: CPK Lower
STD: Standard Deviation

DuPont High Performance Films
U.S. Route 23 & DuPont Road
P.O. Box [illegible]
Circleville, OH 43113
Tel. (614) 474-073[illegible]
Fax (614) 474-0722

DuPont High Performance Films

May 24, 1993

John Lucas
Texas Instruments, Inc.
34 Forest St.
Attleboro, MA 02703

Dear Mr. Lucas,

As a next step in our efforts to certify DuPont's Kapton® 300HN polyimide film, (TI Part No. 27225-4), I have enclosed the following information:

1. Quality Manual for Kapton® and Teflon® film products.

2. Statistical information on point thickness and width of the 300HN product. The point thickness data was taken from 3rd quarter '92 lab measurements, and width from the initial set ups of slit rolls sent to TI over the past year.

3. Actual width and point thickness measurements on recent production. This material is clearly identified on the shipping carton with the TI part no. 27225-1 AND the DuPont Item No. 34485. This carton is in the warehouse at Saylesville, RI awaiting shipment.

Thank you for this opportunity to build on our partnership. If you have any questions or I can be of further assistance, please call me, at 614-474-0730.

Sincerely,

Edward C. McKenzie

Edward C. McKenzie
Senior Technical Service Representative
614-474-0735

/all
Enclosure
(EM006)

TI-NHTSA 017439

PROCESS CAPABILITY ANALYSIS
300HN (TI Part No. 27225-4)
DATE: 5/24/93

POINT THICKNESS (MILS)

		COUNT:	40		
0.037	STD	0.111	3STD		
3.038	AVG	3.148	AVG+3STD	USL	3.300
2.600	MIN	2.927	AVG-3STD	LSL	2.700
3.150	MAX				
			CPU	2.369	
			CPL	3.046	
		>>	CPK	2.369	

USL: Upper Specification Limit
LSL: Lower Specification Limit
CPK: Process Capability Index Measure
CPU: CPK Upper
CPL: CPK Lower
STD: Standard Deviation

PROCESS CAPABILITY ANALYSIS
300HN (TI Part No. 27225-4)
DATE: 5/24/93

WIDTH (INCHES)

		COUNT:	59				
0.002	STD	0.004892	3STD				
0.749	AVG	0.754079	AVG+3STD		USL	0.766	
0.745	MIN	0.744293	AVG-3STD		LSL	0.734	
0.752	MAX						
			CPU	3.436251			
			CPL	3.103710			
		>>	CPK	3.103710			

USL: Upper Specification Limit
LSL: Lower Specification Limit
CPK: Process Capability Index Measure
CPU: CPK Upper
CPL: CPK Lower
STD: Standard Deviation

TI-NHTSA 017441

5/24/93

Texas Instruments Part No. 27226-4

Kapton* 300HN, Du Pont Item Number 34485

Regarding the following data:

Point thickness measurements were taken using a Thwing-Albert VIR electronic thickness tester, Model II. 2 measurement per roll.

Width measurements were taken using a Nikon profile projector, Model V12.

Roll #	Point Thickness (mils)	Width (inches)
1	3.03, 3.01	0.749
2	3.03, 3.04	0.748
3	3.02, 3.04	0.748
4	3.03, 3.02	0.749
5	3.03, 3.02	0.749
6	3.01, 3.03	0.749
7	3.04, 3.06	0.749
8	3.03, 3.03	0.749
9	3.02, 3.03	0.750
10	3.04, 3.03	0.748
11	3.00, 3.03	0.748
12	3.03, 3.04	0.749
13	3.05, 3.04	0.749
14	3.03, 3.06	0.746
15	3.03, 3.05	0.747
16	3.03, 3.04	0.748
17	3.04, 3.04	0.749
18	3.04, 3.04	0.750
19	3.05, 3.06	0.749
20	3.07, 3.07	0.748
21	3.03, 3.06	0.749
22	3.07, 3.08	0.748

* Du Pont registered trademark

Summary of Properties

DuPont High Performance Films

Kapton® polyimide film

General Information

Kapton® polyimide film possesses a unique combination of properties which make it ideal for a variety of applications in many different industries. The ability of Kapton® to maintain its excellent physical, electrical, and mechanical properties over a wide temperature range has opened new design and application areas to plastic films.

Kapton® is synthesized by polymerizing an aromatic dianhydride and an aromatic diamine. It has excellent chemical resistance; there are no known organic solvents for the film. Kapton® does not melt or burn as it has the highest UL-94 flammability rating: V-0. The outstanding properties of Kapton® permit it to be used at both high and low temperature extremes where other organic polymeric materials would not be functional.

Adhesives are available for bonding Kapton® to itself and to metals, various paper types, and other films.

Kapton® polyimide film can be used in a variety of electrical and electronic insulation applications: wire and cable tapes, formed coil insulation, substrates for flexible printed circuits, motor slot liners, magnet wire insulation, transformer and capacitor insulation, magnetic and pressure-sensitive tapes, and tubing. Many of these applications are based on the excellent balance of electrical, thermal, mechanical, physical, and chemical properties of Kapton® over a wide range of temperatures. It is this combination of useful properties at temperature extremes that makes Kapton® a unique industrial material.

Three types of Kapton® are described in this bulletin:

- Kapton® Type HN, all-polyimide film has been used successfully in applications at temperatures as low as -269 °C (-452 °F) and as high as 400°C (752 °F).

  Type HN film can be laminated, metallized, punched, formed, or adhesive coated. It is available as 7.5 µm (0.3 mil), 12.5 µm (0.5 mil), 19 µm (0.75 mil), 25 µm (1 mil), 50 µm (2 mil), 75 µm (3 mil), and 125 µm (5 mil) films.
- Kapton® Type VN, all-polyimide film with all of the properties of Type HN, plus superior dimensional stability. Type VN is available as 12.5 µm (0.5 mil), 19 µm (0.75 mil), 25 µm (1 mil), 50 µm (2 mil), 75 µm (3 mil), and 125 µm (5 mil) films.
- Kapton® Type FN, a Type HN film coated on one or both sides with Teflon® FEP fluoropolymer resin, imparts heat sealability, provides a moisture barrier, and enhances chemical resistance. Type FN is available in a number of combinations of polyimide and Teflon® FEP thicknesses (see Table 16).

Note: In addition to these three types of Kapton®, films are available with the following attributes:

- antistat
- thermally conductive
- polyimides for fine line circuitry
- cryogenic insulation
- corona resistant
- pigmented for color
- conformable
- other films tailored to meet customers' needs

Data for these films are covered in separate product bulletins, which can be obtained from your DuPont representative.

The Chemical Abstracts Service Registry Number for Kapton® polyimide film is [25036-53-7].

Physical and Thermal Properties

Kapton polyimide films retain their physical properties over a wide temperature range. They have been used in field applications where the environmental temperatures were as low as −269 C (−452 F) and as high as 400 C (752 F). Complete data are not available at these extreme conditions, and the majority of technical data presented in this section falls in the 23° to 200 C (73° to 392 F) range.

Table 1
Physical Properties of Kapton Type 100 HN Film, 25 μm (1 mil)

Physical Property	Typical Value at 23 C (73 F)	Typical Value at 200 C (392 F)	Test Method
Ultimate Tensile Strength, MPa (psi)	231 (33,500)	139 (20,000)	ASTM D-882-91, Method A*
Yield Point at 3%, MPa (psi)	69 (10,000)	41 (6,000)	ASTM D-882-91
Stress to Produce 5% Elongation, MPa (psi)	90 (13,000)	61 (9,000)	ASTM D-882-91
Ultimate Elongation, %	72	83	ASTM D-882-91
Tensile Modulus, GPa (psi)	2.5 (370,000)	2.0 (290,000)	ASTM D-882-91
Impact Strength, N·cm (ft lb)	78 (0.58)		DuPont Pneumatic Impact Test
Folding Endurance (MIT), cycles	285,000		ASTM D-2176-89
Tear Strength—Propagating (Elmendorf), N (lbf)	0.07 (0.02)		ASTM D-1922-89
Tear Strength—Initial (Graves), N (lbf)	7.2 (1.6)		ASTM D-1004-90
Density, g/cc or g/mL	1.42		ASTM D-1505-90
Coefficient of Friction—Kinetic (Film-to-Film)	0.48		ASTM D-1894-90
Coefficient of Friction—Static (Film-to-Film)	0.63		ASTM D-1894-90
Refractive Index (Sodium D Line)	1.70		ASTM D-542-90
Poisson's Ratio	0.34		Avg. Three Samples Elongated at 5%, 7%, 10%
Low Temperature Flex Life	Pass		IPC TM 650, Method 2.6.18

*Specimen Size: 25 × 150 mm (1 × 6 in); Jaw Separation: 100 mm (4 in); Jaw Speed: 50 mm/min (2 in/min); Ultimate refers to the tensile strength and elongation measured at break.

Table 2
Thermal Properties of Kapton Type 100 HN Film, 25 μm (1 mil)

Thermal Property	Typical Value	Test Condition	Test Method
Melting Point	None	None	ASTM E-794-85 (1989)
Thermal Coefficient of Linear Expansion	20 ppm/°C (11 ppm/°F)	−14 to 38 C (7 to 100 F)	ASTM D-696-91
Coefficient of Thermal Conductivity, W/m·K	0.12	296 K	ASTM F-433-77 (1987)
cal/cm·sec·°C	2.87 × 10⁻⁴	23 C	
Specific Heat, J/g·K (cal/g·C)	1.09 (0.261)		Differential Calorimetry
Flammability	94V-0		UL-94 (2-8-85)
Shrinkage, %	0.17 1.25	30 min at 150 C 120 min at 400 C	IPC TM 650, Method 2.2.4A ASTM D-5214-91
Heat Sealability	Not Heat Sealable		
Limiting Oxygen Index, %	37		ASTM D-2863-87
Solder Float	Pass		IPC TM 650, Method 2.4.13A
Smoke Generation	DM = <1	NBS Smoke Chamber	NFPA-258
Glass Transition Temperature (T_g)	A second order transition occurs in Kapton between 360 C (680 F) and 410 C (770 F) and is assumed to be the glass transition temperature. Different measurement techniques produce different results within the above temperature range.		

TI-NHTSA 017446

Table 3
Physical and Thermal Properties of Kapton® Type VN Film

Property	Typical Value for Film Thickness 25 µm (1 mil)	50 µm (2 mil)	75 µm (3 mil)	125 µm (5 mil)	Test Method
Ultimate Tensile Strength, MPa (psi)	231 (33,500)	234 (34,000)	231 (33,500)	231 (33,500)	ASTM D-882 91
Ultimate Elongation, %	72	82	82	82	ASTM D-882 91
Tear Strength—Propagating (Elmendorf), N	0.07	0.21	0.38	0.58	ASTM D 1922 89
Tear Strength—Initial (Graves), N	7.2	16.3	26.3	46.9	ASTM D 1004 90
Folding Endurance (MIT), × 10³ cycles	285	55	6	5	ASTM D 2176 89
Density, g/cc or g/mL	1.42	1.42	1.42	1.42	ASTM D 1505 90
Flammability	94V-0	94V-0	94V-0	94V-0	UL-94 (2-8-85)
Shrinkage, %, 30 min at 150°C (302°F)	0.03	0.03	0.03	0.03	IPC TM 650 Method 2.2.4A
Limiting Oxygen Index, %	37	43	46	45	ASTM D-2863-87

Table 4
Physical Properties of Kapton® Type FN Film*

Property	Typical Value for Film Type** 120FN616	150FN019	250FN029
Ultimate Tensile Strength, MPa (psi)			
23°C (73°F)	207 (30,000)	162 (23,500)	200 (29,000)
200°C (392°F)	121 (17,500)	89 (13,000)	115 (17,000)
Yield Point at 3%, MPa (psi)			
23°C (73°F)	61 (9,000)	49 (7,000)	58 (8,500)
200°C (392°F)	42 (6,000)	43 (6,000)	35 (5,000)
Stress at 5% Elongation, MPa (psi)			
23°C (73°F)	79 (11,500)	65 (9,500)	76 (11,000)
200°C (392°F)	53 (8,000)	41 (6,000)	48 (7,000)
Ultimate Elongation, %			
23°C (73°F)	75	70	85
200°C (392°F)	80	75	110
Tensile Modulus, GPa (psi)			
23°C (73°F)	2.48 (360,000)	2.28 (330,000)	2.62 (380,000)
200°C (392°F)	1.62 (235,000)	1.14 (165,000)	1.38 (200,000)
Impact Strength at 23°C (73°F), N cm (ft lb)	78 (0.58)	68.6 (0.51)	156.8 (1.16)
Tear Strength—Propagating (Elmendorf), N (lbf)	0.08 (0.02)	0.47 (0.11)	0.57 (0.13)
Tear Strength—Initial (Graves), N (lbf)	11.8 (2.6)	11.6 (2.6)	17.8 (4.0)
Polyimide, wt %	80	57	73
FEP, wt %	20	43	27
Density, g/cc or g/mL	1.53	1.67	1.57

*Test methods for Table 4 are the same as for Table 1.

**Because a number of combinations of polyimide film and fluorocarbon coating add up to the same total gauge, it is necessary to distinguish among them. A three-digit system is used in which the middle digit represents the nominal thickness of the base Kapton® film in mils. The first and third digits represent the nominal thickness of the coating of Teflon® FEP fluoropolymer resin in mils. The symbol 9 is used to represent 13 µm (0.5 mil) and 6 to represent 2.5 µm (0.1 mil). Example: 120FN616 is a 120-gauge structure consisting of a 25 µm (1 mil) base film with a 2.5 µm (0.1 mil) coating of Teflon® on each side.

TI-NHTSA 017447

Mechanical Properties

The usual values of tensile strength, tensile modulus, and ultimate elongation at various temperatures can be obtained from the typical stress–strain curves shown in Figures 1 and 2. Such properties as tensile strength and modulus are inversely proportional to temperature, whereas elongation reaches a maximum value at about 300°C (570°F). Other factors, such as humidity, film thickness, and tensile elongation rates were found to have only a negligible effect on the shape of the 23°C (73°F) curve.

Figure 1. Tensile Stress–Strain Curves, Type HN Film, 25 µm (1 mil)

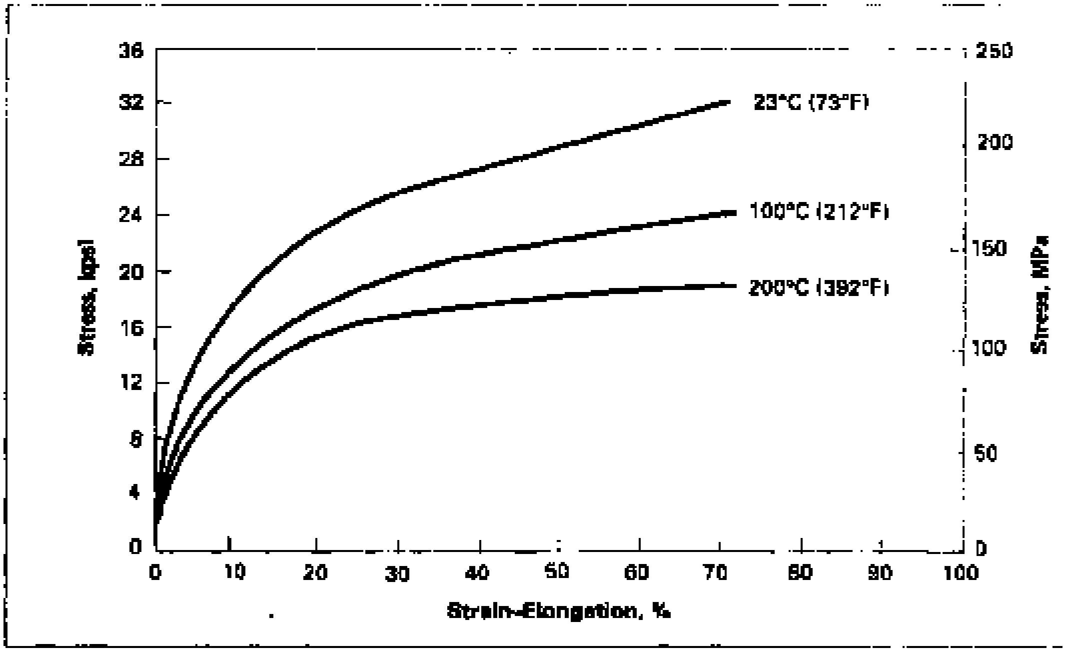
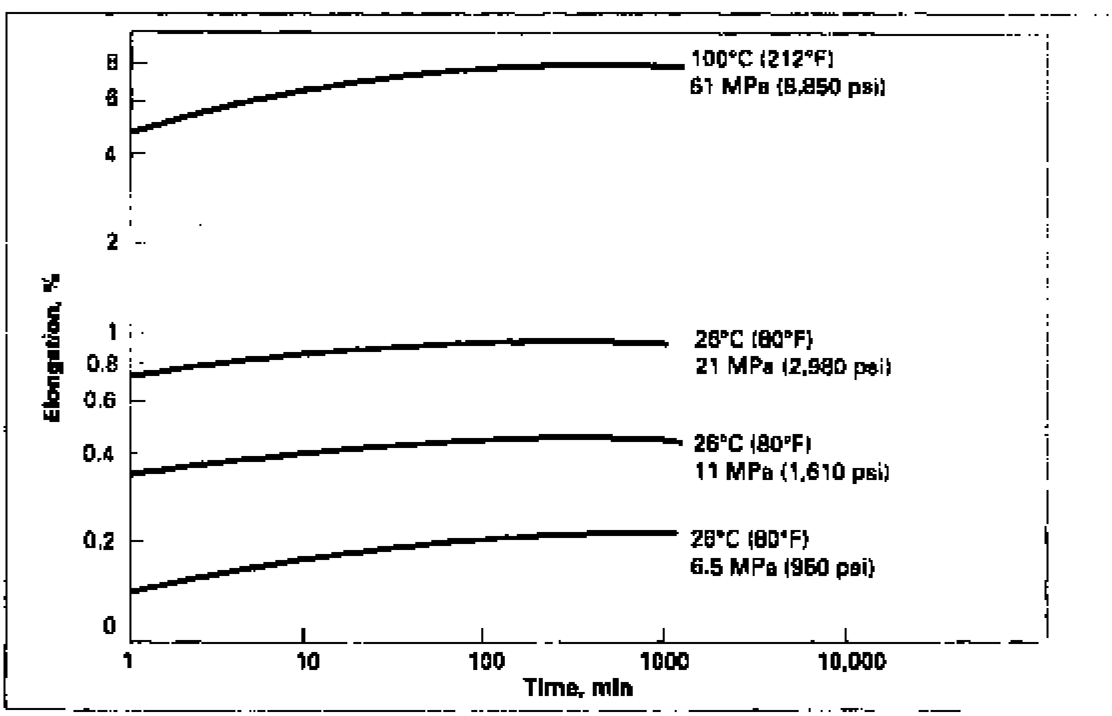


Figure 2. Tensile Creep Properties, Type HN Film, 25 µm (1 mil)



Hydrolytic Stability

Kapton polyimide film is made by a condensation reaction; therefore, its properties are affected by water. Although long-term exposure to boiling water, as shown in the curves in Figures 3 and 4, will reduce the level of film properties, sufficient tensile and elongation remain to ensure good mechanical performance. A decrease in the temperature and the water content will reduce the rate of Kapton property reduction, whereas higher temperature and pressure will increase it.

Figure 3. Tensile Strength After Exposure to 100 C (212 F) Water, Type HN Film, 25 µm (1 mil)

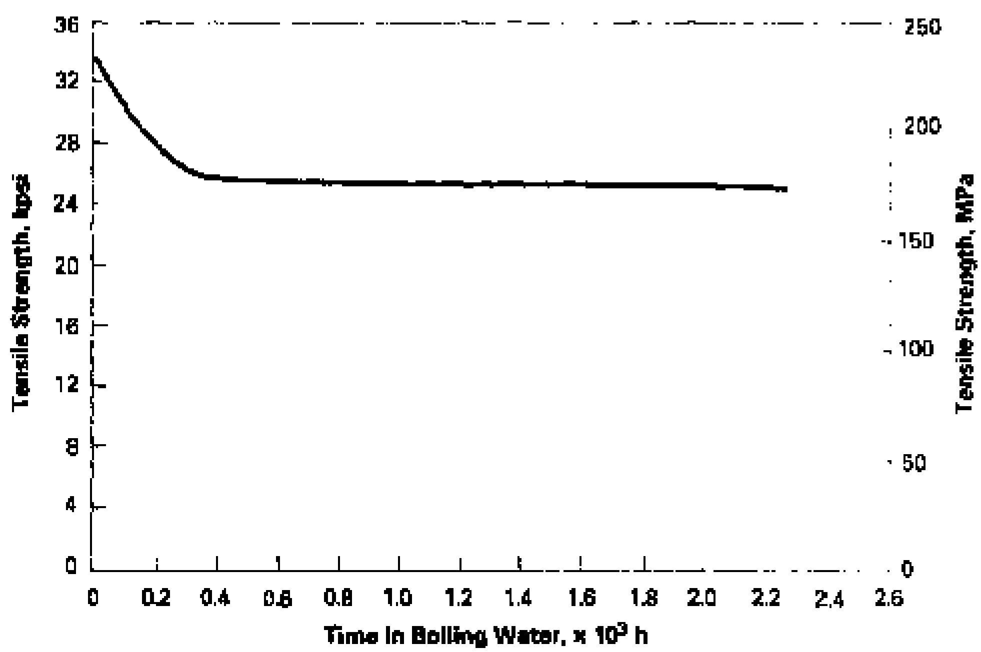
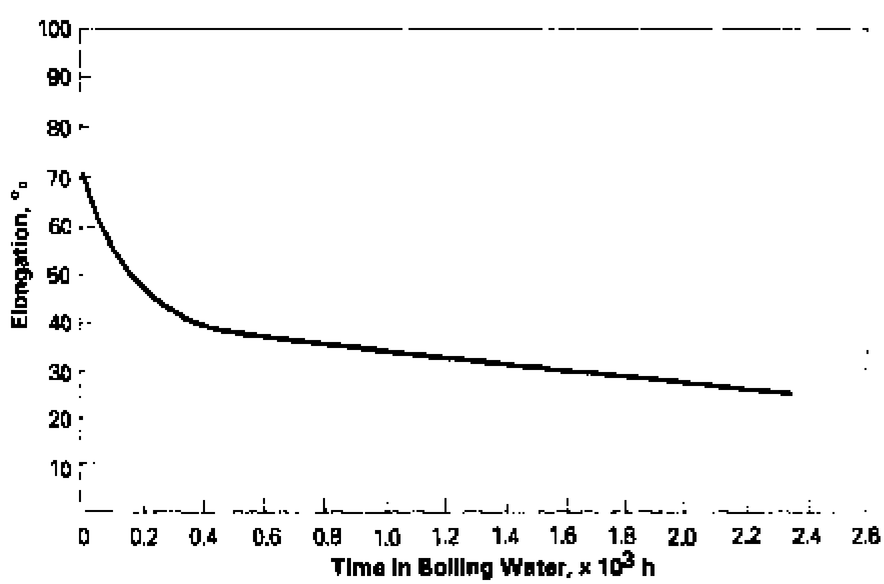


Figure 4. Ultimate Elongation After Exposure to 100 C (212 F) Water, Type HN Film, 25 µm (1 mil)

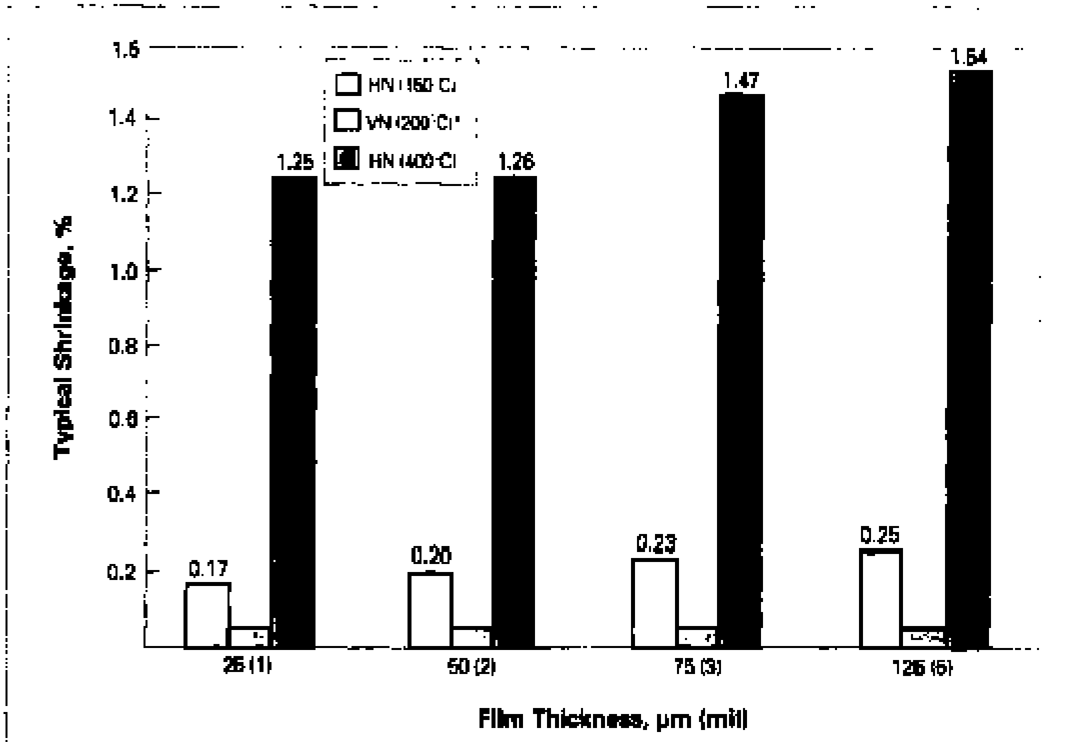


TI-NHTSA 017449

Dimensional Stability

The dimensional stability of Kapton® polyimide film depends on two factors—the normal coefficient of thermal expansion and the residual stresses placed in the film during manufacture. The latter causes Kapton® to shrink on its first exposure to elevated temperatures as indicated in the bar graph in Figure 5. Once the film has been exposed, the normal values for the thermal coefficient of linear expansion as shown in Table 5 can be expected.

Figure 5. Residual Shrinkage vs. Exposure Temperature and Thickness, Type HN and VN Films



*Type VN shrinkage is 0.03% for all thicknesses.

Table 5
Thermal Coefficient of Expansion
Type HN Film, 25 µm (1 mil)
Thermally Exposed

Temperature Range, °C (°F)	ppm/°C
23–100 (73–212)	18
100–200 (212–392)	31
200–300 (392–572)	48
300–400 (572–752)	78
23–400 (73–752)	46

Thermal Aging

The useful life of Kapton* polyimide film is a function of both temperature and oxygen concentration. In accordance with UL-746B test procedures, the thermal life of Kapton* was determined at various temperatures. At time zero and 325°C (617°F), the tensile strength is 234 MPa (34,000 psi) and the elongation is 67%. The results are shown in Figures 6–8.

Figure 6. Tensile Strength vs. Aging in Air at 325°C (617°F), Type HN Film, 25 μm (1 mil)

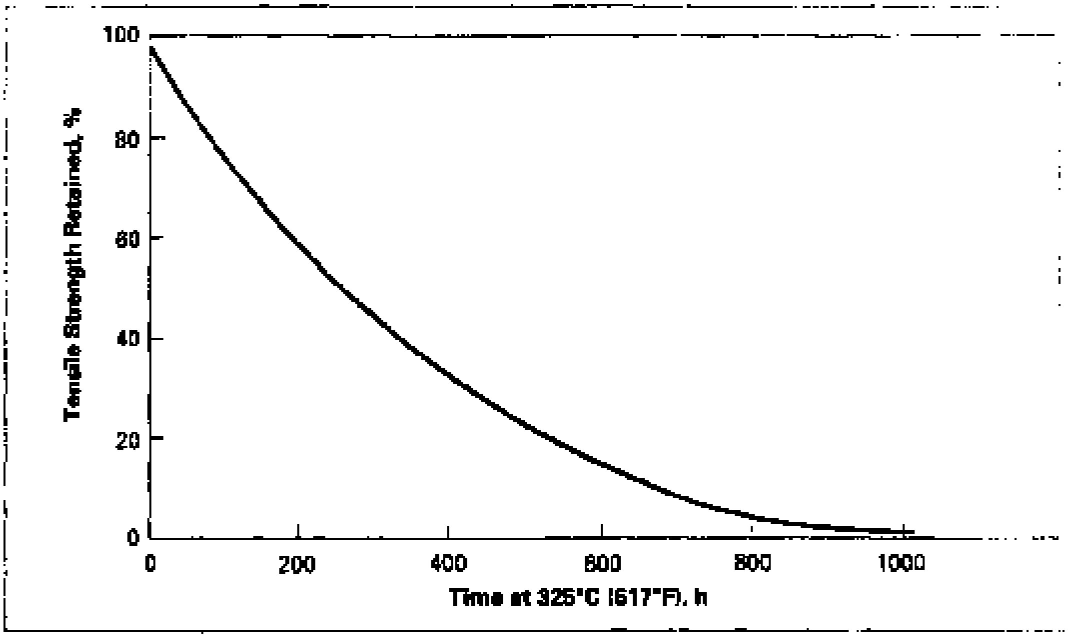


Figure 7. Ultimate Elongation vs. Aging in Air at 325°C (617°F), Type HN Film, 25 μm (1 mil)

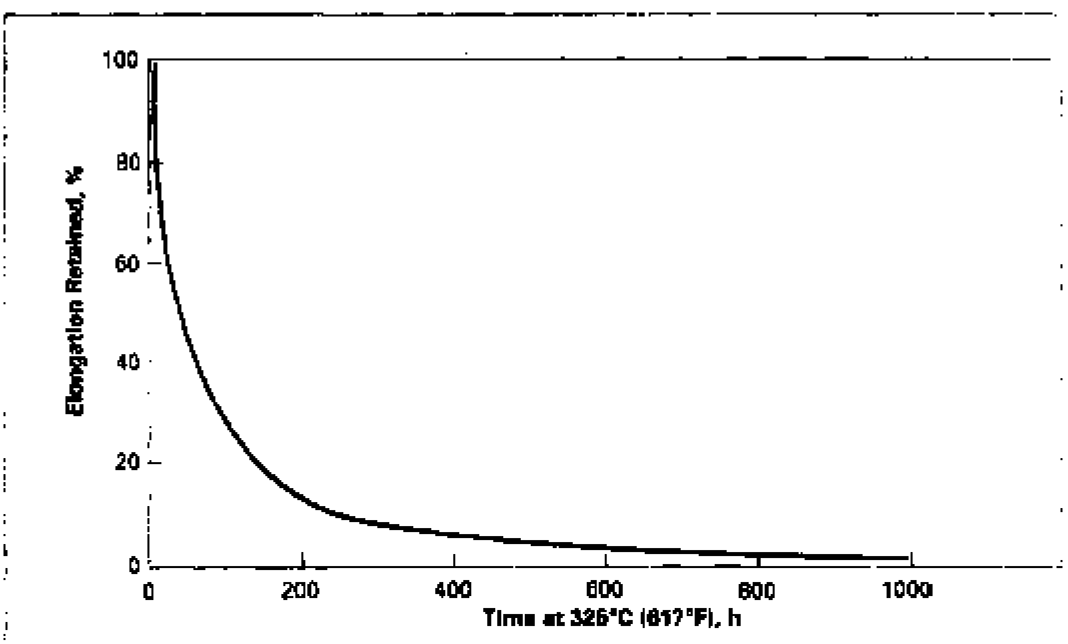
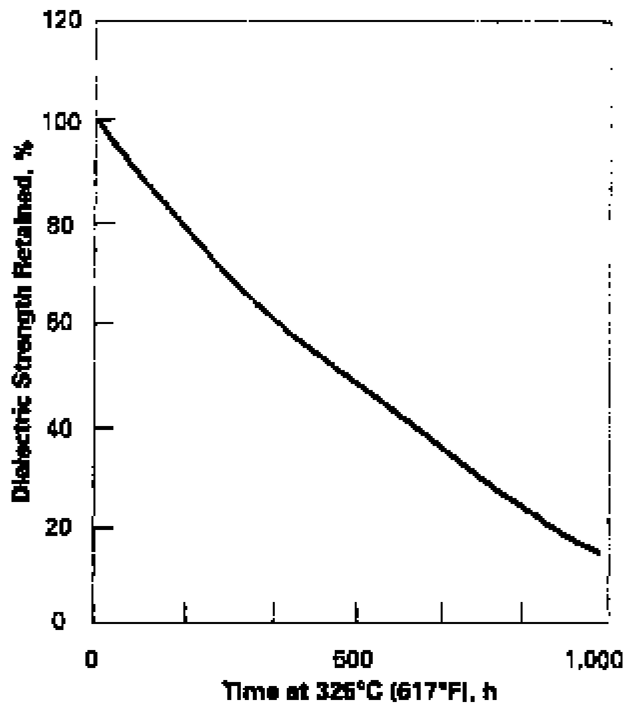
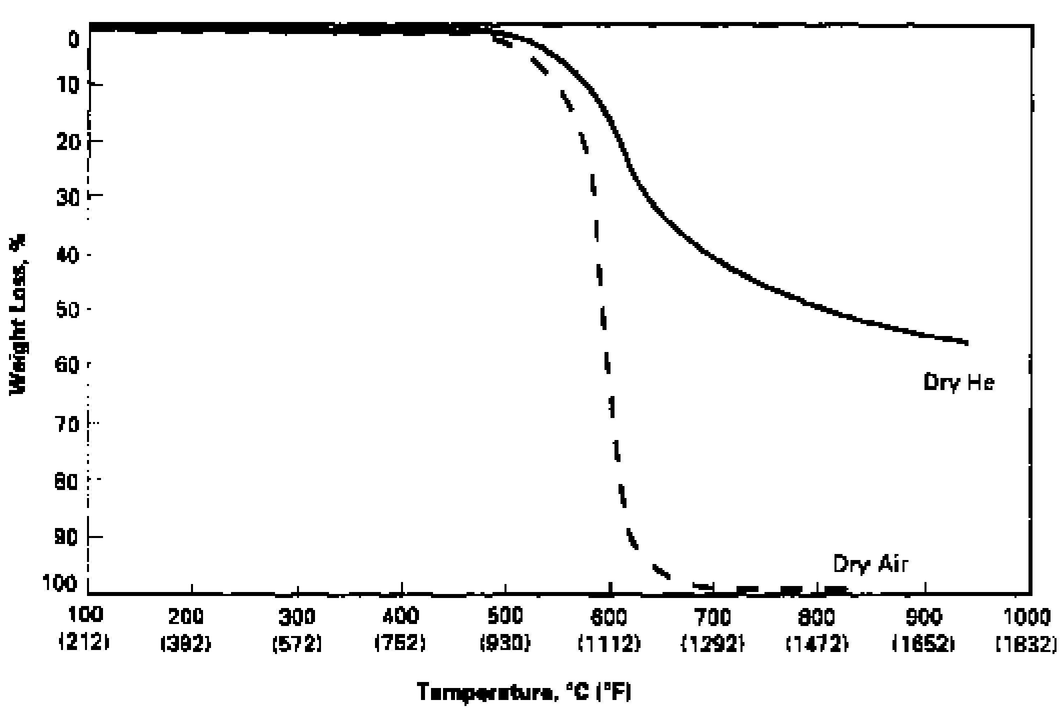


Figure 8. Retained Dielectric Strength at 325°C (617°F) for 25 µm (1 mil) Film, Test Method UL-746B



The life of Kapton* polyimide film at high temperature is significantly extended in a low-oxygen environment. Kapton* is subject to oxidative degradation. Hence, when it was tested in a helium environment, its useful life was at least an order of magnitude greater than in air. Using a DuPont 1090 thermal analyzer system, the weight loss characteristics of Kapton* in air and helium at elevated temperatures are shown in Figures 9 and 10.

Figure 9. Weight Loss, Type HN Film, 25 µm (1 mil)*



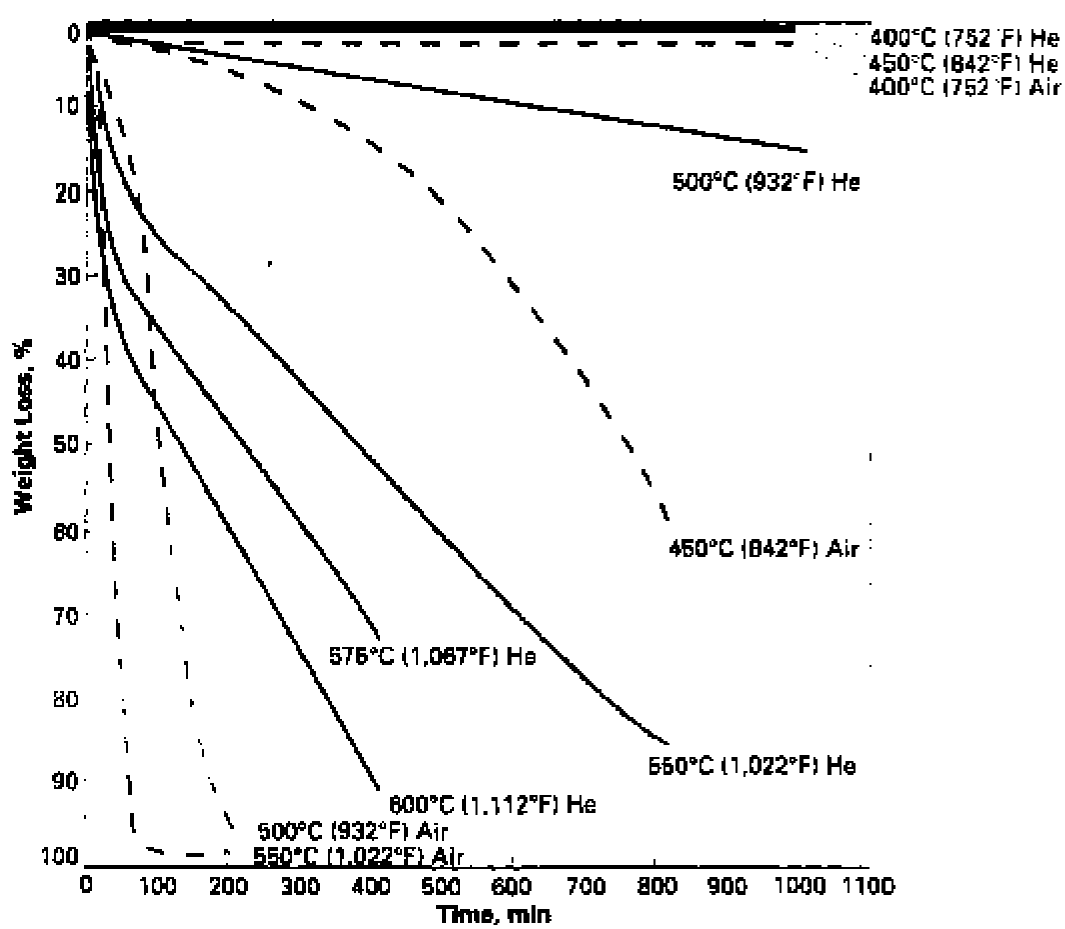
*Rate of temperature rise in °C (°F) was 3°C/min (5.4°F/min)

TI-NHTSA 017482

Table 6
Time Required for Reduction in Ultimate Elongation from 70% to 1%
Type HN Film, 25 μm (1 mil)

Temperature	Air Environment
450 C (840 F)	2 hours
425 C (800 F)	5 hours
400 C (750 F)	12 hours
375 C (710 F)	2 days
350 C (660 F)	6 days
325 C (620 F)	1 month
300 C (570 F)	3 months
275 C (530 F)	1 year
250 C (480 F)	8 years

Figure 10. Isothermal Weight Loss, Type HN Film, 25 μm (1 mil)



TI-NHTSA 017453

Electrical Properties

The most common electrical properties of Kapton® polyimide film of various gauges are shown in Tables 6 and 7. These values were measured at 23°C (73°F) and 50% relative humidity. The effect of such factors as humidity, temperature, and frequency on these basic values can be found in Table 9 and Figures 11–13.

Table 7
Typical Electrical Properties of Kapton® Types HN and VN Films

Property Film Gauge	Typical Value		Test Condition	Test Method
Dielectric Strength	V/μm (kV/mm)	(V/mil)	60 Hz	ASTM D-149-91
25 μm (1 mil)	303	(7,700)	1/4" electrodes	
50 μm (2 mil)	240	(6,100)	500 V/sec rise	
75 μm (3 mil)	205	(5,200)		
125 μm (5 mil)	154	(3,900)		
Dielectric Constant			1 kHz	ASTM D-150-92
25 μm (1 mil)	3.4			
50 μm (2 mil)	3.4			
75 μm (3 mil)	3.5			
125 μm (5 mil)	3.5			
Dissipation Factor			1 kHz	ASTM D-150-92
25 μm (1 mil)	0.0018			
50 μm (2 mil)	0.0020			
75 μm (3 mil)	0.0020			
125 μm (5 mil)	0.0026			
Volume Resistivity	Ω·cm			ASTM D-257-91
25 μm (1 mil)	1.5×10^{17}			
50 μm (2 mil)	1.5×10^{17}			
75 μm (3 mil)	1.4×10^{17}			
125 μm (5 mil)	1.0×10^{17}			

Table 8
Typical Electrical Properties of Kapton® Type FN Film

Property	120FN616	150FN019	250FN029
Dielectric Strength, V/μm (V/mil)	272 (6,900)	197 (5,000)	197 (5,000)
Dielectric Constant	3.1	2.7	3.0
Dissipation Factor	0.0015	0.0013	0.0013
Volume Resistivity, Ω·cm			
at 23°C (73°F)	1.4×10^{17}	2.3×10^{17}	1.9×10^{17}
at 200°C (392°F)	4.4×10^{14}	3.6×10^{14}	3.7×10^{14}

Effect of Temperature

As Figures 14–17 indicate, extreme changes in temperature have relatively little effect on the excellent room temperature electrical properties of Kapton® polyimide film.

Figure 14. AC Dielectric Strength vs. Temperature, Type HN Film, 25 µm (1 mil)

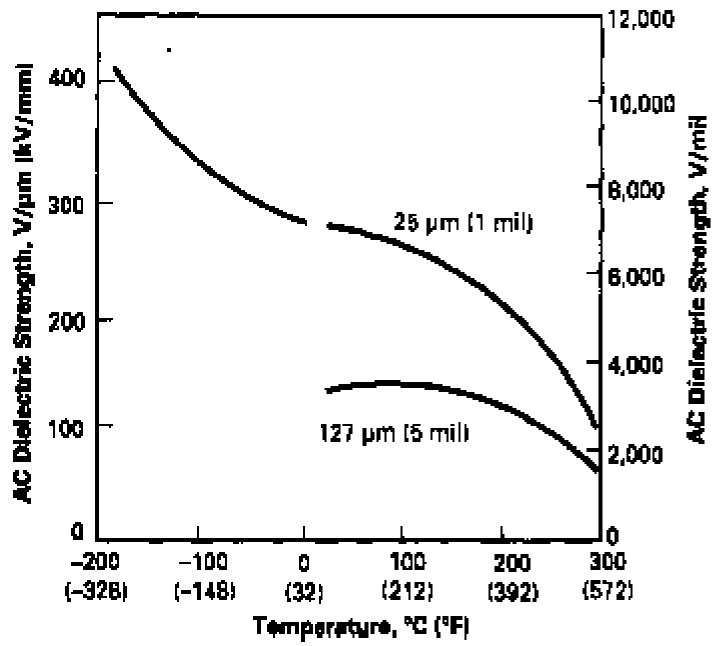
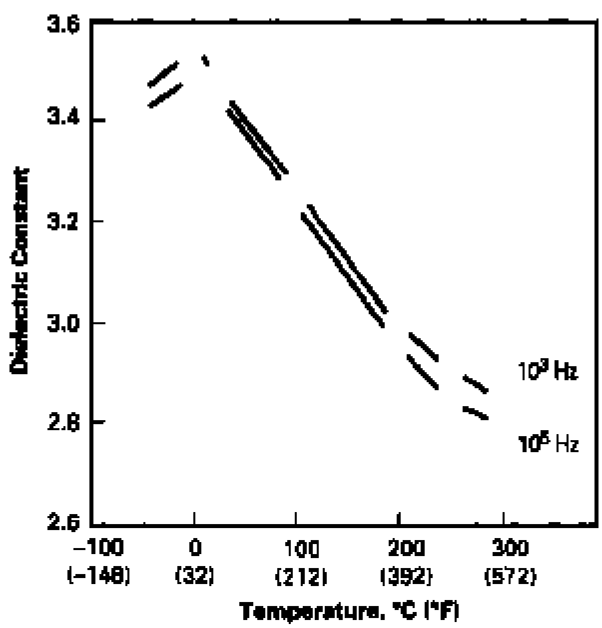


Figure 15. Dielectric Constant vs. Temperature, Type HN Film, 25 µm (1 mil)



TI-NHTSA 017455

Figure 16. Dissipation Factor vs. Temperature, Type HN Film, 25 μm (1 mil)

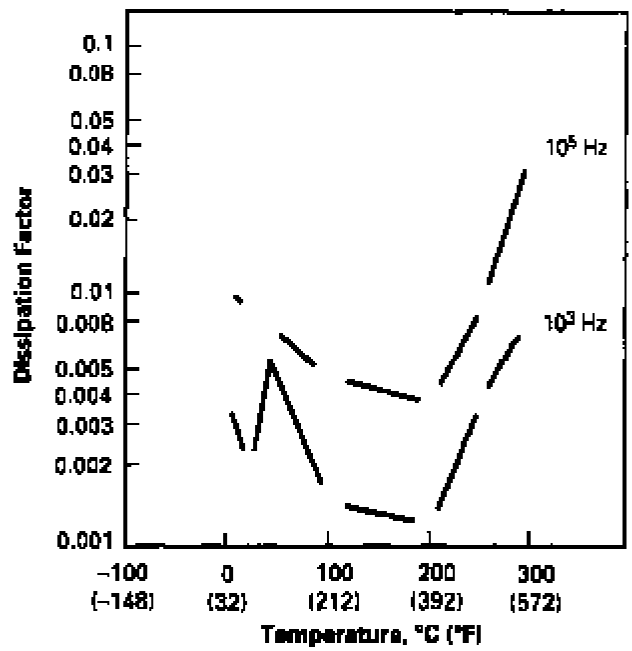
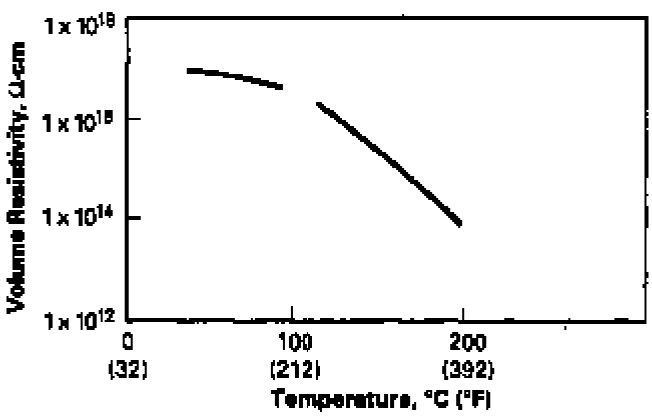


Figure 17. Volume Resistivity vs. Temperature, Type HN Film, 25 μm (1 mil)



TI-NHTSA 017456

Effect of Frequency

The effect of frequency on the values of the dielectric constant and dissipation factor at various isotherms are shown in Figures 18 and 19 for Type HN film, 25 μm (1 mil); and in Figures 20 and 21 for HN, 125 μm (5 mil).

Figure 18. Dielectric Constant vs. Frequency, Type HN Film, 25 μm (1 mil)

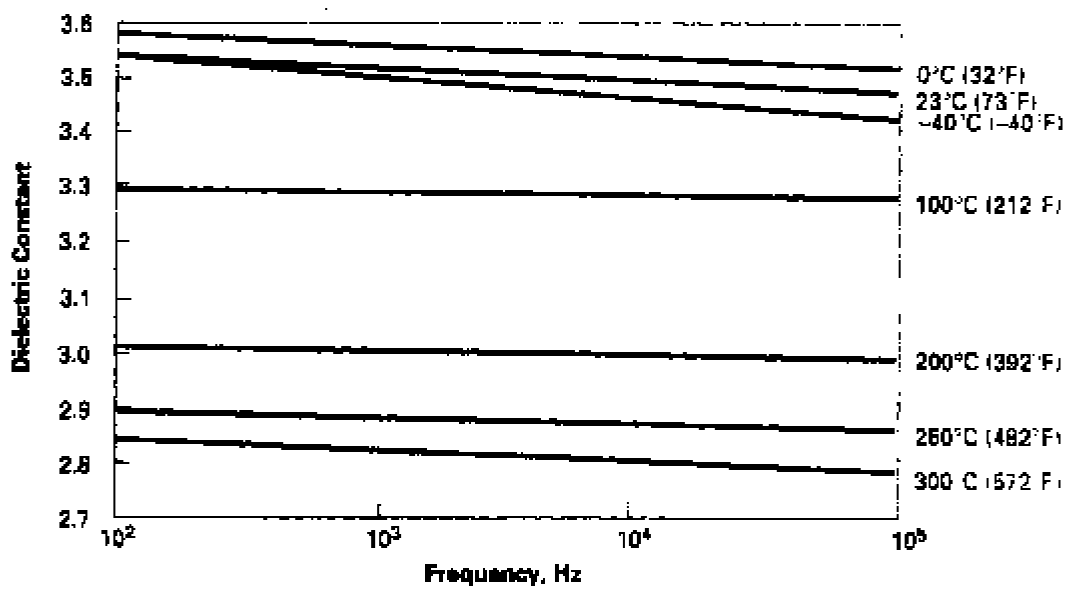


Figure 19. Dissipation Factor vs. Frequency, Type HN Film, 25 μm (1 mil)

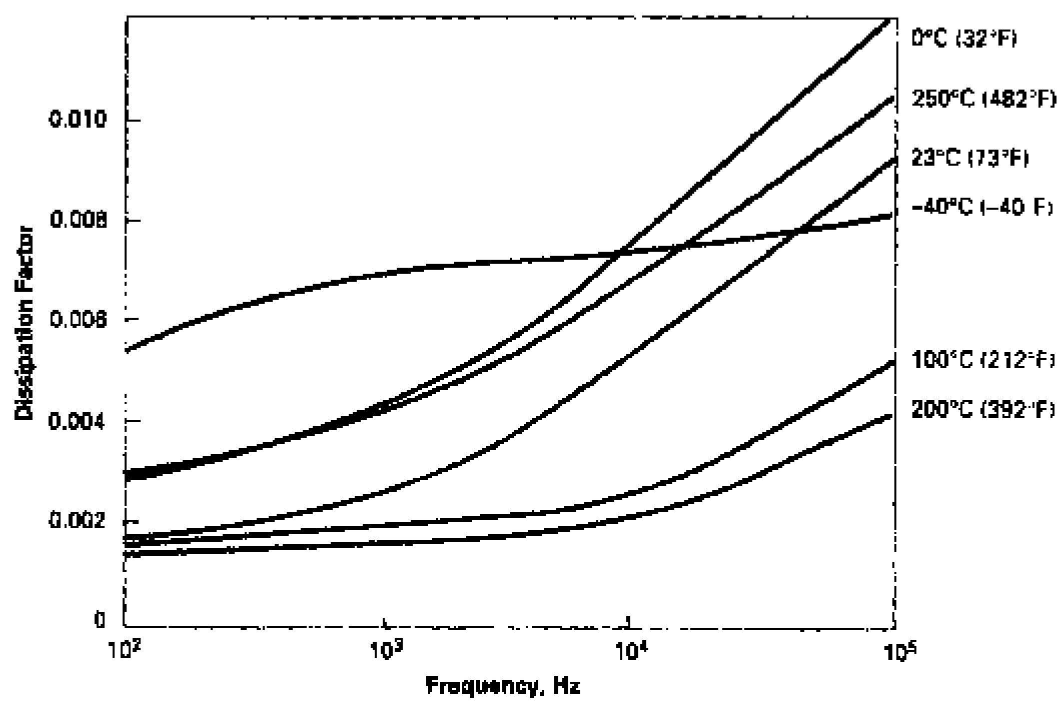


Figure 20. Dielectric Constant vs. Frequency, Type HN Film, 125 μm (5 mil)*

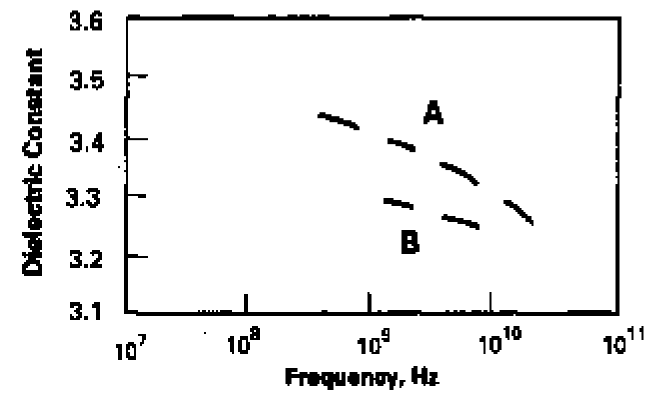
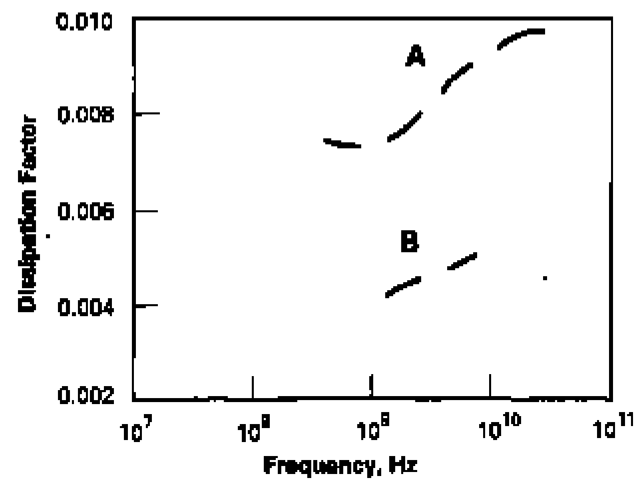


Figure 21. Dissipation Factor vs. Frequency, Type HN Film, 125 μm (5 mil)*



Technical Report AFML-TR-72-39—Curve A is 500H Kapton as received and measured at 25 C (77 F) and 45% RH with the electric field in the plane of the sheet. Curve B is the same measurement after conditioning the film at 100°C (212°F) for 48 hours. Performance of 500HN is believed to be equivalent to 500H.

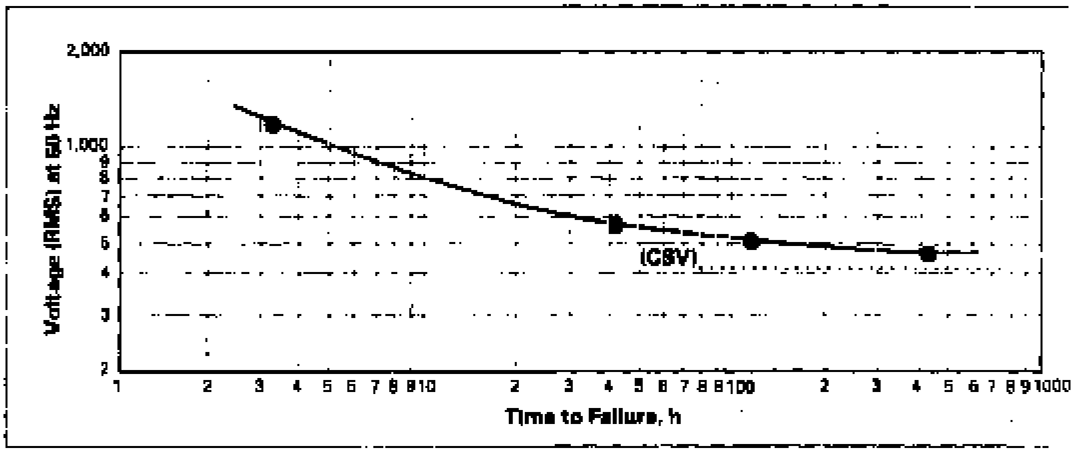
Corona Life

Like all organic materials, Kapton® is attacked by a corona discharge, and when exposed continuously to it will ultimately fail dielectrically. At moderate levels of corona exposure, devices insulated with Kapton® have survived up to 3,000 h, giving reasonable assurance that brief exposure to a corona will not significantly affect the life of a properly designed insulation system based on Kapton®.

Corona threshold voltage and intensity are functions of many parameters, including insulation thickness, air gap thickness, and device shape. Consult with a DuPont technical representative on the suitability of Kapton® for specific applications where a corona may be present.

Figure 22 shows the life for 25 µm (1 mil) Kapton® HN polyimide film as a function of voltage (RMS) at 60 Hz. As the corona starting level is approached, the Kapton® life curve flattens, indicating a long life. It should be emphasized that the superior thermal and moisture-proof capabilities of Kapton® insulated magnet wire, wrappers, and slot insulation can be utilized without fear of corona in properly designed systems. Kapton® can be used alone or in combination with other insulation materials.

Figure 22. Voltage Endurance of 100HN Kapton® Polyimide Film*



*Corona Starting Voltage (CSV) = 425 V

TI-NHTSA 017459

Chemical Properties

Typical chemical properties of Kapton® Types HN and FN films are given in Tables 10 and 11. The chemical properties of Type VN film are similar to those of Type HN.

Table 10
Chemical Properties of Kapton® Type HN Film, 25 μm (1 mil)

Property	Typical Value: Tensile Retained, %	Typical Value: Elongation Retained, %	Test Condition	Test Method
Chemical Resistance				
Isopropyl Alcohol	98	94	10 min at 23°C	IPC TM-650 Method 2.2.3B
Toluene	99	91		
Methyl Ethyl Ketone	99	90		
Methylene Chloride/ Trichloroethylene (1:1)	98	86		
2 N Hydrochloric Acid	98	89		
2 N Sodium Hydroxide	82	54		
Fungus Resistance	Nonnutrient			IPC TM-650 Method 2.6.1
Moisture Absorption	1.8% Types HN and VN		50% RH at 23°C	ASTM D-570-81 (1988)
	2.8% Types HN and VN		Immersion for 24 h at 23°C (73°F)	
Hygroscopic Coefficient of Expansion	22 ppm/% RH		23°C (73°F), 20–80% RH	
Permeability				
Gas	*mL/m²·24 h·MPa*	*cc/(100 in²·24 h·atm)*	23°C (73°F), 50% RH	ASTM D-1434-82 (1988)
Carbon Dioxide	6,840	45		
Oxygen	3,800	25		
Hydrogen	38,000	250		
Nitrogen	910	6		
Helium	63,080	415		
Vapor	*g/(m²·24 h)*	*g/(100 in²·24 h)*		ASTM E-96-92
Water	54	3.5		

Table 11
Chemical Properties of Kapton® Type FN Films

Property	120FN616	150FN019	400FN022
Moisture Absorption, %			
at 23°C (73°F), 50% RH	1.3	0.8	0.4
98% RH	2.5	1.7	1.2
Water vapor Permeability,			
g/(m²·24 h)	17.5	9.6	2.4
g/(100 in²·24 h)	1.13	0.62	0.16

TI-NHTSA 017460

Radiation Resistance

Because of its excellent radiation resistance, Kapton® is frequently used in high radiation environments where a flexible insulating material is required. In outer space, Kapton® is used both alone and in combination with other materials for applications that require radiation resistance at minimum weight. U.S. Government laboratory test data on gamma and neutron radiation exposure of Kapton® are summarized in Tables 12 and 13.

Testing the suitability of Kapton® for nuclear reactors and linear accelerators involves exposure to an adverse chemical environment in addition to radiation. For example, loss of coolant accident (LOCA) tests for qualification in containment areas in nuclear power plants expose the system to steam and sodium hydroxide, both of which tend to degrade Kapton®.

Accordingly, when Kapton® is used in nuclear power systems that require certification to IEEE-323 and -383, engineered designs that protect Kapton® from direct exposure to LOCA sprays are required.

The excellent ultraviolet resistance of Kapton in the high vacuum of outer space is demonstrated by the data in Table 14. In the earth's atmosphere, however, there is a synergistic effect upon Kapton® if it is directly exposed to some combinations of ultraviolet radiation, oxygen, and water. Figure 23 shows this effect as a loss of elongation when Kapton® was exposed in Florida test panels. Figure 24 shows the loss of elongation as a function of exposure time in an Atlas Weatherometer. Design considerations should recognize this phenomenon.

Table 12
Effect of Gamma Radiation Exposure on Kapton® Polyimide Film
(Cobalt 60 Source, Oak Ridge)

Property	Control 1 mil Film	10^4 Gy 1 h	10^5 Gy 10 h	10^6 Gy 4 d	10^7 Gy 42 d
Tensile Strength, MPa (psi × 10^3)	207 (30)	207 (30)	214 (31)	214 (31)	152 (22)
Elongation, %	80	78	78	79	42
Tensile Modulus, MPa (psi × 10^3)	3172 (460)	3275 (475)	3378 (490)	3275 (475)	2903 (421)
Volume Resistivity Ω-cm × 10^{13} at 200°C (392°F)	4.8	6.6	5.2	1.7	1.6
Dielectric Constant 1 kHz at 23°C (73°F)	3.46	3.54	3.63	3.71	3.50
Dissipation Factor 1 kHz at 23°C (73°F)	0.0020	0.0023	0.0024	0.0037	0.0028
Dielectric Strength V/μm (kV/mm)	268	223	218	221	254

Table 13
Effect of Electron Exposure on Kapton® Polyimide Film Mixed Neutron and Gamma

	5×10^7 Gy	10^8 Gy
5×10^{12} neutrons/cm/s Flux at 175°C (347°F)	Film Darkened	Film Darkened and Tough

TI-NHTSA 017461

Table 14
Effect of Ultraviolet Exposure on Kapton Polyimide Film*

	1000 h Exposure
Tensile Strength, % of Initial Value Retained	100
Elongation, % of Initial Value Retained	74

*Vacuum environment, 2 x 10 mm Hg at 50 C (122 F). UV intensity equal to space sunlight to 2500Å.

Figure 23. Effect of Florida Aging on Kapton Polyimide Film

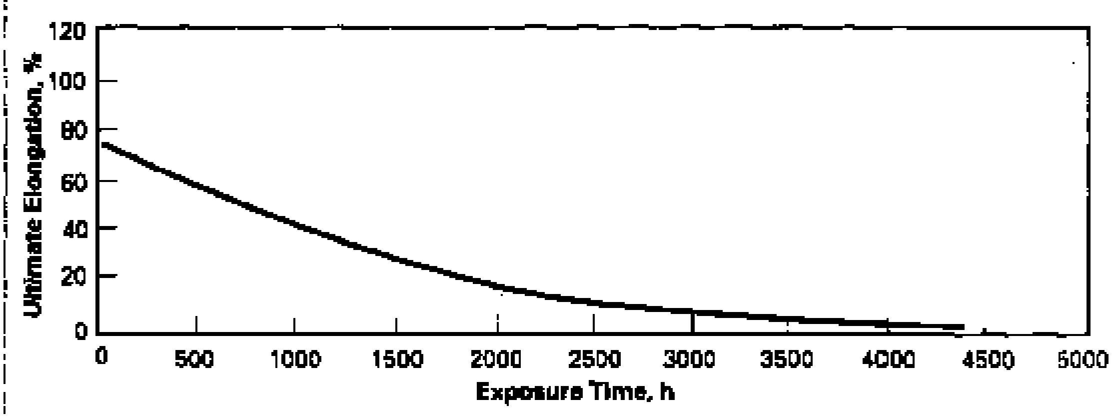
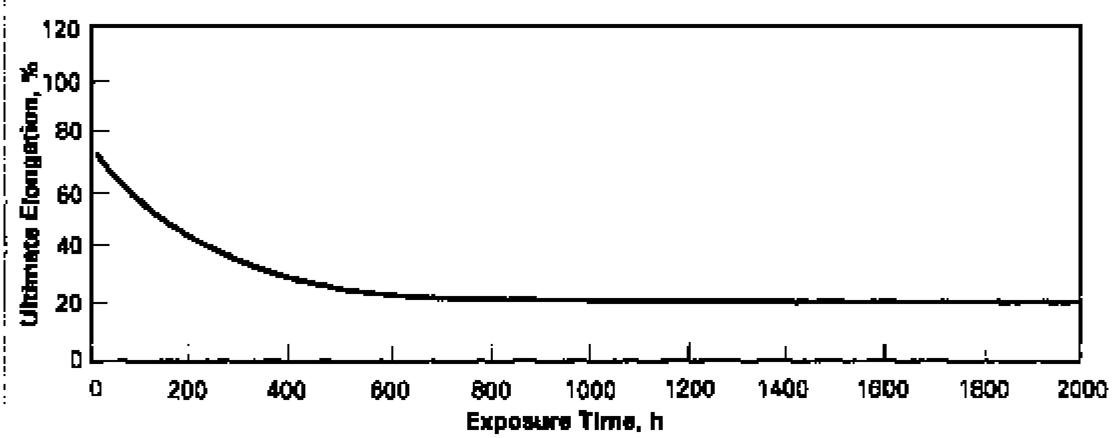
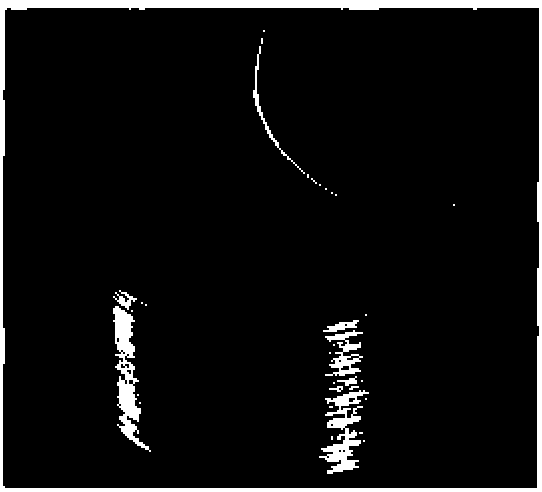


Figure 24. Effect of Weathering on Kapton Polyimide Film (Atlas Weatherometer)



TI-NHTSA 017462



Kapton Film Type Information

Table 15
Type and Thickness

Type	Nominal Thickness		Area Factor	
	μm	mil	m²/kg	ft²/lb
30HN	7.6	0.3	93	455
50HN	12.7	0.5	56	272
75HN	19.1	0.75	37	181
100HN	25.4	1.0	28	136
200HN	50.8	2.0	14	68
300HN	76.2	3.0	9.2	45
500HN	127	5.0	5.5	27
50VN	12.7	0.5	56	272
75VN	19.1	0.75	37	181
100VN	25.4	1.0	28	136
200VN	50.8	2.0	14	68
300VN	76.2	3.0	9.2	45
500VN	127	5.0	5.5	27
100FN099	25.4	1.0	23	110
120FN616	30.5	1.2	21	104
160FN999	38.1	1.5	14	68
150FN019	38.1	1.5	16	77
200FN011	50.8	2.0	11	54
200FN919	50.8	2.0	11	54
250FN029	63.5	2.5	10	49
300FN021	76.2	3.0	8.0	39
300FN929	76.2	3.0	8.0	39
400FN022	101.6	4.0	5.5	27
400FN031	101.6	4.0	6.1	30
500FN131	127	5.0	4.7	23
600FN051	152.4	6.0	4.3	21

Nominal Construction, Type FN

In the Kapton' Type FN order code of three digits, the middle digit represents the nominal thickness of the base Kapton' in mils. The first and third digits represent the nominal thickness of the coating of Teflon' FEP fluoropolymer resin in mils. The symbol 9 is used to represent 12.7 μm (0.5 mil) and 6 to represent 2.54 μm (0.1 mil). Example: 120FN616 is a 120-gauge structure consisting of a 25.4 μm (1 mil) base film with a 2.54 μm (0.1 mil) coating of Teflon' on each side. Illustrated in Table 16 are several examples of the many film types available.

Table 16
Type FN Film Constructions

Type	Construction					
	FEP		HN		FEP	
	μm	mil	μm	mil	μm	mil
100FN099			12.7	0.50	12.7	0.50
120FN616	2.54	0.10	25.4	1.00	2.54	0.10
160FN999	12.7	0.50	12.7	0.50	12.7	0.50
150FN019			25.4	1.00	12.7	0.50
200FN011			25.4	1.00	25.4	1.00
200FN919	12.7	0.50	25.4	1.00	12.7	0.50
250FN029			50.8	2.00	12.7	0.50
300FN021			50.8	2.00	25.4	1.00
300FN929	12.7	0.50	50.8	2.00	12.7	0.50
400FN022			50.8	2.00	50.8	2.00
400FN031			76.2	3.00	25.4	1.00
500FN131	25.4	1.00	76.2	3.00	25.4	1.00
600FN051			127	5.00	25.4	1.00

Safety and Handling

Unheated Kapton* polyimide film is insoluble in most common organic solvents after immersion for up to a year. However, Kapton* is dissolved by strong acids, such as fuming nitric and concentrated sulfuric acid, particularly on heating, and is hydrolyzed by alkali and superheated steam.

Kapton* Type FN exhibits better chemical and oxidative resistance than Types HN and VN.

Kapton* film can be used safely at elevated temperatures with proper ventilation. At elevated temperatures, Kapton* can release small amounts of *N,N*-dimethylacetamide residual solvent. Adequate ventilation in accordance with OSHA (29 CFR 1910.1000) will provide safe handling and use.

For additional information, users should refer to the following bulletins: Kapton* Polyimide Film—Safe Handling, E-72084 and Kapton* Polyimide Film—Products of Decomposition, H-16512.

United States

DuPont High Performance Films
P.O. Box 89
Route 23 South and DuPont Road
Circleville, OH 43113
Ordering Information:
800-967-5607
Product Information:
800-237-4357
Fax: 800-879-4481

Canada

DuPont Canada, Inc.
P.O. Box 2200, Streetsville
Mississauga, Ontario, Canada
L5M 2H3
Inquiries:
(416) 821-5953
Customer Service: 800-268-3943
Fax: (416) 821-5230

Latin America

Argentina

Du Pont Argentina S.A.
Av. Eduardo Madero, 1020
CP 1106-Buenos Aires-
Cap. Federal
Argentina
54-1-312-2011
Fax: 54-1-11-1329
or 54-1-311-9331

Brazil

Du Pont do Brasil S.A.
Alameda Itapecuru, 506
Alphaville, Barueri, SP
Brasil-CEP 06454-080
55-11-421-8122
Fax: 55-11-421-4051

Mexico

Du Pont S.A. de C.V.
Homero 206
Col. Polanco
Mexico, D.F. 11570
905-250-90-33
905-250-80-00
Fax: 905-250 38-45

Venezuela

Du Pont de Venezuela C.A.
Edificio "Los Frailes"
Calle la Guarita
Urbanizatión Chuao
CP 1060, Caracas, Venezuela
58-2-92-6055
58-2-92-9442

Europe

Du Pont de Nemours
International S.A.
P.O. Box 50
2, chemin du Pavillon
CH-1218 Le Grand-Saconnex
Geneva, Switzerland
41 (022) 717-5111
Fax: 41 (022) 717-5109

Asia Pacific

Japan

Du Pont Japan Ltd.
Arco Tower
8-1 Shimomeguro 1-chome
Meguro-ku, Tokyo 153
Japan
Marketing Representative:
81-3-5434-6139
Customer Service:
81-3-5434-6141
Fax: 81-3-5434-6193

ASEAN

Du Pont Singapore Pte Ltd.
1 Maritime Square
07-01 World Trade Center
Singapore 0409
65-273-2244
Fax: 65-272-7494

Australia

Du Pont (Australia) Limited
Northside Gardens
168 Walker Street
North Sydney, NSW 2060
Australia
61-2-923-6111
Fax: 61-2-923-6011

Hong Kong/China

Du Pont China Limited
1122 New World Office Bldg.
East Wing
Salisbury Road, Kowloon
Hong Kong
852-734-5345
Fax: 852 724 4458

India

Du Pont Far East Inc.
Rang Sharda, Block A 6th Floor
K C Road
Bandra Reclamation
Bandra (W)
Bombay 400 050
India
00-91-22-6442963/72
Fax: 00-91-22-6442986

Korea

DuPont Korea Ltd.
4/5th Floor Asia Tower Bldg.
#726, Yeoksam-dong,
Kangnam-ku
Seoul 135-082, Korea
(822) 222-5200
Fax: (822) 222-5470/1
Tlx: K27514 DUPONKO

Taiwan

Du Pont Taiwan Limited
13th Floor, Hung Kuo Bldg.
167 Tun Hwa North Road
Taipei, Taiwan 105
886-2-7191999
Fax: 886-2-7190852

(8/93) 231307A Printed in U.S.A.
(Replaces: E 93189)
Reorder No. H 38492

DuPont High Performance Films

TI-NHTSA 017467

TEXAS INSTRUMENTS

August 13, 1993

Mr. David P. Reifschneider
Accounts Manager
DUPONT IMAGING/MEDICAL
12 Meadows Lane
Wilmington, DE 19807

Dear Dave:

Thank you for your quick response in setting up a plant visit. The situation, as you know, has become critical, and we need to act quickly to build our customer's confidence in Kapton usage.

TI visitors will include me, John Brennan, and possibly Agnes Cardoza. John is our resident plastics expert in Advanced Development. The objectives of our visit, as I see them, follow:

- o Tour the Kapton, manufacturing and Kapton/Teflon laminating lines to fully understand the processes and their controls for items such as:

  Strength (UTS and Elongation at break)
  Pinholes & inclusions
  Thickness variation

- o Understand Kapton chemistry as it relates to power steering fluid compatibility. We need a strong technical position on the use of Kapton in power steering applications, supported by DuPont and TI test Data and DuPont's expertise in Kapton chemistry.

- o Map out a strategy for:

  A. Documenting Kapton processing in a form that can be shared with our customer.
  B. Understanding process variations and their effects e.g., what is expected strength variation run-to-run and within run? We will need data for our customer. What is the size distribution and frequency of pinholes?
  C. How does "worst case" Kapton perform in our switches?
  D. Are other actions needed to improve prevention/detection methods for pinholes/inclusions?

- o Put a plan in place for TI, DuPont US and Toray DuPont Japan to be "one voice" . . . information shared with our end customers needs to be consistent.

- o We would like to leave with:

  1. "Worst Case" Kapton (both monolithic 3 mil and Teflon laminated 1-3-1) for TI testing.
  2. W^3 for TI/DuPont plans to study and report on Kapton compatibility with power steering fluid.
  3. W^3 for determining (documenting) strength variation, pinhole size/distribution, etc.

Our customer meeting is tentatively scheduled for the week of September 13, so we need to build a strong case before then.

Sincerely,

MATERIALS & CONTROLS GROUP
CONTROL PRODUCTS DIVISION

Dave Czarn
Design Engineering Supervisor
MS12-29

DC/kh

cc: John Brennan
Agnes Cardoza

DU PONT/TEXAS INSTRUMENTS
Circleville, Ohio
August 25, 1993

AGENDA

8:45 - 9:00	Arrive at Circleville	
9:00 - 9:20	Welcome	Kevin Corby
9:20 - 9:45	Overview of Process	Ed McKenzie
9:45 - 10:45	Plant Tour	
	- Teflon® Scott Simpson - Kapton® Paul Campbell - Laminator BCM - Finishing Carl Haeger - QC Lab Terrell Holloway	
10:45 - 11:45	Process Capability	
	- Thickness, Tensiles Elongations	
11:45 - 12:30	Lunch	Plum Room
12:30 - 1:30	Defect Detection	Gerhard Maroscher
	- Current capability - Experience with Camera System	
1:30 - 2:30	Automotive Applications	
	- Performance vs Fluids - Helium permeability	
2:30 - 3:00	Review and Path Forward	

Memorandum
August 27, 1993

To: Vishwa Shukla
Francois Padovani

cc: Dave Czarn, Chris Wagner, Tom Charboneau, Rick Conlin

Fr: John Brennan

Re: Trip Report, Du Pont Kapton Facility, Circleville, OH

Dave Czarn and I visited the Du Pont Kapton Facility in Circleville, OH, on August 25. Our intent was to gain information on the processing, quality control, and performance of Kapton film. Kapton is earning a bad reputation for use in automotive fluids at Nissan and this reputation is filtering down to M&C's pressure switch products. Kapton's negative standing is completely unwarranted, based on TI's and Du Pont's lab testing and TI's switch performance. Our visit reinforced our confidence in using Kapton on power steering switches.

The Circleville plant houses the complete processing of Kapton from polymerization down to film slitting and packaging. To make the base polyimide Kapton film (HN type), the polyimide monomers are mixed into a solvent and cast into a film. Solvent is then dried off, followed by polymerization of the monomers.

Circleville makes Teflon FEP film by melt extrusion. If the film is to be used in making Kapton laminates, it undergoes a plasma treatment during processing. This treatment alters the FEP surface chemistry, making it possible for the film to adhere to the polyimide base.

Filtering is quite extensive on these processing lines. Both lines have 20 μ filters at the end of the extruders. Du Pont filters Kapton monomers to 9 μ at the greatest. They filter the solvent to 1 μ.

Laminates are made on a three web laminator. The FEP layers are heated to near their melting points and bonded by nip rolls to the polyimide.

All rolls of the FN film are inspected on a rewind inspection station. Because of the high volumes produced, Du Pont inspects only every sixth roll of HN film. (We currently use FN film on the line-mounted switches. HN film is being considered for the pump mounted parts.) The films pass by two lasers in this inspection. One laser identifies particulate defects, and the other laser identifies craters (pinholes that don't go completely through the film). When a laser spots a defect, the operator locates and tags the defect. The defect is cut out of the film during slitting.

Both the Teflon and Kapton lines have the standard process controls expected in polymer processing. The Kapton line is testing an innovation for film quality control. A battery of 12 cameras with a 0.0025 inch pixel size inspects the film at the end of the Kapton polymerization line. As defects are identified by the cameras, the processing line is adjusted to eliminate the problem. This technique has identified the root causes of two chronic Kapton defects and eliminated them permanently.

Nissan has expressed concern about pinhole defects. Du Pont is adamant that pinholes ("voids" that pass completely through the film) do not exist in Kapton. Craters ("voids" that pass only partly through the film's thickness) do exist. However, Du Pont is insistent that no craters less than 10 mils in diameter exist in the film and that the rewind inspection catches craters larger than 10 mils. Du Pont provided 1992 data for 300HN film, in which 101 rolls of film were inspected. On average, there is 1 crater per 33750 sq. ft. of film. This is equivalent to 1 crater per 8,640,000 pressure switch parts. The worst rolls (there were 2) had a defect rate of 1 crater for 3800 sq. ft. or 1 per 972,800 switch parts. Bear in mind that these defects were slitted out prior to shipment.

Du Pont's explanations about crater creation and the nonexistence of craters smaller than 10 mils remain unclear.

Du Pont provided the results of automotive fluid exposure testing on Kapton films. One test was exposure in 300 F. Dexron ATF. This test showed complete retention of tensile strength and little loss in elongation after 1000 hours of exposure. These results reinforce the testing conducted at TI.

Du Pont analyzed films removed from Wako switches. Nissan became concerned about Kapton because of the poor performance of these switches. The Wako diaphragms are not like ours. Their diaphragm consists of two layers of Kapton bonded together by silicone adhesive. A fluoropolymer film is placed loose on top of the Kapton sandwich. Although the Kapton layers are from Circleville, the fluoropolymer layer is not. Furthermore, the fluoropolymer layer is not FEP, but PTFE, a critical difference.

FEP is Fluorinated Ethylene Propylene. It can be melted and processed from the melt state. PTFE stands for PolyTetraFluoroEthylene. It is Fluorinated Ethylene. PTFE can not be melted. It can be processed only by sintering or dispersion coating. Either processing technique leaves voids–PTFE is porous. This porosity may create leaking problems in Wako switches. TI switches won't have that problem, because our fluoropolymer layer is FEP.

Tasks I need to complete for this project are:

1. Understand the crater formation and size explanations.
2. Obtain a review of Kapton chemistry from Du Pont.
3. Test Kapton pieces returned from service.
4. Organize Du Pont and TI fluid aging results.
5. Find more information about PSF chemistry.
6. Put together a review of PTFE processing and porosity.
7. Test Kapton pieces returned from cycling tests.

Please contact me if you have questions or if there's anything else I can do on this issue.

Take Care,

TI-NHTSA 017472

TEXAS INSTRUMENTS

September 2, 1993

Mr. Edward C. McKenzie
Sr. Technical Service Representative
DuPont High Performance Products
U.S. Route 23 & DuPont Road
P.O. Box 89
Circleville, OH 43113

Dear Ed:

We had a very productive visit August 25, and I'd like to thank all who participated. As you know, the main objective was to better understand the process so TI and DuPont could develop a plan to address our customer's areas of question. These areas are:

- minimum strength of the film
- Kapton usage in power steering applications
- pinhole prevention and detection

Summarized below are the major areas of discussion. Our near term plans include a pre-visit with our customer on 9/14 and 9/15, and a visit to Nissan in Detroit on 9/22. Prior to the 9/14 meeting, it's important that we have at least a rough draft of the report(s) prepared. TI will be responsible for compiling all of the information in a final package, and DuPont's assistance will be greatly needed in assembling the facts and data. As we've discussed, actual data in tabular and/or graphical form will be most useful.

o We discussed Kapton compatibility with power steering fluid. PSF is similar in chemistry to ATF, which DuPont has used for aging tests in the past. 1000 hour, 300 F aging data was presented and it showed no apparent loss of strength occurred after 1000 hours. TI discussed results of used power steering switch analyses which showed no visual Kapton degradation after approximately 10 years and 100k miles in service. TI requested Dupont to determine if the actual 3/4" x 3/4" diaphragms from these switches could be tensile tested by DuPont.

Nissan has asked that DuPont provide an opinion of the use of Kapton in our power steering pressure switch, considering fluid compatibility and strength of the Kapton. TI in parallel is conducting pressure cycling tests and Finite Element Analyses to support this.

Actions:

- Review test data and FEA's with DuPont (TI 9/10 for FEA's; ongoing for test results)
- Letter stating technical opinion of Kapton usage in TI's pressure switches (DUPONT 9/13)
- Determine if DuPont can test 3/4" x 3/4" film samples (DUPONT 9/3)

o DuPont reviewed historical tensile test data from 300HN film. UTS, % elongation and modulus in machine and transverse direction is documented and filed for each mill roll. Data collection has also recently been established for 500FN131 film. DuPont agreed to summarize historical strength data and propose a minimum UTS and % elongation that will be added to TI's prints.

Actions:

- Report of 6 month history of 300HN film data and all 500FN131 data (DUPONT 9/13)
  Report should include all data.

TI-NHTSA 017473

o DuPont presented a summary of efforts for pinhole prevention and detection. Dupont has concluded from their studies that pinholes or craters do not form in sizes less than 10 mils. They also have concluded that holes of 10 mils and greater are detected by both the laser and operator during rewind inspection for 500FN131 film. During the rewind inspection, the operator flags these defects so they are removed during the subsequent finishing operations. DuPont concludes, therefore, that 500FN131 film that is shipped to TI is pinhole and crater free. Due to production volumes, 300HN film is not 100% inspected; rather, every 6th roll is inspected for defects and is accepted based on meeting a set of minimum quality conditions.

Since 300HN film will be used in one of TI's power steering switches, we discussed the need to have a pinhole free product. DuPont agreed to evaluate how to best achieve this. This will prove to be of equal importance to guaranteeing a pinhole free 500FN131 film, in our customer's view.

Actions:

- Report of pinhole prevention and detection; report needs to support conclusions with data and a technical explanation why pinholes/craters cannot (vs. does not) occur in a size less than 10 mils (DUPONT 9/10)

- Provide TI with "worst case" film relative to pinholes and/or inclusions of greater than 30 mils, if possible (DUPONT as available)

o We toured the Teflon, Kapton and laminating lines and the rewind inspection and finishing areas. Included in the tour was a review of some innovative work in film quality control in the Kapton manufacturing area. It's important for DuPont to summarize the process flow and process controls in a form that can be shared with our customers. This description should help explain at what point the strength measurements and rewind inspection are done, etc.

Actions:

- Document process and inspection flow for 300HN and 500FN131 film in a form that can be shared with TI's end customers (DUPONT 9/10)

o We reviewed the limited facts that we had on Toray DuPont's contacts with the Japanese players. Most details were not available and we agreed that the main objectives were 1.) to determine what facts or data have been shared between Toray Dupont (TDC) and JKC or Nissan and 2.) to ensure that DuPont US leads any future correspondence.

We also reviewed what we know of the history of the Kapton concern. DuPont analyzed the diaphragm materials from the competitive switch. The multilayered diaphragm was made up of two layers of 3 mil HN film produced at Circleville, held together by silicone adhesive. The second diaphragm was 2 mil PTFE.

Actions:

- Determine what facts or data have been shared between TDC and JKC or Nissan (DUPONT)

Ed, in closing, I'd like to reiterate my thanks to you and your team. I'm confident that TI and DuPont will be able to work together to support the continued use of Kapton in our products.

Sincerely,

David Crane
Design Engineering Supervisor
Precision Controls
(508) 699-3558

Ed

TEXAS INSTRUMENTS

September 2, 1993

Mr. Edward C. McKenzie
Sr. Technical Service Representative
DuPont High Performance Products
U.S. Route 23 & DuPont Road
P.O. Box 89
Circleville, OH 43113

Dear Ed:

We had a very productive visit August 25, and I'd like to thank all who participated. As you know, the main objective was to better understand the process so TI and DuPont could develop a plan to address our customer's areas of question. These areas are:

- minimum strength of the film
- Kapton usage in power steering applications
- pinhole prevention and detection

Summarized below are the major areas of discussion. Our near term plans include a pre-visit with our customer on 9/14 and 9/15, and a visit to Nissan in Detroit on 9/22. Prior to the 9/14 meeting, it's important that we have at least a rough draft of the report(s) prepared. TI will be responsible for compiling all of the information in a final package, and DuPont's assistance will be greatly needed in assembling the facts and data. As we've discussed, actual data in tabular and/or graphical form will be most useful.

o We discussed Kapton compatibility with power steering fluid. PSF is similar in chemistry to ATF, which DuPont has used for aging tests in the past. 1000 hour, 300 F aging data was presented and it showed no apparent loss of strength occurred after 1000 hours. TI discussed results of used power steering switch analyses which showed no visual Kapton degradation after approximately 10 years and 100k miles in service. TI requested Dupont to determine if the actual 3/4" x 3/4" diaphragms from these switches could be tensile tested by DuPont.

Nissan has asked that DuPont provide an opinion of the use of Kapton in our power steering pressure switch, considering fluid compatibility and strength of the Kapton. TI in parallel is conducting pressure cycling tests and Finite Element Analyses to support this.

Actions:

- Review test data and FEA's with DuPont (TI 9/10 for FEA's, ongoing for test results)
- Letter stating technical opinion of Kapton usage in TI's pressure switches (DUPONT 9/13)
- Determine if DuPont can test 3/4" x 3/4" film samples (DUPONT 9/3)

o DuPont reviewed historical tensile test data from 300HN film. UTS, % elongation and modulus in machine and transverse direction is documented and filed for each mill roll. Data collection has also recently been established for 300FN131 film. DuPont agreed to summarize historical strength data and propose a minimum UTS and % elongation that will be added to TI's prints.

Actions:

- Report of 6 month history of 300HN film data and all 300FN131 data (DUPONT 9/13) Report should include all data.

TEXAS INSTRUMENTS INCORPORATED • 34 FOREST STREET • ATTLEBORO, MA 02703
508-699-3800 • TELEX 210801 • CABLE TEXINS

o DuPont presented a summary of efforts for pinhole prevention and detection. Dupont has concluded from their studies that pinholes or craters do not form in sizes less than 10 mils. They also have concluded that holes of 10 mils and greater are detected by both the laser and operator during rewind inspection for 500FN131 film. During the rewind inspection, the operator flags these defects so they are removed during the subsequent finishing operations. DuPont concludes, therefore, that 500FN131 film that is shipped to TI is pinhole and crater free. Due to production volumes, 300HN film is not 100% inspected; rather, every 6th roll is inspected for defects and is accepted based on meeting a set of minimum quality conditions.

Since 300HN film will be used in one of TI's power steering switches, we discussed the need to have a pinhole free product. DuPont agreed to evaluate how to best achieve this. This will prove to be of equal importance to guaranteeing a pinhole free 500FN131 film, in our customer's view.

Actions:

- Report of pinhole prevention and detection; report needs to support conclusions with data and a technical explanation why pinholes/craters cannot (vs. does not) occur in a size less than 10 mils (DUPONT 9/10)
- Provide TI with "worst case" film relative to pinholes and/or inclusions of greater than 50 mils, if possible (DUPONT as available)

o We toured the Teflon, Kapton and laminating lines and the rewind inspection and finishing areas. Included in the tour was a review of some innovative work in film quality control in the Kapton manufacturing area. It's important for DuPont to summarize the process flow and process controls in a form that can be shared with our customers. This description should help explain at what point the strength measurements and rewind inspection are done, etc.

Actions:

- Document process and inspection flow for 300HN and 500FN131 film in a form that can be shared with TI's end customers (DUPONT 9/10)

o We reviewed the limited facts that we had on Toray DuPont's contacts with the Japanese players. Most details were not available and we agreed that the main objectives were 1.) to determine what facts or data have been shared between Toray Dupont (TDC) and JKC or Nissan and 2.) to ensure that DuPont US leads any future correspondence.

We also reviewed what we know of the history of the Kapton concern. DuPont analyzed the diaphragm materials from the competitive switch. The multilayered diaphragm was made up of two layers of 3 mil HN film produced at Circleville, held together by silicone adhesive. The second diaphragm was 2 mil PTFE.

Actions:

- Determine what facts or data have been shared between TDC and JKC or Nissan (DUPONT)

Ed, in closing, I'd like to reiterate my thanks to you and your team. I'm confident that TI and DuPont will be able to work together to support the continued use of Kapton in our products.

Sincerely,

David Czarn
Design Engineering Supervisor
Precision Controls
(508) 699-3558

cc: Agnes Cardozo - TI
Ed O'Neill - TI
Tom Clyde - DuPont
Dave Reifschneider - DuPont

FAX NO. 508-699-3153

Date 9-10-93

CIRCLEVILLE PLANT
P.O. Box 89
Circleville, OH 43113

Kapton*-Teflon*-SP Resin

FACSIMILE TRANSMISSION COVER SHEET

ADDRESSEE(S):

Name	Company or Department	Location
David Clark	Texas Instruments	Attleboro MA

COPY:

SENDER:

Name	Business Sector	Location
G. McKenzie	DuPont	Circleville OH

Total Number of Pages (Including Cover Sheet) 10

SPECIAL INSTRUCTIONS/INFORMATION TO RECIPIENT:

DuPont, Circleville Kapton*-Teflon*-SP Resin Fax No. - 614-474-0660
Verification number - 614-474-0445

*** CONFIDENTIALITY NOTE ***

The documents accompanying this telecopy transmission contain information from DuPont I/MED which is confidential and/or legally privileged. The information is intended only for the use of the individual or entity named on this transmission sheet. If you are not the intended recipient, you are hereby notified that any disclosure, copying, distribution, or the taking of any action in reliance on the contents of the telecopied information is strictly prohibited, and that the documents should be returned to DuPont I/MED immediately. In this regard, if you have received this telecopy in error, please notify us by telephone (614-474-0445) immediately so that we can arrange for the return of the original documents to us at no cost to you.

*DuPont Registered Trademark

TI-NHTSA 017478

September 10, 1993

David Czarn
Texas Instruments
MS 12-29
34 Forest St.
Attleboro, MA 02703

Dear Dave,

Attached is the following information per your request:

Page

1-2	Pinhole detection in Kapton® film
3	YTD Hole Performance
4-6	Process desciption
7	Process flow chart
8	Summary of contact with TDC (JV partner in Japan)

More info Monday: on tensiles and elongations, and opinion on use in power steering fluid.

Please review and let me know how else we can help.

Sincerely,

Edward C McKenzie

Edward C. McKenzie

September 10, 1993

PINHOLE DETECTION IN KAPTON® FILM
TYPES 300HN, 300FN131

Texas Instruments will only be supplied film which has been 100% inspected. Any pinhole detected will be flagged and removed in the subsequent slitting operation.

Currently, Kapton® film is inspected on an off-line inspection rewinder, using a proprietary laser inspection system development by Du Pont. This system takes advantage of the fact Kapton® blocks certain wavelengths of light. Thus if Kapton® is passed between a light source of this wavelength and a detector, a highly effective method of detecting the presence of pinholes can be constructed. The inspection system has located a 1 mil diameter pinhole which was purposely introduced in the film.

Once detected, the system identifies the area of film where the hole is detected, and stops the film in front of a lighted inspection area. The operator marks the location with tape, flags the end of the mill roll, and logs the location into the defect map which accompanies the roll.

Calibration: The laser system is undergoes routine preventative maintenance based on ISO schedules. The operator sets sensitivity per standard operating procedures.

Occurrence of Holes in 300HN:

Recent studies by Circleville personnel have concluded that the formation of holes less than 10 mils in diameter do not occur in the manufacture of 3 mil film at Circleville. This conclusion is based on over 3 years of research into the cause of such film defects, and the culmination of efforts to develop an on-line high resolution camera inspection system. This system, which will become fully operational by early next year, has permitted the opportunity to look at literally millions of square feet of film, and have detailed pictorial information stored for observed defects.

Further detail is not available due to the proprietary nature of the manufacture of Kapton® film. However, this new information has led to better understanding of the dynamics of our process, and the nature of the polymerization reaction.

Attached is a year to date summary of the pinhole performance on 300HN and 300FN 131 film. The data is obtained from the defect map generated by the inspection rewinders.

To summarize the pinhole performance:

	No. of Holes Detected	No. of Rolls Inspected	Total Sq Footage	Average/ Sq Ft
500FN131	4	13	260000	1 per 65000
300HN	43	20	650000	1 per 15000

If you remove from consideration the 2 rolls which accounted for 35 of the detected holes in the inspected 3 mil, we experienced an average of 1 hole per 4 mill rolls, or 190000 square feet of film.

While we feel it is not possible to "guarantee" hole free film, we do feel that if the film is inspected, we can locate and remove the infrequent holes which do occur. Du Pont is also committed to continuous improvement, as demonstrated by the advent of the on line camera system, which will greatly enhance our ability to locate and to respond to problems as they occur.

Hole Performance: 500FN131 YTD 9/93

Game/Type	Mill Roll	Date	Holes/Bubbles
500FN131	4118040	02/22/93	0
500FN131	4118041	02/23/93	0
500FN131	4118042	02/23/93	0
500FN131	4118043	02/23/93	0
500FN131	4118044	02/23/93	1
500FN131	4118194	05/23/93	0
500FN131	4118223	06/11/93	1
500FN131	4118224	06/17/93	0
500FN131	4118247	07/07/93	0
500FN131	4118248	07/08/93	1
500FN131	4118300	08/05/93	0
500FN131	4118301	08/05/93	0
500FN131	4118306	08/25/93	1

Hole Performance: 300HN YTD 9/93

Game/Type	Mill Roll	Date	Holes & Bubbles
300HNH	8121804	04/13/93	0
300HNH	8121808	04/15/93	0
300HNH	8121811	04/16/93	0
300HNH	8121812	04/16/93	0
300HNH	8121926	05/31/93	0
300HNH	8121927	05/31/93	1
300HNH	8121928	05/31/93	1
300HNH	8121929	06/01/93	2
300HNH	8121930	06/01/93	0
300HNH	8121938	06/02/93	0
300HNH	8121942	06/05/93	0
300HNH	8121946	06/05/93	0
300HNH	8121950	06/08/93	20
300HNH	8121951	06/09/93	18
300HNH	8121952	06/09/93	0
300HNH	8121960	06/13/93	1
300HNH	8121961	06/13/93	0
300HNH	8121962	06/13/93	0
300HNH	8121964	06/14/93	0
300HNH	8121968	06/16/93	0

September 10, 1993

Process Discription
Kapton® 500HN, 500FN131

Kapton® polyimide film is synthesized from a polycondensation reaction between an aromatic dianhydryde and an aromatic diamine. The resulting base film, type HN, is a tough aromatic polyimide film with an excellent combination of mechanical, electrical, and chemical properties. The product is made in thicknesses from 30 gage (3 mil) up to 500 gage (5 mil). Kapton® 500HN is also used as the substate for the 500FN131 laminate.

Process Flow

I. Chemical Area:

Raw materials are mixed with a solvent and passed through a series of filters and holding tanks, to bring the solution to proper viscosity. The final step before casting is to add catalysts in a final mixing operation.

II. Casting:

The polymer solution, held at low temperature is cast through a die onto drum, which is at a higher temperature. This abrupt temperature change begins the imidization process. After the film travels part way aroung the drum, it has sufficient strength to support its weight, and is transferred to a series of air heated zones which remove additional solvent. The film then enters a series of heat zones which finish the polymerization reaction and lower the solvent content to proper levels. The film exits the oven and is wound in roll form on a two turrent winder, with automated transfer capability. Each run of poduct is considered to be one lot, broken up into several "mill rolls" of about 750 to 800 lbs. to permit subsequent handling and processing of the film.

III. Gage Control:

Primary thickness control for the film is accomplished by measuring the film using radiation source based Measurex, which traverses the web. The thickness signal is continuously fed back to a proprietary computer program. This program analyses the thickness information and sends corrective control signals to adjust the die lip openings.

8

At this point, the film is sent to storage, awaiting off line inspection, slitting to fill customer orders, or further processing (laminating or coating).

IV. Teflon® 100 gage film

"Teflon" fluoropolymer films used in 500FN131 laminates are produced from FEP (fluoronated ethalyne-propylene) copolymer. "Teflon" FEP exhibits flow characteristics similar to commonly used thermoplastic resins, allowing melt extusion into films which have good surfaces and homogeneous structures, avoiding problems such as sintering, void content and crystallinity associated with TFE resins. Teflon® FEP film is chemically inert and slovent resistent to virtually all chemicals except molten alkali metals, fluorine at elevated temperatures, and certain complex halogenated compounds at elevated temperatures and pressures.

Teflon FEP resin is processed through a melt extruder, and forced through a die onto a heated quench drum. The film is conveyed through over a series of rolls through a Measurex to measure thickness and is wound into rolls. The Measurex feeds back information to an automatic gage control computer (similar to "Kapton") to close the loop and provide adjustment to the die lip opening.

The 100 gage film is then corona treated in a proprietary process to enhance the surface tension, in preparation for lamination.

V. Lamination

The 500FN 131 laminate is produced in one pass on a 3 web laminator. A combination of heat and pressure is used to join Kapton® 300HN with 1 mil Teflon® FEP film on each side.

VI. Process/Quality Control

Du Pont's Kapton®-Teflon® manufacturing facilities are ISO 9002 certified, with periodic inspections to assure complience. The site processes are run under a state of controlled conditions wich include:

- production schedules, based on orders and forecasts.

- Documented work instructions, Area Procedures and Operating Procedures, explain how tasks are to be performed where lack of such procedures could reduce the product's level of quality.

- Standard Operating Conditions which describe where process parameters should be set.

- Control of process parameters within specific ranges.

- Routine monitoring of these processes to ensure process stability. Monitoring techniques include one or more of the following:

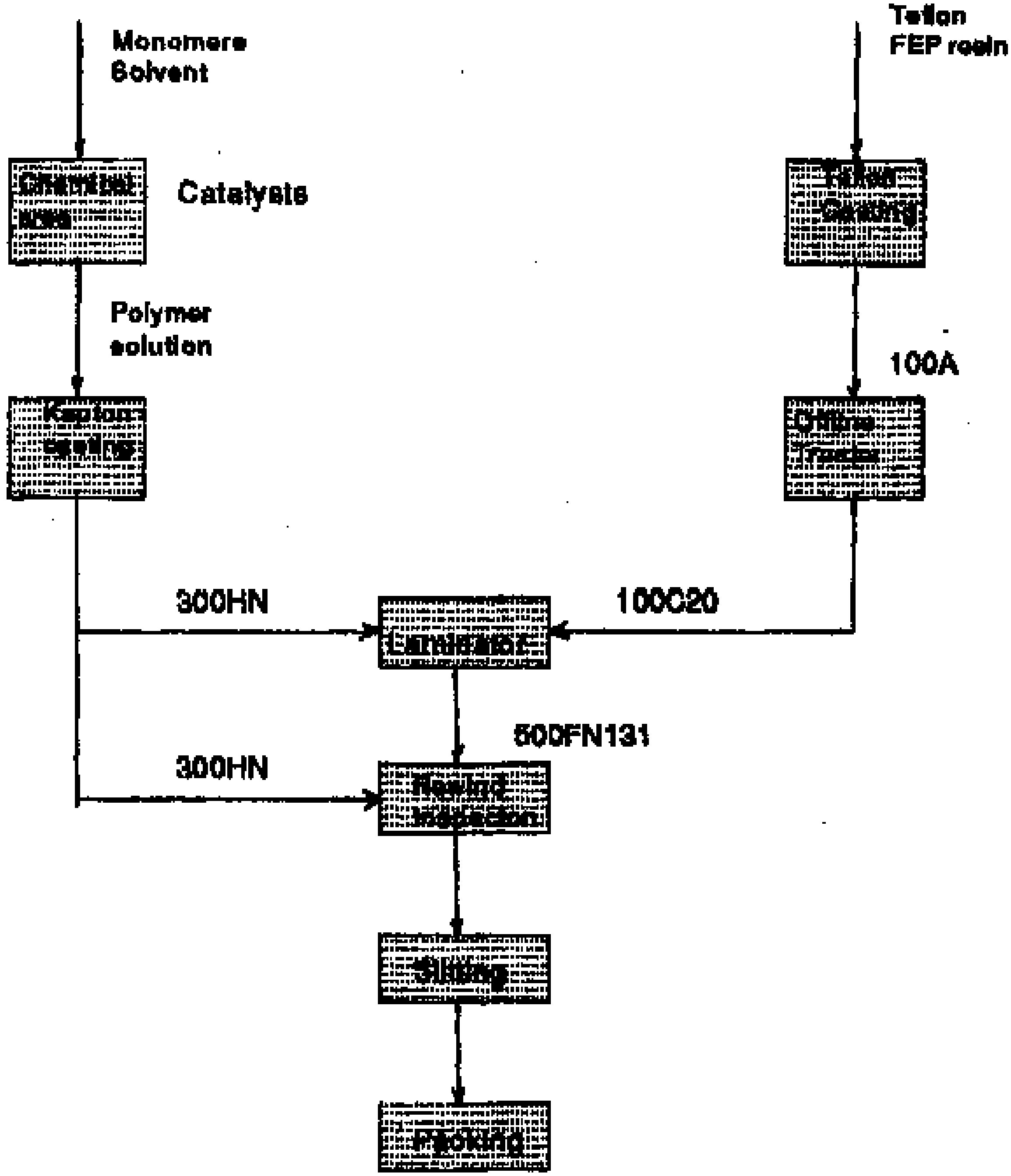
  - automatic control loops
  - manual controls
  - computerized control systems
  - statistical control charts

Physical properties are tested in the Quality control lab. using sample retains that are taken from each mill roll produced. The frequency of testing is determined statically. based on historical data on shift of properies due to changes in process conditions.

7

PROCESS FLOW

KAPTON 300HN, 500FN131



TI-NHTSA 017486

NISSAN BRAKE DIAPHRAGMS

Toray DuPont Company (TDC) is a 50/50% joint venture between Toray and DuPont with Kapton* polyimide film manufacturing facilities located in Tokai, Japan. However, all Teflon* coated or laminated product is manufactured in Circleville, Ohio since TDC does not have this capability. This is important because all the quality statistics and pin hole data shared with Texas Instruments at Circleville applies to the film used in this application in Japan. It is also important to recognize the on-line inspection development program and, hence, the expertise on pin hole characterization resides at Circleville.

Kapton* is used by 5 Japanese diaphragm manufacturers supplying the Japanese automobile industry. The ultimate application and car manufacturer are kept secret. Neither TDC or DuPont was aware that Kapton* was being used in this brake fluid application until failures began to be reported.

The supply chain for the Nissan brake diaphragm goes through several Japanese intermediaries to WACO who makes the switch. The switch is used by JKC in their hydraulic brake booster used by Nissan.

Because of the secrecy agreement between Nissan, JKC, and WACO, we have not been able to get samples of failed diaphragms. However, we are aware that the construction we examined in Circleville is the pre-recall, pre-July 1992 WACO design which will fail after 210,000 flexs in brake fluid, falling to 100,000 flexs if water is introduced.

Nissan's solution to the problem was to introduce a new design from WACO in August, 1992 using Teflon* coated Kapton* (919). This withstands over 800,000 flexs. TDC is reluctant, after only one year of actual experience, to declare the problem solved. However, there have been no reported failures with the new design.

There is no question Nissan's view of Kapton* was negatively impacted by the brake diaphragm failure. Kapton* has performed well in power steering and air conditioning applications and the redesigned switch using Teflon* laminated to Kapton* has corrected the brake diaphragm problem so far. The message here is that the materials supplier, DuPont, must be a partner in the design of the application to insure our materials are selected and applied to meet the required needs.

September 17, 1993

David Czarn
Texas Instruments
MS 12-29
34 Forest St.
Attleboro, MA 02703

Dear Dave,

Enclosed you will find operating procedures for the rewind inspection of Kapton® film, and setting up a calibration roll for the verification of performance. The area has suspended the use of a calibration due to repeatability. It is an unfortunate fact of film manufacturing that the more a roll of film is handled, the quality of the film degrades. Additional airborne contaminates were attracted, making comparisons of defect maps difficult.

I also have spoken with several rewind operators. After the sensitivity is set per the SOC's, at the start of each mill roll of a different gage and/or type of film, a small hole is punched in the film with a pin (10-20 mils) to verify the equipment picks up the defect. A black marker is also used to represent an opaque defect. Should the equipment fail to locate the defect, maintenance is called.

The operating area is aware of the need for a formalized procedure to check calibration, in order to meet ISO requirements. I have added TI's concerns, and will update you on our progress.

Sincerely,

Edward C. McKenzie

DOCUMENT TYPE: K-T Rewinder Area Operating Procedure

DOCUMENT TITLE: Laser Operation

SCOPE/PURPOSE: Operation of Laser for Mill Roll Inspection

CROSS REFERENCE: OP-RW-0950 , OP-RW-0951

EXPLANATION OF CHANGE: Revise, Update and Format for Current Operation.

AUTHORIZED BY:

AREA SUPERINTENDENT, K-T FINISHING: RJ [signature]

TRAINING COORDINATOR, K-T FINISHING: RL Smith [signature]

:mah/smart no. 214

SECTIONS 1, 2, 3 CONTAIN PROPRIETARY INFORMATI[illegible]

4.0 Procedure

4.1 Power supplies

4.1.1 Breaker for individual laser units - north and west of the west rewinder.

4.1.2 Line conditioner on each electronic console.

4.1.3 Power supplies - inside power supply cabinet (north door of laser housing).

PROCEDURE:

4.2 Thread-up

4.2.1 Shutter must be closed to open south doors of the laser housing - shutter handle is located inside the power supply cabinet-top left.

4.2.2 Thread film through cabinet per thread up guide on machine.

4.2.3 Close south cabinet doors and open shutter.

4.3 Edge Masks

4.3.1 Masks serve to block the laser beam and should be adjusted if film width changes.

4.3.2 Adjustment rods for edge masks are located inside the power supply cabinet-lower left side.

4.3.3 Masks should overlap the film edge approximately one inch.

4.3.4 Manual masks with an opaque material may be needed for narrow width films.

4.4 Setting Sensitivity of Laser on Defect Detector.

4.4.1 The laser sensitivity will have to be set on three pots. These pots are marked (small defect, large defect, and pinhole). One other pot is marked " emulsion " the setting on this pot is turned all the way up.(10.00) this will stay the same.

4.4.2 Sensitivity (Noise level) is found by turning the sensitivity pot down until red indicator light blinks , then increase pot setting " 50 to 75 " until indicator light goes out.

4.5 Interlocks

4.5.1 "Bypass" keyswitch must be used to run the rewinder without input from the lasers.

5.0 <u>Review</u>

5.1 This document will be reviewed and reissued at least every two years.

TYPE: Operating Procedure

TITLE: Rewinder Calibration Test Roll Make-Up

SCOPE/PURPOSE: To Create a Calibration Test Roll for Rewinder Laser Testing

CROSS REFERENCES: None

EXPLANATION OF CHANGES: Revised mill roll marking procedure and added permanent lag storage location.

AUTHORIZATIONS:

____
Kapton* Mfg. Area Superintendent

____
Area Document Controller

____
Operating Personnel A

____
Operating Personnel B

*DuPont Registered Trademark
:mah/smart no. 2188

1.0 Introduction

1.1 In order to have a calibration testing procedure for the Kapton* Rewinders, a calibration test roll must be maintained. The following procedure will detail how to set up and mark the test patterns and defects.

2.0 Definitions

2.1 None

3.0 Safety

3.1 Follow all area safety rules that apply to working in this area.

4.0 Procedure

4.1 Obtain a stub mill roll from production control.

4.1.1 100 or 200 gage film types are best

4.1.2 Mill roll will be purchased by area as a sample order.

4.1.3 Schedule rewinder for time to run roll, with east rewinder preferred.

4.2 Place mill roll on rewinder

4.2.1 Tag end will always be on tag end.

4.3 Determine footage to be tested

4.3.1 Test section should be in the middle of the roll.

4.3.2 Approx. 35 ft. will be lost each time test roll is ran through rewinders for thread-up.

4.3.3 Test section should be 750 ft. to 1000 ft. in length.

4.4 Run the rewinder in By-Pass Mode until test section is reached. No inspection is needed. Stop rewinder.

4.5 Place two stripes of 1/2" white tape across width of sheet.

4.6 Using a permanent type ink marker, label the start of Calibration Test Section

4.6.1 Mark roll "Calibration Test-Side A"
4.6.2 Mark the tag end of roll.
4.6.3 Place a flag marked "Test Section" in roll on tag end.
4.6.4 Place a piece of 2" masking tape, marked "Tag End" on tag end of core.

4.7 Reset footage counter to "zero".

4.8 Set rewinder to proper SOC conditions.

4.9 Start rewinder and place different size defects at various points in roll.

4.9.1 Stop machine and use a "Sharpie" fine point permanent marker to place "black speck" like defects in sheet.

4.9.2 Use the point of pen to make "holes" in sheet.

4.9.3 Continue this at various footages and locations in sheet width and mark locations of each as seen by the Laser into computer.

4.9.4 Do not tape defects or flag mill roll.

4.10 After test footage needed has been ran, stop rewinder and mark the end of the test section.

4.10.1 Place two strips of 1/2" white tape across sheet width.

4.10.2 Use permanent ink marker and label as "Calibration Test-Side B"

4.10.3 Mark the tag end of roll.

4.10.4 Place a flag marked "Test Section" in roll on tag end.

4.11 Run a computer print-out of defects in Calibration Test Section.

4.11.1 Enter mill roll I.D. as "testroll" (one word).

4.11.2 Mark Print-Out as "Calibration Test-Side A, Rewind Inspection Standardization Roll".

4.11.3 This Print-Out will now be used to compare future calibration testing of rewinders.

4.12 Run remainder of film on unwind with no inspection needed.

4.13 Remove calibration roll from winder and place it back on the unwind to be ran through rewinder again.

4.13.1 Calibration test must be ran in both directions to have print-outs of both "A" and "B" sides.

4.14 Run film through rewinder with no inspection until tape marked "Calibration Test-Side B" is at the winder.

4.14.1 Be sure that tape is marked "Calibration Test-side B", and tag end recorded.

4.14.1.1 Running mill roll over or under will effect marking. Flags marking "Test Section" should always be on tag end.

4.15 Reset footage counter to zero.

4.16 Reset rewinder to SOC's.

4.17 Run test section and record all defects into computer.
4.17.1 Do not tape defects or flag mill roll.

4.18 At the end of the test section, mark sheet width with tape if needed and label "Calibration Test-Side A". Mark tag end.

4.19 Run a computer print-out of defects.

4.19.1 Enter mill roll I.D. as "testroll" (one word).

4.19.2 Mark print-out as "Calibration Test-Side B, Rewind Inspection Standardization Roll".

4.19.3 Print-out will now be used to compare future calibration testing of rewinders.

4.20 Run remainder of film on roll. No inspection is needed.

4.21 Remove calibration roll from rewinder and replace in storage.

4.21.1 Mark roll wrap with red tape around roll and label "REWIND CALIBRATION Roll Do Not Inventory", "Do not Destroy", "Property of Kapton Mfg. Superintendent."

4.21.2 Have test calibration roll placed in lag location TF09C, this location is reserved for calibration rolls by production control.

4.22 Rewinder operator will take mill roll IVI and print-out sheets to document controllers office.

4.22.1 Document controller will maintain the master calibration print-out and a file system of all calibration tests ran for certification and make comparisons to master print-out.

4.23 Tickler system will be set for calibration roll to be scheduled through production control and ran on both rewinders on monthly basis.

5.0 REVIEW

5.1 This document will be reviewed and reissued at least every two years.