DuPont™
NOMEX®

NOMEX® 410型

技术数据表

NOMEX® 410型是一种经过轧光的绝缘纸，具有较高的固有介电强度，机械韧性、柔性和回弹性。NOMEX® 410型是NOMEX® 纸的最早期的产品，广泛应用于大多数的电气设备中。它有12种厚度(0.05-0.76mm) (2-30mil)，用于几乎所有已知需要电气片型绝缘材料的场合。

电气性能

表I所示为NOMEX® 410型纸的典型电气性能值。表I中的交流电压快速升高时的介电强度值，反映的是在频率为60Hz的情况下能够承受10至20秒时的电场强度水平，而非长期高电压。杜邦公司建议，变压器中的持续强不要超过1.6kV/mm (40V/mil)，以便将局部放电(电晕) 的危险降低到最小程度。表I中的全波冲击介电强度值是在诸如层间和围屏之类的平板材料上所产生的数据。系统结构的几何形状会影响材料实际冲击强度值。这些介电强度数据是典型值，并非作为设计用的推荐值。如有需要，可以提供设计值。

如图1所示，温度对介电强度和介电常数的影响较小。

表I：典型的电气性能

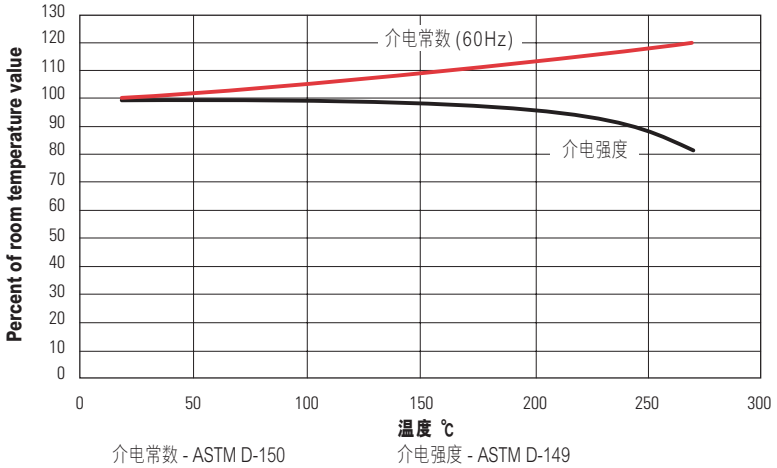
标称厚度 (mil)	2	3	5	7	10	12	15	20	24	25.5	29	30
(mm)	0.05	0.08	0.13	0.18	0.25	0.30	0.38	0.51	0.61	0.65	0.73	0.76
介电强度												
- 交流快速上升[1]												
(V/mil)	430	550	680	840	815	820	830	810	800	730	750	680
(kV/mm)	17	22	27	33	32	32	33	32	31	29	30	27
- 全波冲[2]												
(V/mil)	1000	1000	1400	1400	1600	N/A	1400	1400	N/A	N/A	N/A	1250
(kV/mm)	39	39	55	55	63	N/A	55	55	N/A	N/A	N/A	49
介电常数[3]												
60Hz	1.6	1.6	2.4	2.7	2.7	2.9	3.2	3/4	3.7	N/A	3.7	3.7
介质损耗因数[3]												
60Hz (x10³)	4	5	6	6	6	7	7	7	7	N/A	7	7

[1] ASTM D-149使用50mm (2英寸) 电极，快速上升；与IEC 243-1项9.1相符，只是将电极设置为50mm (2英寸)

[2] ASTM D-3426

[3] ASTM D-150

图1：温度对NOMEX® 410-0.25MM (10MIL)的电气性能的影响



介电常数 - ASTM D-150　　介电强度 - ASTM D-149

请注意：

数据表中的数据均属典型或平均值，不可用作技术规范。除非另有说明，所有数据都是在“标准条件”下测得的 (温度为23℃，相对湿度为50%)。注意：如同其它造纸技术的产品一样，NOMEX® 纸在纵向上的性能 (MD) 与横向 (XD) 性能相比有些差别。在某些应用场合，可通过调整纸的方向，以发挥其最佳性能。

10^4 Hz以下的频率变化对NOMEX® 410型纸的介电常数基本上没有影响。温度和频率对干燥的NOMEX® 410型-0.25mm (10mil) 型纸的介质损耗因素的影响曲线如图2所示。在温度低于200℃较薄纸与0.25mm (10mil) 纸的60Hz介质损耗因数基本相同。在较高的湿度和频率下，较厚纸的介质损耗因数要比0.25mm (10mil) 纸的略高一些。

图3所示为干燥的NOMEX® 410型-0.25mm (10mil) 纸的表面及体积电阻率与湿度之间的函数关系。其它厚度的NOMEX® 410型纸的相应值都非常相似。

从表II可以看出，潮气 (湿度) 对NOMEX® 410型-0.25mm (10mil) 纸的电器性能的影响相对较小。

表II：**湿度对NOMEX® 410型-0.25MM (10MIL)纸的电气性能的影响**

相对湿度(%)	烘干	50	96
介电强度[1] (V/mil)	850	815	780
(kV/mm)	33.5	32.1	30.7
介电常数[2] 60Hz	2.5	2.7	3.2
1kHz	2.3	2.6	3.1
介质损耗因数[2] 60Hz ($x10^{-3}$)	6	6	11
1 Hz($x10^3$)	13	14	25
体积电阻率[3] (0hm.cm)	$6x10^{16}$	$2x10^{16}$	$2x10^{14}$

[1] ASTM D-149使用50mm (2英寸) 电极，快速上升；与IEC 243-1项9.1相符，只是将电极设置为50mm (2英寸)　[2] ASTM D-150　[3] ASTM D-257

图2：**NOMEX® 410型-0.25MM (10MIL)的介质损耗因数与温度和频率的关系**

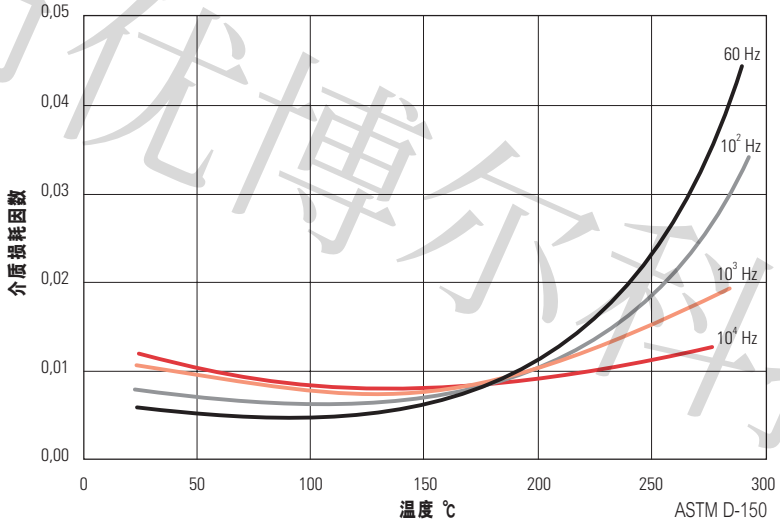
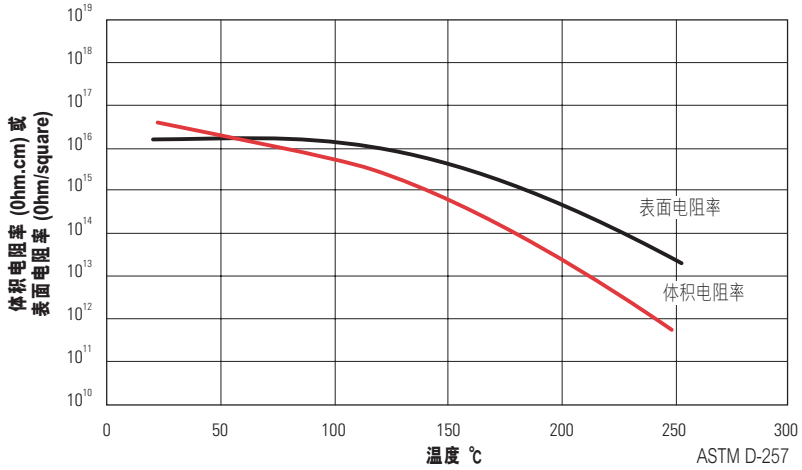
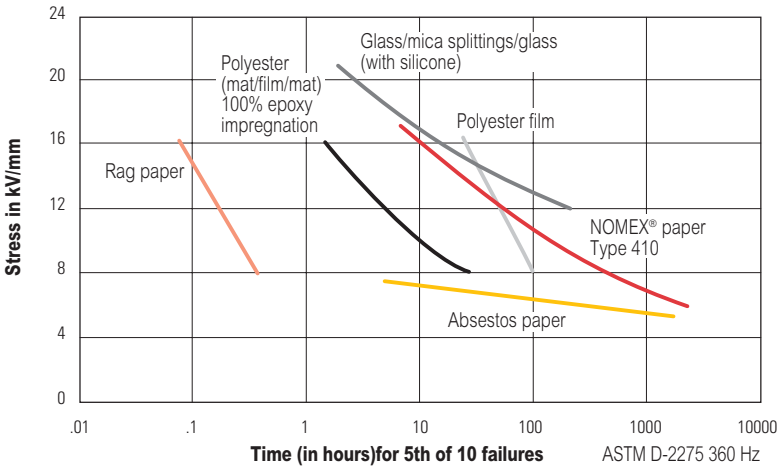


图3：**NOMEX® 410型-0.25MM (10MIL)的电阻率与温度的关系**



同其它有机绝缘材料一样，NOMEX® 纸会被电晕放电逐渐被侵蚀。电晕强度为电场强度的函数，而电场强度又几乎完全取决于诸如电路元件之间的间隔、平滑与尖锐的外形等设计参数。尽管经过适当设计的设备在正常运行过程中不会产生电晕，但是任何设备都有可能承受突然的过电压，产生瞬时的电晕放电：而绝缘材料在这些情况下不会失效非常重要。从图4可以看出，NOMEX® 410型纸的耐受电压强度 (在电晕冲击下的失效时间) 优于其它常用的有机绝缘材料，甚至可以与某些无机合成物质相媲美。这些数据都是在室温、50%相对湿度和360Hz频率的条件下的单层0.25mm (10mil) 材料上获得的。在50-60Hz下材料的失效时间约为图示的6-7倍。

图4：**各种绝缘材料和单层NOMEX® 410型-0.25MM (10MIL) 的耐电压强度**



表III：**典型的机械性能**

标称厚度	(mil)	2	3	5	7	10	12	15	20	24	25.5	29	30	测试方法
	(mm)	0.05	0.08	0.13	0.18	0.25	0.30	0.38	0.51	0.61	0.65	0.73	0.76	
典型厚度[1]	(mil)	2.2	3.1	5.2	7.2	10.2	12.2	15.2	20.3	24.1	25.4	28.7	30.4	ASTM
	(mm)	0.06	0.08	0.13	0.18	0.26	0.31	0.39	0.52	0.61	0.65	0.73	0.77	D-374
基准重量[2]	g/m²	41	63	116	175	249	309	397	547	693	696	854	847	ASTM D-646
密度 (g/cc)		0.72	0.80	0.87	0.95	0.96	1.00	1.03	1.06	1.13	1.08	1.17	1.10	
抗拉强度 (N/cm)														
	MD	39	65	137	219	285	378	459	606	741	758	860	841	ASTM
	XD	18	32	66	111	152	196	252	354	497	524	630	595	D-828
延伸率(%)	MD	9	11	15	18	19	22	19	20	18	19	16	17	ASTM
	XD	6	8	12	14	15	17	14	16	14	16	12	13	D-828
埃尔门多夫抗撕强度[4] (N)	MD	0.8	1.2	3.4	3.9	6.0	7.4	9.5	14.2	N/A	N/A	N/A	N/A	TAPPI-
	XD	1.6	2.3	5.2	7.4	10.8	14.2	17.2	23.7	N/A	N/A	N/A	N/A	414
初始抗撕强度[2] (N)	MD	11	16	33	50	71	93	116	163	201	209	252	251	ASTM
	XD	6	8	17	27	42	55	74	113	157	159	199	200	D-1004
300℃时的收缩率(%)	MD	2.2	1.1	0.9	0.6	0.4	0.4	0.3	0.1	0.0	N/A	0.0	0.2	
	XD	0.1	0.0	0.0	0.2	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	

[1] 方法D； 17N/cm²

[2] 表中所列数据反映的是按照ASTM D-1004规定方向的样品的初始抗撕强度。该方向与样板方向成90度角。因此，对于具有较高的MDITR报告值的纸，其横向将具有更高的抗撕强度。

MD = 纸的纵向

XD = 纸的横向

机械性能

NOMEX® 410型纸的典型机械性能值如表III所示。图5反映的是高温对抗拉强度及延伸率的影响。NOMEX® 片形材料在极低温度下仍保持著良好机械性能。在液氮沸点 (负196℃或77K) 下，NOMEX® 410型-0.25mm (10mil) 纸的抗拉强度超过其室温值的30至60% (与方向有关)，而断裂延伸率仍然大于3% (优于大多数室温下的无机材料)。这使得NOMEX® 410型在低温环境下仍能正常地工作。

水是NOMEX® 410型纸的一种软性增塑剂。潮气 (湿度) 对抗拉强度及延伸率的影响如图6所示。同延伸率一样，NOMEX® 410型纸的抗撕强度及韧性在湿度较高情况下也会有所提高。暴露于相对湿度为95%的环境中时，完全干燥的NOMEX® 410型纸的尺寸在纵向上至多增多1%，在横向至多增多2% (由于吸收潮气)。对纸再次干燥，这种膨胀在基本上是可以恢复的。当然，尺寸的变化率与纸的厚度及形状有关 (例如。单张片材与紧密缠绕的纸卷进行比较就不同。环境湿度的变化通常只会引起1%以下的尺寸变化。但是，即使是小的尺寸变化，特别是当这些变化不均匀时，也会引起或加重片材的不平整 (凹陷、起皱等)，从而可能使在诸如复合、起皱等关键处理过程中出现问题。因此，用于此种场合的NOMEX® 410型纸在使用之前应一直密封在其聚乙烯保护包装之中，以保持均匀的潮气含量。

图5：**温度对NOMEX® 410型-0.25MM (10MIL) 的机械性能影响**

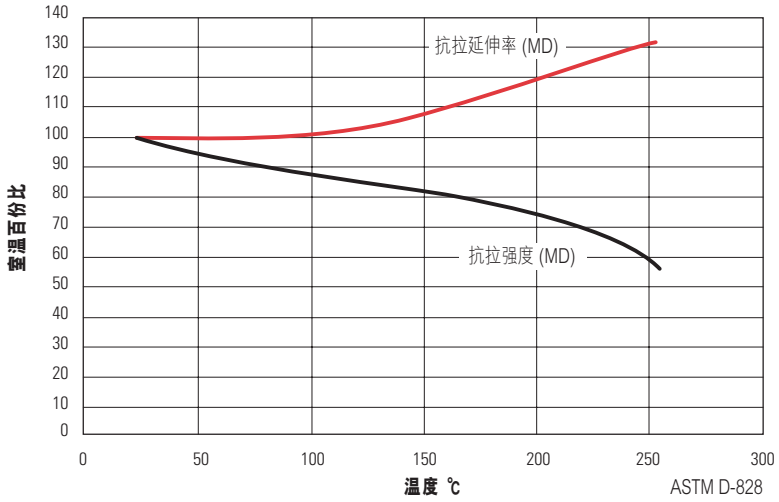
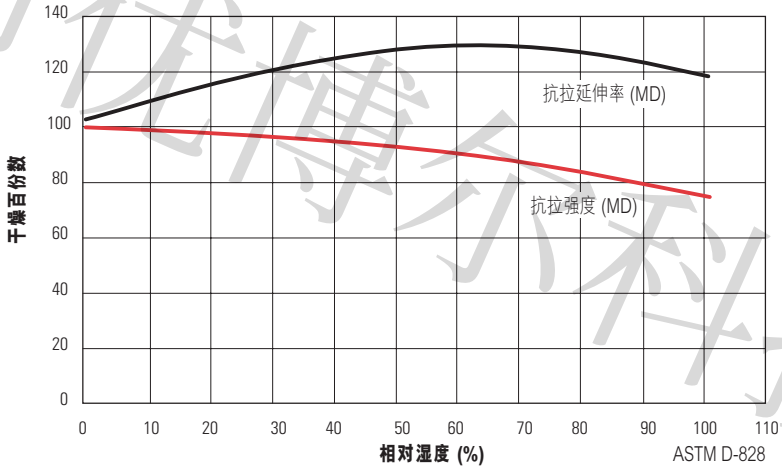


图6：**潮气对NOMEX® 410型-0.25MM (10MIL) 的机械性能的影响**



热性能

长期暴露于高温下对NOMEX® 410型-0.25mm (10mil) 的重要电气及机械性能的影响如图7、8、9所示。这些阿仑尼乌斯老化性能曲线是NOMEX® 410型纸被保险商实验所 (UL)、美国海军以及其它机构确认为220℃绝缘材料的基础，而且在超过35年的商业实践中也得到证实。这些曲线还可被延伸至更高的温度。例如，测量结果表明，在400℃下，NOMEX® 410型纸能保持12kV/mm (300V/mil) 的介电强度达几小时之久。这与阿仑尼乌斯曲线所推测的性能相同。

图7：**NOMEX® 410型-0.25MM (10MIL) 的有效寿命与温度的关系**

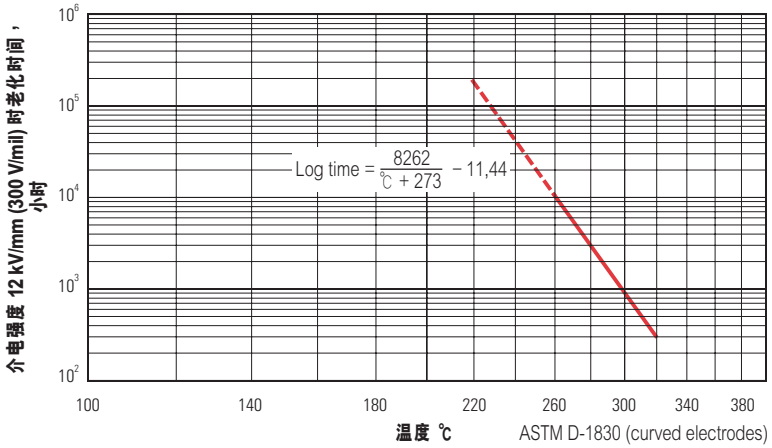
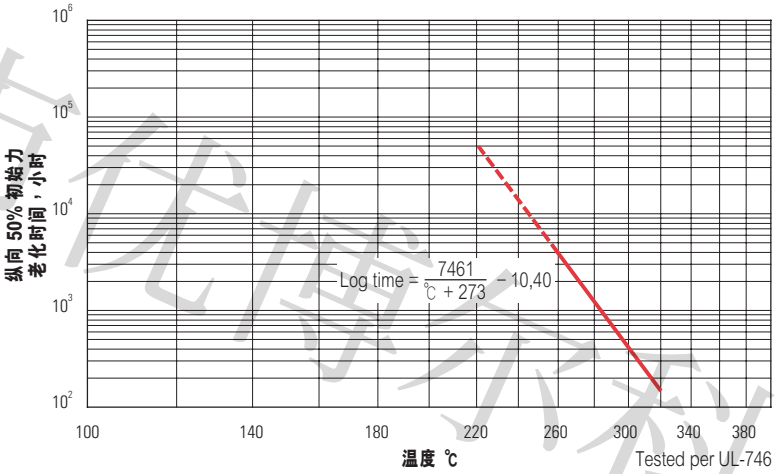


图8：**NOMEX® 410型-0.25MM (10MIL) 的有效寿命与温度的关系**



NOMEX® 410型-0.25mm (10mil) 纸的导热率如图10所示。这些值与纤维纸的导热率相近，并同多数材料一样，主要由比重 (密度) 决定。因此，由表IV可见，不太密的较薄的NOMEX® 410型纸导热率略低。而较密的且较厚的NOMEX® 410型纸的导热率较高。整个体系系统的构成可能会对总导热率产生影响，因此，将各个表中的数据应用到实际场合时应加以注意。例如，导热率不同的两层绝缘材料对同一线圈的传热效果完全不同，由于刚性或线圈张力不同，会影响绝缘层之间的间距。

图9：**NOMEX® 410型-0.25MM (10MIL) 的有效寿命与温度的关系**

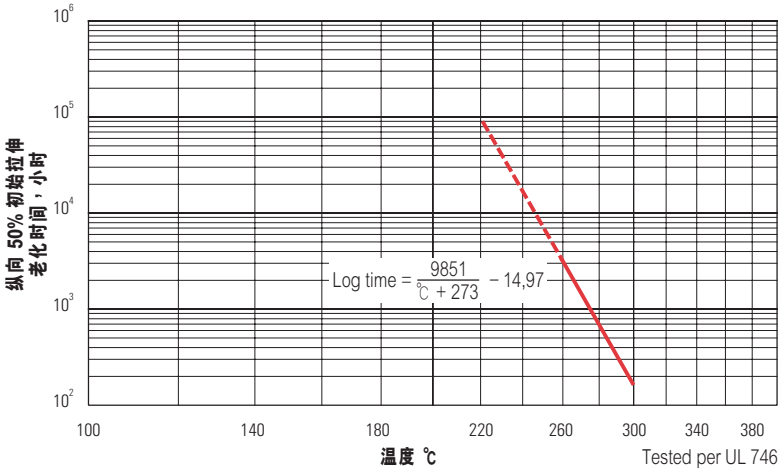
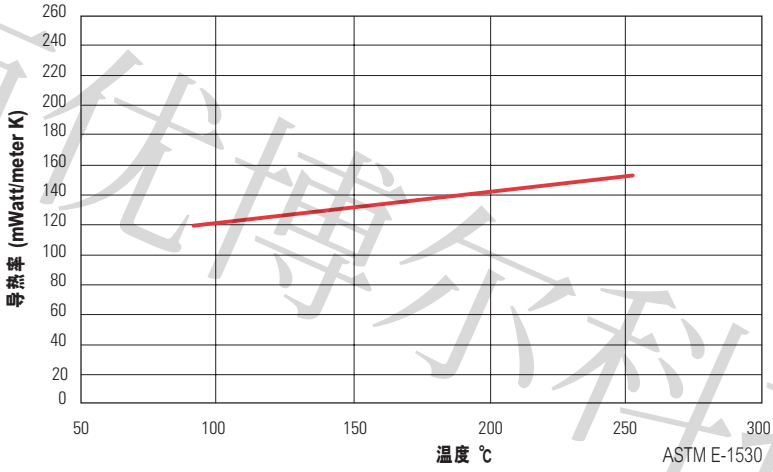


图10：**NOMEX® 410型-0.25MM (10MIL) 的导热率与温度的关系**



表IV：**导热率**

标称厚度	(mil)	2	3	5	7	10	15	25	30
	(mm)	0.05	0.08	0.13	0.18	0.25	0.38	0.51	0.76
密度 g/cc		0.72	0.08	0.87	0.95	0.96	1.03	1.06	1.10
热导率[1] (mWatt/meter K)		103	114	123	143	139	149	157	175

[1] 所有数据都是在150℃下测得的

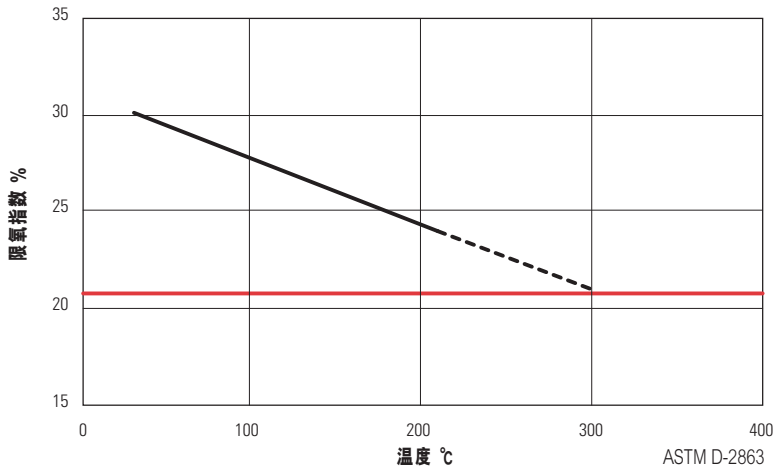
化学稳定性

NOMEX® 纸和层压板几乎与全部的电气清漆和粘结剂 (聚酰亚胺、聚硅氧烷、环氧物、聚酯、丙烯酸、酚类物质、合成橡胶等) 以及电气设备上的其它元件兼容，许多包含NOMEX® 制品系统，已经UL认可，也已有长期的商业实践。NOMEX® 纸还与变压器油 (矿物油、硅油及其它合成物质) 以及密封系统中所用的润滑油和冷冻剂完全兼容。与水的一样，常用的工业溶剂 (酒精、甲酮、丙酮、甲苯、二甲苯) 会对NOMEX® 410型纸产生轻微的软化和膨胀影响。但是去除溶剂后，这些影响大部份可以清除。

在室温下，NOMEX® 410型纸的限氧指数 (LOI) 在27%至32%之间 (取决于纸的厚度及密度)，在220℃时，该指数变化为22%至25%。LOI大于20.8%的材料 (在空气中) 不会燃烧。只有在加热到240℃至350℃ (仍取决于厚度) 之间时，NOMEX® 410型的LOI值才能降到可燃点。NOMEX® 410型-0.13mm (5mil) 纸的限氧指数 (LOI) 的大小如图11所示。

表V所示为6400兆拉德 (64Mgy) 的2MeV的β射线辐射对NOMEX® 410型纸的机械和电气性能的影响。(作为比较，浸渍了100%环氧物的相同厚度的聚酯薄膜和聚脂板的复合板经800兆拉德或8Mgy的β射线辐射后破碎)。暴露在γ射线时获得了相似的结果。NOMEX® 纸优异的抗辐射性能使之已应用于核能装置的关键控制设备之中。

图11：**NOMEX® 410型-0.13MM (5MIL) 纸的限氧指数 (LOI)**



表V：**NOMEX® 410型-0.25mm (10MIL) 抗2MEV电子 (β射线) 辐射能力**

(Mgy)测量		0	1	2	4	8	16	32	64
抗拉撕度[1]	MD	100	96	100	100	94	87	81	65
(原有值的%)	XD	100	89	99	99	97	86	81	69
延伸率[1]	MD	100	100	92	96	76	60	36	18
(原有值的%)	XD	100	92	91	88	82	47	27	16
介电强度[2] kV/mm		34	34	33	33	33	34	35	31
介电常数[3]	60Hz	3.1	3.0	3.0	3.0	3.0	3.1	2.3	2.5
	1 Hz	3.0	3.0	2.9	3.0	2.9	3.1	2.3	2.5
	10 Hz	2.9	2.9	2.9	2.9	2.8	3.0	2.2	2.4
介电因数[3]	60Hz	8	14	10	12	9	14	7	10
(x10³)	1kHz	13	16	15	16	13	16	11	13
	10kHz	18	21	20	20	19	20	15	17

[1] ASTM D-828　[2] ASTM D-149使用直径为6.4mm (1.4英寸) 的电极　[3] ASTM D-150

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Guide Information

E I DUPONT DE NEMOURS & CO INC E34739
AFS BUSINESS CENTER
5401 JEFFERSON DAVIS HWY
PO BOX 27001
RICHMOND, VA 23261 USA

									H	D	
		Min.		H	H	R T I			V	4	C
		Thk	Flame	W	A	Elec	Mech		T	9	T
Material Dsg	**Color**	**mm**	**Class**	**I**	**I**		**Imp**	**Str**	**R**	**5**	**I**
Aramid Insulating Paper, designated "Nomex" furnished as pellets.											
442	NC	0.034-0.042	VTM-0	□	□	□	□	□	□	□	□
Aramid Insulating Paper, designated "Nomex" furnished as sheets.											
410	NC	0.051	□	0	4	220	□	220	□	□	□
		0.12	V-0	0	4	220	□	220	□	□	□
		0.18	V-0	0	4	220	□	220	□	□	□
		0.38	V-0	0	0	220	□	220	□	□	□
		0.76	V-0	0	0	220	□	220	3	□	3
411	NC	0.12	□	0	4	220	□	220	□	□	□

		0.25	V-0	0	4	220	□	220	□	□	□
		0.58	V-0	0	0	220	□	220	1	□	3
414	NC	0.18	V-0	0	0	220	□	220	3	□	□
		0.38	V-0	0	0	220	□	220	□	□	3
416	NC	0.051	□	4	4	200	□	200	□	□	□
		0.381	□	3	2	200	□	200	3	6	□
418	NC	0.076	V-0	4	4	220	□	220	□	□	□
		0.12	V-0	4	4	220	□	220	□	□	□
		0.25	V-0	4	4	220	□	220	3	□	3
419	NC	0.18	V-0	□	3	220	□	220	□	□	□
		0.33	V-0	4	4	220	□	220	2	□	□
464	NC	0.051	VTM-0	4	3	200	□	200	□	□	□
		0.076	VTM-0	4	2	200	□	200	4	□	2
992	NC	1.6	V-0	1	□	220	□	220	□	□	□
		3.2	V-0	0	□	220	□	220	3	□	3
993	NC	1.0	V-0	3	□	220	□	220	□	□	□
		3.0	V-0	0	□	220	□	220	2	□	3
		4.0	V-0	0	□	220	□	220	□	□	□
994	NC	1.0	V-0	□	□	220	□	220	□	□	□
		2.0	V-0	1	□	220	□	220	□	□	□
		3.0	V-0	1	□	220	□	220	2	□	3
		4.0	V-0	1	□	220	□	220	□	□	□
		6.4	V-0	1	□	220	□	220	□	□	□
		9.6	V-0	1	□	220	□	220	□	□	□
E56, E56A	NC	0.12	VTM-0	0	□	220	□	220	□	□	□
		0.25	V-0	0	□	220	□	220	□	□	□
		0.38	V-0	0	3	220	□	220	□	□	□
		0.51	V-0	0	3	220	□	220	□	□	3
EMS	GY	0.13	VTM-0	□	□	□	□	□	□	□	□
		0.19	V-0	□	□	□	□	□	□	□	□

N-196	NC	0.038	□	□	□	□	□	220	□	□	□
		0.051	□	□	□	□	□	220	3	3	□
		0.50	□	□	□	□	□	220	3	3	□
N729	NC	0.051	□	4	4	□	□	200	□	□	□
		0.381	□	3	2	□	□	200	3	6	□
N738	NC	0.0381	VTM-0	□	□	220	□	200	□	□	□
Aramid Insulating Paper, board, designated "Nomex" furnished as sheets.											
585, GABR	NC	0.50	V-0	3	□	220	□	220	□	□	3
586, GABS	NC	0.50	V-0	3	□	220	□	220	□	□	2
Aramid Insulating Paper, designated "Thermount" furnished as sheets.											
2N710	NC	0.05	V-0	□	□	□	□	160	□	□	□
3N710	NC	0.08	V-0	□	□	□	□	160	□	□	□
4N710	NC	0.10	V-0	□	□	□	□	180	□	□	□
E210	NC	0.04	V-0	□	□	□	□	160	□	□	□
E220	NC	0.08	V-0	□	□	□	□	160	□	□	□
E230	NC	0.10	V-0	□	□	□	□	180	□	□	□

Marking: Company name or tradename "NOMEX" , "Thermount" and material designation on container, wrapper or finished part.

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DUPONT

Material Safety Data Sheet

NOMEX® BRAND PAPER AND PRESSBOARD

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MSDS NUMBER: **SP6015**

Revision Date: **February 2, 2000**

MANUFACTURER/DISTRIBUTOR

DuPont
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS

PRODUCT INFORMATION: 1-(800) 453-8527
TRANSPORT EMERGENCY: 1-(800) 424-9300 CHEMTREC
MEDICAL EMERGENCY: 1-(800) 441-3637

TRADE NAMES/SYNONYMS

NOMEX® Brand Paper
NOMEX® Brand Pressboard
NOMEX® Brand M Aramid Mica Paper
DuPont Aramid Paper

2. COMPOSITION/INFORMATION ON INGREDIENTS

MATERIAL	CAS Number	Wt. %
Poly (isophthaloyl chloride/m-phenylenediamine)	25765-47-3	
NOMEX® Paper (non-mica products)		93-100
(Types 418 & 419 mica papers)		43-50
Dimethyl Acetamide (DMAc)	127-19-5	0.1-0.5
Mica (in Types 418 & 419 mica papers)		46-50
Water	7732-18-5	0-7
Antioxidant		0-4

(%WT BASED ON DRY WEIGHT.)

Description of above components:

NOMEX® meta-aramid paper and pressboard are composed principally of a solid organic polymer composed of carbon, oxygen, nitrogen and hydrogen. Mica is added to some papers for improved electrical performance. The polymer contains up to 7% moisture, dependent upon storage and use conditions; a small amount of residual dimethylacetamide (DMAc) from the manufacturing process; and additives in some products designed to enhance specific performance. Those additives present no known hazards in use.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Based on more than 30 years of experience in commercial use and extensive toxicological testing, NOMEX® brand paper and pressboard present minimal risk to human health and the environment.

As shipped, NOMEX® paper and pressboard do not pose a hazard. When mechanically working these products, some dust may be generated. The dust generated by processing some products will contain mica dust, which can cause eye irritation, coughing and sneezing. Repeated excessive exposures may cause chronic lung disorders. Use adequate ventilation.

When NOMEX® paper and pressboard are processed at elevated temperatures, the residual DMAc may be volatilized and accumulate in poorly ventilated areas. Over-exposure to DMAc by inhalation, ingestion, skin or eye contact may initially cause nausea, headache or weakness and can cause abnormal liver and kidney function. Wash hands after handling. Avoid personnel exposure to hot processing in confined spaces. Use adequate ventilation.

Because the remaining DMAc concentration is low and because the DMAc is not readily released from the paper below 200 degrees C, hazardous exposure to DMAc under normal operating conditions is unlikely.

During a fire, burning NOMEX® paper and pressboard may release toxic and irritating gases, much like wool. NOMEX® will burn only with added heat, but dust may smolder.

NOMEX® brand paper and pressboard are non-biodegradable and nontoxic to aquatic life; they pose no unusual environmental hazard in a spill or fire.

POTENTIAL HEALTH EFFECTS:

EYE

Paper fly and dust may cause slight mechanical irritation. Polymer of NOMEX® is untested for eye irritancy. Mica-containing dust may irritate the eyes.

SKIN

Based on animal and human skin patch tests, NOMEX® does not cause sensitization (allergic reaction) and has little potential for skin irritation. Continual rubbing of paper debris on the skin, as when it is trapped under cuffs or collar, or constantly handling paper edges may cause skin irritation. Mica-containing dust may irritate the skin.

INGESTION

Based on animal studies, polymer of NOMEX® and mica-containing dust is nontoxic when eaten.

INHALATION

NOMEX® fibers in paper are too big to inhale into the lungs, but dust and fly from processing paper may be breathed into the nose and throat. Working unprotected in dusty conditions may cause upper respiratory irritation and cold-like symptoms.

CHRONIC EFFECTS

Processing NOMEX® paper and paperboard may create dust in the air small enough to be breathed into the lungs. Paper dust instilled into the lungs of rats produced no permanent lung damage. Repeated excessive exposures to mica-containing dust may cause chronic lung disorders.

CARCINOGENICITY INFORMATION

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

4. FIRST AID MEASURES

INHALATION

If exposed to excess levels of DMAc, fiber dust or fly, remove to fresh air. Get medical attention if cough or other symptoms develop.

SKIN CONTACT

Wash with soap and water. Get medical attention if irritation develops or persists. Use hand cream to soothe and moisten irritated skin.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician, if irritation persists or develops later.

INGESTION

Not a probable route. However, in case of gastro-intestinal distress following accidental ingestion, call a physician.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

Flash point:	Not applicable
Flammable limits in Air:	Not applicable
Lower Explosive limits:	Not applicable
Upper Explosive limits:	Not applicable
Auto-ignition temperature:	Not available

HAZARDOUS COMBUSTION PRODUCTS

Combustion gases are similar to those from wool - mostly carbon dioxide, water and oxides of nitrogen. However, carbon monoxide, small amounts of hydrogen cyanide, ammonia, aldehydes, aliphatic hydrocarbons and other toxic gases may be produced depending on the conditions of burning.

UNUSUAL FIRE AND EXPLOSION HAZARDS

NOMEX® brand paper and pressboard are inherently flame resistant, but can be ignited. The limiting oxygen index (LOI) of these products ranges from 27 to 63 depending on thickness, type and density. The aramid papers (Types 410, 411, 412, and 414) range from 27 to 32; the aramid pressboard (Types 992, 993, and 994) range from 29 to 39, and the mica-containing papers (Types 418 and 419) are as high as 63. All of these products must be heated to temperatures in excess of normal use conditions (greater than 240°C) for the LOI to drop below 21%.
Burning normally stops when the ignition source is removed, but dust may smolder.
Dust from NOMEX® paper and pressboard does not present an explosion hazard.

EXTINGUISHING MEDIA

Water, foam, dry chemical and CO_2 are all acceptable.

FIRE FIGHTING INSTRUCTIONS

Wear self-contained breathing apparatus.
Keep personnel removed and upwind of fire.
Wear full protective equipment (full bunker gear.)

6. ACCIDENTAL RELEASE MEASURES

SAFEGUARDS (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (personnel) sections before proceeding with clean up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean up.

SPILL CLEAN-UP

Vacuum or sweep up material for salvage or disposal.
Paper and pressboard are not biodegradable and should not be flushed to surface waters or drains.

ACCIDENTAL RELEASE MEASURES

Wash, shovel or mop up and place in solid waste containers.
NOMEX® brand paper and pressboard are not biodegradable; do not flush to drains.

7. HANDLING AND STORAGE

HANDLING (Personnel)

Use good material handling practices.

HANDLING (Physical Aspects)

Use good material handling practices.

STORAGE

NOMEX® paper and pressboard are degraded by ultraviolet light. Do not store in direct sunlight. Fluorescent lighting will cause discoloration, but will not affect mechanical properties.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

ENGINEERING CONTROLS

Use sufficient ventilation to keep employee exposure below recommended limits.

GENERALLY APPLICABLE CONTROL MEASURES AND PRECAUTIONS

Use only with adequate ventilation. Avoid dust generation. Do not consume food, drink or tobacco in areas where they may become contaminated with this material.
If fumes or dusts are generated, use engineering controls (where technically feasible) whenever necessary to control exposures below applicable limits. Fumes and smoke from laser cutting or machining of papers of NOMEX® should be well exhausted or removed by ventilation

PERSONAL PROTECTIVE EQUIPMENT

EYE PROTECTION: Wear safety glasses with side shields for general protection.

SKIN PROTECTION: None required. If handling paper edges continuously, wear gloves to prevent skin cutting, abrasion and irritation.

RESPIRATORY PROTECTION:

Respirator use must be in accordance with OSHA Standard 29 CFR 1910.134 (the "Respirator Standard").

Where airborne dust concentrations are expected to exceed applicable exposure limits, or where there is potential for irritation of the nasal passages by the mechanical action of dust or fly, NIOSH-approved respirators should be used.

An air-purifying respirator with a dust/mist/fume cartridge or canister may be used under circumstances meeting the Respirator Standard.

Disposable dust masks (3M model N95 8210 or equivalent) may also be used.

When NOMEX® brand paper and pressboard are used at elevated temperatures, or in a way that might create airborne DMAc or decomposition products in excess of applicable exposure limits. wear NIOSH-approved organic vapor cartridge respirators.

EXPOSURE GUIDELINES

Component	Exposure Guidelines			
	OSHA PEL	ACGIH TLV	DuPont AEL*	AIHA WEEL
Poly(isophthaloylchloride/ m-phenylenediamine) (Polymer of NOMEX®)	None established	None established	10mg/m^3, 8 hr TWA, total dust 5mg/m^3, 8 hr TWA, respirable dust	5mg/m^3 8 hr TWA total dust for non-respirable fibers and non-fibrous particles
N,N-dimethylacetamide (DMAc)	10ppm, 35mg/m^3 8hr. TWA, skin	10ppm, 36mg/m^3 8hr. TWA, skin, A4	10ppm, 8hr. TWA, skin	None established
Mica - Quartz free (In Types 418 and 419 paper)	3 mg/m^3 8 hr. TWA, respirable dust	3 mg/m^3 8 hr. TWA, respirable dust	None established	None established

* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits that are lower than the AEL are in effect, such limits shall take precedence.

9. PHYSICAL AND CHEMICAL PROPERTIES

ODOR:	Mild
FORM:	Solid, Sheets, Tape.
SPECIFIC GRAVITY:	NOMEX® Fiber, 1.38g/cc; papers and pressboard variable depending on grade.
VAPOR DENSITY:	Not applicable
COLOR:	Off-white, tan, gray
pH:	Not applicable
VAPOR PRESSURE:	Not applicable
BOILING POINT:	Not applicable
SOLUBILITY IN WATER:	Insoluble
MELTING POINT:	Does not melt

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY:
Stable at normal temperatures and storage conditions.

CONDITIONS TO AVOID:
Heating NOMEX® paper above about 200°C (392°F) will rapidly drive out the DMAc. DMAc vapors may present an inhalation hazard in confined spaces.

INCOMPATIBILITY WITH OTHER MATERIALS:
None reasonably foreseeable.

DECOMPOSITION:
NOMEX® paper and pressboard begin to thermally degrade rapidly above about 300°C (572°F). Decomposition can produce irritating and toxic gases.

POLYMERIZATION:
Polymerization will not occur.

11. TOXICOLOGICAL INFORMATION

NOTE ON DMAc HAZARD: Keep in mind that the effects of DMAc cited in this MSDS are exposure dependent, and may not appear except at significant exposures. Because the DMAc in NOMEX® is not readily available at room temperature, typical workplace handling has only produced levels of absorbed DMAc that are well below the levels at which health effects occur

EYE EFFECTS:

NOMEX® is untested for eye irritancy. As with other particles, mechanical action of fibers in the eye may cause slight irritation.

DMAc is an eye irritant in animals and man. Eye contact may include eye irritation with discomfort, tearing, or blurring of vision.

SKIN EFFECTS:

NOMEX® is not a skin irritant, or a skin sensitizer in animals.

Skin sensitization has not been observed in human patch tests or in industrial experience. NOMEX® brand fibers have been used in direct contact with the skin in industrial gloves and protective apparel for many years.

The mechanical action of the fibers may cause slight skin irritation at clothing binding points. Repeated harsh rubbing of the skin with fibrous dust or supported fiber structures (e.g., sized, coated or impregnated papers, paper edges, etc.) may cause abrasion, with resulting irritation and rash. Symptoms disappear following cessation of skin contact.

DMAc skin absorption toxicity: LD 50 for rabbits is 2240mg/kg (moderately toxic by skin absorption).

DMAc is a skin irritant, but not a skin sensitizer in animals. In humans, skin contact can cause irritation with discomfort or rash.

Mica dust is untested for skin irritancy or for animal sensitization.

ACUTE ORAL EFFECTS:

NOMEX® has very low toxicity by ingestion.
Oral ALD >7500mg/kg in rats.
DMAc LD50 in female rats is 4930mg/kg (slightly toxic).

ACUTE INHALATION EFFECTS:

Industrial experience shows that inhalation of fibrous dust and fly may cause mechanical irritation of the mucous membranes of the nose and throat with resulting dry cough, sneezing, scratchy throat and runny nose. Symptoms cease upon cessation of exposure.

Human health effects of overexposure to DMAc by inhalation or skin absorption may initially include nonspecific discomfort such as nausea, headache, or weakness; temporary nervous headache, confusion, loss of coordination, and loss of consciousness; abnormal liver and kidney functions as detected by laboratory tests or jaundice (liver). Skin permeation occurs rapidly and can occur in amounts capable of producing the effects of systemic toxicity. There are no reports of human sensitization. Individuals with pre-existing diseases of the liver may have increased susceptibility to the toxicity of excessive exposure.

Mica dust has very low acute toxicity by inhalation; 4 hour LC50 is greater than 24 mg/liter.

SUBCHRONIC INHALATION EFFECTS:

A two-week subchronic test in which mice were exposed to DMAc via inhalation showed liver and testicular effects at high exposure concentrations (300, 500 and 700ppm.) No adverse effects were observed at 100 ppm.

CHRONIC INHALATION EFFECTS:

NOMEX® Fibers:

NOMEX® brand paper and pressboard do not break down into respirable fibrils when abraded; instead they produce non-fibrous particles. A 2.5mg sample prepared by grinding NOMEX® paper into small particles was instilled once into rat lungs. Tissue response was measured histopathologically in groups of rats at periodic sacrifices from 2 days to 2 years. No sign of adverse response to the dust from NOMEX® was seen.

No animal tests have been run to define mutagenic, developmental or reproductive hazards of NOMEX® paper.

DMAc:

Toxic effects, described in animals, from exposure by inhalation, ingestion or skin contact include retinal, liver, lung and kidney effects, reduced spermatogenesis, bone marrow effects and ataxia. Tests in animals demonstrate no carcinogenic activity. Tests in mammalian cell cultures demonstrate no mutagenic activity. In laboratory tests, application of DMAc to the skin of pregnant rats has caused fetal deaths when the doses were close to the lethal dose level for the mother. Embryonal malformations have been observed at dose levels 20% of the lethal dose and higher. However, when male and female rats were exposed to mean concentrations of DMAc at 31ppm, 101ppm, and 291ppm for 6 hours per day over several weeks, no reproductive effects were observed.

If there is significant potential for skin contact with DMAc, biological monitoring should be done to measure the level of DMAc metabolites in urine specimens collected at the end of the shift. It is DuPont practice to limit individual end-of-shift DMAc metabolite in urine levels to 40ppm or below, expressed as monomethylacetamide (MMAc) and to control average DMAc metabolite in urine levels for the job to 20ppm or below, expressed as MMAc.

Mica:

There is some evidence in animal exposure studies and human epidemiology that mica dust may cause fibrosis at repeated high exposures. Individuals with pre-existing diseases of the lungs may have increased susceptibility to the toxicity of excessive exposures.

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION:

NOMEX® brand paper and pressboard are essentially inert in the environment. They do not decompose in landfills and other natural environments and do not release toxic degradation materials into the ecosystem.

This material would not be toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL

These products are not hazardous waste as defined by regulations implementing the Resource Conservation and Recovery Act (RCRA). In general, waste materials of NOMEX® may be discarded in accordance with the State and Local regulations governing the disposal of other common or non-RCRA regulated waste materials

14. TRANSPORT INFORMATION

DOT

Proper Shipping Name: None. Not regulated.

CANADA

TDG CLASS: Not regulated.

ICAO

International Civil Aviation Organization classification not required.

IMDG

International Maritime Dangerous Goods classification not required.

15. REGULATORY INFORMATION

U. S. FEDERAL REGULATIONS

OSHA:

This MSDS is provided to comply with provisions of the Hazard Communication Standard (29 CFR 1910.1200).

EPA:

NOMEX® is listed on the TSCA Inventory.

CERCLA: NOMEX® is not regulated as hazardous waste under CERCLA

SARA: TITLE III, Section 313: Not reportable.

CLEAN AIR ACT AMENDMENTS OF 1990: NOMEX® paper and pressboard and their packaging do not contain, nor are they manufactured with, any of the ozone-depleting substances listed in either Class I (chlorofluorocarbons, halons, carbon tetrachloride, and methyl chloroform) or Class II (hydrochlorofluorocarbons) of the Clean Air Act Amendments of 1990.

FDA/USDA:

No NOMEX® brand paper or pressboard products are approved for use as articles or components of articles intended for repeated contact with food.

STATE REGULATIONS

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

NOMEX® paper and pressboard contain none of the substances known to the State of California to cause cancer or reproductive toxicity.

Pennsylvania and New Jersey Right-to-Know Laws:

NOMEX® paper and pressboard are considered "articles" and not subject to the provisions of the Pennsylvania and New Jersey Right-to-Know laws.

INTERNATIONAL REGULATIONS

CANADA

This material is not **WHMIS** controlled.
This material is not **TDG** regulated.

16. OTHER INFORMATION

CAUTION: DO NOT USE IN MEDICAL APPLICATIONS INVOLVING PERMANENT OR TEMPORARY IMPLANTATION IN THE HUMAN BODY OR CONTACT WITH BODY FLUIDS.

NFPA Ratings		NPCA-HMIS Ratings	
Health	0	Health	0* (chronic health effects)
Flammability	1	Flammability	1
Reactivity	0	Reactivity	0

REFERENCES:

Reinhardt, C.F., M.D., *Proceedings of the National Workshop on Substitutes for Asbestos*, (1980), EPA-560/3-80-001, 443-447.

Malley, L.A., Slone, T.W., Jr., Makovec, G.T., Elliott, G.S. and Kennedy, G.L., Jr., *Fundamental and Applied Toxicology, 28* (1995), 80-93.

Skulberg, K.R., Gylseth, B., Skang, V., Hanoa, R., *Scand. J. Work Environ. Helath II (1985), 65-74.*

NOTE:

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

RESPONSIBILITY FOR THIS MSDS:

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End of MSDS