

**Report No. PD08001**

**Title:**

**M295 Plus and R396 Thermal Transfer Ribbons  
for Flexible Packaging Printing**

**Date:** 10/23/08

**Author:** Tu A. Bui

**Technician:** Jose Lafuente

**QF01-05**

## **ABSTRACT:**

The flexible packaging market demand since 1995 continues to grow at a healthy rate of 3.6%<sup>1</sup> annually. The 2006 estimate by the Flexible Packaging Association (FPA) for the flexible packaging market in the US is \$22 Billion USD. Dai Nippon Printing Company (DNP) has developed several new thermal transfer ribbon products, namely M295 Plus and R396, to address the flexible packaging market printing and coding requirement. These two products are presented as the next generation near edge thermal transfer ribbons designed specifically for the flexible packaging market wherein higher printing speed and durability are the hallmark of their applications.

These products have been tested extensively by DNP technical teams in Japan using various substrates common in the Japanese market. The evaluations by DNP Japan using the Markem Smartdate 3C, one of the leading Original Equipment Manufacturer (OEM) printers for this application, focused on various flexible substrates, printing speed, durability, solvent resistance, and print quality. The results of these evaluations are available in a separate report.

The determination of the range of the performance of these products are therefore limited to the test conditions, substrate types and operational parameters of the test device conducted at DNP Japan. It is the intention of this study to evaluate the performance of these products on substrates that are widely used in the US markets. In addition, evaluation parameters may be expanded to testing devices that are recognized as market leaders in this application.

By market share, the Videojet Dataflex Plus printer is also considered as a leader in near edge flexible packaging printing devices. The Videojet testing device would be employed in this evaluation to increase the breadth and range of performance across the dominating OEM printers' manufacturer by market share.

There are more than 8 large multinational substrate manufacturers in the US and around the world with each having more than 1000 formulations. The evaluation will focus on some of the most popular substrates for the food products market, which currently commands 57% of the total market utilization. These popular substrates were delivered in the form of laminate composites. The flexible market demands good heat resistance for sealability on the outside layer while the inside layers, which are in contact with the food products, must comply with governmental regulation CFR21. In addition, these substrates must not impart odor to the food at point of contact.

DNP has engaged C&H Packaging Company, a subsidiary of Appleton Performance Packaging to provide typical film packaging substrate in this study.

## **Objective:**

To evaluate the performance range and capability of the DNP flexible packaging R396 and M295 Plus thermal transfer ribbons on various substrates that are currently in demand in the US market using one of the market leading printing engines.

1. FPA Estimate and US Census Bureau  
2. Proprietary to C&H Packaging Company (Division of Appleton)

## Media Substrate:

This study will evaluate substrates manufactured by C&H Packaging Company, a converting and printing subsidiary of Appleton. Appleton is recognized as a leading substrate manufacturer for the flexible packaging market. The selected substrates used are the most popular by market demand for the food products processing, personal care, medical, household, and industrial products markets.

	Substrate	Structures	Target Market	Printing Surface
1	Ref 67392 <sup>2</sup>	48 gauge Polyester/Adhesive/1.75 mil LLDPE	Condiments, powder food and prepackaged mixes such cake mixes.	PET
2	Ref 67393 <sup>2</sup>	60 gauge Biaxial Oriented Nylon/Adhesive/2.00 mil LLDPE	Liquid packaging.	BON
3	Ref 67394 <sup>2</sup>	75 gauge OPP/ink/adhesive/1.50 mil Coextrusion	Salty snack foods.	OPP

The media substrates were provided for evaluation in roll form. The substrates were wound on 3" paper fiber cores. The substrate structures are laminates of selected material combined to achieve good heat sealability and good food contact compliance without imparting odor to food.

Although C&H Packaging Company is the final converter of these substrates, the make-up products were manufactured by Appleton Performance Packaging – films and other key industry suppliers.

The test substrate is a laminate of various components. This is to ensure the construction, which generally provides the material its physical strength and superior performance. In addition, by combining the best qualities of these materials, the final laminates deliver a broad range of protective properties yet employ a minimum of materials. Adhesive may be used, as well as coating on the top or bottom of the face sheet, to dramatically increase or decrease the usefulness of the stock.

The components are produced under various trade names and are briefly described herein. The 60 gauge Biaxially Oriented Nylon (BON) is manufactured by American Biaxial Inc.. The trade name is BIAXIS film and the generic name is polyamide 6, nylon 6, polycaprolactam, biax-nylon, BOPA. The laminating adhesive under the trade name TYCEL is manufactured by Henkel Adhesive. The linear low density polyethylene (LLDPE) is manufactured by Appleton Performance Packaging - Films. The Polyethylene Terephthalate (PET) is manufactured by Film Quest Group under the trade name Questar. The Polypropylene homopolymer or copolymer is manufactured by AET Film.

## Performance Testing:

Testing was conducted at the laboratory of DNP IMSA Corporation of Concord, North Carolina. The test procedure was defined by DNP as shown below. The general test condition was at 75°F and 30~50%RH, which was the standard condition of the laboratory. Test equipment includes:

Videojet Dataflex Plus custom printer  
Image design software - Clarisoft  
Macbeth RD918 densitometer  
Atlas crockmeter

1. FPA Estimate and US Census Bureau  
2. Proprietary to C&H Packaging Company (Division of Appleton)

**Test Method:**

The Videojet printer was fitted with the M295 Plus and the R396 thermal transfer ribbons for the respective printing tests. The various substrates were fed into the printer so that the outer layer is the surface that will be printed. The standard test format consisted of solid block, bar codes in the ladder and picket orientation, and alpha numeric characters. The test parameters were adjusted for print energy and printing speed to obtain a range of operational parameters.

Test pattern example:



**Results:**

PRODUCT	SUBSTRATE	ENERGY	IPS	DENSITY	PRINT QUALITY RATING
R396	BON	75	12	1.84	4.5
		75	14	1.81	3.5
		75	16	1.00	1.0
		75	18	1.00	2.0
		85	18	1.80	2.5
		85	18	1.77	4.5
		90	18	1.86	4.0
		95	18	1.80	4.0

R396	PET	75	12	1.82	4.0
		75	14	1.84	3.5
		80	16	1.83	4.0
		75	16	1.73	3.0
		85	18	1.88	3.5
		80	18	1.75	3.0
		90	18	1.50	2.0
		95	18	1.90	4.0
		95	20	1.87	4.0
		95	22	1.24	2.5

1. FPA Estimate and US Census Bureau  
 2. Proprietary to C&H Packaging Company (Division of Appleton)

R396	OPP	75	12	1.87	5.0
		75	16	1.77	4.5
		75	18	1.74	4.5
		75	20	1.85	5.0
		75	22	1.76	5.0
		80	22	1.33	1.5

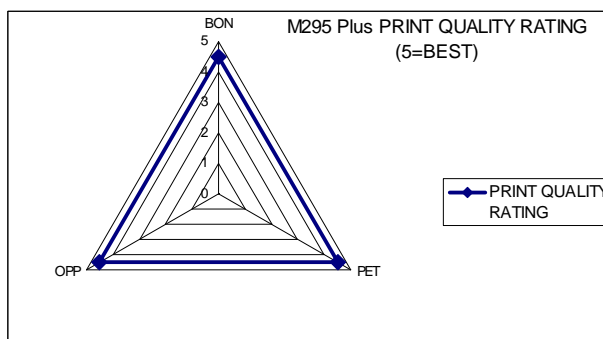
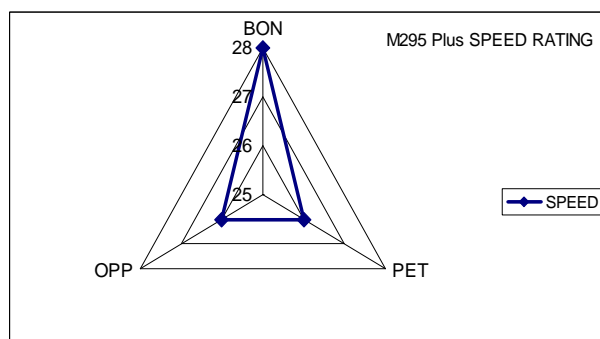
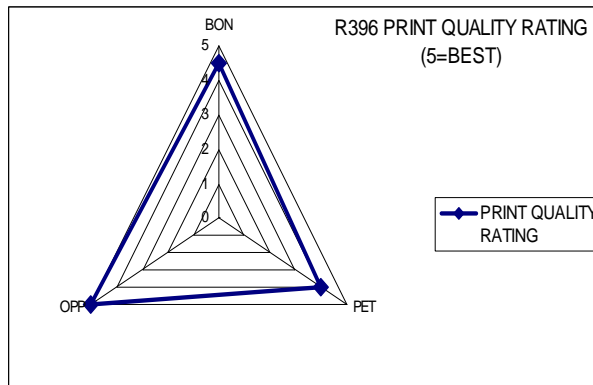
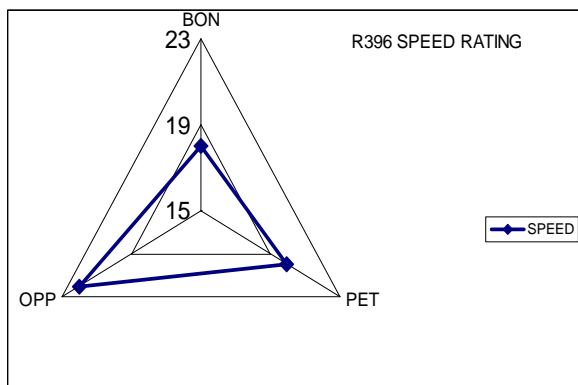
PRODUCT	SUBSTRATE	ENERGY	IPS	DENSITY	PRINT QUALITY RATING
M295 Plus	BON	75	12	1.50	3.5
		75	14	1.51	4.0
		75	16	1.50	3.5
		75	18	1.52	3.5
		75	20	1.57	4.0
		75	22	1.54	5.0
		75	24	1.55	4.0
		80	26	1.55	4.5
		80	28	1.47	4.5
		85	30	1.37	4.0
		85	32	1.28	4.0
		85	34	1.12	3.5
		85	36	1.04	3.0

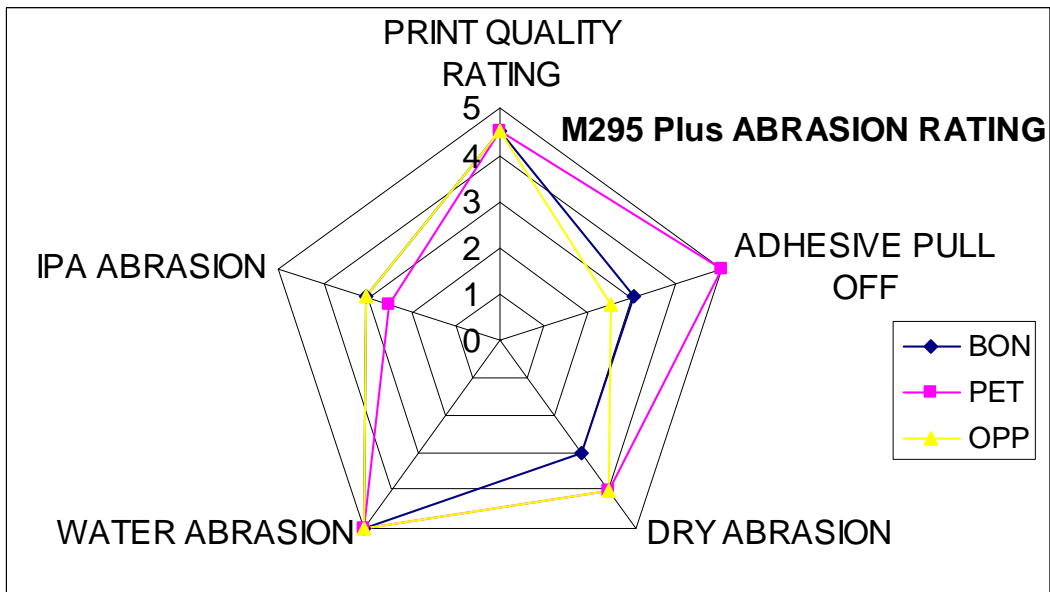
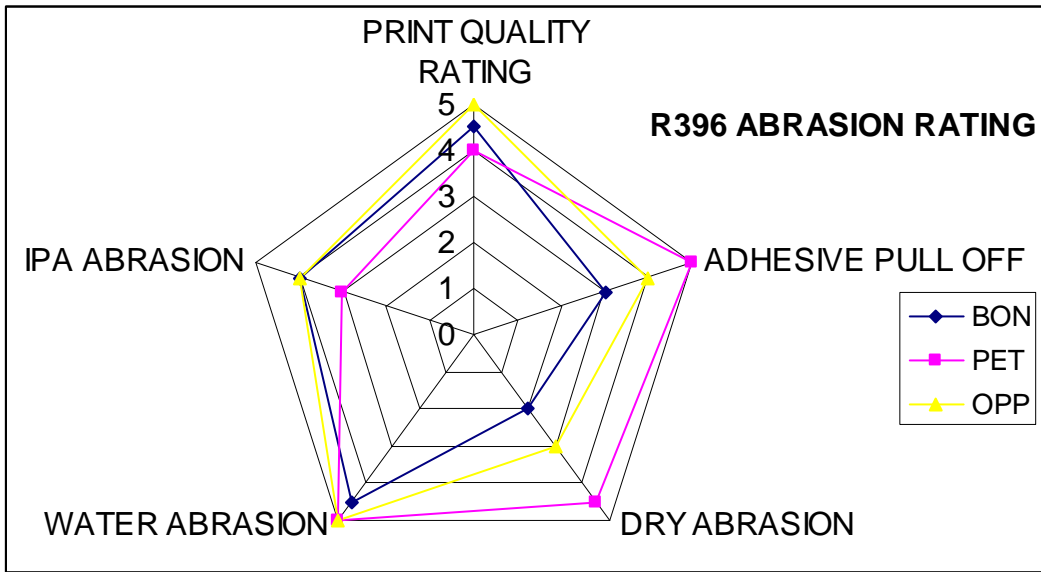
M295 Plus	PET	75	12	1.51	4.0
		75	14	1.34	3.5
		80	16	1.58	4.5
		80	18	1.59	4.5
		80	22	1.58	4.5
		85	26	1.57	3.5
		90	26	1.56	4.5
		90	28	1.37	4.0
		90	30	1.22	3.0
		90	32	1.22	3.0
		90	34	1.15	2.5
		90	36	1.12	3.0
		90	38	0.95	3.0

M295 Plus	OPP	75	12	1.6	3.5
		75	16	1.56	3.5
		75	18	1.59	3.0
		75	20	1.46	2.5
		80	22	1.57	2.5
		80	24	1.41	3.0
		80	26	1.67	4.5
		80	28	1.47	3.0
		80	30	1.42	3.5
		80	32	1.41	3.5
		80	34	1.45	3.0
		80	36	1.19	3.0
		80	38	1.26	3.0

1. FPA Estimate and US Census Bureau  
2. Proprietary to C&H Packaging Company (Division of Appleton)

PRODUCT	SUBSTRATE	SPEED	PRINT QUALITY RATING	ADHESIVE PULL OFF	DRY ABRASION	WATER ABRASION	IPA ABRASION
R396	BON	18	4.5	3	2	4.5	4
	PET	20	4	5	4.5	5	3
	OPP	22	5	4	3	5	4
M295 Plus	BON	28	4.5	3	3	5	3
	PET	26	4.5	5	4	5	2.5
	OPP	26	4.5	2.5	4	5	3





## **Discussion:**

The R396 formulation successfully achieved top printing speed of 22 inches per second (IPS) when printing on OPP substrate. Top printing speed for BON and PET substrate was 18 and 20 IPS, respectively. The print quality at this top printing speed was rated on a scale of 1-5 with 5 being the best. This scale is based on a visual inspection and print density. The top printing speed may be increased for each respective substrate by changing certain variables such as print energy. However, beyond the optimum condition, the print quality tends to diminish in the area of density and character edge definition.

The M295 Plus formulation's top printing speed was 28 IPS (BON) and 26 IPS (PET and OPP). The above results of top printing speed and print quality were obtained based on the printing patterns shown, consisting of a complex set of bar codes and alpha numeric characters of various font sizes. Additional top printing speed may be achieved when printing simpler text formats. In industrial applications, date coding typically consists of a single line of alpha numeric characters in small font representing the date of manufacturing or other batching process identities.

As with most printing systems, printing quality can further be enhanced with the adjustment of print energy. For the printing system of this study, the optimal print energy for best print quality can be achieved in the range of 75 to 95. The relationship between the print energy, printing speed, and print quality is complimentary and can be stated that optimizing one or more of these parameters could improve overall output of the print image and system performance.

## **Conclusion & Recommendation:**

The results obtained from this study are based on the printing system consisting of the Videojet printer, substrates from C&H Packaging Company, DNP thermal transfer ribbon media, and controlled testing conditions. Test results may vary when one or more of the variables are changed.

The overall print quality was excellent for the R396 and M295 Plus on all tested substrates. The R396 has a wider range of performance with regard to the adhesive pull out test and the abrasion resistance using dry, water, and isopropanol alcohol (IPA) test criteria. This is expected as the R396 formulation, being resin based, was designed to provide more abrasion resistance than the M295 Plus wax/resin base. The overall abrasion performance, despite the difference between the two formulations, is still very good for date coding applications.

The R396 resin formulation was able to achieve a top printing speed of 22 IPS with the OPP substrate, whereas the M295 Plus wax/resin formulation was able to attain a top printing speed of 28 IPS with the BON substrate. Although the top printing speeds with the other substrates were slightly slower, the print quality was excellent across all the substrates tested.

The durability of the printed images was better with the R396 resin formulation during the solvent and physical abrasion test. The PET substrate achieved best adhesive pull testing and water abrasion testing under the R396 and M295 Plus formulation.

Overall, the R396 and M295 Plus are highly compatible with the substrates supplied by C&H Packaging Company. The features and results evaluated by this examination demonstrate excellent print quality and extensive performance range required for the coding application of the flexible packaging market.