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Mining and Metals Division
Niagara Falls, NY 14302
December 6, 1973

PLAINTIFF'S EXHIBIT
UC-225

PROJECT REPORT

AUTHOR: B. L. Ingalls

SUBJECT: SHRINK-WRAP PACKAGING TESTS

SCOPE & OBJECTIVES

1. Moisture and dust control for "Calidria" Product
2. Package Integrity
3. Pallet Integrity

OBSERVATIONS

With the above objectives in mind, an investigation of shrink-wrap equipment was undertaken several months ago by V. D. Holt of the engineering department. Two specific types of equipment were considered for evaluation on the basis of technical and economic advantages; an automatic high-production pallet shrink-film tunnel manufactured by U.S. Steel Supply Company, Chicago, IL, and an individual bag shrink-wrapping system manufactured by Master Packaging Equipment, Inc., Trussville, AL.

Individual Bag Shrink-Wrap

Six pallets of "Calidria" product were bag wrapped at Master Packaging Equipment, Inc. with production shrink-filming equipment. Bags from two pallets of RG-244, three pallets of SG-210, and one pallet of RG-144 were shrink wrapped with various types and gauges of polyethylene film.

The packaging tests were performed September 6-7, 1973 and observed by J. L. Myers, D. Holt, J. Walsh, and B. L. Ingalls. It was generally concluded by those attending that the shrink film provided a clean, attractive package which confined dust and afforded both moisture protection and package integrity.

Grab samples for moisture analysis were obtained from several bags in each pallet prior to shrink wrapping. The shrink-wrapped bags were subsequently repalletized and shipped to either King City, CA or Niagara Falls, NY for observation and further moisture tests. Eight bags each of RG-144 and RG-244 were sent to St. Regis Paper Company, Contonment, FL for conditioning at 90% RH and 100°F over a period of several weeks. These bags were subsequently returned to Niagara Falls for moisture analysis.

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With the exception of one pallet which was glued between bag layers, the pallets arrived in a loose condition at their destination. Most of the pallets had to be completely restacked. Low-slip PE film which was used on one complete pallet of bags did not maintain pallet integrity. No bags were damaged by handling or transit in any of the test pallets.

No significant advantage was associated with the use of 5/4 mil* gauge film over 3 mil film. The heavier gauge film did appear to act as a slightly better moisture barrier, however, the difference was marginal.

One pallet of SG-210 bags with 3 mill low-slip PE film were restacked at King City with the automatic palletizer. The shrink-wrapped package worked very well with the automatic equipment according to the plant report.

General observations of the pallets upon arrival at their destination were as follows:

Pallet No.	Product	Film	Location	Comments(1)
I	RG-244	3 & 5/4 mil	KC	Loose bags required restacking.
II(2)	RG-244	3 & 5/4 mil	NF	Loose bags required restacking.
III	SG-210	3 mil low-slip	KC	Loose bags restacked with automatic palletizer. Bag palletized well.
IV	SG-210	3 & 5/4 mil	KC	Loose bags required restacking.
V	SG-210	3 & 5/4 mil	KC	Bags glued between layers. Pallet arrived intact.
VI(2)	RG-144	3 & 5/4 mil	NF	Loose bags required restacking.

(1) Small holes (1/8-1/2 in.) and a few tears or splits in the film were observed in some instances, but in general the shrink-wrap appeared to be in good condition. None of the bags were damaged.

(2) Partial pallet; eight bags sent to St. Regis, Contenment, FL for "Jungle Room" tests.

Moisture Analyses

On the average, moisture content of the RG-244 shrink-wrapped product increased from 1.3% to 2.6% over a period of six weeks (refer Table I). RG-144 Product increased from 1.4% to 2.0% for the same period of time. Some of the bags were found to have small holes (1/4 to 2 inches) in them, however, this did not appear to have a significant effect on moisture pickup.

*5 mil film top sheet - 4 mil film bottom sheet.

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TABLE I

MOISTURE ANALYSES ON BAG SHRINK-FILMED PRODUCT(1)

Description	Sample Identification	% Moisture Original	2 Weeks	3 Weeks	6 Weeks
RG-244, 3 mil film	II A-3	1.29		2.24	
" "	II B-3	1.38		3.90 (2.91)(2)	
" "	II C-3	1.20			2.57
" "	II D-3	1.12			2.79
RG-244, 5 mil film	II G-5/4	1.60		2.19	
Top/4 mil film	II H-5/4	1.33		2.09	
Bottom "	II I-5/4	1.12			2.31
"	II J-5/4	1.09			2.60
RG-144, 3 mil film	VI A-3	1.46	1.87 (1.90)(2)		
"	VI B-3	1.37	2.25 (3.07)(2)		
"	VI C-3	1.45			1.99
"	VI D-3	1.49			2.04
RG-144, 5 mil film	VI G-5/4	1.38		1.74	
Top/4 mil film	VI H-5/4	1.47		1.75 (1.66)(2)	
Bottom "	VI I-5/4	1.36			1.89
"	VI J-5/4	1.37			1.86

(1) The shrink-filmed bags were conditioned at St. Regis Paper Co., Contonment, FL.

(2) Small holes or tears were found in some of the PE film. The moisture values shown in parentheses were obtained on bag samples taken in the vicinity of the hole.

A visit was also made to the activated carbon operation of Westvaco in Covington, VA on October 2, 1973, to observe their bag bundle-wrap operation. Mr. Frank Eveline and Mr. Leonard Grumblatt were the men contacted. Fifty pound bags of activated carbon dust were being bundle wrapped. The bags were the sewn type on both ends. Pallets of bags were cleaned by means of an air hose. The "bundle-wrap" oven was operated by five men who fed bags and removed finished units from the equipment by hand. The time required to thread new rolls of polyethylene film into the machine was approximately five minutes. Mr. Eveline and Mr. Gumblatt indicated that the excess labor was to speed up a certain shipment for that day and also union personnel relations. It is felt that one man would be sufficient for the operation of this equipment at our King City production facilities. The finished product had a neat appearance.

Cost Information

Current prices quoted by the UCC Films Division are $.29/lb. and $.39/lb. for clear PE and UV green, respectively. Low-slip material may be obtained at no added cost. Price quotes by U.S. Steel Supply Company and Master Packaging Equipment Company were $.30/lb. for clear and $.39/lb. for UV treated PE film. It is expected that film costs will increase by 1-2 cents per pound in the near future. $.30/lb. was used for clear and $.39/lb. for UV green as the basis for

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these calculations. There is some speculation that PE film will be in short supply by mid 1974. However, according to Nick Potter, UCC Films Division, it should not effect internal UCC consumption and only a few customers are expected to be on allocation. Clear film will definitely go to $.30/lb. around the first of the year, according to Mr. Potter. UCC is currently working on a super low-slip film, but it is not ready for marketing yet. Film costs per bag of various products were calculated as follows:

BUNDLE WRAP

COST OF FILM PER BAG(1)

	3 Mil		5 Mil	
	Clear	UV Green	Clear	UV Green
RG-244	$.062	$.079	$.101	$.131
SX-24	.068	.088	.113	.147
RG-144	.062	.090	.103	.134
SX-14	.057	.074	.095	.124
T-135-P	.045	.058	.075	.097
HPP	.045	.058	.075	.097
HPO	.062	.080	.103	.134
SG-210	.064	.083	.106	.138
SG-100	.042	.055	.070	.091

(1) Refer sample calculations attached.

Our largest bagged product is SX-24 and smallest bagged product is SG-100. The difference in the cost of film per bag for these two products is $.026 per bag for clear PE and $.033 for UV green with 3 mil film. Something less than 3 mil film should be investigated after the equipment has been installed. I think we can use 3 mil or something lighter with the bag bundle wrap. A 2 mil clear film would cost $.04 per bag for RG-244; with UV green $.052 per bag.

Using RG-244 as an example, at 1000 tons per year production equals 200,000 bags, plant film costs for 3 mil clear will approximate $12,200. Darden Holt has calculated the cost of equipment and its operation as $10,700 per year, not including manpower. It is felt that the man hours required will not change appreciably for the bundle-wrap operation from present plant requirements for the overwrap operation. The $10,700 figure is derived as $2700 per year for straight-line, 10-year depreciation on equipment; $5725 per year power; $500 per year air; $1225 per year maintenance; and $550 per year taxes. Adding an operating cost of $.054 per bag of RG-244 product. Total costs per bag of RG-244 using clear PE $.115; for UV green $.133. Total production cost per year for RG-244 product using clear 3 mil PE would be $22,900; for 3 mil UV green $26,600.

Our current cost for RG-244 includes the PE overwrap ($.067/bag), cardboard shroud ($8/pallet), plus maintenance, power, etc.

Pallet Shrink-Wrap

Pallet shrink-wrap equipment was observed in operation at U.S. Steel Supply Company, Chicago, IL on September 13-14, 1973, Messrs. V. D. Holt and B. L. Ingalls attending.

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Six pallets of RG-144 were used for pallet shrink-wrapping tests. The PE bag overwrap was removed prior to shrink filming. The pallet numbers were VII through XII which is a continuation of the pallet number sequence that was started with the bag bundle-wrap shrink test of September 6-7, 1973.

Samples were removed from 4 bags of each pallet for moisture analysis. All pallets were shrink wrapped with UCC 5 mil UV green tinted polyethylene film. Pallet Nos. VIII, X, and XII had 3 mil clear polyethylene film deck liners between the bags and the pallet, and the bags were glued between layers. Pallets VII and IX had bags glued in place but no deck liner. Pallet No. XI had no deck liner and was not glued between bag layers. All pallets resulted in a neat, tight shrink-wrap with gripping at the pallet corners. Complete perimeter ceiling did not occur on any of the pallets with deck sheets. Several small holes developed in each pallet shrink-wrap during the heating procedure.

Pallet Nos. VII and XII were shipped to the "Jungle Room" of St. Regis Paper Company at Pensacola, FL. These pallets were stored outside for three weeks.

Pallet Nos. VIII and X were shipped to Niagara Falls and pallet Nos. IX and XI were shipped to the King City plant.

With the exception of pallet XI, all the overwrapped pallets arrived intact. The overwrap was missing upon arrival at King City and the bags had to be restacked. All the other pallets were found to have tears in the film overwrap. Three bags were found to be damaged in pallet XII. The pallet was too small and bags on the bottom layer overhung the pallet causing tears.

Moisture tests on the shrink-wrap pallets are shown in Table II. As expected, the use of a bottom liner enhanced moisture protection.

TABLE II

MOISTURE ANALYSES ON PALLET SHRINK-WRAPPED RG-144 PRODUCT

OUTSIDE STORAGE

Description	Film Used	Test Location	% Moisture		
			Original	2 Weeks	3 Weeks
VII A-5 UV	5 mil UV green	Florida	0.87		2.12
VII B-5 UV	pallet wrap	"	0.81		1.91
VII C-5 UV	"	"	0.79		2.06
VII D-5 UV	"	"	1.11		1.82
X A-5 UV	5 mil UV green	Niagara Falls	1.15	1.16	
X B-5 UV	pallet wrap	"	1.12	1.14	
X C-5 UV	with 3 mil clear	"	0.81	1.01	
X D-5 UV	deck liner	"	0.88	1.02	
XII A-5 UV	5 mil UV green	Florida	1.01		1.40
XII B-5 UV	pallet wrap	"	1.15		1.39
XII C-5 UV	3 mil clear	"	0.96		1.34
XII D-5 UV	deck liner	"	1.03		1.19

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PE Film For Outdoor Storage

Published data on outdoor exposure tests for clear and UV green PE are attached. UCC considers 50% retained elongation as an arbitrary level below which the film is considered no longer functional. I would estimate 2-3 months storage life with clear PE and ~6 months for UV green based on general comments by several people in the industry. Two pallets with 5 mil UV green are currently being observed for stability characteristic under outside storage conditions at King City and Niagara Falls.

Cost Information

The cost of centerfold 5 mil PE pallet shrink-wrap film would be in the range of $.90 to $1.40 depending on pallet size and type of film used. Clear and UV green 5 mil film would cost $.95 and $1.23 per pallet for RG-144 product (pallet size 54 X 44 X 65 in.). Refer sample calculations.

A formal price quotation was not requested from U.S. Steel Supply Company for pallet shrink-wrap equipment, however, the basic equipment costs for the automatic shrink tunnel were reported to be in the range of $16,000 to $18,000, not including installation.

CONCLUSIONS

It has been concluded that the individual bag shrink-wrap is the more effective of the two shrink film processes for dust control, package integrity, and moisture protection. The pallet overwrap was found to provide good pallet integrity and moisture protection over the period monitored. However, the pallet overwrap appeared to be more susceptible to damage during handling and transit. Furthermore, dust control is of proprietary interest and shrink wrapping the individual bag provides a relatively dust-free package.

Plans are currently in progress for the purchase of a Sleeve Master System Module I-A, Model SW45-12 Sleevewrapper and Module II-A, Model 1832-94 Industrial Shrink Tunnel from Master Packaging Equipment, Inc. This equipment will be used to shrink film the RG-244 package, replacing the present overwrap.

$26,000 etc. height + width

① Equipment purchased already
② Delivered April-May
③ Installed ~July

12/7

B. L. Ingalls

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12/6/73

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Zendel

SHRINK FILM

PALLET WRAPPING FOR OUTDOOR STORAGE

Outdoor storage of palletized materials can reduce storage costs particularly where construction of covered enclosed facilities would otherwise be required.

Short Term storage (90 to 120 days) is attractive to industries with seasonal demand fluctuations, or in cases when palletized materials cannot be shipped immediately or in the event of delays enroute.

When pallets are to be stored outside it is recommended that a deck sheet be used to provide six side enclosure. The deck sheet will keep ground moisture from the pallet where it would condense on the inside and possibly cause water damage.

ZENDEL outdoor storage films are available in gauges from 3 through 8 mils thick. Deck sheets need not be of ultra violet resistant film, but for ease of sealing as the load passes through the tunnel, should be of a thinner gauge than the shrink bag.

The exposure of films in areas receiving large quantities of sunlight such as Florida and Arizona provides data for determining the survival life of various film materials and gauges.

Evaluation of film performance on the basis of exposure time only, without some reference to radiation intensity could be misleading. Therefore, the total number of solar energy units transmitted to the films has been included in the charts on the other side of this page. The unit of energy is termed a Langley which by definition is equal to one gram calorie per square centimeter of exposed surface. As the radiation level for a given film gauge and time period increases, the expected film life decreases.

TEST CRITERIA

Exposure of Polyethylene films to ultra violet radiation causes a deterioration of the films which can be measured by the change in elongation. As the film weathers, the elongation which it will tolerate prior to failure, decreases. The test is one of the most widely used for determining the extent of weathering. Results are expressed as the percentage of original elongation of an unweathered sample.

We have selected 50% retained elongation as an arbitrary level below which the film is considered no longer functional. Additional testing may refine this level in either direction and will depend on the degree of load stability and continued pallet protection required after the termination of outdoor storage.

UNION CARBIDE

UNION CARBIDE CORPORATION

FILMS ⁘ PACKAGING DIVISION

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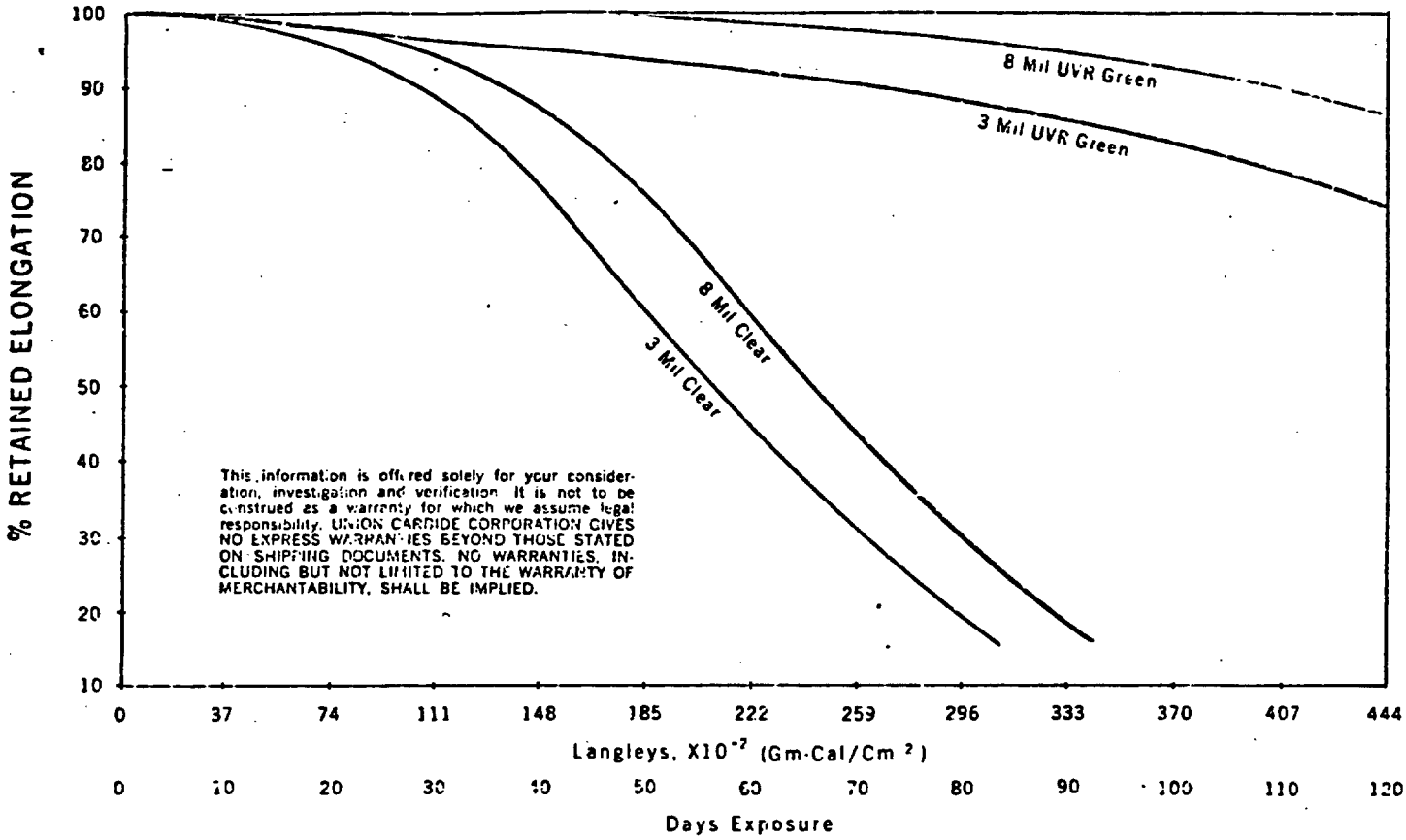
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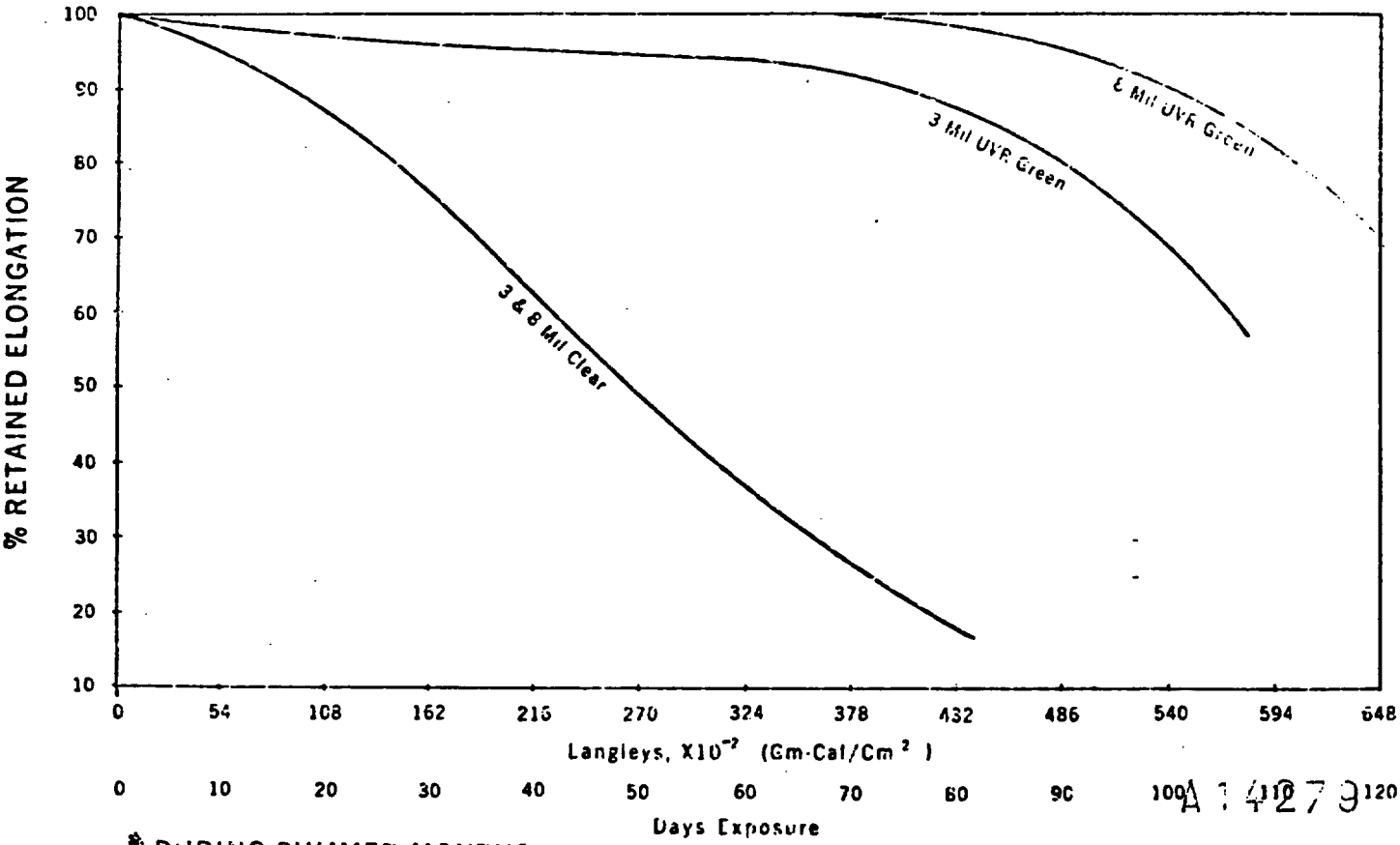
PRELIMINARY OUTDOOR EXPOSURE TEST RESULTS

Zonolel® PALLET SHRINK WRAP FILM

FLORIDA *



ARIZONA *



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* DURING SUMMER MONTHS

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SAMPLE COST CALCULATIONS

Film Cost:

Clear PE	- $.30/lb.
With UV stabilizer	- $.32-.36/lb.
With UV stabilizer + tin + (UV green)	- $.39/lb.

Film Conversion Chart

Film Gauge	Sq. Inches per lb.
.002	15,000
.003	10,000
.004	7,500
.005	6,000
.006	5,000

Cost Calculations For Bag Shrink-Film

Top roll sheet dimensions in inches

W = Bag width in inches
h = Bag height in inches
L = Bag length in inches

Width = W + 2(h-1)
Length = L + 2h

Bottom roll sheet dimensions in inches

Width = h + W
Length = L + 4

Example:

RG-244 filled bag dimensions - 27 X 17.5 X 7.5 inches

Top roll width = 17.5 + 2(7.5-1) = 30.5 inches
Top roll length = 27 + 2(7.5) = 42.0 inches
Area (L X W) = 1281 sq. inches

Bottom roll width = 7.5 + 17.5 = 25.0 inches
Bottom roll length = 27 + 4 = 31.0 inches
Area (L X W) = 775 sq. inches

Total film required for top and bottom sheets = 2056 sq. inches.

Cost per bag for 3 mil clear PE film @$.30/lb.

$$\frac{2{,}056 \text{ in.}^2}{10{,}000 \text{ in.}^2/\text{lb.}} \times \$.30/\text{lb.} = \$.0617/\text{bag}$$

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Cost Calculations For Pallet Shrink-Film

(pallet height + 6) + (1/2 pallet width) = Film Length

multiplied by

pallet width + pallet length + 4 = Film Width

multiplied by 2

= Total square inches required.

RG-144 pallet dimensions = 54 X 44 X 65 inches

(65 + 6) + (1/2 X 44) = 93

(44 + 54 + 4) = 102

(93 X 102) X 2 = 18,972 $in.^2$

Cost/pallet for 5 mil UV green @$.39/lb.

$$\frac{18{,}972\ in.^2}{6{,}000\ in.^2/lb.} \times \$0.39/lb. = \$1.23/pallet.$$

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