



MaxCell®

Technical Manual

Design Parameters

EM Product Line

Milliken & Company

# MaxCell® Design Parameters

## EM Product Line Materials of Construction

Emerging Mkt MaxCell Fabric	<ul style="list-style-type: none"> <li>• Warp - Polyester Monofilament</li> <li>• Diameter = 0.23 +/- 0.02 mm</li> <li>• Denier = 520 +/- 75</li> </ul>	<ul style="list-style-type: none"> <li>• Filling - Nylon 6 Monofilament</li> <li>• Filling - Polyester Multifilament</li> <li>• Diameter = 0.19 +/- 0.02 mm</li> <li>• Denier = 325 +/- 50 (Nylon 6)</li> <li>• Denier = 200 +/- 50 (Polyester)</li> </ul>
Fire Resistant MaxCell Fabric	<ul style="list-style-type: none"> <li>• Warp and Filling – Nylon 6 Monofilament</li> <li>• FR – Non Halogenated / Low Smoke</li> </ul>	<ul style="list-style-type: none"> <li>• Diameter = 0.25 +/- 0.03 mm</li> <li>• Denier = 520 +/- 75</li> </ul>
1250 Pull Tape	<ul style="list-style-type: none"> <li>• High Tenacity Multifilament Polyester</li> <li>• Tenacity = 7.9 +/- 0.2 gm per denier</li> </ul>	<ul style="list-style-type: none"> <li>• Breaking Tensile &gt; 565 Kg</li> </ul>
500 Pull Tape	<ul style="list-style-type: none"> <li>• High Tenacity Multifilament Polyester</li> <li>• Tenacity = 7.9 +/- 0.2 gm per denier</li> </ul>	<ul style="list-style-type: none"> <li>• Breaking Tensile &gt; 225 Kg</li> </ul>
Sewing Line	<ul style="list-style-type: none"> <li>• High Tenacity Multifilament Polyester</li> <li>• Stitches = 2.0 +/- 0.2 stitches per cm</li> </ul>	
Lubricate	<ul style="list-style-type: none"> <li>• 100% Polydimethyl Siloxane</li> <li>• Temperature Range = -40 to 205 degree C</li> <li>• Add-On Weight = 2.5 +/- 1.0%</li> </ul>	<ul style="list-style-type: none"> <li>• Density = 8.4 +/- 0.1 lbs / gal</li> <li>• Viscosity = 350 +/- 25 cps</li> </ul>
Detectable Wire - Copper	<ul style="list-style-type: none"> <li>• AWG 18 Ga. Solid Core Copper</li> <li>• Vinyl Insulation Thickness approx. 0.38 mm</li> <li>• Nylon Jacket Thickness approx. 0.10 mm</li> </ul>	<ul style="list-style-type: none"> <li>• TFN Insulation Type</li> <li>• Wt = 10.4 +/- 0.15 gm / meter</li> </ul>
Detectable Wire - Stainless Steel	<ul style="list-style-type: none"> <li>• 0.7mm 316 Stainless Steel Alloy +/- 0.127mm</li> <li>• Vinyl Insulation Thickness approx. 0.38mm</li> <li>• Annealed – Soft Temper</li> </ul>	<ul style="list-style-type: none"> <li>• TFN Insulation Type</li> <li>• Wt = 3.1 +/- 0.10 gm / meter</li> </ul>
Temperature Range	-30 to 100 degrees C	
UV Performance	Do not store MaxCell unprotected in direct sunlight for more than 30 days	
Length Measurement	-0.0, +0.5%	



# MaxCell® Design Parameters

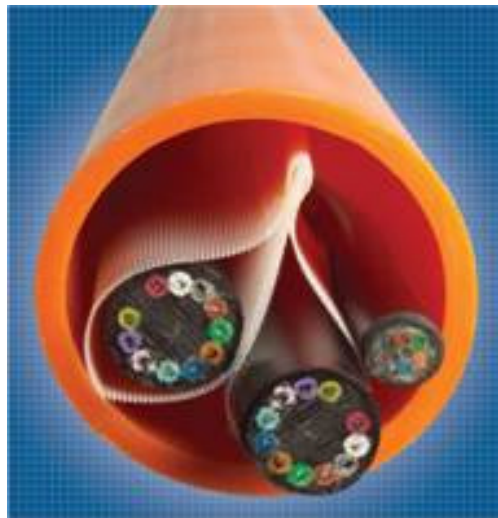
## EM Product Offering

Product	Available Options				
	Available Cells	FR Fabric Yes / No	Pull Tape * (Color Coded)	Detectable, Yes / No	Product ID Thread Color **
EM 9636 - x	1, 2 or 3	Y	565 kg Flat Tape	Y	Black, Red, White
EM 7126 - x	1, 2 or 3	Y	565 kg Flat Tape	Y	Black, Red, White
EM 5621 - x	1, 2 or 3	Y	565 kg Flat Tape	Y	Black, Red, White
EM 4616 - x	1, 2 or 3	Y	565 kg Flat Tape	Y	Black, Red, White
EM 4014 - x	1, 2 or 3	Y	565 kg Flat Tape	Y	Black, Red, White
EM 3614 - 2	2	Y	225 kg Flat Tape	N	Black, Red, White
EM 3212 - 2	2	Y	225 kg Flat Tape	N	Black, Red, White
EM 2810 - 2	2	Y	225 kg Flat Tape	N	Black, Red, White

\* 1. All Pull Tape is Colored Coded for identification purposes

2. The 225 kg pull tape has a limited breaking strength and in certain applications may need to be replaced with a pull rope of sufficient pulling strength.

\*\* Other Thread colors are available upon request



# MaxCell® Design Parameters

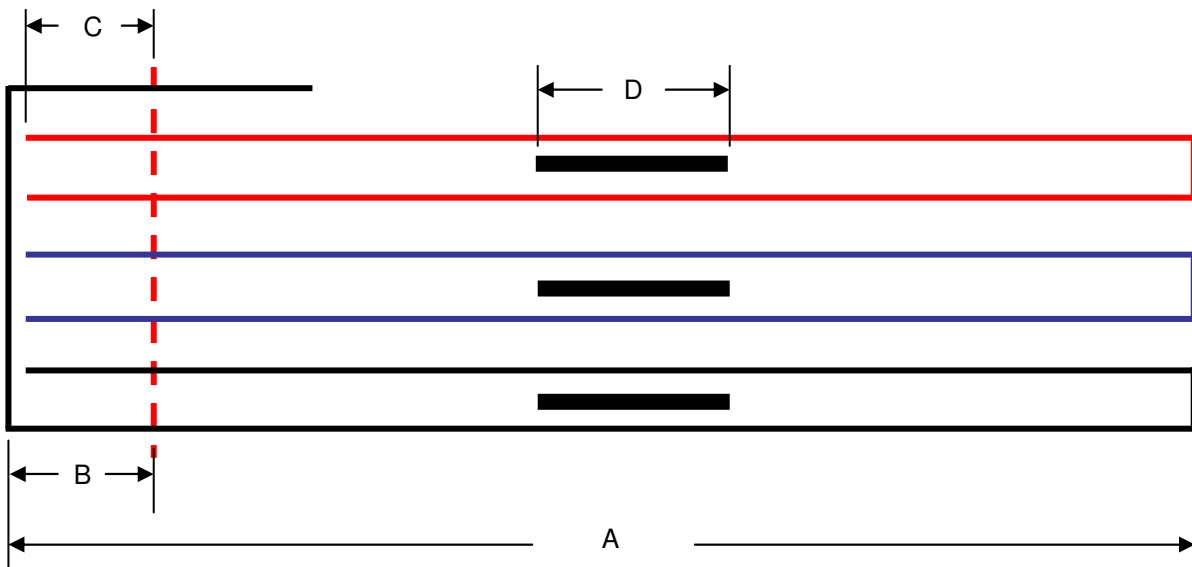
## EM Product Dimension Sheet, mm

Product *	Maximum Cable Diameter, mm **	Cell Dimensions, +/- 2 mm		Product Dimensions, +/- 2 mm			
		Circum	Diameter	Total Width, A	Seam Margin, B	Layer Margin, C	Pull Line Width, D ***
EM 9636 - x	36	176	56	96	8	7	12
EM 7126 - x	26	127	40	71	8	7	12
EM 5621 - x	21	95	30	56	8	7	12
EM 4616 - x	16	77	25	46	8	7	12
EM 4014 - x	14	63	20	40	8	7	12

\* Available in 1, 2 and 3 cell configurations

\*\* OD of Cable without cable grip, assumes use of a Kellums cable grip attachment

\*\*\* Standard Color Coded 1250 Pull Tape @ 565 kg breaking strength



# MaxCell® Design Parameters

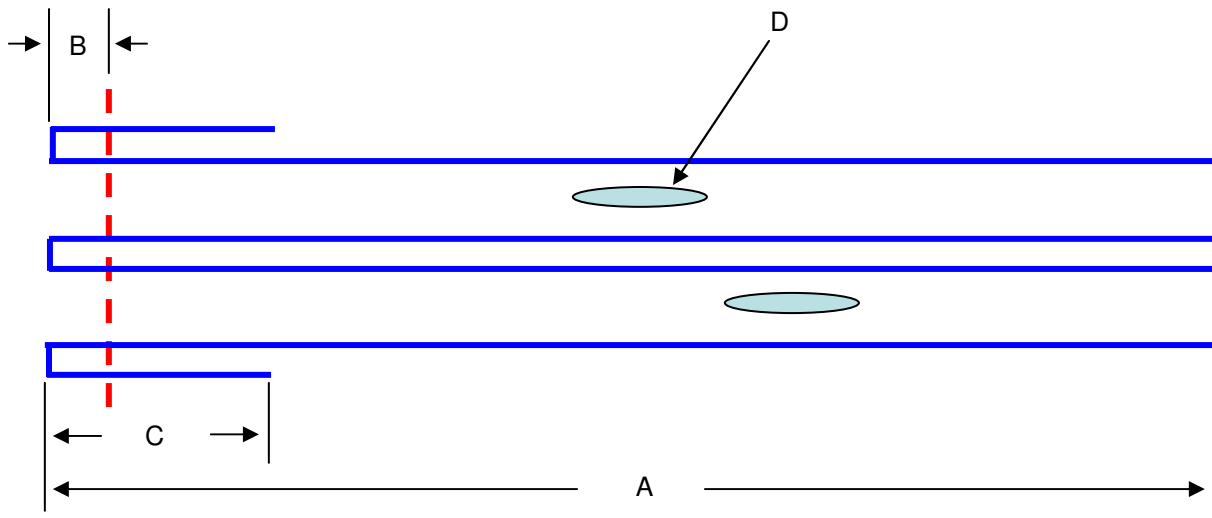
## EM Product Dimension Sheet, mm

Product *	Maximum Cable Diameter, mm **	Cell Dimensions, +/- 2 mm		Product Dimensions, +/- 2 mm			
		Circum	Diameter	Total Width, A	Seam Margin, B	Layer Margin, C	Pull Line Width, D ***
EM 3614 - 2	14	61	19	36	4	8	6
EM 3212 - 2	12	53	17	32	4	8	6
EM 2810 - 2	10	45	14	28	4	8	6

\* Only available in 2 cell configurations

\*\* OD of Cable without cable grip, assumes use of Kellums cable grip attachment

\*\*\* Standard Color Coded 500 Pull Tape @ 225 kg breaking tensile



# MaxCell® Design Parameters

## EM Product Line Tensile Strength, kgs

Product	EM MaxCell		Fire Resistant MaxCell	
	Breaking Tensile, kgs	Estimated % Elongation @ 50 Kgs	Breaking Tensile, kgs	Estimated % Elongation @ 50 Kgs
9636 - 3	> 2,250	< 0.3%	> 1,100	< 0.6%
2	> 1,550	< 0.5%	> 700	< 1.0%
1	> 775	< 0.7%	> 325	< 1.4%
7126 - 3	> 1,700	< 0.4%	> 800	< 0.8%
2	> 1,125	< 0.6%	> 550	< 1.1%
1	> 600	< 0.7%	> 275	< 1.4%
5621 - 3	> 1,350	< 0.4%	> 625	< 0.8%
2	> 900	< 0.7%	> 400	< 1.3%
1	> 500	< 0.9%	> 200	< 1.9%
4616 - 3	> 1,100	< 0.5%	> 500	< 1.0%
2	> 775	< 0.7%	> 325	< 1.4%
1	> 400	< 0.9%	> 175	< 1.9%
4014 - 3	> 950	< 0.5%	> 425	< 1.0%
2	> 625	< 0.8%	> 300	< 1.7%
1	> 325	< 1.2%	> 150	< 2.3%
3614 - 2	> 600	< 0.8%	> 275	< 1.7%
3212 - 2	> 525	< 0.9%	> 250	< 1.9%
2810 - 2	> 500	< 1.1%	> 225	< 2.1%

Test Method: ASTM D 2256 as referenced by Bellcore 356 5.3.3

### Explanation of Elongation:

MaxCell's typical installation tension is less than 50 kgs. In actual field applications, installation tension is not linear down the length of the conduit. Tension on the product is a maximum at the head-end and decreases to "zero" at the conduit entrance. Therefore product elongation decreases from the head end down to "zero" at the conduit entrance. The above results were produced from short 15 cm samples tested in a laboratory environment. In real installations, under normal conditions, we expect product elongation to be very small. Although MaxCell can be easily installed manually, typically field installation are completed with the assistance of a mechanical device. In some demanding applications installation tension placed on Maxcell has been in excess of 200 kg. In these applications MaxCell was not damaged and it's performance was as expected.



# MaxCell® Design Parameters

## EM Product Line Physical Properties

Physical Properties	Standard Values	Test Method
<u>Dynamic Coefficient of Friction</u> <ul style="list-style-type: none"> <li>• HDPE vs. Emerging Mkt MaxCell, w/o Lube</li> <li>• MDPE vs. Emerging Mkt MaxCell w/o Lube</li> <li>• PVC vs. Emerging Mkt MaxCell w/o Lube</li> <li>• Nylon vs. Emerging Mkt MaxCell w/o Lube</li> </ul>	<ul style="list-style-type: none"> <li>&lt; 0.12</li> <li>&lt; 0.16</li> <li>&lt; 0.26</li> <li>&lt; 0.09</li> </ul>	<ul style="list-style-type: none"> <li>ASTM D4518</li> <li>Bellcore 356 4.1.5</li> </ul>
<ul style="list-style-type: none"> <li>• HDPE vs. FR MaxCell, w/o lube</li> </ul>	< 0.10	
Bending Test	PASS	Bellcore 356 4.2.5
Environmental Stress Cracking	PASS	ASTM D1693
Hydrocarbon Resistance	< 7.5% Tensile Loss	Bellcore 356 4.3.2
Print Durability	PASS	Bellcore 356 5.3.5
Melting Point	> 215 Degrees C	ASTM D3418
Fungi Resistance	PASS	ASTM G21
Halogen Content	Halogen Free	MIL PRF 85045 F
Smoke Toxicity Index	PASS	NES 713
Optical Smoke Density	PASS	ASTM E662
Oxygen Index	22 to 24	ASTM D2863
Flammability, in Electrical Metallic Tubing	PASS	UL 797
<u>Coefficient of Thermal Expansion</u> <ul style="list-style-type: none"> <li>• MaxCell, mm / 100 M / 5 degrees C</li> <li>• HDPE Inner duct, mm / 100 M / 5 degrees C</li> </ul>	<ul style="list-style-type: none"> <li>8.4</li> <li>60.9</li> </ul>	<ul style="list-style-type: none"> <li>ASTM 4723</li> </ul>

The above specifications are for Emerging Market MaxCell Fabric.

Please contact manufacturing for the physical properties of other MaxCell Fabric offerings.



# MaxCell® Design Parameters

## Statement of Longevity and Chemical Resistance

---

1. Color will remain in the stitching for many years provided it is not exposed to direct sunlight for the duration. Prior to shipment all MaxCell reels are wrapped with a UV protective film. This film will provide up to six months of UV protection prior to in ground installation. The stitching is bonded and is resistant to water, oils, fuels, etc.
2.
  - A. The general properties of polyester and nylon provide excellent tenacity, toughness, abrasion resistance and temperature resistance - the combination of these two polymers in MaxCell® produce a robust product. Both polymers have excellent resistance to fuels, including jet fuels, gasoline, diesel, and natural gas. Both fibers have superior mechanical properties and chemical resistance compared to polypropylene and polyethylene.
    - B. Although MaxCell® is not UV resistant, UV degradation should not be an issue due to limited exposure. UV resistant wrapping is placed on the reels to provide up to 6 months of protection prior to in ground installation.
    - C. Both polyester and nylon should not be degraded by biological attack in soil.

Both nylon and polyester have been successfully used in geotextiles for decades in environments that are more severe than the environments intend for MaxCell®. Polyester accounts for approximately 32%, second to polypropylene, in percentage of fibers used in geotextiles, confirming polyester's acceptance for in-soil applications. The major concern for polyester will be hydrolysis. Under normal soil conditions (temperature = 68F and pH 3-9) this problem will be non-existent. Models indicate that at 100% RH and 68F the polyester should survive 150 years with only 20% strength loss. Other research indicates service life up to 100 years under these soil conditions. Some case studies: A polyester non-woven geotextile was recovered and tested after six years of service and only 10% of its strength was lost. Another study using woven polyester straps to support a vertical wall found only a 2% strength loss after 17 years of service. A polyester fabric used underwater in Indonesia found only a 7% strength loss after 5 years of service.

Nylon generally has better hydrolysis resistance than polyester, especially at neutral and high pH. Currently, nylon is commercially used for oven baking bags and for autoclave bags where there is repeated long exposure to high temperature and humidity. The majority of literature reviewed indicated the effect of hydrolysis below the polymer's Tg is negligible; polyester (158-176F) and nylon (122-140), it is not anticipated to see these temperature ranges in below ground applications.
  - D. MaxCell® was tested for heat aging for 1 week at 248F. Grab tensile results found 4.6% strength reduction in the warp and 39.6% strength reduction in the fill. Trap tear results found a 9% strength loss in the warp and a 52.6% strength loss in the fill. This would be approximately 30 years of service life. Since MaxCell® is deployed underground, there should not be an issue with strength or abrasion resistance loss over time.



# MaxCell® Design Parameters

## Statement of Longevity and Chemical Resistance

---

( Cont'd )

- E. Precise prediction of service life is actually impossible to predict for MaxCell®, but based on scientific studies and past experience noted in textile literature, the nylon and polyester yarns are the materials of choice for this type of product in the underground environment.
3. MaxCell® will not react with the chemicals in fiber cladding, iron pipe or other elements within conduit.
  4. MaxCell® lubricity tests results on recovered MaxCell®, after 4 months in an underground application, shows no loss of lubricant on the fabric. Technically, there should be no loss or degradation of the lubricant. There is the possibility that organic fuels can wash off the lubricant. This lubricate will not evaporate.
  5. Water and mud should not affect the life expectancy of MaxCell®. (see 2C above)
  6. MaxCell® is printed with ink jet technology. The print will not bleed if exposed or submerged in water. The print is not UV resistant and may fade over several months of exposure to direct sunlight. UV resistant wrapping is placed on the reels to protect the MaxCell® and the print prior to shipment. As a precautionary measure MaxCell® should not be stored uncovered in direct sunlight for a prolonged period of time.

Sources:

Nylon and Plastics Handbook

Edited by: Melvin I. Kohan

Hanser/Gardner Publications

Chemical Resistance Volume I – Thermoplastics Second Edition

Published by Plastic Design Library

Durability and Aging of Geosynthetics

Plastic Canada – Chemical Resistance Guide



# MaxCell® Design Parameters

## EM Product Line Chemical Resistance

Reagent Tested	Percent Tensile Loss		Test Method
	EM MaxCell	Standard 1250 Pull Tape	
Acetic Acid	< 0.5%	< 0.5%	ASTM D543
Hydrogen Peroxide, 3%	< 12.5%	< 12.5%	
Heavy Duty Detergent	< 0.5%	< 0.5%	
Kerosene	< 0.5%	< 0.5%	
Gasoline	< 10.0%	< 2.0%	
Diesel	< 5.0%	< 2.0%	
Hydraulic Fluid	< 0.5%	< 0.5%	
Synthetic Lubrication Oil	< 3.0%	< 2.0%	
Transmission Fluid	< 0.5%	< 3.0%	
Water, heat aging	< 10.0%	< 10.0%	
UV Exposure	< 25.0%	< 25.0%	
Ozone	< 15.0%	< 15.0%	

The above specifications are for Emerging Market MaxCell Fabric.

Please contact manufacturing for the physical properties of other MaxCell Fabric offerings.



# MaxCell® Design Parameters

## Chemical Resistance Summary Chart

**Table of Chemical Resistance to Common Reagents**

Reagent	Conc., %	Exposure Temp, degrees C	Exposure Time, days	% Retained Tensile Strength
Acetic Acid	glacial	23	31	100
Ammonium Hydroxide	2	23	31	100
	10	22	30	95
Antifreeze	50	23	21	90 - 95
Bleach	5	23	28	107
Brake Fluid		49	30	97
		66	28	80 - 90
Detergents	0.25	23	31	100
	0.25	75	1	100
Diesel Fluids		22	30	100
Ethylene Glycol		23	21	95 - 99
Freon F113		23	21	91 - 99
Gasoline		23	365	90 - 95
Gear Lube		23	21	90 - 96
Lithium Grease		23	21	95 - 100
Hydraulic Fluids		23	28	115
Hydraulic Oils		23	21	94 - 100
Hydrochloric Acid	10	23	21	96 - 98
Hydrofluoric Acid	48	23	31	80
Hydrogen Peroxide	28	23	31	100
Motor Oils		23	28	113
Nitric Acid	10	23	31	100
	40	23	31	75
Power Steering Fluid		23	21	97 - 100
Sodium Chloride	10	22	30	98
Sodium Hydroxide	2	23	31	100
	2	75	1	90
	10	23	21	0 - 47
Steam		100	7	82
		100	14	55
Sulfuric Acid	3	23	31	100
	10	23	21	91 - 96
Water		23	365	92
		71	21	90 - 95

Source: Plastic Design Library, PO Box 443, Morris NY 13808, 607-263-2316



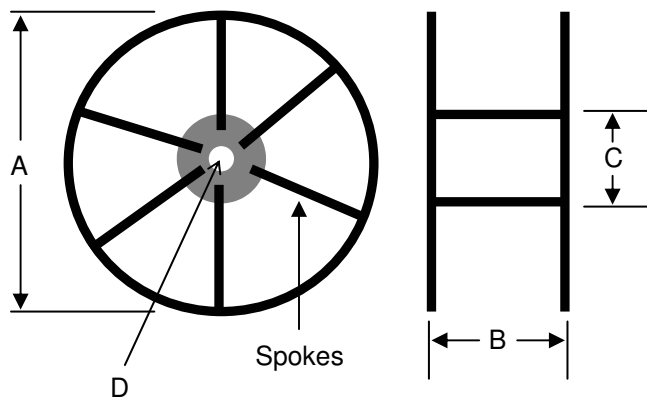
# MaxCell® Design Parameters

## Reel Dimension Chart

Reel Name	Material of Construction		Number of Spokes	Dimensions, cm				Empty Reel Wt, kg
	Flange	Core		Height A	Width B	Core C	Arbor Dia D	
315	20 mm Plywood	Fiberboard	na	84	36	20	7.6	10
322	20 mm Plywood	Fiberboard	na	84	56	20	7.6	11
415	20 mm Plywood	PVC	na	122	36	22	7.6	23
422	20 mm Plywood	PVC	na	122	56	22	7.6	25
615	14 ga 25mm Steel Square Tubing with 4 mm Plastic sides	14 ga Steel	6	183	36	38	7.6	36
622	14 ga 25mm Steel Square Tubing with 4 mm Plastic sides	14 ga Steel	6	183	56	38	7.6	37
645	14 ga 25mm Steel Square Tubing with 4 mm Plastic sides	14 ga Steel	8	183	114	38	7.6	39

All dimensions are approximate and are intended to be used as reference purposes only.

Dimensions are subject to change.



Prior to shipping all reels:

- Are wrapped with a UV protective film and
- Installation Instructions are attached



# MaxCell® Design Parameters

## EM Product Line Available Reel Lengths, M

Product	Available Reel Lengths		
	Custom Lengths	Minimum	Maximum
EM 9636 - 3	Y	150 M	to 4,750 M
2	Y	150 M	to 6,000 M
1	Y	150 M	to 7,250 M
EM 7126 - 3	Y	150 M	to 5,500 M
2	Y	150 M	to 6,500 M
1	Y	150 M	to 6,500 M
EM 5621 - 3	Y	150 M	to 6,250 M
2	Y	150 M	to 7,000 M
1	Y	150 M	to 7,500 M
EM 4616 - 3	Y	150 M	to 7,500 M
2	Y	150 M	to 6,400 M
1	Y	150 M	to 9,000 M
EM 4014 - 3	Y	150 M	to 5,050 M
2	Y	150 M	to 7,000 M
1	Y	150 M	to 9,500 M
EM 3614 - 2	Y	150 M	to 7,250 M
EM 3212 - 2	Y	150 M	to 7,500 M
EM 2810 - 2	Y	150 M	to 7,625 M



Intentional leave it blank

