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THE DEMISE OF FIELD CONNECTOR INSTALLATION

EXECUTIVE SUMMARY

In this issue, we demonstrate that the future of field connector installation is in question. This situation arises from the advent of low cost fusion splicers developed for use in FTTH installations. These splicers change the total installed cost analysis from favoring field installation of connectors to favoring fusion-spliced pigtails. The impacts of this change are:

- Manufacturers of low cost fusion splicers can anticipate increased sales from field installers.
- Manufacturers of cleave and crimp designs can expect reduced sales.
- Pigtail sales volume will increase.
- Installers will experience increased profits from reduced installation labor cost.

The analyses demonstrate a break-even of between 725 and 3000 connectors, depending on the method of installation, the cost of the splicer, and the total loaded labor rate. Above the break even number, the installer has recovered the cost of the splicer and experiences reduced total installed cost. This break-even range indicates the potential for significantly increased purchases of low cost fusions splicers by installation organizations.

One caveat is that fusion splicing of multimode fibers not result in reduced bandwidth due to disruption of the IR profile. The data on this concern are mixed.

INTRODUCTION

The advent of low cost fusion splicers reduces the equipment cost for installation of connectors from previous levels. In the past, fusion splicers cost $10,000-$30,000. At this time, fusion splicers are available below $10,000. This reduction in cost changes the total installed cost analysis. This reduction in cost reduces the total number of connectors that must be installed to recover the cost of the splicer. With this reduction in number, savvy installation firms will find fusion splicing of pigtails to be less expensive, and more profitable, than field installation of connectors.

In this issue, we present a model for estimating the total installed cost (TIC) of connectors. With this model, we compare the TIC of connectors installed by three methods to the TIC of fusion-spliced pigtails. The three methods are: Hot Melt adhesive, cleave and crimp, and epoxy.

As the results of any comparison depend on the assumptions made, we present this model as a method of determining the conditions under which fusion spliced pigtails become the method of choice. The cost factors presented in this issue are generic and are not meant to represent the values that all installers will pay.

THE BASIC MODEL

The basic cost model has two parts: the cost for splicing pigtails and the cost for field installation of connectors. The model enables estimation of a break even number of connectors. This break even number is the number of connectors that the installation organization must install in order to recover the cost of the splicer through reduced TIC.

Splicing of pigtails includes material and labor costs. The material costs are:

- Amortized cost of the splicer
- A splice tray
- A splice cover
- A pigtail
- Yield of splices

We examine two splicer costs, $7200 and $8500. These costs include the cost of a precision cleaver, which is required for high yield. We assume a splice tray cost of $13 and a splice cover cost of $0.40. Since the tray will allow 12 splices, the tray and cover cost is $1.48 per splice.

We assume that the installer purchases a 900-µ pigtail with connectors on both ends. We estimate the cost of this pigtail at $5.75 for multimode fiber and $7 for singlemode fiber. We believe these prices to be close to market prices in a competitive situation.

We assume a splice yield of 98 %. This value is consistent with our experience in both field splicing and training programs.

The labor costs are:

- Time to make the splice
- Total loaded labor rate
- Utilization of labor time
- Yield

We assume a splicing time of 3 minutes. This time assumes that the cable end is prepared and ready for splicing. This time includes the time to strip the fiber, install the splice cover, clean the fiber, cleave the fiber, make the splice, shrink the splice cover, and place the splice in the splice tray. Placement of the tray and the connector into the enclosure is not included as this time will be approximately the same for both splicing and field installation of connectors.

Field installation of connectors includes material and labor costs. The material costs are:

- Connector cost
- Tooling cost
- Supply cost
- Yield

The connector cost depends on the style (ST, SC, LC), the method of installation (Hot Melt, cleave and crimp, epoxy) and the fiber mode. We will present various values, which we believe to be typical market prices.

The tooling cost depends on the method of installation, with epoxy and Hot Melt tools at $500 and cleave tools and crimp tools at either $1700 or $1000. We will present an explanation of this price difference.

Supplies include epoxy, syringes, polishing films, alcohol, batteries for microscope, etc. Such supplies are needed for epoxy and Hot Melt. Fewer supplies are required for cleave and crimp connectors.

Yield depends on the method of installation and the type of cleaver used in the cleave and crimp method. We assume a yield of 95 % for both Hot Melt and epoxy methods. We assume a yield of 95 % for the cleave and crimp method with a high precision cleaver. We assume a yield of 90 % for the cleave and crimp method with a low cost cleaver. Based on our training experience with the low cost cleavers, we believe the yield of 90 % to be optimistic.

Connector labor factors include:

- Total loaded labor rate
- Labor utilization
- Installation time

We assume a total loaded labor rate of $55/hour. We believe this is a median rate for the US. Rates higher than $55 will result in reducing the number of connectors required to amortize the cost of the fusion splicer. Lower rates result in increasing the number of connectors required to amortize the cost of the fusion splicer. We examine one reduced labor cost, $40/hour.

Labor utilization is the percent of time that the installer spends in the connector installation activity. This factor accounts for time spent in travel to the site, set up of equipment, packing of equipment for the next location, and clean up of the installation site. We assume a value of 80 %. We believe that this value is realistic, though utilization can be as low as 60 %.

The installation time is the time spent installing the connector. This time excludes cable end preparation time and time spent installing the connector into the enclosure.

The installation time depends on the method of installation. This time can vary between 2 and 7.5 minutes per connector.

COMPARISON 1: HOT MELT MULTIMODE CONNECTORS AND A $7200 SPLICER

In the first comparison, we compare the TIC of fusion spliced pigtails to that of Hot melt connectors. To the basic model information presented above, we add the following values:

- Connector cost: $4.80
- Connector installation time: 4 minutes (15/hour)
- Supply cost: $1/connector

As shown in Table 1, the TIC becomes approximately the same at 2200 connectors; the TIC for splicing is $11.14 and for connector installation is $11.17. At this number of connectors, the installer has recovered the cost of the splicer.

Table 1: TIC Comparison For Hot Melt Installation

MULTIMODE	**Pigtail Splice**		**Pigtail Splice**	
If splicer costs	7200	$	7200	$
If 900µ double end pigtail costs	5.75	$	5.75	$
If yield is	98%		98%	
If number of connectors is	2200		4400	
If splice tray and cover cost is	1.48	$	1.48	$
If time to splice is	3	Minutes	3	Minutes

If utilization is	80%		80%	
Total loaded labor rate	55	$/hour	55	$/hour
Total cost of connector installation is		11.14		9.50
Savings for quantity		66.75		6807.20

	Hot Melt		**Hot Melt**	
If connector cost is	4.8	$	4.8	$
If yield is	95%		95%	
If installation time is	4	Minutes	4	Minutes
If utilization is	80%		80%	
If supply cost is	1	$	1	$
If tooling cost is	500	$	500	$
Total cost of connector installation is		11.17		11.05

Of significance is the net savings that the installer experiences at 4400 connectors: $6807 (Table 1).

COMPARISON 2: CLEAVE AND CRIMP MULTIMODE CONNECTORS AND A $7200 SPLICER

In the second comparison, we compare the TIC of fusion spliced pigtails to that of cleave and crimp connectors. To the basic model information presented above, we add the following values:

- Connector cost: $12
- Connector installation time: 2 minutes (30/hour)
- Supply cost: $0.40/connector
- Tooling cost: $1700

The tooling cost includes a high precision cleaver. We recommend this type of cleaver, as our training and testing experience has shown this cleaver provides increased yield and reduced loss. As shown in Table 2, the TIC becomes approximately the same at 725 connectors; the TIC for splicing is $17.80 and for connector installation is $17.93. At this number of connectors, the installer has recovered the cost of the splicer.

Table 2: TIC Comparison For Cleave And Crimp Connectors

MULTIMODE	**Pigtail Splice**		**Pigtail Splice**	
If splicer costs	7200	$	7200	$
If 900µ double end pigtail costs	5.75	$	5.75	$
If yield is	98%		98%	
If number of connectors is	725		1450	
If splice tray and cover cost is	1.48	$	1.48	$
If time to splice is	3	Minutes	3	Minutes
If utilization is	80%		80%	
Total loaded labor rate	55	$/hour	55	$/hour
Total cost of connector installation is		17.80		12.83
Savings for quantity		98		5607

	Cleave and Crimp		**Cleave and Crimp**	
If connector cost is	12	$	12	$
If yield is	95%		95%	
If installation time is	2	Minutes	2	Minutes
If utilization is	80%		80%	
If supply cost is	0.4	$	0.4	$
If tooling cost is	1700	$	1700	$
Total cost of connector installation is		17.93		16.70

Of significance is the net savings that the installer experiences at 1450 connectors: $5607 (Table 2).

If the installer chooses a low cost cleaver, the yield and tooling cost change. The yield drops to 90 %[1] and the tooling kit cost drops to $1000. As shown in Table 3, the TIC becomes approximately the same at 725 connectors; the TIC for splicing is $17.80 and for connector installation is $17.86. At this number of connectors, the installer has recovered the cost of the splicer.

Table 3: TIC Comparison For Cleave And Crimp Connectors With Low Cost Cleaver

	Pigtail Splice		**Pigtail Splice**	
If splicer costs	7200	$	7200	$
If patch cord costs	5.75	$	5.75	$
If yield is	98%		98%	
If number of connectors is	725		1450	
If splice tray and cover cost is	1.48	$	1.48	$
If time to splice is	3	Minutes	3	Minutes
If utilization is	80%		80%	
Total loaded labor rate	55	$/hour	55	$/hour
Total cost of connector installation is		17.80		12.83
Savings for quantity		43		6175

	Cleave and Crimp		**Cleave and Crimp**	
If connector cost is	12	$	12	$
If yield is	90%		90%	
If #/hour is	2	Minutes	2	Minutes
If utilization is	80%		80%	
If supply cost is	0.4	$	0.4	$
If tooling cost is	1000	$	1000	$
Total cost of connector installation is		17.86		17.09

Of significance is the net savings that the installer experiences at 1450 connectors: $6175 (Table 3).

COMPARISON 3: EPOXY MULTIMODE CONNECTORS AND A $7200 SPLICER

In the third comparison, we compare the TIC of fusion-spliced pigtails to that of epoxy connectors. To the basic model information presented above, we add the following values:

- Connector cost: $3.50
- Connector installation time: 7.5 minutes (8/hour)
- Supply cost: $1/connector

As shown in Table 4, the TIC becomes approximately the same at 1150 connectors; the TIC for splicing is $14.13 and for connector installation is $14.24. At this number of connectors, the installer has recovered the cost of the splicer.

Table 4: TIC Comparison For Epoxy Connectors

	Pigtail Splice		**Pigtail Splice**	
If splicer costs	7200	$	7200	$
If patch cord costs	5.75	$	5.75	$
If yield is	98%		98%	
If number of connectors is	1150		2300	
If splice tray and cover cost is	1.48	$	1.48	$
If time to splice is	3	Minutes	3	Minutes
If utilization is	80%		80%	
Total loaded labor rate	55	$/hour	55	$/hour
Total cost of connector installation is		14.13		11.00
Savings for quantity		130		6935

	Epoxy		**Epoxy**	
If connector cost is	3.5	$	3.5	$
If yield is	95%		95%	
If #/hour is	7.5	Minutes	7.5	Minutes
If utilization is	80%		80%	
If supply cost is	1	$	1	$
If tooling cost is	500	$	500	$

Total cost of connector installation is	14.24	14.01

Of significance is the net savings that the installer experiences at 1450 connectors: $6935 (Table 4).

SUMMARY OF FIRST THREE ANALYSES

Table 5: Summary Of Three Comparisons

	Quantity= X	$/connector Splicing	$/connector Connector	Savings @ 2X
Hot Melt	2200	$11.14	$11.17	$6,807
Cleave and Crimp	725	$17.80	$17.93	$5,607
Epoxy	1150	$14.13	$14.24	$6,935

ADDITIONAL ANALYSES

When we examine the impacts of splicer cost and labor rate, we see the obvious impacts: the break even number of connectors increases with increases in total loaded labor rate and splicer cost (Table 6-8). In spite of such increases, the break even numbers are low enough to indicate increased purchase of low cost fusion splicers by installation organizations.

Table 6: Break Even Numbers And Savings At 2X For $8500 Splicer And $55/Hour

Splicer Cost	$8,500.00	Labor Rate=	$55	Per hour

	Quantity= X	$/connector Splicing	$/connector Connector	Savings @ 2X
Hot Melt	2650	$11.07	$11.13	$8,264
Cleave and Crimp	900	$17.31	$17.45	$6,967
Epoxy	1375	$14.05	$14.17	$8,297

Table 7: Break Even Numbers And Savings At 2X For $7200 Splicer And $40/Hour

Splicer Cost	$7,200.00		Labor Rate=	$40	Per hour

	Quantity= X	$/connector Splicing	$/connector Connector	Savings @ 2X
Hot Melt	2600	$9.68	$9.82	$7,390
Cleave and Crimp	700	$17.20	$17.36	$5,646
Epoxy	1600	$11.41	$11.64	$7,426

Table 8: Break Even Numbers And Savings At 2X For $8500 Splicer And $40/Hour

Splicer Cost	$8,500.00		Labor Rate=	$40	Per hour

	Quantity= X	$/connector Splicing	$/connector Connector	Savings @ 2X
Hot Melt	3000	$9.74	$9.79	$7,505
Cleave and Crimp	850	$16.91	$16.91	$6,715
Epoxy	1900	$11.38	$11.59	$8,770

FACTORS EXCLUDED

We have ignored costs for maintenance of splicer and cleaver. These costs do not change the conclusions significantly. For example, electrodes for splicers cost $50-$100 and allow at least 1000 splices.[2] Thus, electrode maintenance cost is $0.05 to $0.10 per splice. As a second example, replacement cleaver blades cost $200-$300 and allow 10,000 cleaves, or 5000 splices. Thus, cleaver maintenance cost is $0.04 to $0.06 per splice. Inclusion of these two cost factors will increase the break even numbers slightly.

IDENTIFICATION OF INSTALLATION ORGANIZATIONS

The analysis presented herein indicates that the break even number is between 725 and 3000 connectors. To determine the number of installation jobs that will consume these numbers, we must model a typical installation. To create a model, we must define a number of floors, for a premises installation, or a number of buildings, for a campus installation. In addition, we must define the number

of fibers per cable. While these numbers can vary widely, we offer Table 9 as an estimation of the number of jobs required to justify use of fusion splicing.

Table 9: Definition Of Number Of Jobs

	24	48	=Number of fibers
	5	10	=Number of floors
Number of Connectors	Number of Jobs	Number of Jobs	
500	4.2	1.0	
1000	8.3	2.1	
1500	12.5	3.1	
2000	16.7	4.2	
2500	20.8	5.2	
3000	25.0	6.3	

If the installation organization wishes to recover its investment in 5 years, a 20 % ROI, the number of jobs per year ranges from less than one to 5, depending on the number of connectors per job (Table 10).

Table 10: Definition Of Number Of Jobs Per Year

	24	48	=Number of fibers
	5	10	=Number of floors
Number of Connectors	Number of Jobs	Number of Jobs	
500	0.8	0.2	
1000	1.7	0.4	
1500	2.5	0.6	
2000	3.3	0.8	
2500	4.2	1.0	

3000	5.0	1.3

The number of jobs in Table 10 is low. With such a low number, we believe that most installation organizations will be potential customers for low cost fusion splicers.

ONE CAVEAT

There is evidence that fusion splicing can reduce the bandwidth of multimode fibers. This evidence is based on testing performed by Pearson Technologies Inc. and Fotec in 2000. This testing was performed on fibers manufactured in the mid-1990s. This reduction in bandwidth becomes of concern in Gigabit and 10 gigabit networks.

There is contradictory evidence from Corning. This evidence suggests that current generation, laser optimized, fibers can be fusion spliced without reducing the bandwidth at gigabit and 10 gigabit bandwidths.

Pearson Technologies Inc. and the Fiber Optic Association are conducting a study on the impact of splicing on the bandwidth of current generation fibers. When this study is complete, the FOA will issue a report.

CONCLUSIONS

Fusion spliced pigtails are an alternative to field installed connectors. Fusion splicer cost can be sufficiently low to enable installation organizations to recover this cost rapidly. The cost analyses presented indicate recovery of the splicer cost between 700 and 3000 connectors. This range is realistic for the fiber optic installer that is serious about being in the fiber optic installation business. Payback can be within 0.2 and 5 jobs, depending on the number of connectors per job. With rapid recovery, or high ROI, installation organizations will find it difficult to avoid purchasing splicers.

Those installation organizations that replace field installation with fusion splicing will have a cost and profit advantage over those that ignore this change in installation method.

In addition, with cost of used splicers at $5000, installation organizations can recover the splicer cost at a number of connectors less than that indicated in Tables 5-8. Thus, the market for, and value of, used fusion splicers should increase.

Respectfully submitted for your consideration,

Eric R. Pearson, CPC, CFOS

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[1] We believe this yield to be optimistic.

[2] Our experience is that electrodes last to between 2000 and 3000 splicers.