CASE STUDY:

CLEERLINE SSF™ vs. INDUSTRY STANDARD BEND INSENSITIVE FIBER

WHY CLEERLINE SSF™

Cleerline SSF™ incorporates an integral polymer as part of the glass fiber. This advancement in fiber optic technology allows significant improvements in the strength of the glass fiber, safety of the installer, and speed of termination.

COMPARISON GOALS

This study's goal was to quantify the equivalence of Cleerline SSF™ product in signal transfer performance to the most common bend insensitive fiber in the market. Secondly, the study sought to demonstrate the extreme durability, safer handling, and faster termination of Cleerline SSF™.

RESULTS

Cleerline SSF™ met or exceeded all expectations, as proven by experienced industry technicians.

Cleerline Technology Group engaged one of the top electrical contractors in the state of Nevada to conduct a case study on the advantages of Cleerline SSF™ fiber. This firm offers complete electrical construction and service.

Additionally, their scope of work includes in-house design/build or design/assist pre-construction services, conceptual estimation and budgeting, electrical installation, and low voltage services.

The company's résumé encompasses varied projects, such as high-line work from helicopters and placing electrical lines underground in the greater Los Angeles area. They have worked extensively with the gaming industry in Las Vegas, and have also completed projects with various professional sports organizations, and with the National Parks System.

Cleerline SSF™ incorporates an integral polymer as part of the SSF™ glass fiber. This advancement in fiber optic technology allows significant improvements in the strength of the glass fiber, safety of the installer, and speed of termination.

This study's goal was first to quantify the equivalence of Cleerline SSF™ product in signal transfer performance to the most common bend insensitive fiber in the market. Secondly, the study sought to demonstrate the extreme durability, safer handling, and faster termination of Cleerline SSF™.

Cleerline SSF™ met or exceeded all expectations, as proven by the experienced industry technicians from this highly respected firm.

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PRELIMINARY REPORT SUMMARY

On February 22, 2014, an electrical contractor in Las Vegas, NV arranged for three of their most experienced union fiber technicians to spend six working hours with Cleerline Technology Group to conduct a controlled study on termination procedures.

The control group (Control) was the firm's preferred cable and connector: Corning Clearcurve SM XB fiber with Corning Unicam SC-UPC connectors. This was tested against Cleerline's SSF™ (Stronger, Safer, Faster) with the same SC-UPC Corning Unicam connectors.

The goal of this study was to quantify the SSF™ product as equivalent in performance to the most common bend insensitive fiber in the market, while demonstrating the benefits of extreme durability, safer handling, and faster termination. The Cleerline SSF™ product met or exceeded all expectations.

TESTING OUTLINE

Control Testing

Three experienced technicians to terminate twelve connectors on a length of the current standard format 12 strand single mode distribution style cable.

Measurements Included:

1. Time to terminate each connector
2. Attenuation for the entire cable (Double Ended Testing)
3. Attenuation for each connector (Single Ended Testing)

Cleerline SSF™ Testing

The same three experienced technicians used in the Control Group terminate twelve connectors on Cleerline SSF™ Fiber (SSF™ fiber w/250um "Soft Peel")

Measurements Included:

1. Time to terminate each connector
2. Attenuation for the entire cable (Double Ended Testing)
3. Attenuation for each connector (Single Ended Testing)

PROCEDURES AND DOCUMENTATION

Three Corning-certified fiber technicians provided by the contracted firm were chosen for testing. Each technician was instructed to bring just their Corning fiber termination kit for use within the study.

Technician #1 and #3 had the new Corning Unicam kit (TKT-UNICAM-PFC) with new verification tool and hand-held "score and snap" cleaver. Technician #2 had the older tool kit (TKT-UNICAM) combined with a Fujikura CT30 cleaver. All terminated fiber using SC-UPC connectors. Cleerline provided Inno and Fujikura cleavers with the blade height adjusted to cleave SSF™ fibers.

GOALS

- **Demonstrate the equivalence of Cleerline SSF™ product in signal transfer performance to the most common bend insensitive fiber in the market.**
- **Demonstrate a quantifiable reduced labor time using Cleerline SSF™ Fiber products vs. competitive fiber products.**

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RESULTS SUMMARY

The results for Cleerline's SSF™ fiber vs. the Control are as follows:

Allowing for the margin for error inherent in both testing methods, we can confidently state SSF™ fiber returned almost identical attenuation loss compared to the control. As demonstrated by the data, Cleerline SSF™ measured loss within 0.03dB of the control in all tests.

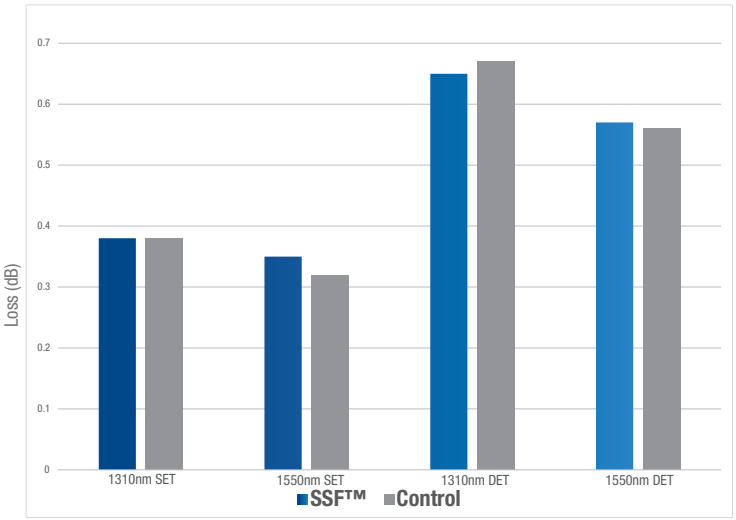
Using SSF™, the labor component for terminating fiber was reduced by roughly 33% with experienced fiber technicians. The control took an average of 159 seconds (2 minutes and 39 seconds) to terminate, whereas SSF™ was terminated in an average of 106 seconds (1 minute, 46 seconds).

It is important to note that all three technicians had not previously used the SSF™ product. All three technicians showed dramatic improvement in termination times during testing. Due to this increase in speed, we are confident that the figure of 33% would improve further over time as their familiarity with the product increased.

Our goal with this data is to assemble a strong business case for the use of Cleerline's SSF™ product wherein reducing labor to terminate, improving safety for the technicians, and reducing the footprint required by the cable plant yields significant profit gains for our customers.

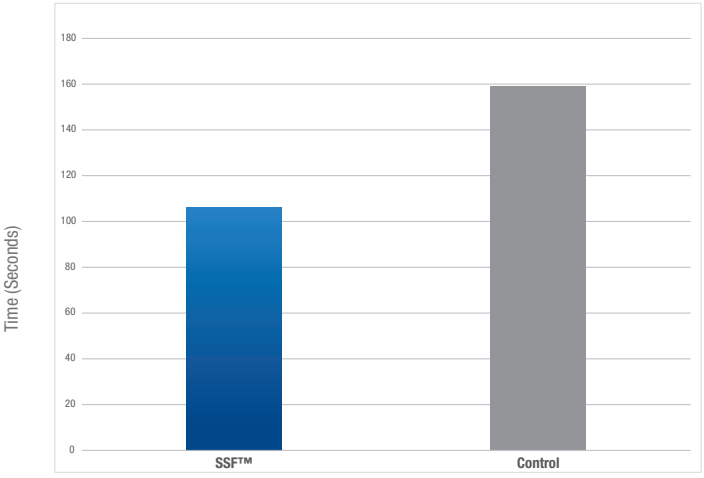
The case study also lays the foundation for a broader adoption of fiber as the preferred cable type for networking inside premise.

Attenuation (dB): Cleerline SSF™ vs Control



Testing Type SET = Single Ended DET= Double Ended	Cleerline SSF™ Loss (dB)	Control Loss (dB)
1310nm SET	0.38	0.38
1550nm SET	0.35	0.32
1310nm DET	0.65	0.67
1550nm DET	0.57	0.56

Termination Time (Seconds): Cleerline SSF™ vs Control



Fiber Type	Cleerline SSF™	Control
Termination Time	106 seconds	159 seconds

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FULL RESULTS

PROCEDURE AND DOCUMENTATION

For the control, each technician was provided a 50 ft. length of a standard Corning SM 12 strand distribution cable made with Corning's Clearcurve XB bend insensitive glass and 12 Corning SM Unicam
SC-UPC connectors. Each cable and strand was noted by color and number for reference. For each technician, one corresponding Cleerline representative was present to time the termination process.

For SSF™ testing, each technician was given a 50 ft. length of Cleerline's SSF™ SM OS2 micro distribution with pre-installed fan out kits. The fan out kits were used to build up the fiber in order to more closely match conditions for termination of the control. Building the fiber up from 250um to 900um allowed Unicam connectors to be installed without additional furcation tubing. Fan out kits are not required for regular termination as the Cleerline fiber has been proven to be more durable than traditional 900um buffered fiber. The technicians were additionally provided 12 Corning SM Unicam SC-UPC connectors.

For both the control and SSF™, each technician proceeded to terminate 6 strands in color and number order and the corresponding 6 strands on the other side of the cable, for a total of 12 terminations. Of the 12 strand cable, 6 strands were not terminated.

CONTROL GROUP TESTING

Summary Results

Technician	Technician 1	Technician 2	Technician 3
Average Termination Time	2 min 53 sec	2 min 29 sec	2 min 36 sec

Technician	Technician 1	Technician 2	Technician 3
Average Loss Per Connector (1310nm)	0.50 dB	0.30 dB	0.34dB
Average Loss Per Connector (1550m)	0.43dB	0.26dB	0.28dB

The fastest termination for the control group was Tech #3, Connection #9 at 1 min 50 sec, with loss figures of 0.40db at 1310nm and 0.35db at 1550nm.

The slowest termination for the control group was Tech #1, Connection #1 at 4 min 38 sec, with loss figures of 0.67dB at 1310nm and 0.54dB at 1550nm.

For all data, including full Double Ended Testing results, see Appendix A.

SSF™ TESTING

For the SSF™ test, Cleerline representatives trained each technician on the different properties of the Cleerline SSF™ product, proper usage, and core benefits of the glass. The most notable difference was the handling of the fiber. Specifically, the process of removing the soft peel acrylate coating is different from removing hard acrylate from

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traditional fiber. SSF™ can also be handled with increased ease due to its bendability and mechanical strength.

Note: the technicians quickly realized the fiber would not break like other types of glass. They were able to handle the fiber much less gently, and without having to restart termination due to breakage.

Prior to the test, each technician was give two connectors and a length of SSF™ fiber in order to practice removing the soft peel acrylate using their fingernails. After ten minutes of trial and practice testing proceeded.

Summary Results

Technician	Technician 1	Technician 2	Technician 3
Average Termination Time	1 min 47 sec	1 min 45 sec	1 min 45 sec

Technician	Technician 1	Technician 2	Technician 3
Average Loss Per Connector (1310nm)	0.39dB	0.39dB	0.35dB
Average Loss Per Connector (1550m)	0.37dB	0.38dB	0.32dB

The fastest termination for the SSF™ group was Tech #3, Connection #9 at 1 min 2 sec, with loss figures of 0.31db at 1310nm and 0.31db at 1550nm.

The slowest termination for the SSF™ group was Tech #1, Connection #1 at 4 min 58 sec, with loss figures of 0.41db at 1310nm and 0.41db at 1550nm.

When interviewed, the technicians discussed the following three points:

1. They felt more confident in handling the SSF™ fiber due to its extreme flexibility. They were not operating in fear of breaking the fiber when inserting it into the connector. This allowed them to work with increased speed
2. While the 250um soft peel was a little challenging initially, each of the technicians grew to appreciate its ease of use. They felt if they used the product on a regular basis they would become more proficient and comfortable with the soft peel coating.
3. The SSF™ fiber simplified the process. They felt less training would be necessary with SSF™.

The data collected demonstrates that SSF™ fiber terminated with Corning Unicam connectors easily exceeds the industry standard for mechanical splice pre-polished connector loss (loss < 0.75dB). Termination time was reduced by just under 1 minute on average, or approximately 33%.

For all data, included full Single Ended and Double Ended testing results, see Appendix A.

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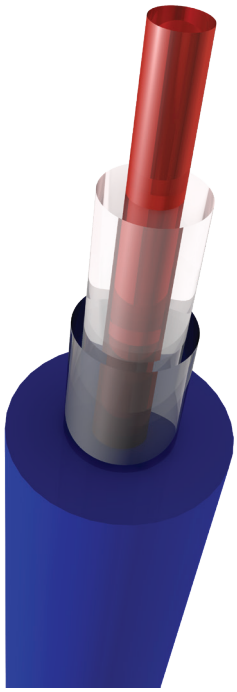
SUMMARY

SUMMARY DATA:

	CONTROL FIBER					SSF™ FIBER				
		Average Loss (dB) Double Ended Testing		Average Loss (dB) Single Ended Testing			Average Loss (dB) Double Ended Testing		Average Loss (dB) Single Ended Testing	
Technician	Average Termination Time	1310nm	1550nm	1310nm	1550nm	Average Termination Time	1310nm	1550nm	1310nm	1550nm
1	2:53	0.62	0.54	0.50	0.43	1:47	0.75	0.63	0.39	0.37
2	2:29	0.62	0.51	0.30	0.26	1:45	0.60	0.53	0.39	0.38
3	2:36	0.79	0.63	0.34	0.28	1:45	0.61	0.54	0.35	0.32
Overall Average	2:39	0.67	0.56	0.38	0.32	1:46	0.65	0.57	0.38	0.35
					Termination Time Difference	-33%				



SSF™ Fiber's integral hybrid cladding at 125um (the industry standard glass diameter) allows new technicians to terminate Cleerline's fiber products with less training. The properties of SSF™ polymeric coating also reduce termination time and increase safety for experienced fiber technicians, all while providing more durable and reliable connections.

This case study demonstrates that the use of Cleerline SSF™ provides significant savings to businesses and installers in the following areas:

- Time to terminate fiber optics, with no performance difference between traditional fiber and SSF™ hybrid cladded glass.
- Increased safety.
- Easier handling.
- Smaller form factor.

Cleerline believes that fiber optics offer the best-in-class networking platform for today and the future. Its customers will be more profitable and see greater efficiency in deployment of fiber optic networking compared to current copper alternatives.

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APPENDIX A

SINGLE ENDED REFERENCE TEST								
			CONTROL			SSF™		
Technician	Cable #	Connector	Loss at 1310nm	Loss at 1550nm	Time to Terminate	Loss at 1310nm	Loss at 1550nm	Time to Terminate
1	1	1	0.67	0.54	4:38	0.49	0.44	1:58
	7	2	0.23	0.21	2:17	0.57	0.49	1:17
	2	1	0.25	0.23	2:57	0.34	0.39	1:55
	8	2	0.35	0.33	2:27	0.41	0.41	4:58
	3	1	0.20	0.22	2:40	0.54	0.46	1:53
	9	2	0.62	0.53	3:47	0.34	0.29	1:21
	4	1	0.21	0.21	2:36	0.31	0.31	1:02
	10	2	0.56	0.45	2:31	0.33	0.31	1:36
	5	1	0.90	0.76	2:34	0.28	0.26	1:25
	11	2	1.01	0.81	2:14	0.22	0.20	1:17
	6	1	0.26	0.24	2:42	0.33	0.34	1:27
	12	2	0.79	0.62	3:21	0.55	0.50	1:25
2	1	1	0.22	0.15	3:09	0.71	0.60	3:15
	7	2	0.15	0.12	2:47	0.41	0.39	1:23
	2	1	0.30	0.28	3:14	0.29	0.31	1:41
	8	2	0.39	0.37	1:52	0.18	0.21	1:28
	3	1	0.11	0.19	2:56	0.26	0.27	2:12
	9	2	0.25	0.21	2:18	0.47	0.43	1:34
	4	1	0.18	0.13	3:03	0.28	0.30	1:36
	10	2	0.41	0.35	1:50	0.47	0.43	1:32
	5	1	0.56	0.47	2:04	0.35	0.37	1:44
	11	2	0.28	0.20	2:14	0.48	0.43	1:45
	6	1	0.30	0.26	2:13	0.35	0.35	1:32
	12	2	0.42	0.37	2:11	0.47	0.43	1:28
3	1	1	0.38	0.34	2:56	0.53	0.44	2:41
	7	2	0.31	0.27	4:18	0.69	0.56	1:56
	2	1	0.54	0.43	2:49	0.33	0.30	1:58
	8	2	0.29	0.24	2:32	0.34	0.32	1:43
	3	1	0.24	0.23	2:20	0.22	0.24	1:52
	9	2	0.40	0.35	1:50	0.26	0.27	1:28
	4	1	0.51	0.41	2:23	0.38	0.29	1:42
	10	2	0.27	0.23	2:06	0.26	0.35	1:36
	5	1	0.25	0.22	2:48	0.38	0.29	1:43
	11	2	0.47	0.37	2:17	0.15	0.18	1:43
	6	1	0.13	0.11	2:21	0.37	0.35	1:19
	12	2	0.26	0.21	2:40	0.23	0.24	1:29
Overall Average			0.38	0.32	2:39	0.38	0.35	1:46

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DOUBLE ENDED REFERENCE TEST								
			CONTROL			SSF™		
Technician	Cable #	Connector	Loss (dB) 1310nm	Loss (dB) 1550nm	Time to Terminate	Loss (dB) 1310nm	Loss (dB) 1550nm	Time to Terminate
1	1	1	0.82	0.68	4:38	1.06	0.85	1:58
	7	2			2:17			1:17
	2	1	0.46	0.40	2:57	0.61	0.58	1:55
	8	2			2:27			4:58
	3	1	0.75	0.66	2:40	0.44	0.37	1:53
	9	2			3:47			1:21
	4	1	0.52	0.48	2:36	0.95	0.74	1:02
	10	2			2:31			1:36
	5	1	0.77	0.66	2:34	0.67	0.54	1:25
	11	2			2:14			1:17
	6	1	0.41	0.38	2:42	0.74	0.67	1:27
	12	2			3:21			1:25
2	1	1	0.71	0.55	3:09	1.15	0.96	3:15
	7	2			2:47			1:23
	2	1	0.73	0.63	3:14	0.58	0.51	1:41
	8	2			1:52			1:28
	3	1	0.51	0.41	2:56	0.72	0.58	2:12
	9	2			2:18			1:34
	4	1	0.24	0.20	3:03	0.36	0.35	1:36
	10	2			1:50			1:32
	5	1	0.86	0.75	2:04	0.32	0.35	1:44
	11	2			2:14			1:45
	6	1	0.64	0.53	2:13	0.48	0.44	1:32
	12	2			2:11			1:28
3	1	1	0.91	0.74	2:56	0.58	0.49	2:41
	7	2			4:18			1:56
	2	1	1.31	1.00	2:49	0.75	0.66	1:58
	8	2			2:32			1:43
	3	1	0.51	0.43	2:20	0.63	0.56	1:52
	9	2			1:50			1:28
	4	1	1.27	1.02	2:23	0.78	0.64	1:42
	10	2			2:06			1:36
	5	1	0.42	0.36	2:48	0.46	0.44	1:43
	11	2			2:17			1:43
	6	1	0.29	0.24	2:21	0.48	0.44	1:19
	12	2			2:40			1:29
Overall Average			0.67	0.56	2:39	0.65	0.57	1:46

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TESTING PROCEDURES AND ATTENUATION MEASUREMENTS

Testing equipment utilized was an AFL SMLP 5-5 Loss Test Kit consisting of a factory calibrated OLS4 Optical Laser Source and OPM5 Optical Power Meter.

Testing, unless otherwise noted, followed testing procedures of TIA/EIA-568-B.1 utilizing the One Reference Jumper Method / FOTP-171 test specified by ANSI/TIA/EIA-526-7, Method A.1 for single mode systems. For double ended insertion loss testing, OFSTP-7 specified by ANSI/TIA/EIA-526-7-98 testing procedures were followed.

A one meter single mode SC/SC UPC factory-terminated reference cable with SC/SC coupler was employed in the single reference cable test. Two one meter single mode SC/SC UPC factory-terminated reference cables and two SC/SC couplers were employed in the double ended testing.

Notes on Fiber Testing from Reputable Sources

This case study has endeavored to present the test information as clearly as possible. Since there is no absolute standard, both single and double ended testing was carried out utilizing an optical power meter and light source. While the OPMLS is widely recognized as the most accurate method of testing possible, the method described above in "Testing Procedures and Attenuation Measurements" may vary depending upon the testing entity. As a result, we have presented results for both data sets. We recommend reviewing industry testing information, such as the following, for details on testing methods and differing points of view on testing data.

More Information

Crook, Brian and Bruce Roberson. "Practical Fiber Optic Measurement Procedures." Kingfisher International. 1997-2003. https://www.kingfisherfiber.com/Application-Notes/10-Fiber-Optic-Test-Procedures.aspx

"LANscape Solutions: Recommended Fiber Optic Test Guidelines." Corning Cable Systems LLC. Document available: https://www.accu-tech.com/hs-fs/hub/54495/file-20982317-pdf/docs/lan-1561-aen.pdf

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ABOUT US

Cleerline Technology Group has redefined how optical cable can be installed and terminated. Cleerline SSF™ glass fibers incorporate a polymeric coating as an integral part of the optical glass fiber. Cleerline SSF™ fiber optic cables meet or exceed all requirements for both multimode and single mode fiber optic cabling industry standards.

SSF™ Fibers Are

- Stronger with over 10,000x the bend capability and up to 3 to 4 times the tensile strength over traditional fiber.
- Safer to work with as SSF™ glass fiber will not penetrate skin or soft tissues.
- Faster, allowing for terminations that are in excess of 30% faster compared to other traditional glass fibers.

SSF™ fiber is compatible with all common connector systems for standard 50/125 multimode and 9/125 single mode fibers. SSF™ fiber is available in today's most common cabling configurations for optical cables and also in a wide variety of optical patch cords, providing superior fiber connections and greater reliability in all applications.

Cleerline Technology Group constantly strives to improve all forms of fiber optic connectivity, from the glass itself to the tools and accessories that are utilized in the process of termination.

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