Ameristar Impasse II Palisade Fence Test Report

Introduction

The perimeter security requirements for critical sites are changing. No longer are a chain-link fences considered adequate for all critical applications. Sophisticated intruders and saboteurs created the need for much more formidable fences that can intelligently detect intruders. Further, there is a desire to integrate the perimeter security components into a complete solution that incorporates all aspects of the customer's security requirements. Based on this trend, Fiber SenSys, Inc. (FSI) performance tested our Fiber Defender® sensor with the Ameristar Impasse II fence platform, one of the leading high security fences in the United States.

Executive Summary

The Ameristar Impasse II fence performed well with the Fiber SenSys Fiber Defender fiber optic fence sensor. The probability of detection (PoD) was measured at 100% for a total of 40 intrusion attempts. Almost no nuisance alarms occurred during the evaluation period that lasted almost two weeks and included inclement weather conditions. The rigid nature of the fence structure and the exceptional sensor coupling provided by the horizontal channels formed a very good sensor platform. This platform, combined with the tuning capabilities of the sensor form a good combination that is capable of detecting serious threats.

Objectives

Test and evaluate our Alarm Processing Units (APUs) on different fence types to ensure that our products meet customer expectations for detection as well as nuisance and false alarm rates. The objective of this test is to qualify the FD525, with both our SC3-C sensor cable in conduit and SC-4 sensor cable for use on the Ameristar Impasse II palisade fence.

The goals of this testing are:

- Probability of Detection (PoD) of ≥ 97% for climbing and sawing intrusions
- Nuisance Alarm Rates (NAR) of ≤ 1 per day
- False Alarm Rates (FAR) of 0 per day

In addition to qualifying both sensor cables on this fence type, it is an auxiliary goal of the testing to form some performance comparison between the two sensor cables as they are deployed on the fence.

Materials/Equipment Used:

QTY	UoM	Description
1	EA	FD525 APU S/N: DEMO2
1	EA	2ZB-525, Dual-zone breakout box kit with end-of-line termination device
75	ft.	SC3-C, 3mm sensor cable in ½" black conduit
75	ft.	SC-4, 4mm sensor cable
45	ft.	SM-06, Six-strand single mode lead in cable
A/R	-	Ameristar SWC100, Impasse II Sensor Wire Clip – Stainless Steel
1	EA	Remote PC with Fiber Commander Monitoring Software
Hardware for Mounting Breakout Box to Rail		
2	EA	6.5" long pieces of 1.5" channel strut
2	EA	5/16"x 2-9/16" x 5-3/16" steel U-bolt with nut and strap
4	EA	ZA1001/4EG-10, ¼" steel spring nut for 1.5" strut
4	EA	¼"-20 x 2" Machine Screw

Table 1: Materials Used to Setup Experiment. The diagrams to the left depict the difference in construction between the two most commonly used sensor cables deployed with Fiber SenSys APUs.

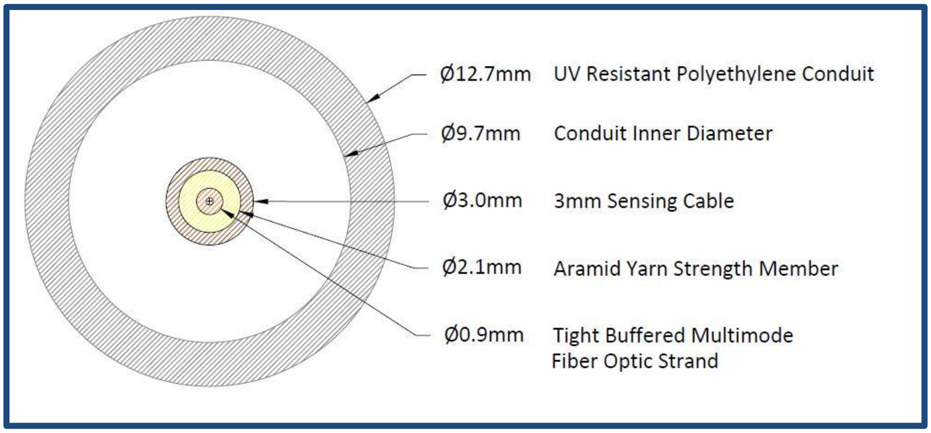

Figure 1: SC3-C, 3mm Sensor Cable in 1/2" Conduit

SC3-C, shown in Figure1, consists of 3mm tight buffered sensor cable protected by ½" conduit.

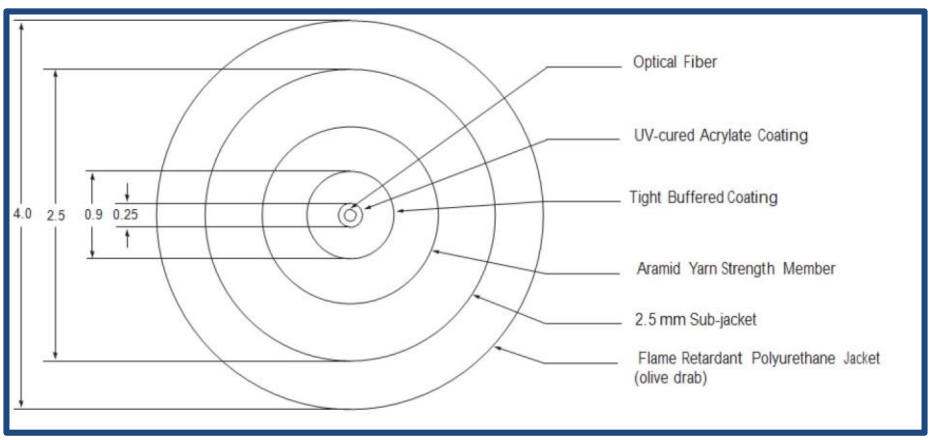

Figure 2: SC-4, 4mm Sensor Cable. Dimensions are in mm

SC-4, in Figure 2, is also a tight buffered cable but has an additional 4mm jacket for protection.

Test Setup:

At Fiber SenSys headquarters in Hillsboro, Oregon, USA, eight panels of Ameristar Impasse II fence were erected for a linear length of 64 feet in our demo yard.

Figure 3: 64 ft. Ameristar Impasse II Fence

After the fence was constructed SM-06 was spliced into a backbone cable connected to an existing DB32 (distribution box) installed in the demo yard. The SM-06 was run from a vault through a conduit sweep that exited directly into the bottom rail of the fence until the middle post (32 feet) where a 2ZB-525 breakout box was mounted using a combination of channel strut, U-bolts, and miscellaneous hardware.

Figure 4: Mounting the 2ZB-525 Breakout Box to Bottom Rail

The mounting hardware components were painted black to match the fence which resulted in a much lower visual impact. In addition to improved aesthetics, it causes a potential intruder to be less likely to notice the breakout box.

Next, both sensors were routed along the top and bottom rails. Every 12” each sensor, SC3-C and SC-4, were secured using the SWC100 sensor wire clips (see figure 5 below). The 12” spacing corresponds to one sensor clip every other pale. Since the clips caused some interference with both sensor cables as installed, the SC-4 was placed in first and then the SC3-C. This caused the SC3-C to have a wavy appearance as it had to bend over previously installed sensor wire clips; however, it was determined that there was still sufficient mechanical coupling of the SC3-C to the fence to conduct testing.

Figure 5: Sensor Wire Clips (SWC100) Securing SC-4 and SC3-C

At the end post, four panels from the breakout box, the sensor cables were secured to the inside of the post on its transition to the top rail to ensure it could not vibrate freely in the wind.

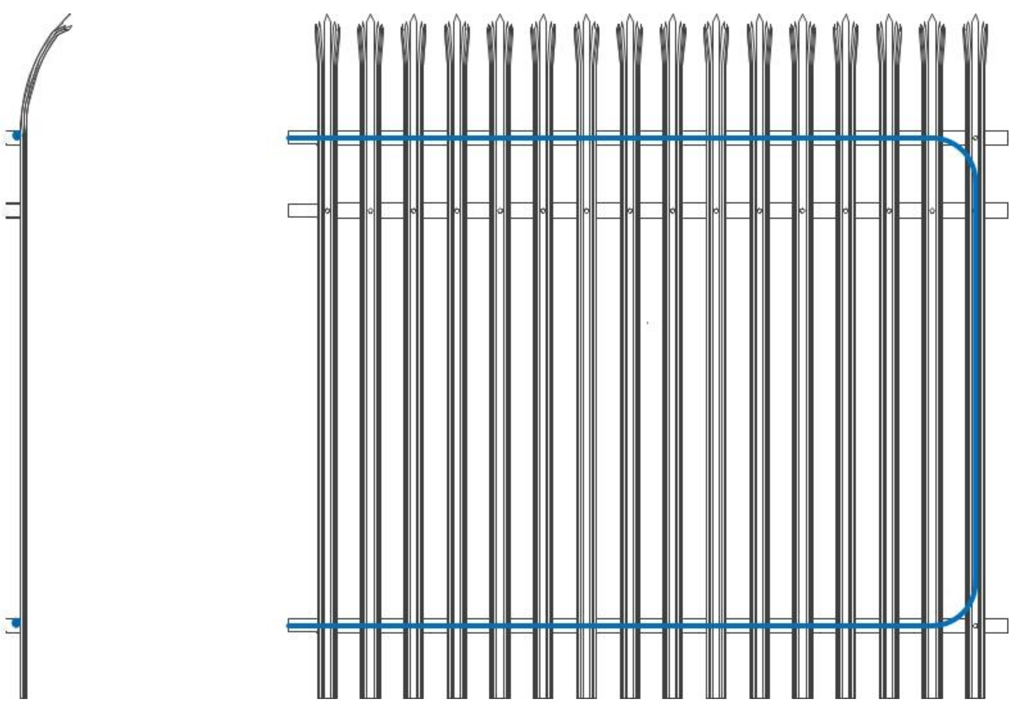

Figure 6: Sensor Cable Routing on the Ameristar Impasse II Fence

Next, the sensor cable was routed in a loopback (or double run) configuration. At the end of each sensor an end-of-line terminator, included in the 2ZB-525 breakout box kit, was fusion spliced. Care was taken with the SC-4 to not apply any clips over the portion of the cable and terminator where the 900um tight buffer was exposed under the heat shrink.

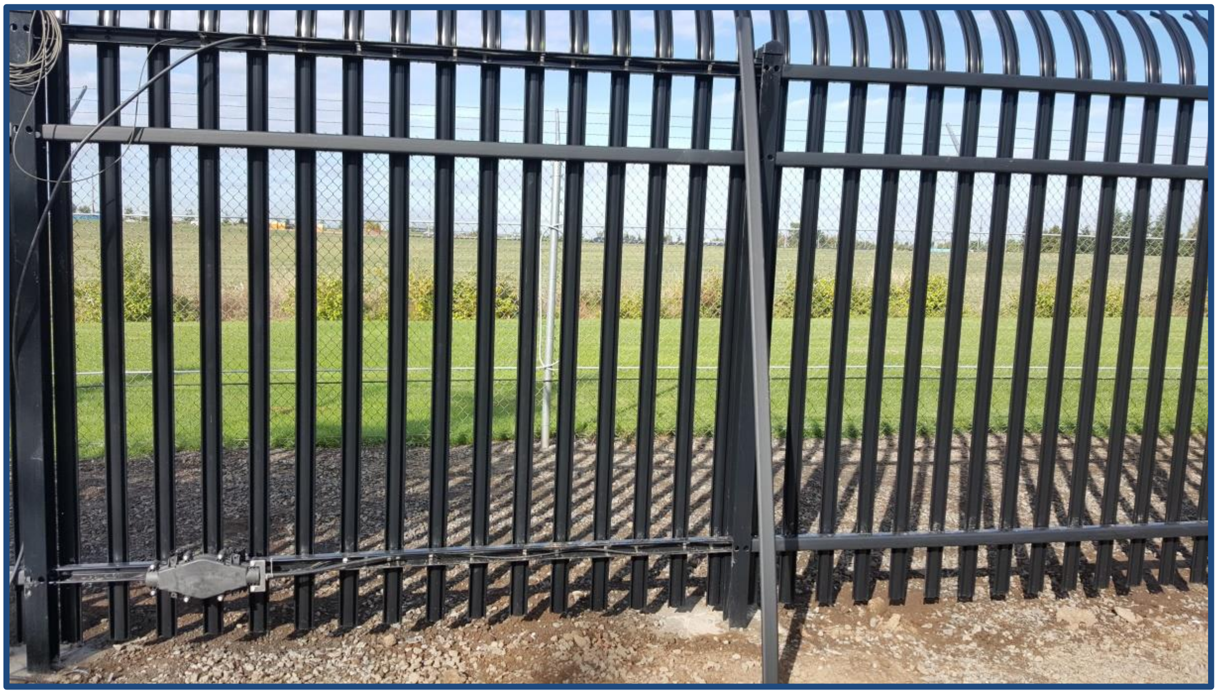

Figure 7: Sensor Deployment Complete - Awaiting End-of-Line Terminators

After the end-of-line terminators were installed the rail covers were put into place. Configuration and tuning of the system was performed following the guidelines in PM-ENG-036 500 Series Software Suite User Manual Rev H.

APU Configuration and Zone Tuning

Tuning was done with the 500 Series Suite v 5.3.6. The tuning parameters are listed below in Table 2:

Zone #	Default	SC3-C	SC-4
Location	N/A	Test Shed	Test Shed
Alarm Processing Unit(APU) Model	N/A	FD525	FD525
Firmware Version	2.14.01	2.14.01	2.14.01
Channel	N/A	N/A	N/A
Serial Number	N/A	DEMO2	DEMO2
Reflection Height	35-85%	85%	86%
Laser Power (mA)	-	176.0	176.0
Input Power (VDC)	120VAC	120VAC	120VAC
Relay Operation	PASS	N/A	N/A
Time & Date Setting	PASS	PASS	PASS
Application	Fence	Fence	Fence
Settings			
Gain (1-50)	20	20	20
Sensitivity (1-500)	23	35	40
Processor #1			
Enabled	Yes	Yes	Yes
Signal (1-40 dB)	10	5	5
Low Frequency (10-600 Hz)	170	100	100
High Frequency (10-600 Hz)	600	600	600
Duration of Signal (1-25 sec/10)	3	4	3
Tolerance (1-10 dB)	5	5	5
Event Count (1-100)	3	3	3
Event Window (1-200 sec/10)	50	50	50
Event Mask (1-100 sec/10)	2	2	2
Processor #2			
Enabled	Yes	No	No
Signal (1-40 dB)	10	10	10
Low Frequency (10-600 Hz)	300	300	300
High Frequency (10-600 Hz)	600	600	600
Duration of Signal (1-25 sec/10)	1	1	1
Tolerance (1-10 dB)	3	3	3
Event Count (1-100)	5	3	3
Event Window (1-200 sec/10)	80	80	80
Event Mask (1-100 sec/10)	7	7	7
Wind Rejection Software			
Enable Wind Rejection Software	Yes	Yes	Yes
Wind Reject (20-80)	50	60	60
Probability of Detection (PD) and Nuisance Alarm Rate / False Alarm Rate (NAR/FAR) Testing			
Detected Intrusions	18-20	40	40
Missed Intrusions	0-2	0	0
Probability of Detection(PD)	90-95%	100.0%	100.0%
Days	N/A	13	13
Nuisance Alarms	N/A	1	1
False Alarms	N/A	0	0
Nuisance Alarm Rate(NAR) per day	0-3	0.08	0.08
False Alarm Rate(FAR) per day	0-1	0	0
Evaluation	Pass	Pass	Pass

Table 2: FD525 APU Parameters

Intrusion Testing

Due to the structure of the palisades fence it was determined that that the only likely forms of intrusion would be either climbing the fence or attempting to saw through the pales using a hacksaw or Sawzall. Climbs were done by an intruder weighing 155 lbs. with tennis shoes equipped. The climber pulled himself up to the top of the fence until one foot was on the top rail before dismounting by pushing off.

Figure 8: Non-Destructive Saw Intrusion Simulation

To simulate the act of sawing through the fence a flat piece of steel was fastened to the pales of the fence using vise clamps as shown in Figure 8 to the left.

After the steel plate was secured a threaded rod (for example ¼”-20) approximately 8” in length was dragged back and forth across it for five or more seconds.

It was found that the signal from sawing intrusions was much larger in amplitude than climbs. This coupled with the long duration and high frequency excitation from sawing enabled us to capture both climbs and cuts using only processor one which is why processor two was disabled as shown in Table 2.

Figure 9 below represents the signal on SC3-C from a sawing intrusion.

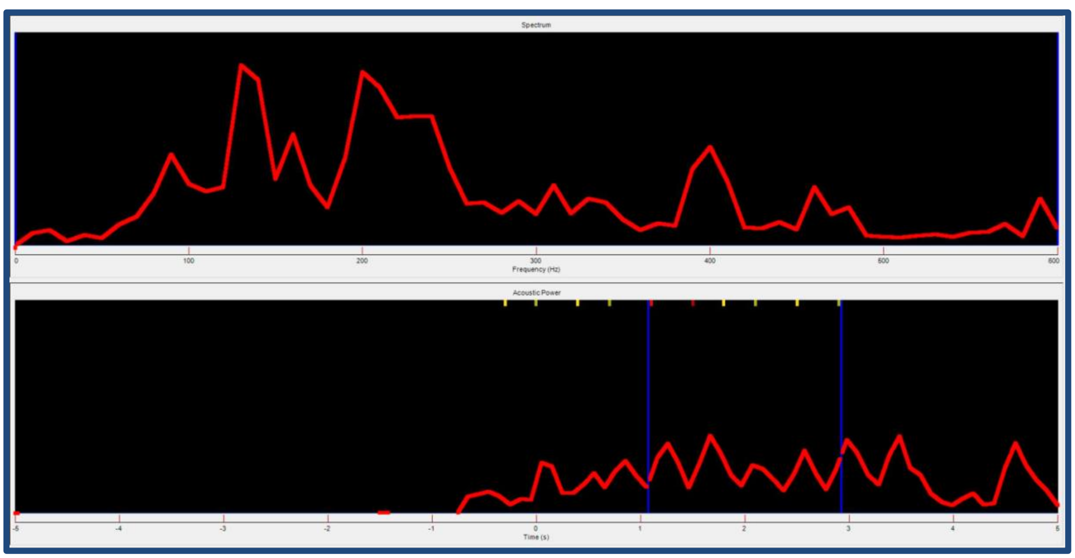

Figure 9: Sawing Intrusion Using Coarse-Thread Rod

Having both sensor cables located in the same rails allowed for a direct comparison of the signal power between SC3-C and SC-4 for the same intrusion. Referencing Figure 10 below it is shown that the SC3-C (aqua) exhibits greater signal response to intrusions than SC-4 (blue). This is also evident from the APU parameters in Table 2. Both sensors have nearly identical parameter sets, with exception to duration being .1 seconds longer for SC3-C and sensitivity which is 35 and 40 for SC3-C and SC-4 respectively.

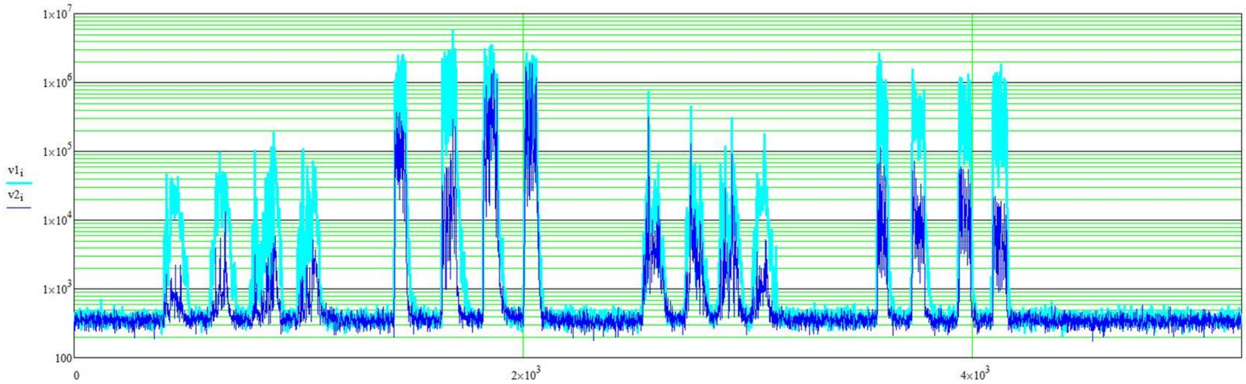

Figure 10: Difference in Sensitivity for SC3-C (Aqua) and SC-4 (Blue) for Four Mid Panel Climbs, Four Coarse-Thread Saw Intrusions, Four Post Climbs, and Four Fine-Thread Saw Intrusions. Note the Logarithmic Scale.

Probability of Detection (PoD) testing was performed 9/30/2015 after collaboration and finalization of the parameters between Engineering Support members. 20 climbs were conducted in various locations along the four panels with sensor deployed. 20 saw intrusions were conducted at various heights and positions along the four panels. Referring to Table 2 both sensors exhibited 100% PoD for all 40 intrusions.

Nuisance Monitoring

After tuning and Probability of Detection (PoD) testing was completed, the FD525 monitoring both sensor cables on the Impasse II fence was left running and alarms were logged via Fiber Commander for a period of 13 days. The duration of the test was dictated by the amount of time it took for inclement weather in the form of wind and rain to occur at FSI.

Date	SC-4 NA	SC-3 NA	Max Temp F	Min TemperatureF	Max Gust SpeedMPH	PrecipitationIn	Events
9/30/2015	0	0	71	44	9	0	
10/1/2015	0	0	78	42	15	0	Fog
10/2/2015	0	0	63	43	18	T	
10/3/2015	0	0	71	45	17	0	
10/4/2015	0	0	80	42	16	0	
10/5/2015	0	0	84	41	16	0	
10/6/2015	0	0	75	45	13	0	
10/7/2015	0	0	64	54	8	0.08	Rain
10/8/2015	0	0	73	50	10	0	Fog
10/9/2015	0	0	72	49	11	T	Fog
10/10/2015	1	1	68	49	26	0.38	Fog-Rain
10/11/2015	0	0	65	45	8	0	Fog
10/12/2015	0	0	67	43	8	0	Fog

Table 3: Number of Nuisance Alarms for Each Sensor and Daily Weather

As can be seen from Table 3 above there was only one nuisance alarm on each sensor cable during the 13-day monitoring period. From the Fiber Commander logs for 10/10/2015 the time of the SC3-C alarm was at 2:06PM and the alarm for SC-4 was at 2:53PM. Referencing the historical daily weather[1] it was observed that there was a large wind and rain storm with the inclement weather peaking between 2-3PM.

[1] Historical weather data was taken from http://www.wunderground.com/history/ with area code 97124 (KHIO airport)

Day	TemperatureF	Wind SpeedMPH	Gust SpeedMPH	PrecipitationIn	Conditions
12:53 PM	64	8.1	-	0.07	Light Rain
1:53 PM	64.9	9.2	-	0.02	Overcast
2:48 PM	62.6	19.6	26.5	0.12	Rain
2:53 PM	62.1	15	26.5	0.19	Heavy Rain
2:58 PM	62.1	17.3	24.2	0.01	Light Rain
3:02 PM	61	15	24.2	0.01	Light Rain

Table 4: Detailed Weather for the Afternoon of 10/10/2015

This data was used to populate Table 2 for NAR and FAR. Both sensors completed the testing period with an NAR of .08 per day (one alarm in over 13 days) and FAR of 0.

Conclusion

The test result of the fence platform and sensor working provided the following results.

Criteria	Goal	Result		Conclusion	
		SC3-C	SC-4	SC3-C	SC-4
Probability of Detection	≥ 95%	100%	100%	**PASS**	**PASS**
Nuisance Alarm Rate	≤ 1 per day	0.08	0.08	**PASS**	**PASS**
False Alarm Rate	0 per day	0	0	**PASS**	**PASS**

Table 5: Summary of Test Results

Both SC3-C fiber optic sensing cables factory installed in flexible conduit and SC-4 ruggedized sensing cables deployed in conjunction with the Fiber Defender® Alarm Processing Unit were able to capture intrusions with a 100% probability of detection. Nuisance alarm performance dramatically exceeded expectations and provided one nuisance alarm in over 13 days. The testing indicates that either sensor cable can be reliably deployed on the Ameristar Impasse II fence structure.