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REV	DESCRIPTION	DATE	APPROVED
-	RELEASED AS REVISION -	10/30/07	<i>R. Throm</i>

NAVSEA DRAWING NO. 8346971
ESWBS 408

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REV STATUS OF SHEETS	REV SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS TOLERANCES ARE:	CAGE CODE CONTRACT NO.		DEPARTMENT OF THE NAVY NAVAL SEA SYSTEMS COMMAND WASHINGTON, D.C. 20362-5101 FUSION SPLICE, FIBER OPTIC, MIL-PRF-24623/6, MIL-PRF-24728/8, SPECIFIC METHOD PERTAINING TO FABRICATION. INSTALLATION					
	APPROVED	R. THROM 10/30/07						
	ENGINEER	C. GOOD 10/30/07						
	CHECKED	A. COX 10/30/07						
FRACTIONS +/- ANGLES P DO NOT SCALE DRAWING	DECIMALS .xx+/- .xxx+/-	PREPARED	M. BROWN 10/30/07	SIZE	CAGE	ESWBS	DRAWING NO.	REV
MATERIAL:	ACCEPTED FOR NAVSEA	R. THROM 10/30/07	SIGNATURE DOES NOT DENOTE APPROVAL	A	53711	408	8346971	-
FINISHES:	APPROVED BY NAVSEA	(SIGN ONLY IF ENGINEERING HAS BEEN PROVED BY MANUFACTURE AND TEST)	SCALE: NONE	UCI	WT GRP	SHEET 1 of 18		

REV -
SHT 2
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FUSION SPLICE INSTALLATION METHOD FOR NAVAL SHIPS

1. SCOPE.

1.1 Scope. This method describes the procedure for the forming, shaping and fusion splicing of two optical fibers with a fusion splicer approved to Commercial Item Description (CID) A-A-59799. The resultant splice shall adhere to MIL-PRF-24623/6 splices, with 250, 500 or 900 micron protective jacket (buffered fiber), within a Fiber Optic Interconnection Box (FOICB), splice tray holder module and a splice tray.

2. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in Table 2K1-I shall be used to perform this procedure.

Table 2K1-I. Fusion Splice Equipment and Materials

Description	Quantity
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Alcohol bottle with alcohol/2-propanol	1
OFCC strip tool (NAVSEA DWG 6872811-10 or equal)	1
Kevlar shears (NAVSEA DWG 6872811-16 or equal)	1
Cable Jacket Stripping Tool (NAVSEA DWG 6872813-8 or equal)	1
Safety glasses	1
Ruler	1
Buffer strip tool (NAVSEA DWG 6872811-9 or equal)	1
Heat gun (Raychem 500B or equal)	1
1.25 inch or 0.75 inch Fiberglass Cloth Tape (MIL-I-19166C)	As required
4 inch long self-clinching straps (SAE AS 23190 or equal)	As required
12 inch strand of 900 micron fiber	As required
Fusion Splice Protectors	As required
Fusion Splicing Kit including High Precession Cleaver (per CID A-A-59799)	1

CAUTION: Throughout the fabrication process, cleanliness is critical to obtaining a high quality optical connection. Make sure that your hands and the work area are as clean as possible to minimize the ingress of dirt into the splices.

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3. Splice and Splice Tray Preparation Procedure.

3.1 Safety summary. The following safety precautions shall be observed:

- a. Safety glasses shall be worn at all times when handling bare fibers.
- b. Do not touch the ends of bare fiber. Wash hands thoroughly after handling bare fibers.
- c. When visually inspecting an optical fiber, never stare into the end of a fiber connected to a laser source or LED.
- d. Observe warnings and cautions on equipment and materials.

3.2 Cable entry and preparation

Step 1 - Verify that the procedures of Method 2A1, Method 2B1, Method 2G1 or Method 2H1 of MIL-STD-2042 and the fiber blowing process (if required) have been completed.

Step 2a - When installing BOF individual fibers or BOF fiber bundles; Install a furcation unit using Method 2F1 of MIL-STD 2042. Route the furcation legs within the FOICB in accordance with Method 2C1 of MIL-STD-2042.

Step 2b - When installing M85045 conventional cable refer to Method 2C1 of MIL-STD 2042 for routing, forming and shaping within the FOICB.

3.3 Shaping and forming in the splice tray

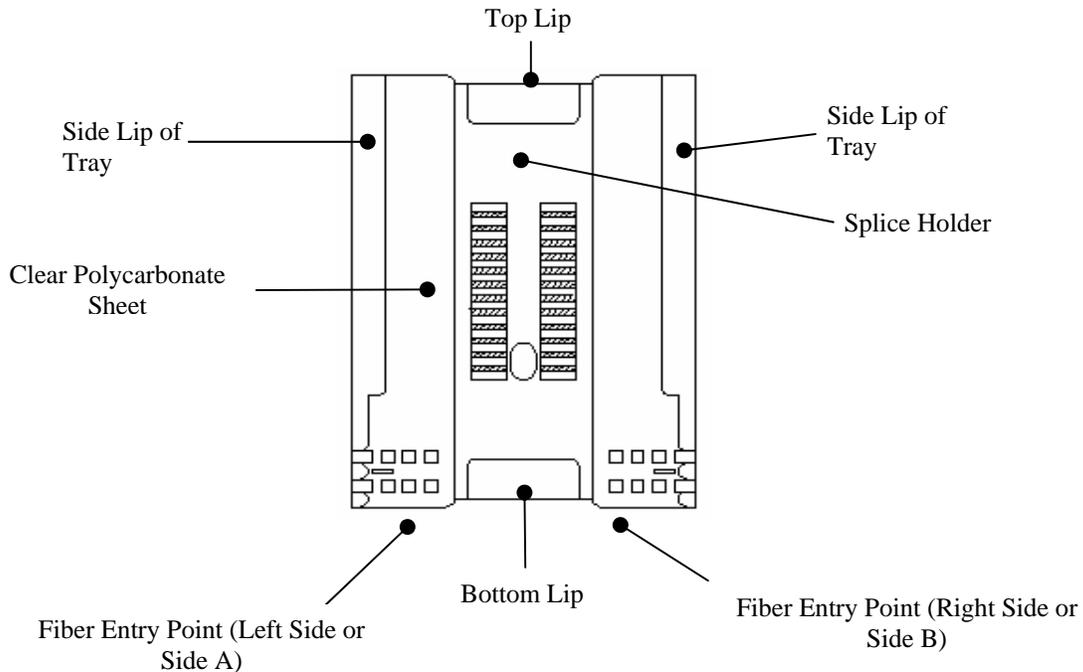


Figure 1 - Diagram of Splice Tray

Step 1 - Bring the OFCC and/or furcation legs (from here forth OFCC) to the splice tray where the optical fibers will be spliced. Place a mark on the OFCC where the fiber enters the splice tray. Place a second mark on the OFCC at the retention slot in the splice tray farthest away from the entry point.

NOTE: Ensure 25 inches of fiber extend past the splice tray entry point.

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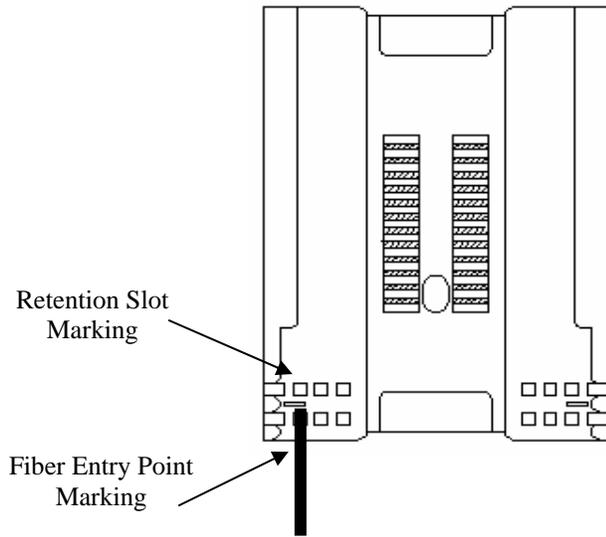


Figure 2 – OFCC Initial Marking

Step 2 – Install OFCC fiber identification markers on the OFCCs entering and exiting the splice tray (See Figure 3 below).

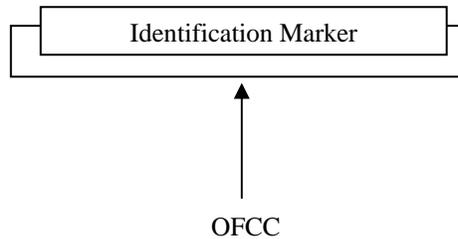


Figure 3 – Installing ID Marker

Step 3 – There are two sets of fibers to be spliced, set “A” (Input) and set “B” (Output). Set “A” fibers are fusion spliced to set “B” fibers. From the retention slot mark (from Step 1) on the OFCC measure out 6 inches on set “A” and mark that point. From the retention slot mark (from Step 1) on the OFCC measure out 25 inches and mark that point. Cut off any remaining fiber past the 25 inch mark (See Figure 4 below). Remove the OFCC jacket and Kevlar past the 6 inch mark. Then remove the remaining OFCC jacket past the retention slot mark leaving six inches of Kevlar in place. Repeat this process for all remaining fibers in both sets “A” and “B” (See Figure 5 below).

NOTE: For 2mm OFCC jacket, the optimum way to remove the OFCC jacket is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

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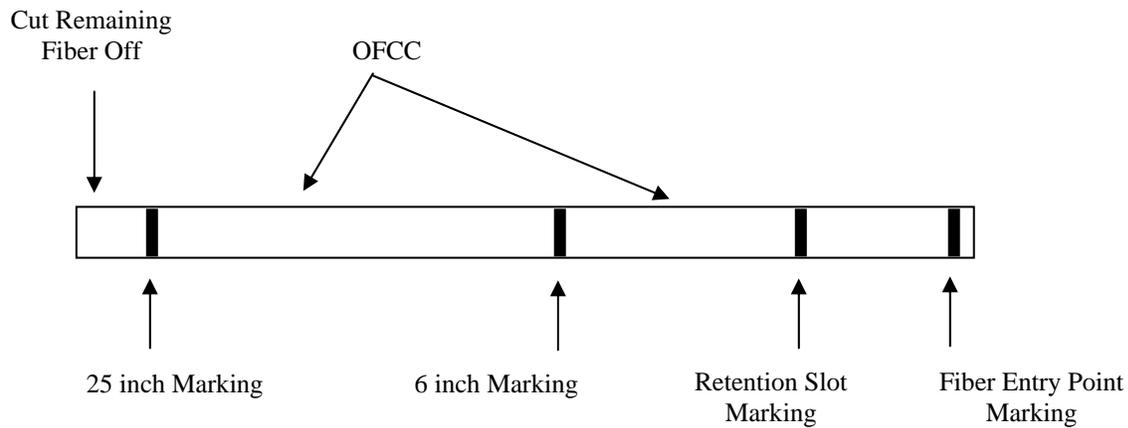


Figure 4 – OFCC Final Marking

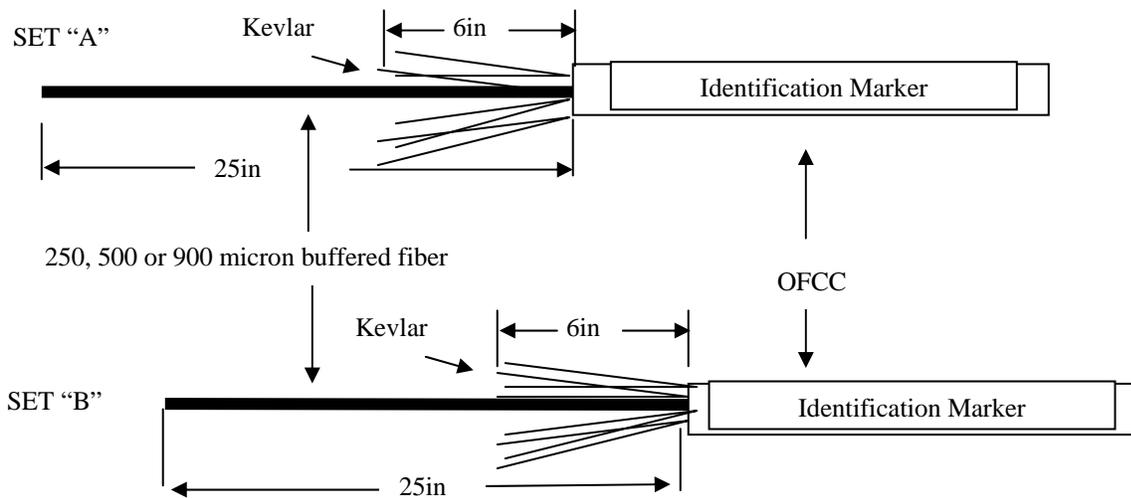


Figure 5 – Diagram of 25in Strip Length with Kevlar

Step 4 – Fiber sets “A” (Input) and “B” (Output) (250, 500 or 900 micron buffered fibers) shall enter the splice tray at opposite corners of the same end of the splice tray. Set “A” should enter on the left side of the tray and set “B” should enter on the right side of the tray. Approximately 0.75 inch of the 2mm OFCC shall enter the tray at each corner.

Step 5 – Install fiber identification markers on the buffered fiber (See Figure 6 below).

NOTE: Do not shrink the identification markers on the buffered fiber.

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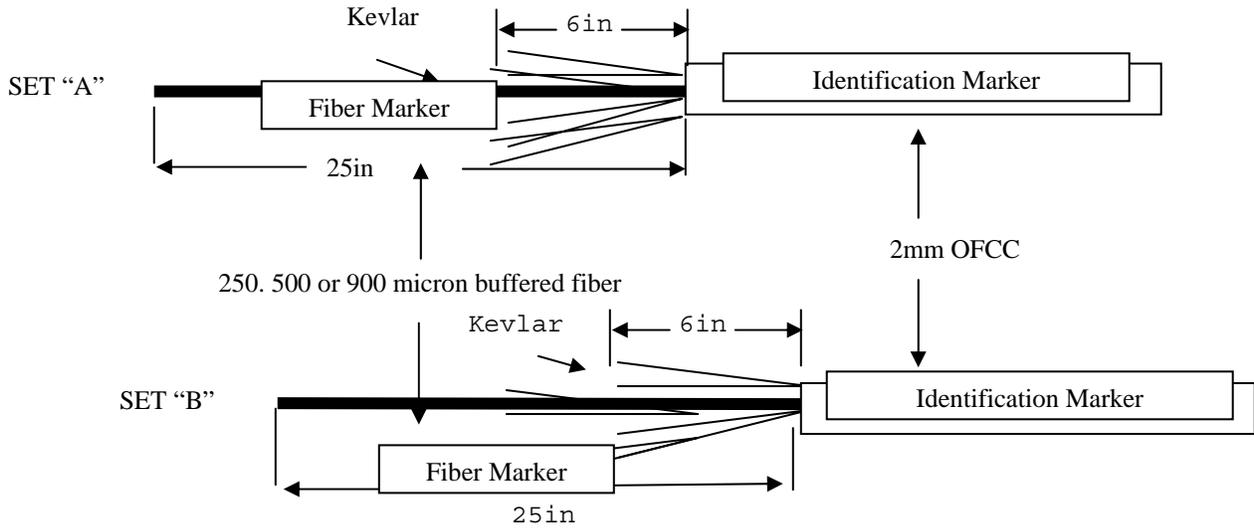


Figure 6 – Fiber Identification Markers

NOTE: Ensure that the OFCC identification marker placed on the OFCCs during Step 2 match the fiber identification marker installed on the buffered fiber.

Step 6 – Separate the Kevlar from the buffered fiber ensuring it does not cross another fiber strand. Gather the Kevlar of the first OFCC group for set “A” and wrap the bundled Kevlar around the outer most retention slot (See Figure 7 below).

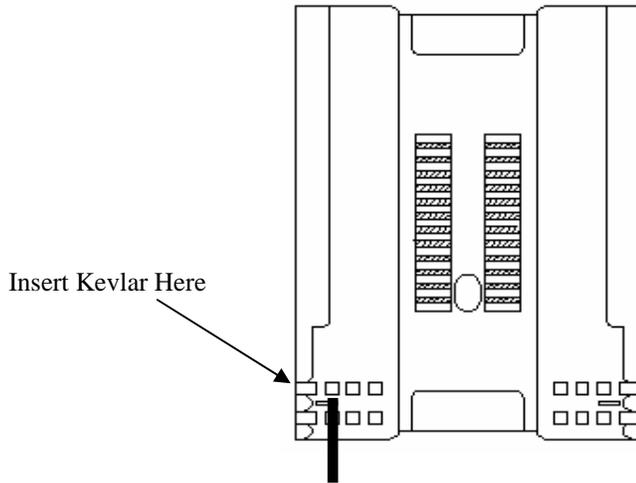


Figure 7 – Inserting Kevlar

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Step 7 - Insert a tie wrap into the first set of retentions slot closest to the entry point of the splice tray (See Figure 8 below). Cinch the tie wrap down around the OFCC group and Kevlar until snug and cut off the excess tie wrap.

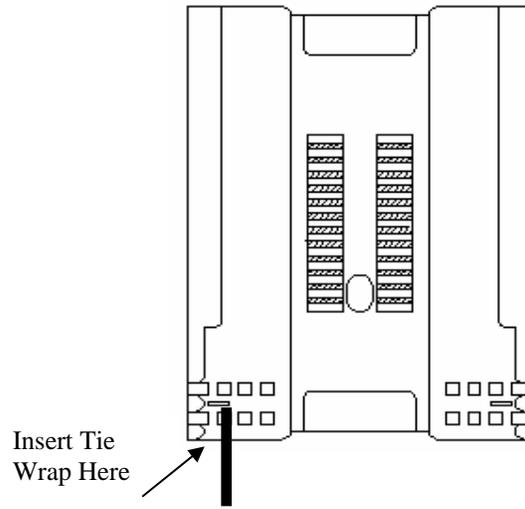


Figure 8 – Tie Wrap Installation

NOTE: Ensure that the permanent tie wraps are installed with the buckle on the back/outside of the splice tray.

NOTE: Do not cut Kevlar. Remaining length will be used in steps to follow.

Caution: Great care should be taken to ensure fibers are not damaged when installing tie wraps. Excessive cinching may cause high loss or broken fibers.

NOTE: No more than four fibers shall be grouped together when using tie wraps to hold the fibers to the splice tray.

NOTE: When grouping fibers together, fiber set “A” (Input) and fiber set “B” (Output) shall be grouped from outside-to-inside on the appropriate side of the splice tray. For the left side (Set “A”), the order of the grouped fibers shall be splices 1-4 at the most left position, splices 5-8 at the center position, and splices 9-12 at the most right position. For the right side (Set “B”), the order of the grouped fibers shall be splices 1-4 at the most right position, splices 5-8 at the center position and splices 9-12 at the most left position.

Step 8 - Gather the Kevlar bundle and twist the strands together. Pull the twisted group forward toward the end of the splice tray opposite from the fiber entry point.

Step 9 - Tape down the Kevlar to the back/outside of the splice tray with fiberglass cloth tape (See Figure 9 below).

NOTE: Clean back/outside of the splice tray with alcohol before applying tape.

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A	53711	408	8346971	-
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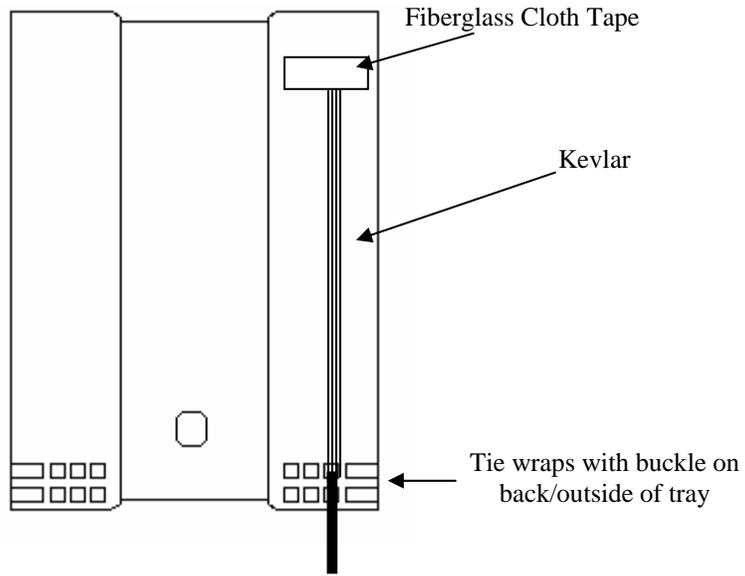


Figure 9 - Taping Down Kevlar

Step 10 – Loop the 12 inch piece of 900 micron fiber and insert it through the front-left retention slot in the splice tray farthest away from the entry point (See Figure 10 below).

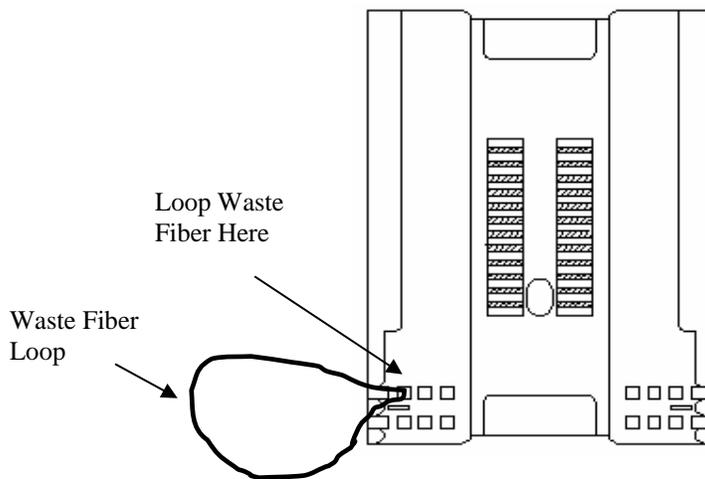


Figure 10 - Fiber Waste Loop

Step 11 - Gather the Kevlar of the second OFCC group for set “A” and insert the bundled Kevlar through the loop using the left retention slot (See Figure 11 below).

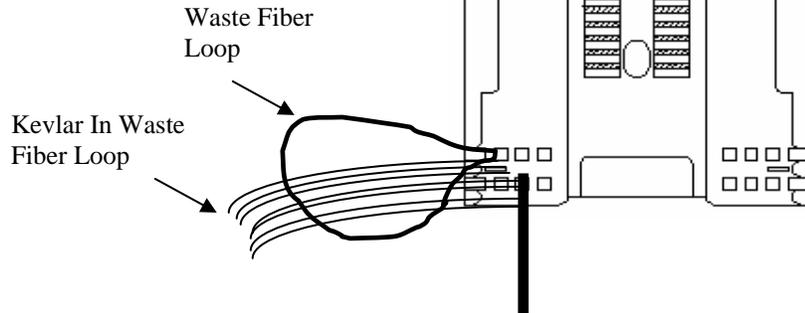


Figure 11 – Gathering Kevlar

Step 12 - Pull the 900 micron waste section and the bundle of Kevlar through the splice tray retention slot. Pull Kevlar back to the OFCC group and first set of retentions slot closest to the splice tray entry point.

Step 13 - Insert a tie wrap into the first set of retentions slot closest to the entry point of the splice tray (See Figure 12 below). Cinch the tie wrap down around the OFCC group and Kevlar until snug and cut off the excess tie wrap.

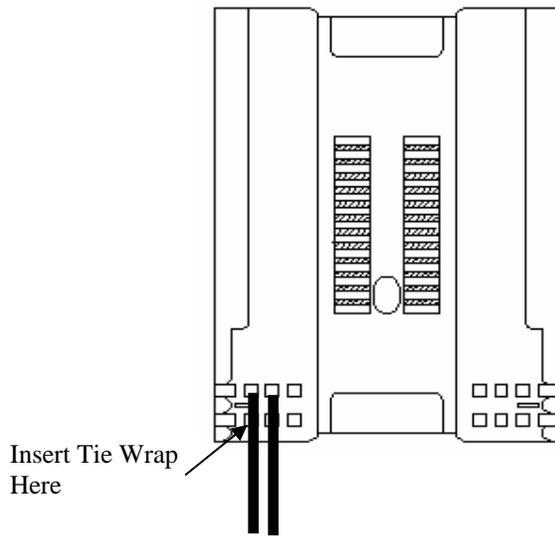


Figure 12 – Tie Wrap Installation

Step 14 - Gather the Kevlar bundle and twist the strands together. Pull the twisted group forward toward the end of the splice tray opposite from the fiber entry point.

Step 15 – Insert twisted Kevlar under tape used for set “A” group 1 fibers (See Figure 13 below).

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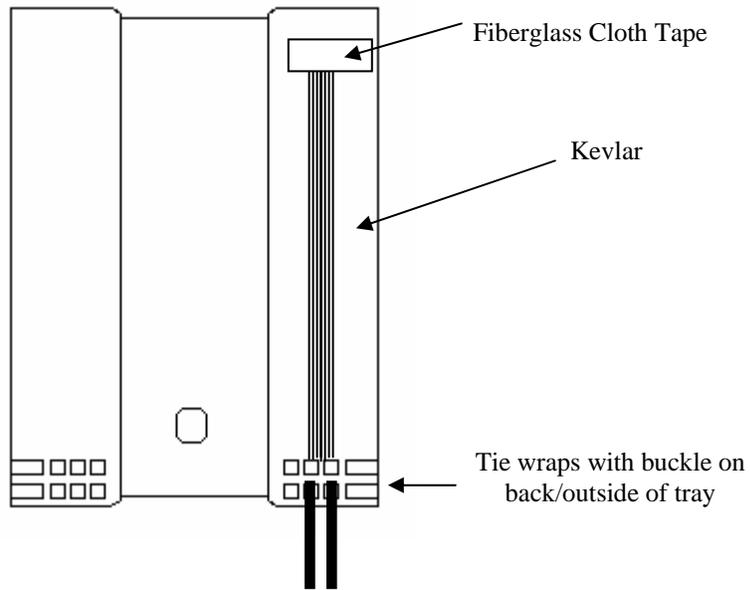


Figure 13 – Kevlar Positioning on Back of Splice Tray

Step 16 - Gather the Kevlar of the third OFCC group for set “A” and insert the bundled Kevlar through the loop of 900 micron waste using the center retention slot.

Step 17 - Pull the 900 micron waste section and the bundle of Kevlar through the splice tray retention slot. Pull Kevlar back to the OFCC group and first set of retention slot closest to the splice tray entry point.

Step 18 - Insert a tie wrap into the first set of retentions slot closest to the entry point of the splice tray. Cinch the tie wrap down around the OFCC group and Kevlar until snug and cut off the excess tie wrap.

Step 19 - Gather the Kevlar bundle and twist the strands together. Pull the twisted group forward toward the end of the splice tray opposite from the fiber entry point.

Step 20 – Insert twisted Kevlar under tape used for set “A” group 1 fibers.

Step 21 - Once all the groups of Kevlar for set “A” have been taped down in place, cover the exposed Kevlar with a one and quarter inch wide section of Fiberglass Cloth tape to secure all the Kevlar strands to the back/outside of the splice tray (See Figure 14 below for completed set “A” fibers).

NOTE: Alternate tape width of 0.75 inch fiberglass cloth tape may be used (two pieces overlapped).

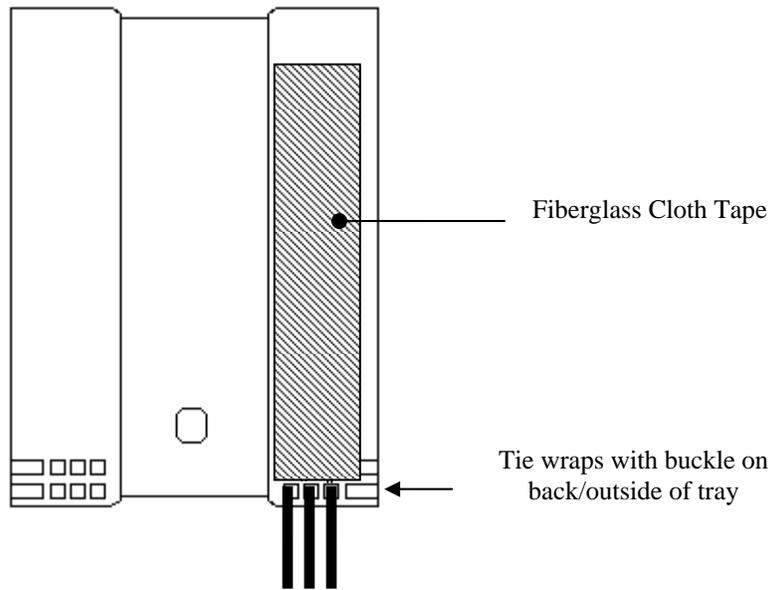


Figure 14- Taping Kevlar Down on Back of Splice Tray

Caution: Ensure that the fiberglass cloth tape does not extend onto the raised center section of the splice tray and that the tape is flush against the tie wrap(s). This will prevent the Kevlar and tape from snagging on the splice tray holder module slot.

NOTE: Ensure that the permanent tie wraps have the buckle on the back/outside of the splice tray.

Step 22 – Repeat steps 6-21 for set “B” fibers.

Step 23 – Perform fusion splice in accordance with procedure 3.4.

Step 24 - Gently grasp and lift splice(s) at splice protection sleeve.

Step 25 – Rotate splices 180 degrees causing fibers to cross and create a figure eight pattern (See Figure 15 below).

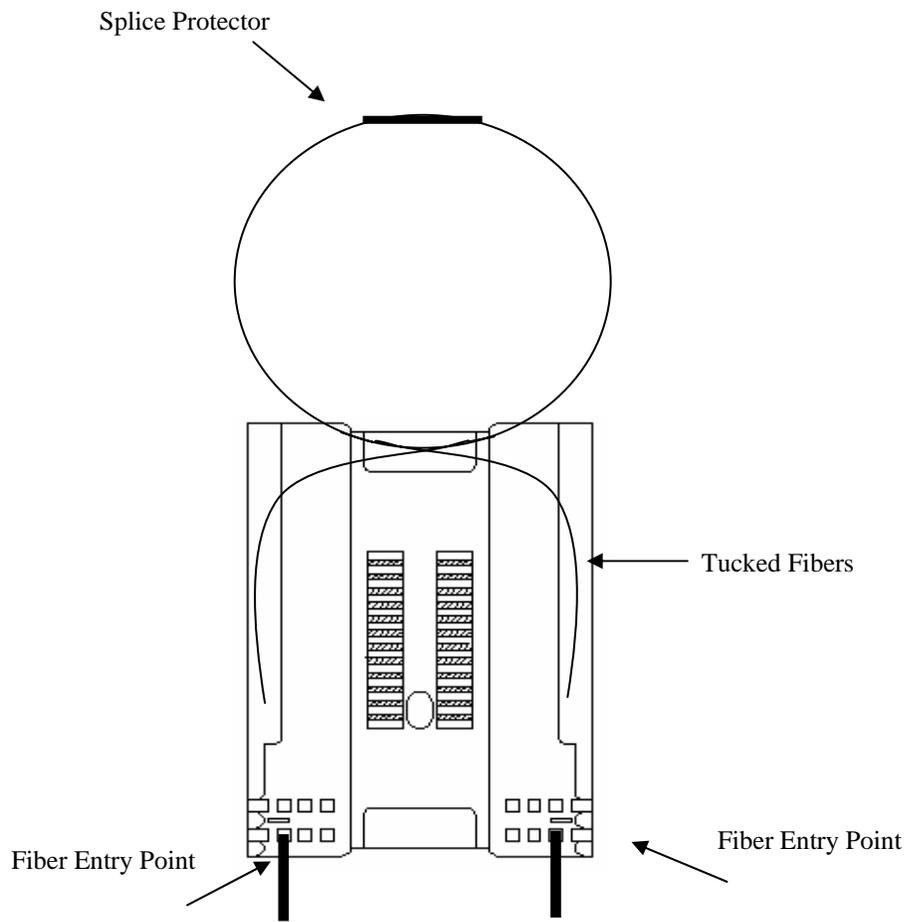


Figure 15 – Figure Eight Pattern

Step 26 - Tuck fibers under side lips of tray.

Step 27 - Gently grasp and flip splice(s) toward the fiber entry point of the tray (See Figure 16 below).

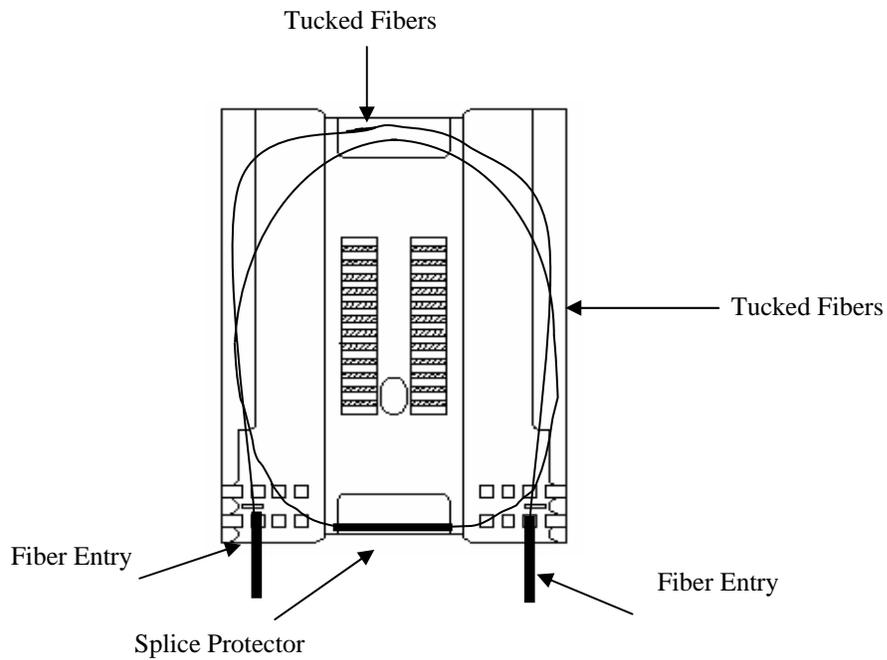


Figure 16 – Fiber Tucking

Step 28 - Tuck fibers under top lip of tray and ensure fibers stay tucked underneath side lips of tray.

Step 29 – Rotate splices 180 degrees causing fibers to cross and create a figure eight pattern.

Step 30 - Place splice(s) in designated splice holder location.

Step 31 - Tuck all remaining fibers under lips of the splice tray (See Figure 17 below).

CAUTION: Great care shall be taken when performing the figure eight method. Fiber can become pinched or exceed designated bend diameter when performing this method.

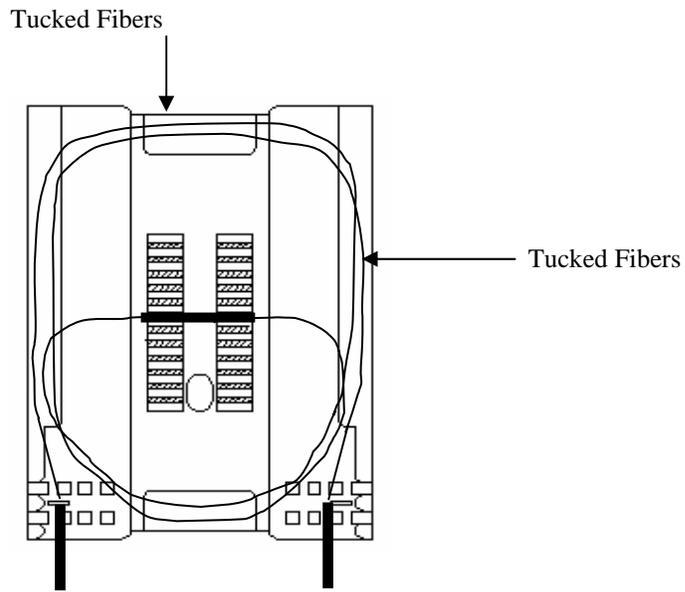


Figure 17 – Splice Installation

3.4 Fusion Splice Procedure.

Step 1 – Turn splicer on.

NOTE: To mitigate dirt ingress, keep cover of splicer closed whenever not loading/unloading fibers or removing completed splices.

Step 2 – Check and/or select the splicing program and parameters that are needed to splice the fibers being used. (See operational manual for fusion splicer being used)

NOTE: This step may be splicer manufacturer specific. Refer to operations manual for exact operation and setup.

NOTE: If additional visual inspection of splice during splicing process is desired, see manufactures operational manual in order to activate ARC pause features.

Step 3 – Perform an arc test using same cable type to be spliced.

NOTE: Arc Check/Calibration/Test should be performed each day prior to initial use of the machine, and when high splice losses are observed or when moving fusion splicer location. Consult operational manual of fusion splicer being used for additional guidance. Arc power, arc duration and arc center are adjusted based on environmental conditions, type of fiber being spliced and electrode wear.

NOTE: Arc test may be performed using approximately one foot of the same fiber type as being spliced. Typically a piece of fiber waste trimmed from a section to be spliced is used. Follow same fiber preparation as identified in steps 3 through 5 of section 3.4.1. Perform Arc Test instead of complete fusing.

3.4.1 Cable and Fiber Preparation

Step 1 - Choose a fiber out of Set “A” to be spliced.

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Step 2 – Slip the heat shrink splice protector over the fiber(s) (250, 500 or 900 micron buffered fiber). (See Figure 18)

NOTE: Splice protector can be placed on either set “A” or set “B”.

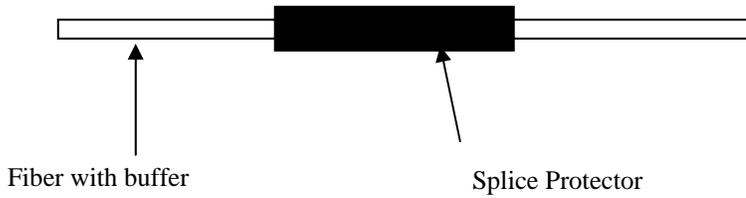


Figure 18 – Splice Protector Installation

WARNING: Wear safety glasses when removing the fiber buffer and coating to avoid possible eye injury.

Step 3 – Strip (remove) approximately 30mm (1.2 in) of the buffer from the end of the fiber using the buffer strip tool. Remove the buffer and coating in small sections approximately 0.25 inch at a time. Strip the fiber down to the bare glass (See Figure 19 below).

CAUTION: The uncoated fiber is in its most vulnerable state. Extreme care shall be taken to not damage the fiber.

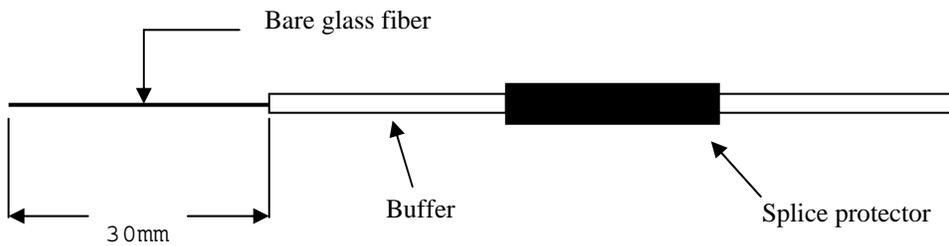


Figure 19 – Fiber Stripping

Step 4 - Clean the bare fiber with a lint-free gauze pad moistened with pure alcohol and wipe 1-2 times to remove any coating residue.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

Step 5 - Use the precision cleaving tool provided with the fusion splicer to cleave the fiber. Maximum cleave length is 12.0 mm. For recommended cleaving procedures see the manufacturer’s operation manual for details.

NOTE: Do not let the end face of the bare fiber come into contact with any surface.

NOTE: Do not clean/touch the bare fiber after it has been cleaved.

Step 6 - Repeat steps 2 thru 5 with set “B” fibers of same splice.

3.4.2 Fusion Splicing

Step 1- Insert both optical fibers (Set “A” and Set “B”) into the splicer in accordance with the insertion procedure of the splicer (see operational manual).

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NOTE: Ensure that during the insertion process the endface of the fiber does not contact any surfaces. Avoid plowing or pushing the fiber endface through the v-groove of the splicer.

NOTE: If additional visual inspection of splice during splicing process is desired, see manufactures operational manual in order to activate ARC pause features.

Step 2 – Following specific manufacturer’s splice procedure, splice the two fibers together.

NOTE: If the fibers fail inspection for cleave criteria (Maximum 12.0 mm), repeat section 3.4.1 steps 3-5 of the preparation process.

Step 3 – Before removing splice from fusion splicer, inspect the completed splice to ensure there are no physical flaws as seen on the LCD screen that will be a detriment to the performance of the splice.

NOTE: Ensure that the estimated loss from the LCD screen of the splicer is less than 0.03 dB. Note that the final criteria (insertion loss) over a fusion spliced fiber is 0.2 dB.

Step 4 – After the splice has been successfully completed, perform tension test in accordance with fusion splicer operation manual.

NOTE: Tension test is performed by the splicer unit.

Step 5 – Slide the heat shrink splice protector close to the splice area and in accordance with the fusion splicer operations manual, remove the splice from the fusion splicer ensuring not to damage the exposed glass.

NOTE: Maintain slight tension on the splice to ensure the spliced region is not bent or bowed.

Step 6 - Slide the heat shrink splice protector over the spliced region and center. Insert it in the heater attached to the splicer. Activate the heater assembly and shrink the sleeve down (see operational manual of heater).

NOTE: Ensure splice protector is properly centered on the splice region by utilizing splice protector gauge on splicer unit (see splicer operational manual for this feature).

Step 7 – Visually inspect the splice protector after the shrinking process is complete to ensure there are no bubbles or other detrimental defects.

NOTE: Additional fibers can be spliced before placing in the splice tray.

Step 8 – Place completed splices in the splice tray in accordance with section 3.3, steps 24 thru 31.

NOTE: Allow splice protector to cool before inserting splice into splice holder. Splice protectors may be damaged or deformed if inserted into the splice holder while still hot.

Step 9 – Repeat steps 1 thru 8 for each additional fiber pair (Set “A” and Set “B”) to be spliced.

Step 10: Ensure that polycarbonate sheet is installed (if supplied by splice tray manufacturer) over splices and tucked under side edges to hold splices in place when cover is removed. Replace splice tray cover and place splice tray into the proper slot in the splice tray holder module.

NOTE: Polycarbonate sheet is only required if supplied by splice tray manufacturer.

NOTE: See Figure 20 for an example of the finished product.

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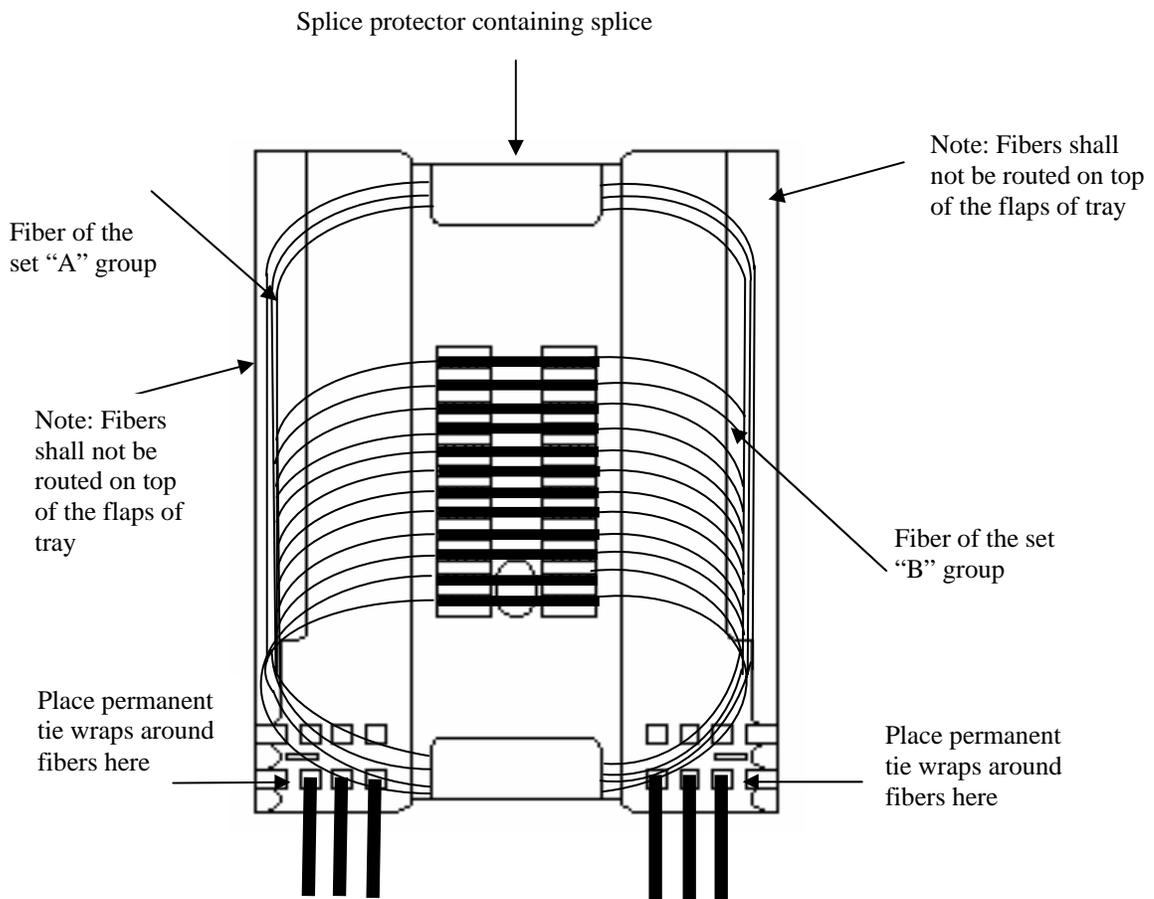


Figure 20 – Finished Product

CAUTION: Do not exceed the minimum bend diameter of 32mm (1.25 in).

NOTE: Splice holders are numbered one (1) through twelve (12). Splice holder number one (1) is located opposite side of fiber entry into the splice tray. Conversely, splice holder number twelve (12) is located same side as fiber entry to the splice tray.

3.5 Splice Tray Labeling

An optional label for the splices contained within the splice tray can be installed on the outside of the splice tray cover as depicted in Figure 21 below.

Ensure that the splices within the splice tray and label on the outside of the splice tray cover have corresponding identification numbers.

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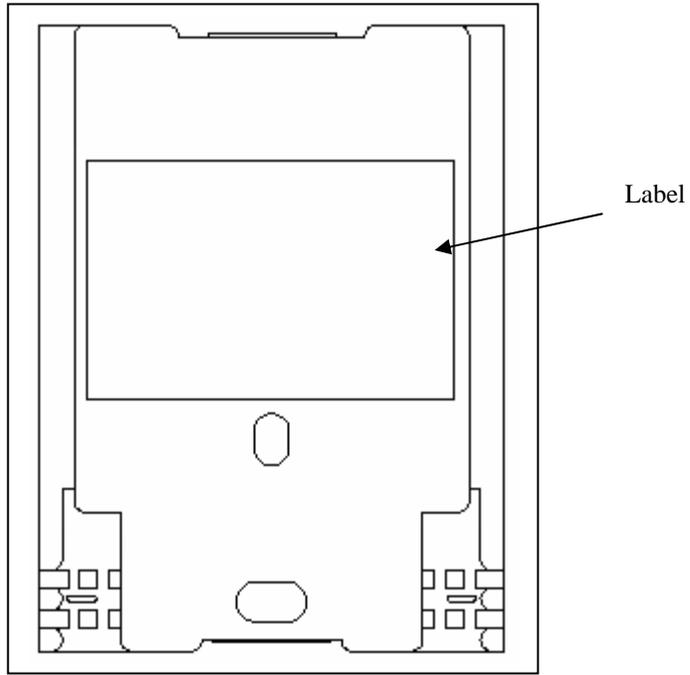


Figure 21 – Example of Labeling