Fiber Optic Testing Standards

Introduction

The Contractor tasked to perform testing or splicing on any fiber optic cable will follow these testing standards to fulfill their contractual obligations. The Contractor must utilize the correct equipment and testing techniques to gain acceptance, or the work cannot be approved. This testing document lists the equipment and techniques necessary to meet those installation obligations. Any questions or issues regarding this testing standard should be addressed to UTOPIA Fiber.

Test Equipment

The Optical Time Domain Reflectometer (OTDR) will be used to test splice loss and to conduct span analysis.

An Optical Power Meter and Laser Light Source will be used to measure power loss on each completed ring or distribution span to verify continuity between fibers (no fibers incorrectly spliced together). No specific vendor is required for the Power Meter and Laser Light Source, but it must be able to operate at both 1310nm and 1550nm wavelengths. Both units must have a dynamic range suitable for long-haul applications (spans greater than 120 km) and short distance testing. The contractor must calibrate their power meters before testing a span and provide the unit's calibrated reference for that span. (Power Meter calibration is performed by using a Laser Light Source connected to the Power Meter and recording the measured light level on the Power Meter).

When conducting pigtail tests, a 1-km launch reel (sometimes referred to as a load coil) will be used in conjunction with the OTDR. This provides the tester with the ability to accurately measure the connector loss, connector back reflectance and the adjacent splice loss on a short span (15-30 meters from terminating distribution panel). Pigtail tests taken with long patch cords, or any other "adaptation", will not be accepted.

Testing Requirements and Splice Loss Thresholds

Index of Refraction and Backscatter Coefficient

When conducting pigtail or end to end span tests, the Contractor must use the proper index of refraction according to the type of fiber being tested. Use the following chart as a reference:

Fiber Type	1310nm	1550nm
AFL	1.4659	1.4666
Corning SMF-28	1.4675	1.4681
Corning LS	1.4710	1.4700
CommScope	1.4738	1.4732
Sterlite	1.4700	1.4690

The following backscatter coefficient settings must be selected based on the type of fiber. When conducting *pigtail* tests with SMF-28 patch cords, the backscatter coefficient will be **–83**. When conducting *end to end* span tests over Corning LEAF, the backscatter coefficient will be **–80**. Any variance in these settings will result in an incorrect reflectance measurement. Contact UTOPIA for correct backscatter coefficients of other fiber types when applicable.

Initial Splice Testing

These initial splices are to be tested uni-directionally with an OTDR at 1550nm. If the measured loss of a splice is greater than a **0.30 dB** the contractor must break the splice, then re-splice the fiber/s until the measured loss is a 0.30 dB or less. If the contractor cannot achieve a measured loss of 0.30 dB or less after three attempts, then the maximum measured loss should not exceed **0.35 dB**. If, after two additional re-splicing attempts a measured loss of a 0.30 dB can not be achieved, the splice will be marked out of specification (OOS) by the inspector. Once a .30 dB loss has been achieved (or .30 dB with inspector approval), the contractor may continue onto the next obligation *once signed by an authorized UTOPIA staff member or pre-appointed designee*. If more than 10% of the fibers are not within specification, the fiber will be cut back 10 feet and re-spliced. While not a requirement for initial field splicing, Contractors should verify reflectance measurements are also within specification. A fiber splice report will be submitted to UTOPIA upon completion of the span and the associated end to end and power meter tests.

Pigtail Testing

As stated above, pigtail tests must utilize a 1km-launch reel. Refer to the listed backscatter coefficient for the proper setting for this test. The following testing standard must be adhered to when conducting pigtail tests.

Range: 4km
Resolution: 1 meter
Pulse Width: 50 ns
Averaging: Medium
Wavelength: 1550nm

A uni-directional test will be conducted on all pigtail splices with no greater than a **.8 dB** loss accepted. Any loss higher than a .8 dB after 5 repeated attempts results in the replacement and re-splicing of that pigtail. A reflectance measurement of no less than –50 dB (-55, -60…etc…) is required for acceptance. Any deviation from this standard cannot be accepted. Measurements for pigtail splice loss and reflectance will be taken using the OTDR's "two-point loss" measurement tool. Any deviation or issue regarding pigtail testing will need to be addressed by an authorized UTOPIA staff member or pre-appointed designee.

End to End Span Testing

Once a complete span between facilities has been completed and installed, the Contractor will perform end to end testing of each fiber. If the span is 64 km (40 miles) or less in optical distance, it will be tested at both wavelengths (1550 and 1310). *If the span is greater than 64-km 1310nm testing will not be conducted*. End to end tests are accepted on a per-span basis and are bi-directional, meaning each span will be tested and averaged from both ends.

All traces must be saved on a disc and presented to UTOPIA for final acceptance. UTOPIA reserves the right to conduct independent acceptance tests. In the event discrepancies occur between tests performed by the Contractor and UTOPIA, the results from tests performed by UTOPIA will prevail and will be utilized for accepting or rejecting the work performed under the contract.

Power Meter Span Testing

Power meter testing will be conducted on all completed spans and interconnections. This allows proper system power configuration and management and verifies continuity (no "frogged" or transposed fibers). Power meter testing will be conducted at both wavelengths (if under 64 km) and only at 1550nm for spans greater than 64 km. Each power meter test must include the reference of the calibration as taken from a stable light source. The power

meter tests must also be submitted to UTOPIA upon span completion after inspection and acceptance by the UTOPIA inspector.

Ring Designation – Naming Convention:
It has been determined that in all the Footprint Cabinets on the Utopia Project the Ring Distribution Fibers will be designated as; Side A, and as Side B. The designations will be determined in the following manner. From an aerial view, traffic to each Footprint Cabinet will travel in either a Clockwise or Counter-Clockwise direction from the traffic origination point, (Hub or POP). The POP or Hub will be the determining factor in establishing the direction of the traffic. The Fibers that feed the cabinets from the Hub or POP in a Clockwise direction will be designated as Side A. The Fibers that feed the cabinets in a Counter-Clockwise direction from the Hub or POP, will be designated as Side B. These records will be reflected in the Allocation Sheets for each cabinet. This information will be applicable to turn-up and ongoing maintenance of the rings and cabinets.

Trace Naming Convention

As stated above, every bi-directional and pigtail trace must be saved on a compact disk and submitted to UTOPIA for final acceptance. The following standard will describe how to properly name each trace for ease and management and network standardization.

For this example, assume and OTDR reading is being taken from Dallas to Houston.

1. Look up the 4 letters for the site the OTDR is shooting from (Murray 05= MU05)
2. Look up the 4 letters for the site the OTDR is shooting to (West Valley 11 = WV11)
3. The next character indicates the cable number. For sites where there is only one cable, this will be the number **1.** If there are multiple cables, then the second cable will be number 2. Assume there is only one cable between Murray 05 and West Valley 11 and the filename is MU05WV111
4. The next character indicates the wavelength the trace is being tested at. If the trace is at 1310nm, this number will be a 3. If the trace is at 1550nm, this number will be a 5. Assume that the reading between Murray 05 and West Valley 11 is being tested at 1550 and the filename is now MU05WV115
5. The three-digit file extension is used to indicate the fiber number that the trace is being shot on. Fiber number 1 is noted at 001. Fiber 95 is noted as 095. Assume that the trace being tested between Murray 05 and West Valley 11 is on fiber 13 and the filename is now MU05WV1115.013.

For *pigtail* tests, a "p" is used in place of the wavelength reference, but all other letters remain the same. Assume that a pigtail test is being conducted from Murray 05 and West Valley 11 on fiber 13 (remember all pigtail tests are conducted at 1550nm) and the filename would be MU05WV111p.013.

Final Acceptance

Final acceptance is given for any span or interconnection once all spans have been tested bi-directionally with the OTDR and power meter, pigtail tests conducted on terminations, labels correctly placed and all paperwork submitted. Once UTOPIA has verified the splices are within specification as analyzed from the received trace data, and that all the necessary files are present, UTOPIA will announce acceptance for that particular span or interconnect. Any faults or splices found out of specification during this final analysis *must* be corrected and re-tested in order to gain final acceptance.

UTOPIA Fiber:

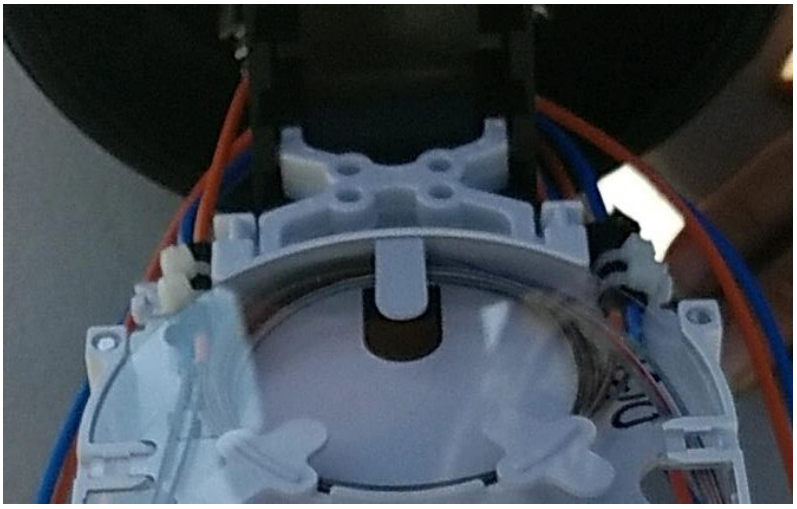
Cable Tags (reference photo below): Use two tags unless cable is a tail (if cable is a midsheath, it needs a cable tag on both sides of cable going in and out of case. If there is a tail(s) splicing to the midsheath, that cable will need its own tag as well). Tags will be labeled with the cable name and size, date of build, and CO (or Feed) or FLD (or

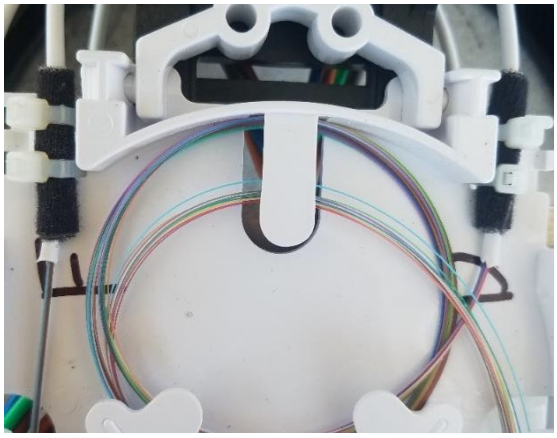
Distribution), depending on which it is.

Blue Tape: Must be blue or white tape on the CO (Feed) cable and for the rest it must be black tape.

GPS Camera: GPS stamp required on every picture (there are GPS camera apps to download onto phone).

Buffer Tube Management (reference photo below): Ensure your felt padding is secure to buffer tubes. Place your buffer tubes in the tray by placing them outside to inside according to the color code. Ensure both zip ties are fastened snug, but not too tight to





where it will cause pressure on buffer tubes.

Labeling: A label maker will be used for all important information in the tray such as Vault/Pole ID#, Cable name and size, and Hut (large) and Field (small) callout info (this label should go in the part of the tray itself that the feed side fiber gets coiled in). Use a sharpie for F and D (write on tray itself, close to where the tubes are landed), as well as for signing the case (write on tray lid itself).

Label Maker Specs: Font size is 14pt

First line: Vault/Pole ID#.

Second line: Cable ID and Size.

Third line: Hut (large) call out.

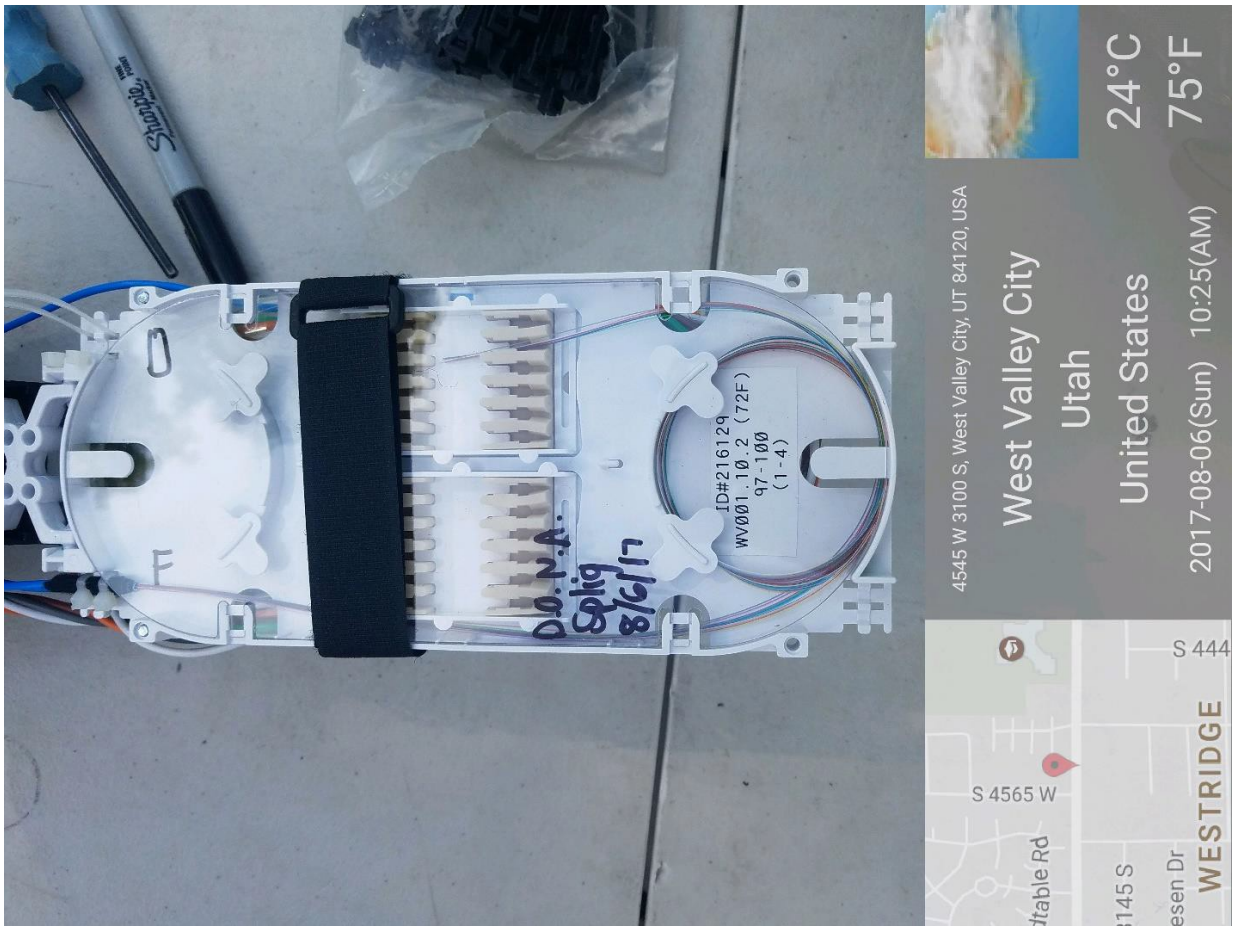
(Allocated hut fibers) Fourth

line: Field (small) call out.

(Allocated field fibers)

Landing/Routing Tubes and Fibers:

If the splice case is facing like the picture shows below, the Feed buffer tube(s) are landed at the bottom of the tray and the Distribution buffer tube(s) are landed at the top. Feed fibers will coil on the right of the tray and Distribution fibers will coil on the left. If splicing is to be done, route and coil the fiber as just explained, then after spliced, land the splice into the manifold in its correct position according to color code.



Test Specs:

- Unidirectional testing from hut/cabinet location to tail.
- -40 or lower reflectance at connector/bulkhead event (-39 and greater fails, -41 and lower passes).
- .850 (dB) max loss at connector/bulkhead event.
- .309 (dB) max loss at all field events.
- 1500' min launch reel.
- Naming fibers: Hut location (BF007); Cable (.1, .2); Fiber Number (001) (use an underscore to separate fiber number from hut/cable info). Example: BF007.1_001 and so on.
- Once all splicing and testing has been completed, VFL or 2K tone to all tail cables (VFL/tone blue and aqua fiber of every tube, or first and last fiber of fiber range that splices to that tail).

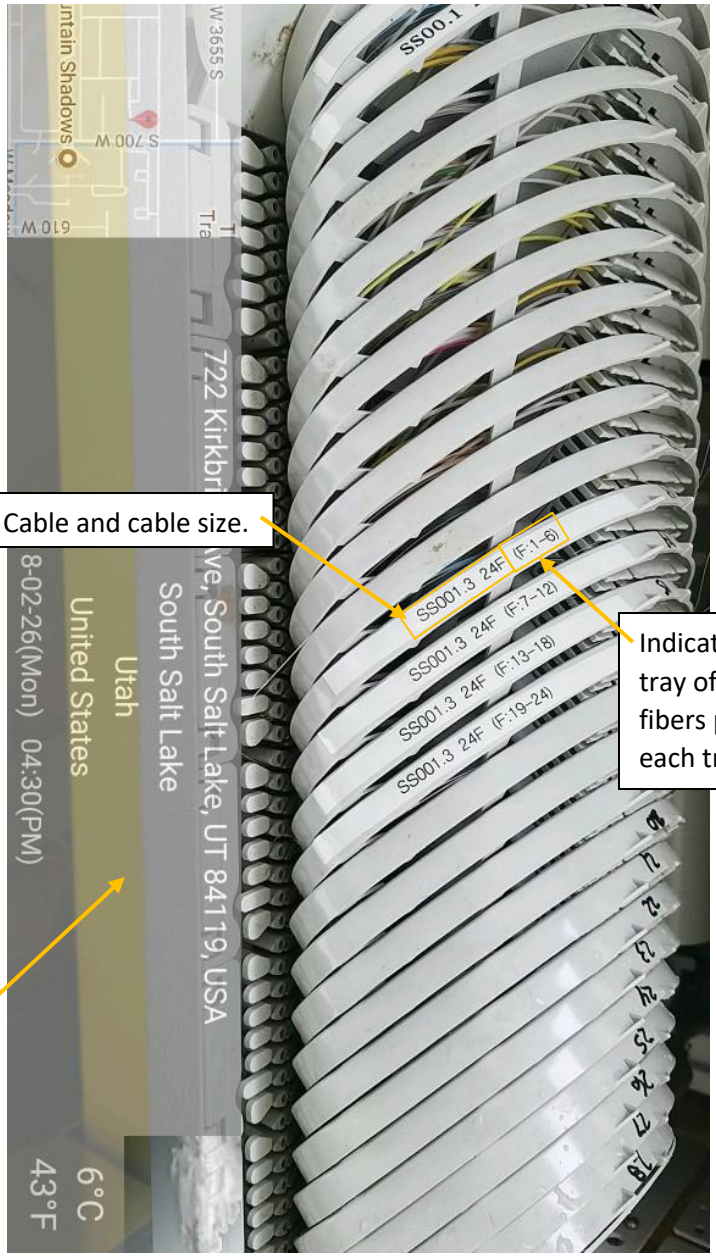
How to: Hut Cassettes

-Picture should not be blurry and everything labeled on cassettes should be visible and legible.

-Try to get only the cassettes from cable being turned in, in picture.

How to: Cabinet Trays

-Picture should not be blurry and everything labeled on trays should be visible and legible.



Cable and cable size.

Indicates the numbers of fibers in said tray off the cable being placed. Only 6 fibers per tray. Fibers only get landed in each tray, not spliced.

GPS stamp

Take picture like this.

Only turned sideways to see better.

How to: Customer Drop Cases

-Picture should not be blurry and everything labeled on case should be visible and legible.

Bottom of Case

FEED and DISTRIBUTION (F & D on tray, Feed on right and Distribution on left (from bottom of case))

Distribution coils at bottom of case.

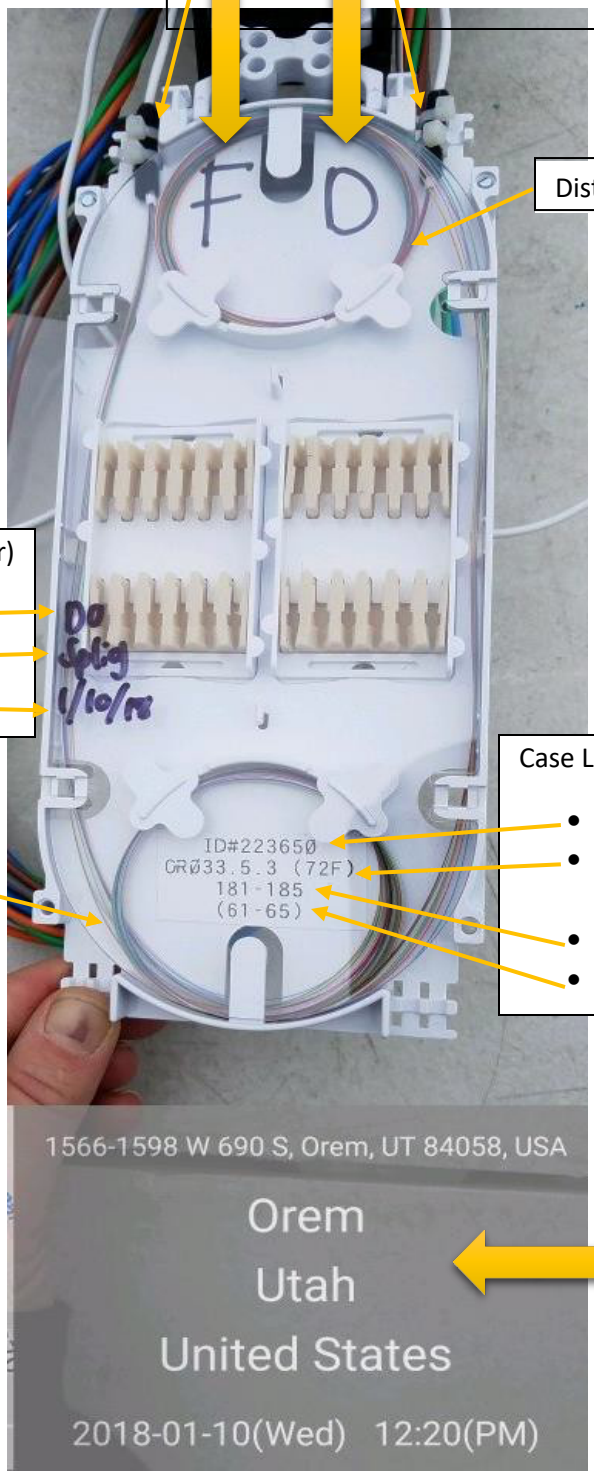
Signature (On tray lid, not in specific order)

- Name
- Company
- Date

Feed coils at top of case.

Case Label (On tray, in order)

- Vault/Pole ID Number
- Cable Tag Name and size of cable
- Large Callout
- Small Callout



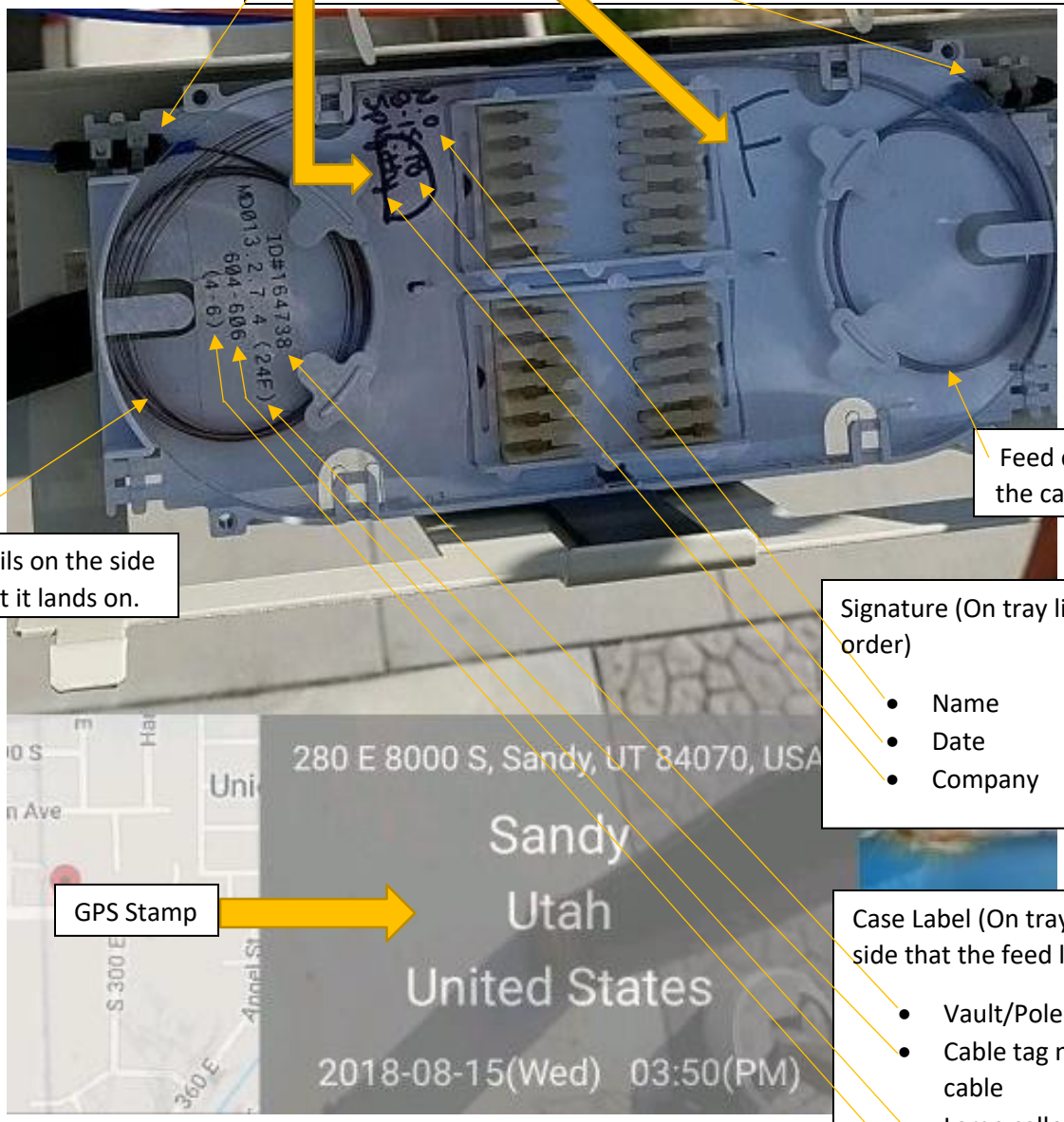
GPS Stamp

Top of Case

How to: Aerial Customer Drop Cases

- Picture should not be blurry and everything labeled on case should be visible and legible.

DISTRIBUTION and FEED (F and D on tray, the side they are on will depend on which direction the feed is coming from.)



Feed coils on the side of the case that it lands on.

Distribution coils on the side of the case that it lands on.

Signature (On tray lid, not in specific order)

- Name
- Date
- Company

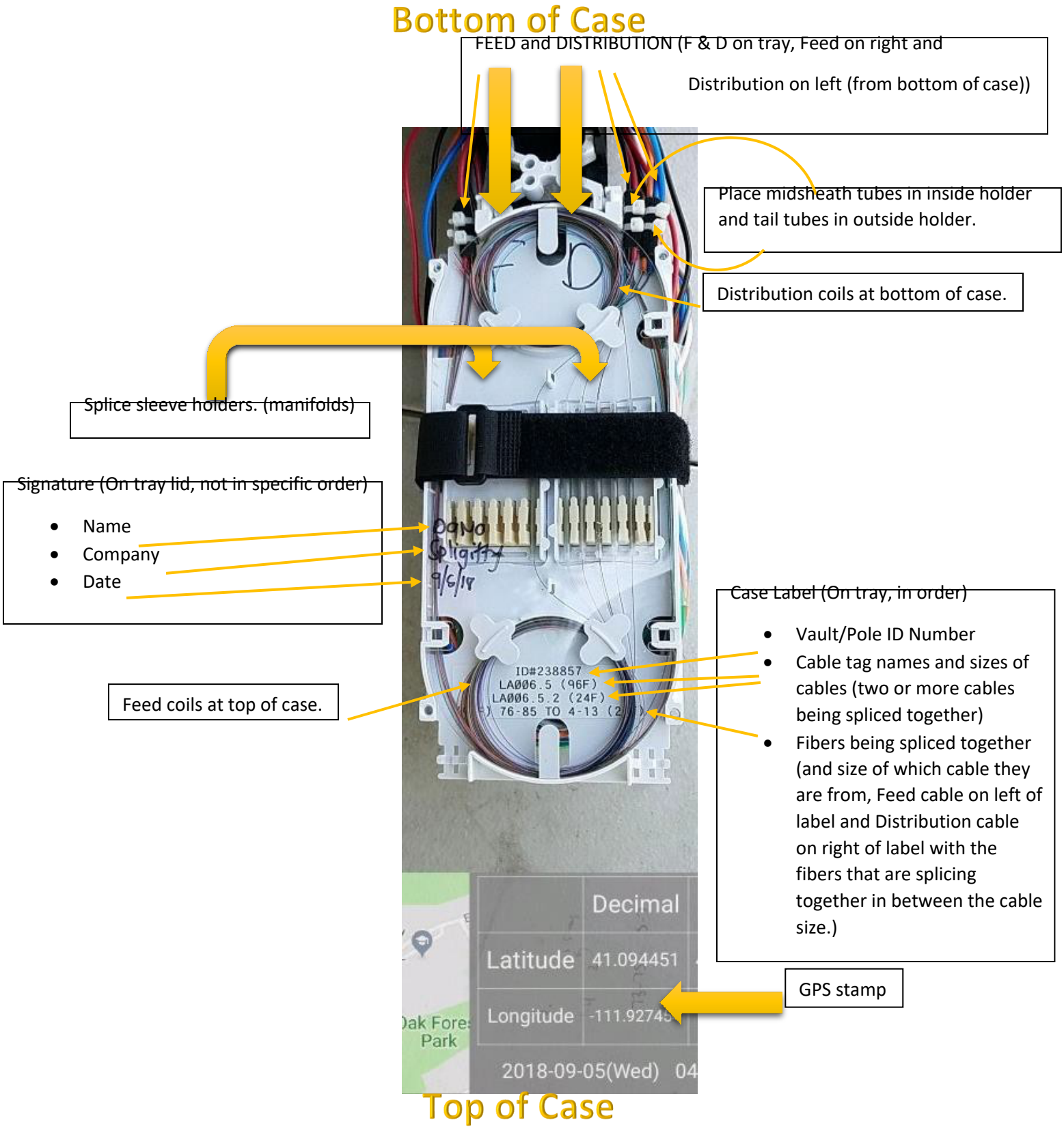
GPS Stamp

Case Label (On tray on the opposite side that the feed lands on, in order)

- Vault/Pole ID number
- Cable tag name and size of cable
- Large callout
- Small callout

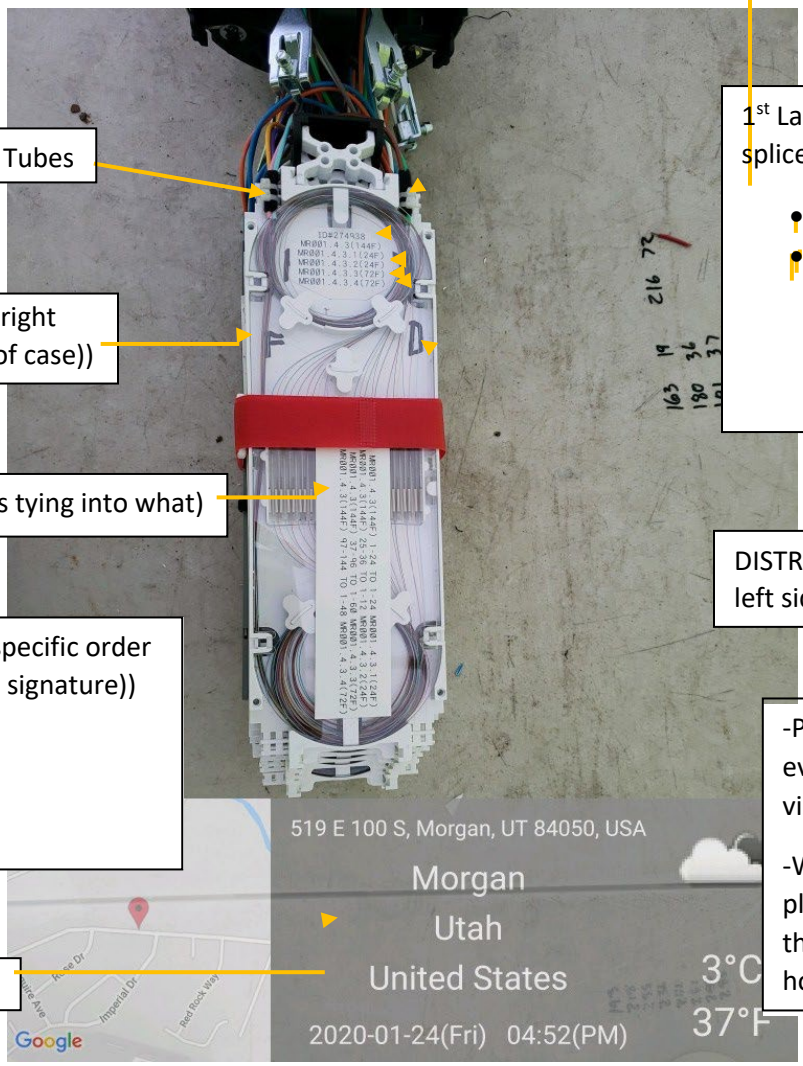
How to: Small Splice Points (96 splices and below)

-Picture should not be blurry and everything labeled on case should be visible and legible.



How to: Medium Splice Points (holds up to 144 splices)

Bottom of Case



Distribution Tubes

Feed Tubes

1st Label (on tray, naming all cables being spliced)

- Case ID Number
- Cable tag names and sizes (in order of Feed cable first and then all the Distribution cables tying in, in the order they are on the cutsheet)

FEED (F on tray, on right side (from bottom of case))

2nd Label (on tray lid, what is tying into what)

DISTRIBUTION (D on tray, on left side (from bottom of case))

Signature (on tray lid, not in specific order (this picture doesn't have the signature))

- Name
- Company
- Date

-Picture should not be blurry and everything labeled on case should be visible and legible.

-When placing buffer tubes in tray, place them in color code order from the outside holder to the inside holder.

GPS stamp

Top of Case

How to: Large Splice Points (holds up to 576 splices)

Bottom of Case

Feed Tubes

Distribution Tubes

1st Label (on tray, naming all cables being spliced)

- Vault/Pole ID Number
- Cable tag names and sizes (in order of Feed cable first and then all the Distribution cables tying in, in the order they are on the cutsheet)

FEED (F on tray, on right side (from bottom of case))

DISTRIBUTION (D on tray, on left side (from bottom of case))

2nd Label (on tray lid, what is tying into what)

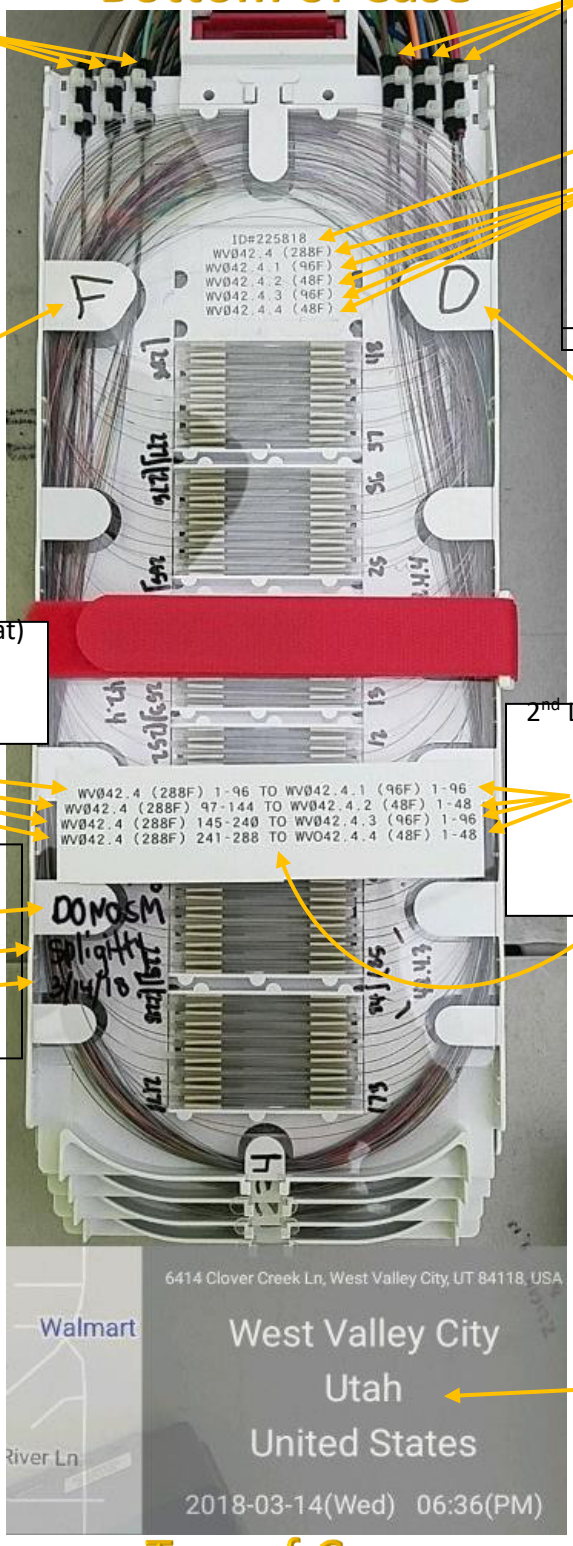
- Feed cable on the left side of label.

2nd Label (on tray lid, what is tying into what)

- Distribution cables on the right side of label.
- TO in the middle.

Signature (on tray lid, not in specific order)

- Name
- Company
- Date



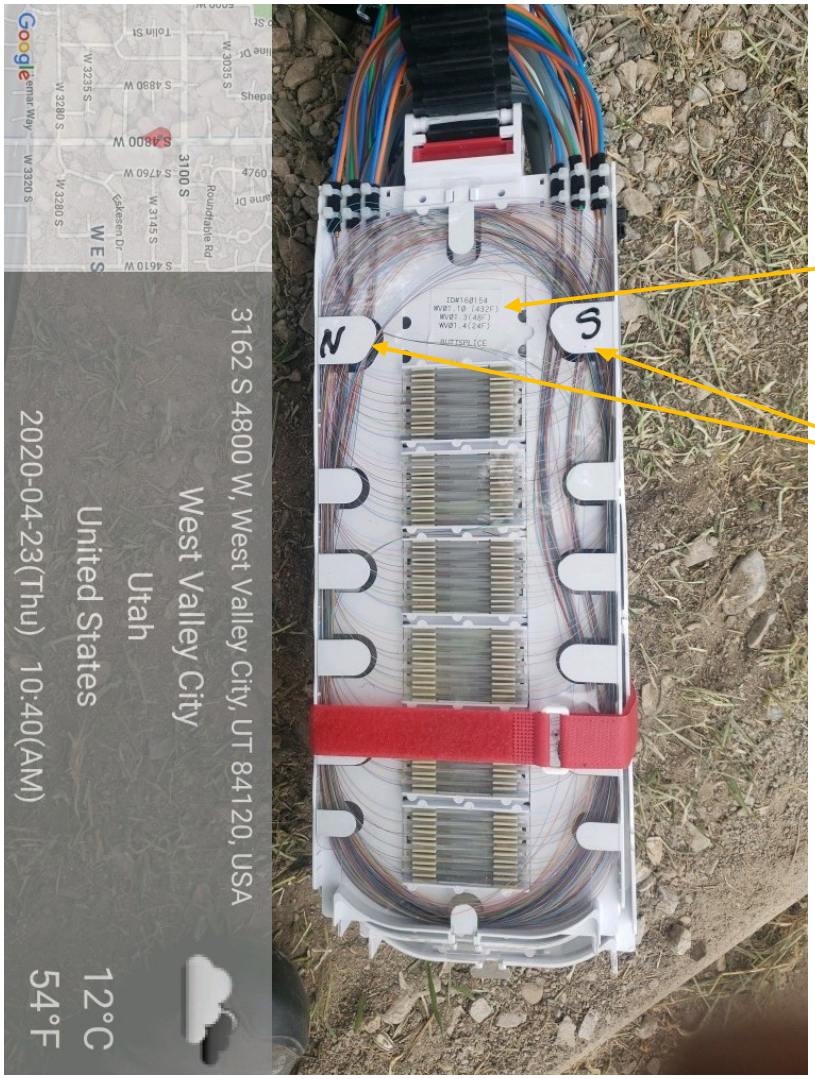
-Picture should not be blurry and everything labeled on case should be visible and legible.

-When placing buffer tubes in tray, place them in color code order from the outside holder to the inside holder.

GPS stamp

Top of Case

How to: Labeling a buttsplice



The label will go on the tray itself in the very top manifold. It needs to include Vault/Pole ID Number, then cable(s) being buttspliced, and then BUTTSPLICE. If you know what way the feed comes from, put F and D like normal, if not, use directions (NESW) of which way the cable(s) come from.