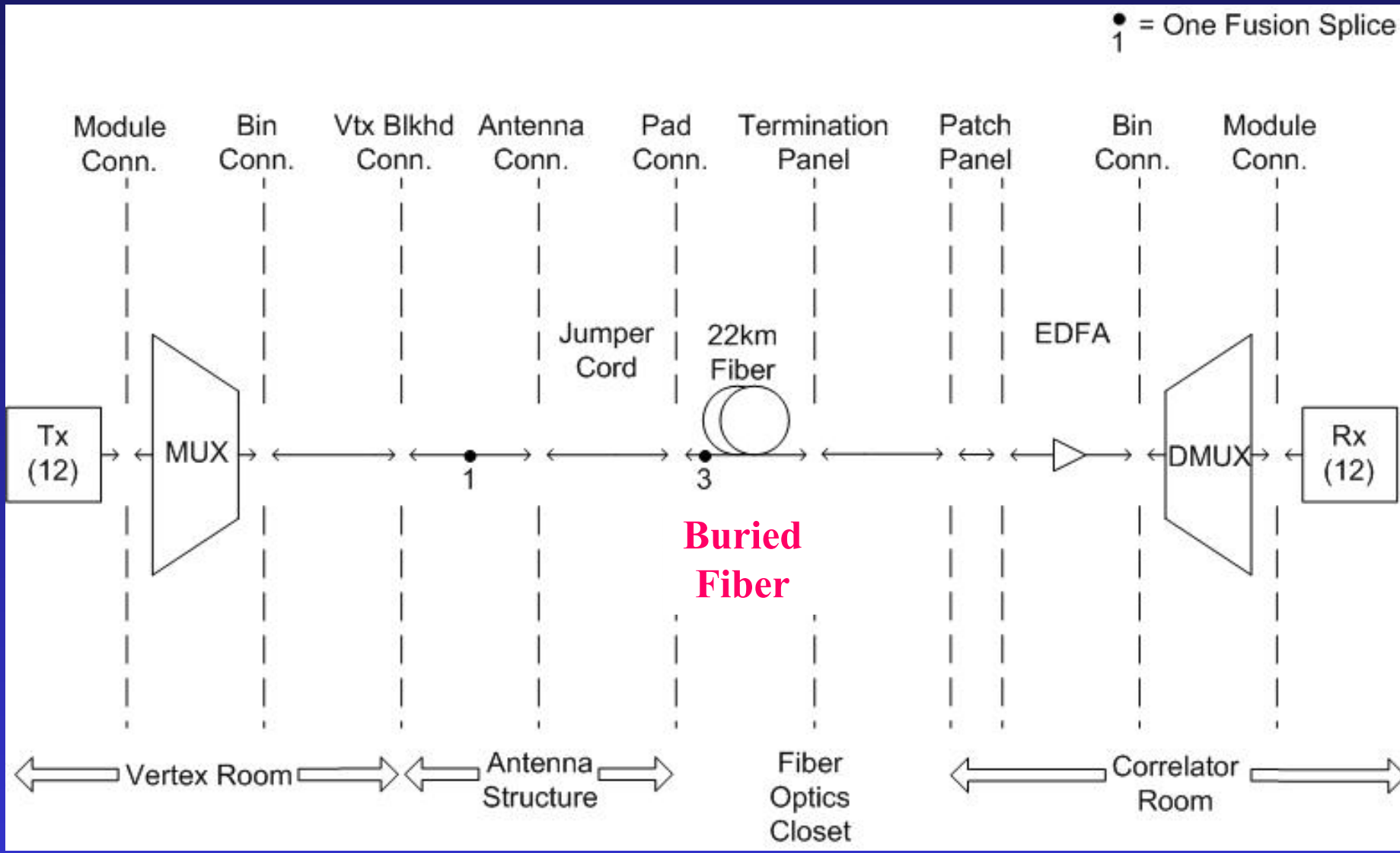
Fiber Installation
Preliminary Design Review

December 5, 2001

IF Signal Path



Cable Installation

The IF system parameters were major factors in selecting fiber.

The LO system parameters are major factors in selecting an installation method.

Burial Depth
Determined by LO phase stability

- LO system requires phase stability.
  - Stability determined partly by fiber thermal expansion
  - Fiber in ground contributes to total expansion.
  - Expansion determined by ground temperature

  - LO short term stability must be < 0.5 ps in 1sec.
  - LO long term stability must be < 1.4 ps in 30 min.

Burial Depth
LO Parameters

- Highest transmitted LO is 500 MHz
- Period of 500 MHz is 2000 ps
- Wavelength of 500 MHz in fiber is 40 cm

Burial Depth
Fiber Thermal Expansion

- Coefficient of expansion of fiber = 18 x 10^{-7} /°C
  (From F. Quan, Corning, Inc.)

- Average annual temp. variation at 1 m = 17.4 °C.
  (See EVLA Memo 10 by T. Cotter)

Burial Depth
Fiber Thermal Expansion

- Assuming:
  - A linear average rate of temperature change

$\Delta L = (18 \times 10^{-7}\ /°C)(17.4\ °C/yr)(22\ km)$

$= 68$ cm over 180 days

$= 7.9 \times 10^{-3}$ cm in 30 min

$= 4.4 \times 10^{-6}$ cm in 1 sec

Burial Depth
LO Phase Instability

- Long Term LO phase stability in the ground

  Stability = (2000 ps) (7.9 x 10^{-3} cm in 30 min) / (40 cm)

  = 0.395 ps in 30 min **<< 1.4 ps**

- Short Term LO phase stability in the ground

  Stability = (2000 ps) (4.4 x 10^{-6} cm in 1 sec) / (40 cm)

  = 0.00022 ps in 1 sec **<< 0.5 ps**

Burial Depth
Antenna Fiber

- Assuming L = 20m, Δt = 10C, ΔL = .036 cm

- Long Term LO phase stability on the antenna

  Stability = (2000 ps) (.036 cm in 30 min) / (40 cm)

  = 1.8 ps in 30 min **NOT << 1.4 ps**

- Short Term LO phase stability on the antenna

  Stability = (2000 ps) (2.0 x 10^{-5} cm in 1 sec) / (40 cm)

  = 0.001 ps in 1 sec **<< 0.5 ps**

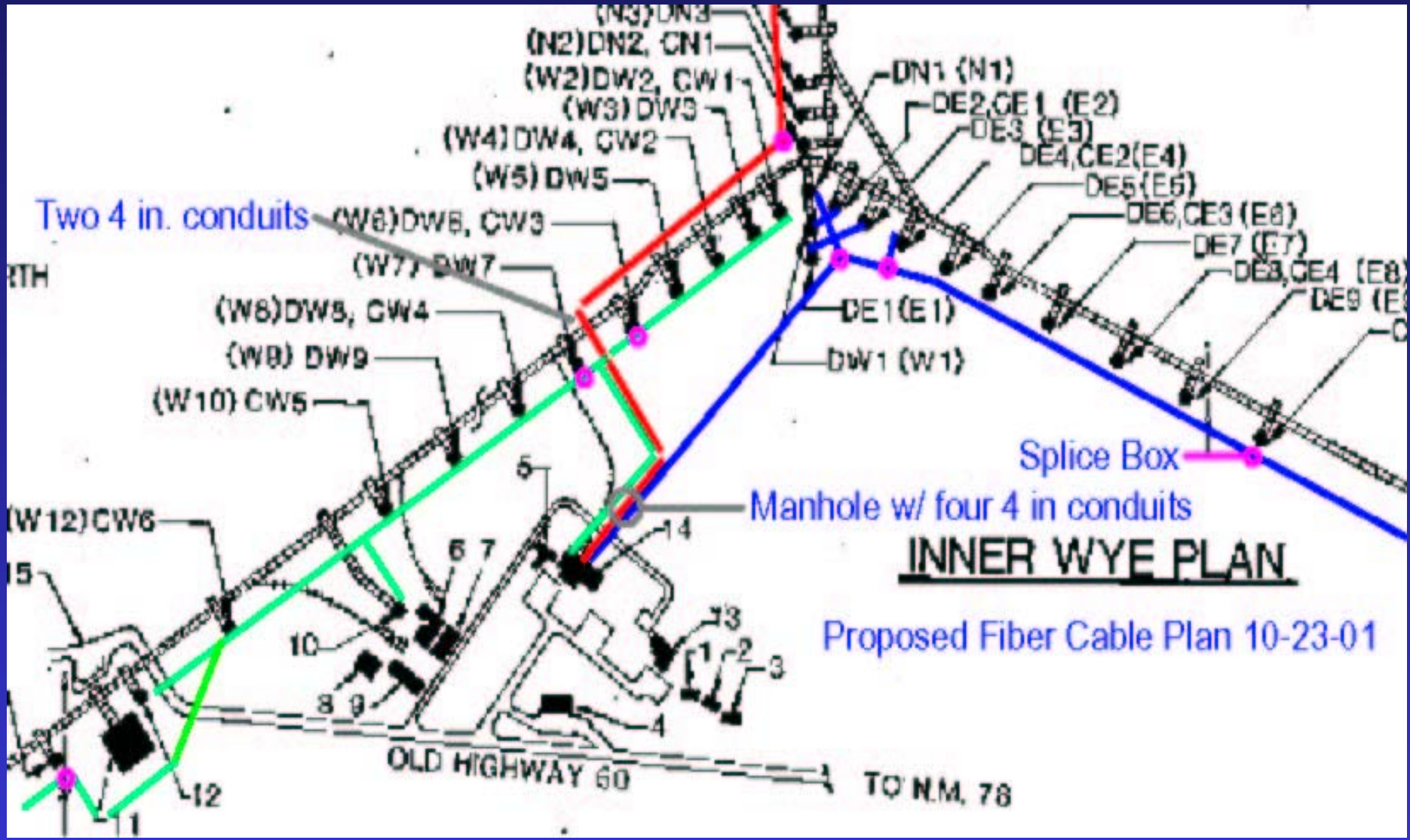
Burial Depth
Summary

- One meter burial depth is sufficient.
- Contribution of the buried fiber to the LO system instability is small.
- Contribution of fiber on antenna structure is a greater concern.

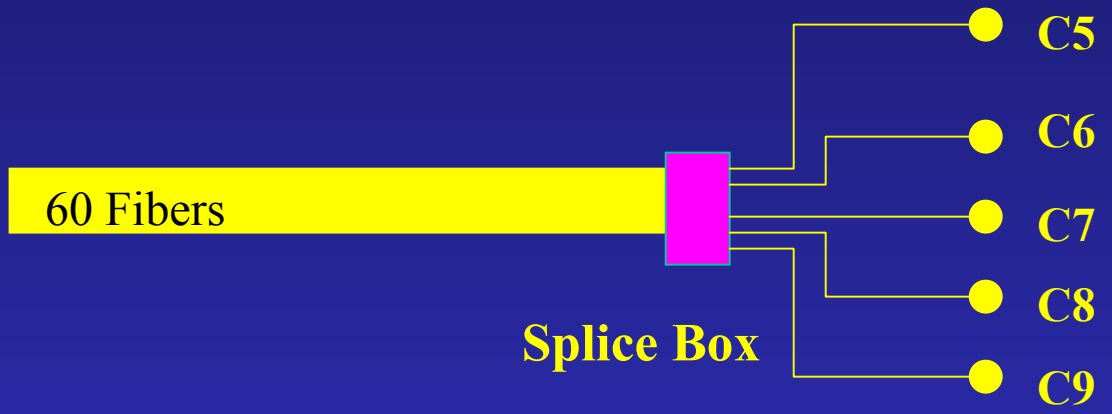
Cable Burial Plan
Fiber Acceptance Test

- Every fiber to be tested upon delivery.
- Every fiber to be tested after installation.
- Acceptance specification to be developed.

Cable Burial Plan



Basic Cabling Plan



12 Fibers per antenna

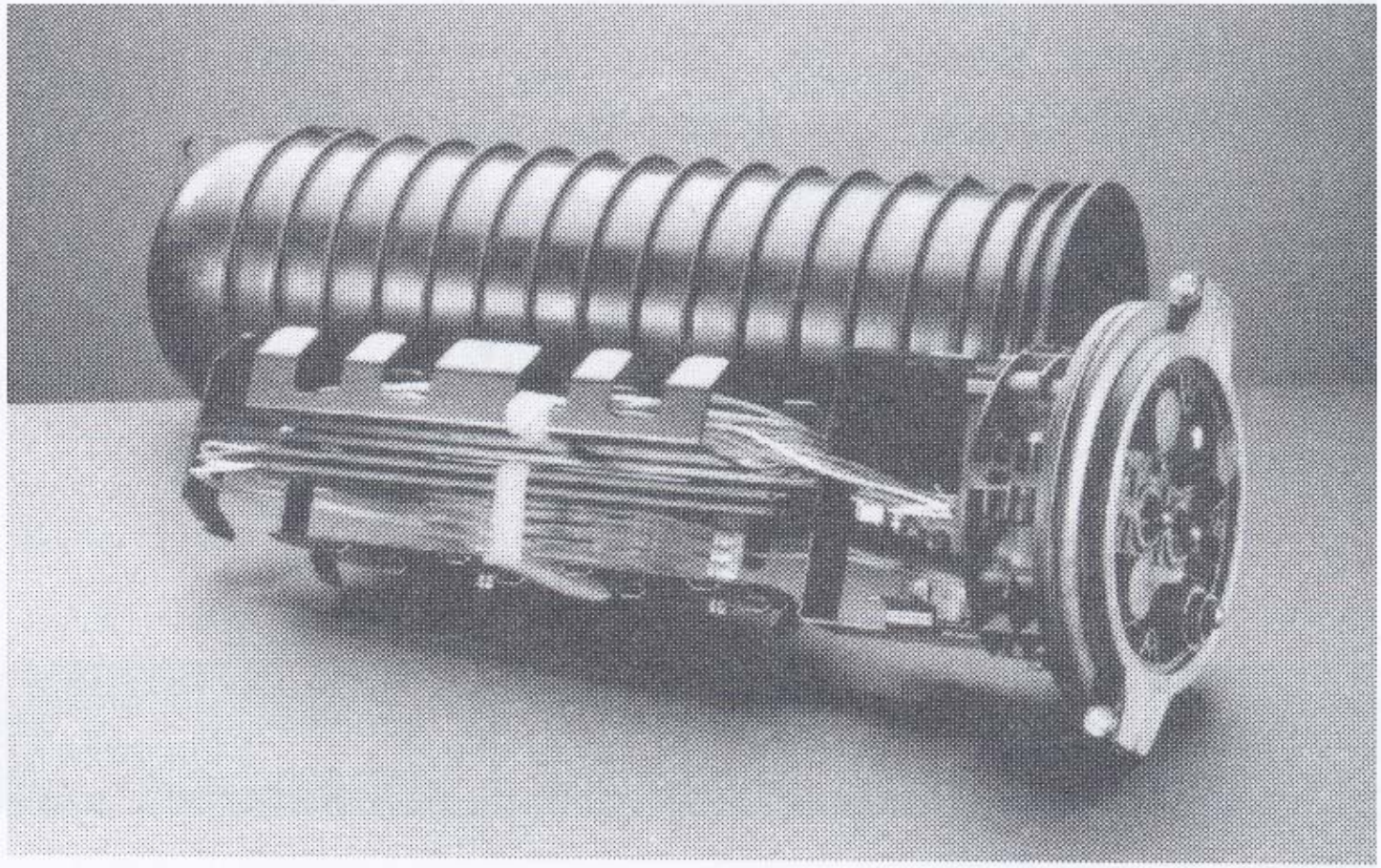
Cable Burial Plan

Trunks

Cable ID	Service for Pads	Destination	Fiber Count
East Trunks			
TY	DN1,DW1,DE1,DE2,DE3	DW1	60
TDE	DE4,DE5,DE6,DE7,DE8,DE9	DE4	72
TCE	CE5,CE6,CE7,CE8,CE9	CE5	60
TBE	BE5,BE6,BE7,BE8,BE9	BE5	60
TAE	AE5,AE6,AE7,AE8,AE9	AE5	60
West Trunks			
TDW	DW2,DW3,DW4,DW5,DW6	DW6	60
TCW	DW7,DW8,DW9,CW5,CW6,MP	DW7	72
TBW	CW7,CW8,CW9,BW5,BW6,BW7,BW8,BW9	CW7	96
TAW	AW5,AW6,AW7,AW8,AW9	AW5	60
North Trunks			
TDN	DN2,DN3,DN4,DN5,DN6,DN7,DN8,DN9	DN2	96
TCN	CN5,CN6,CN7,CN8,CN9	CN5	60
TBN	BN5,BN6,BN7,BN8,BN9	N. of RT. 60	60
TAN [2.]	AN5,AN6,AN7,AN8,AN9	AN5	60

Cable Burial Plan

Direct Burial Splice Box



Cable Burial Plan
Cable Type

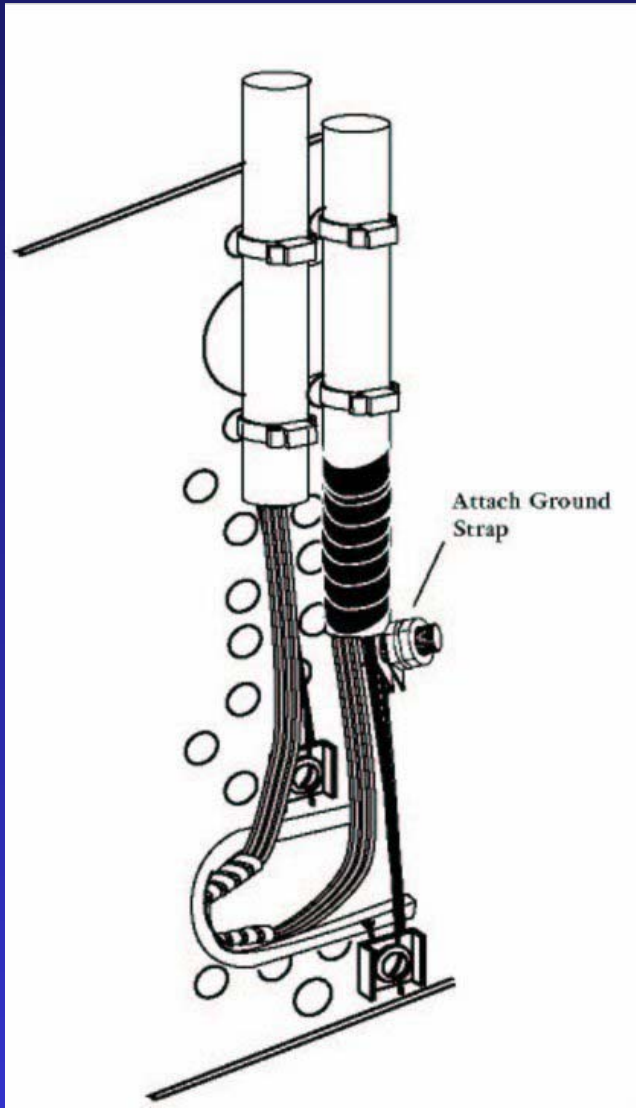
- Armor protects the fiber from
  - Rodents
  - Crushing forces
- Armor - lightning protection issue
  - Armor must be grounded
- First layer of armor is sacrificial
  - Double armor is required

Cable Burial Plan

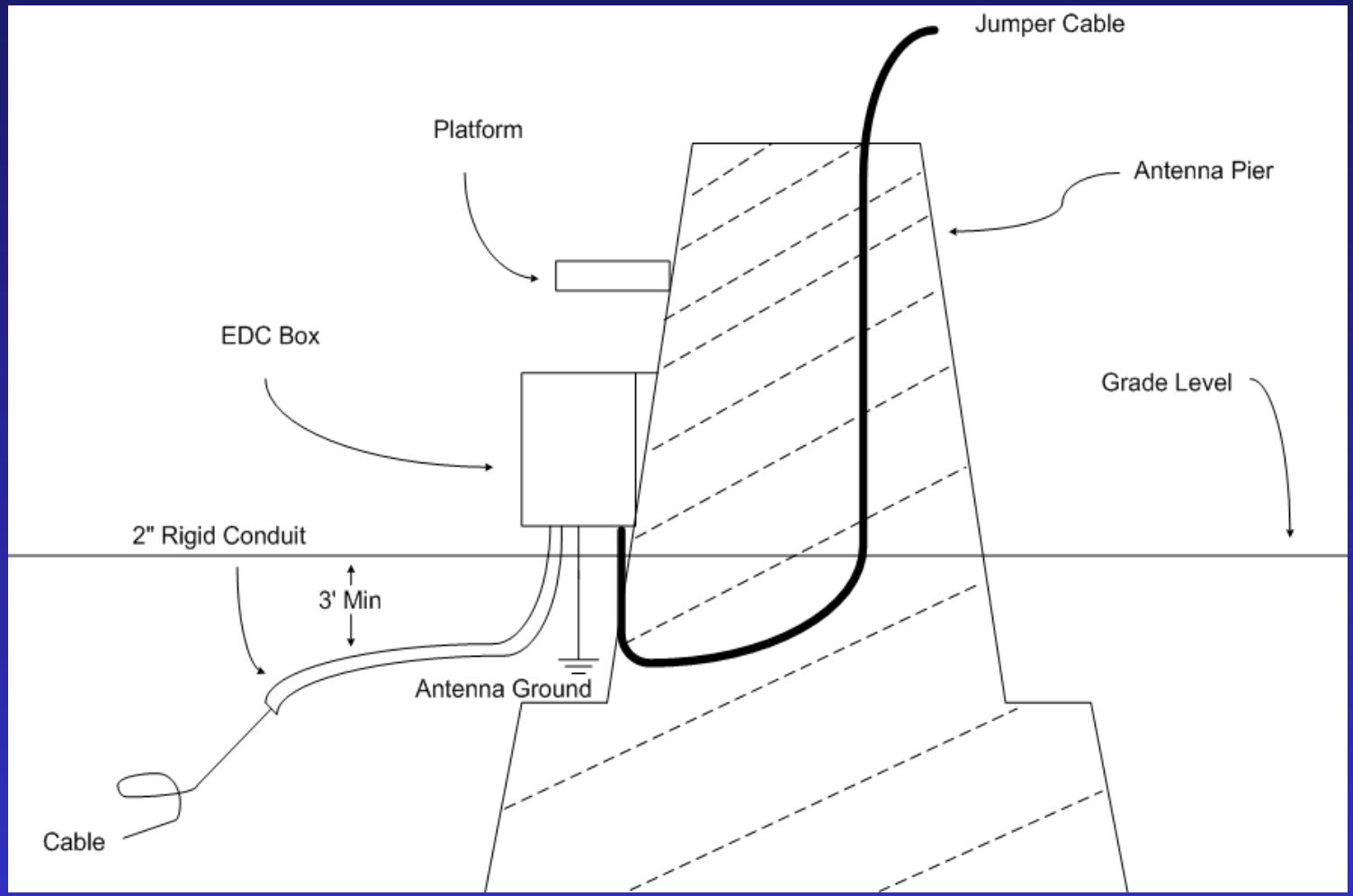
Cable Cross Section

Cable Burial Plan
Grounding

- Bonded to ground at every connection.
  - Bonded with 8 AWG copper, minimum.
  - Bonded to antenna ground, control building ground, or a ground rod.



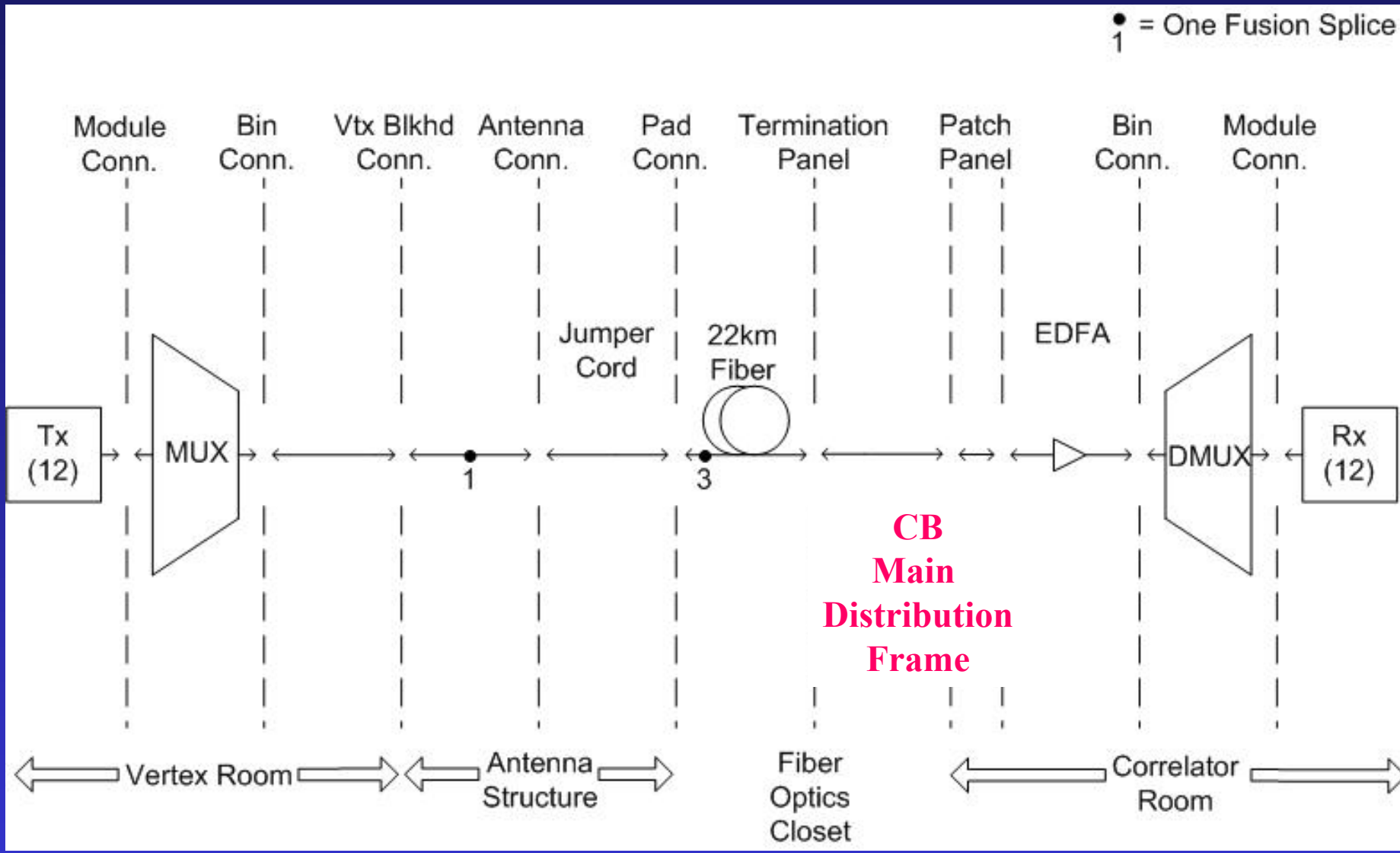
Antenna Termination
Antenna Pad Enclosure



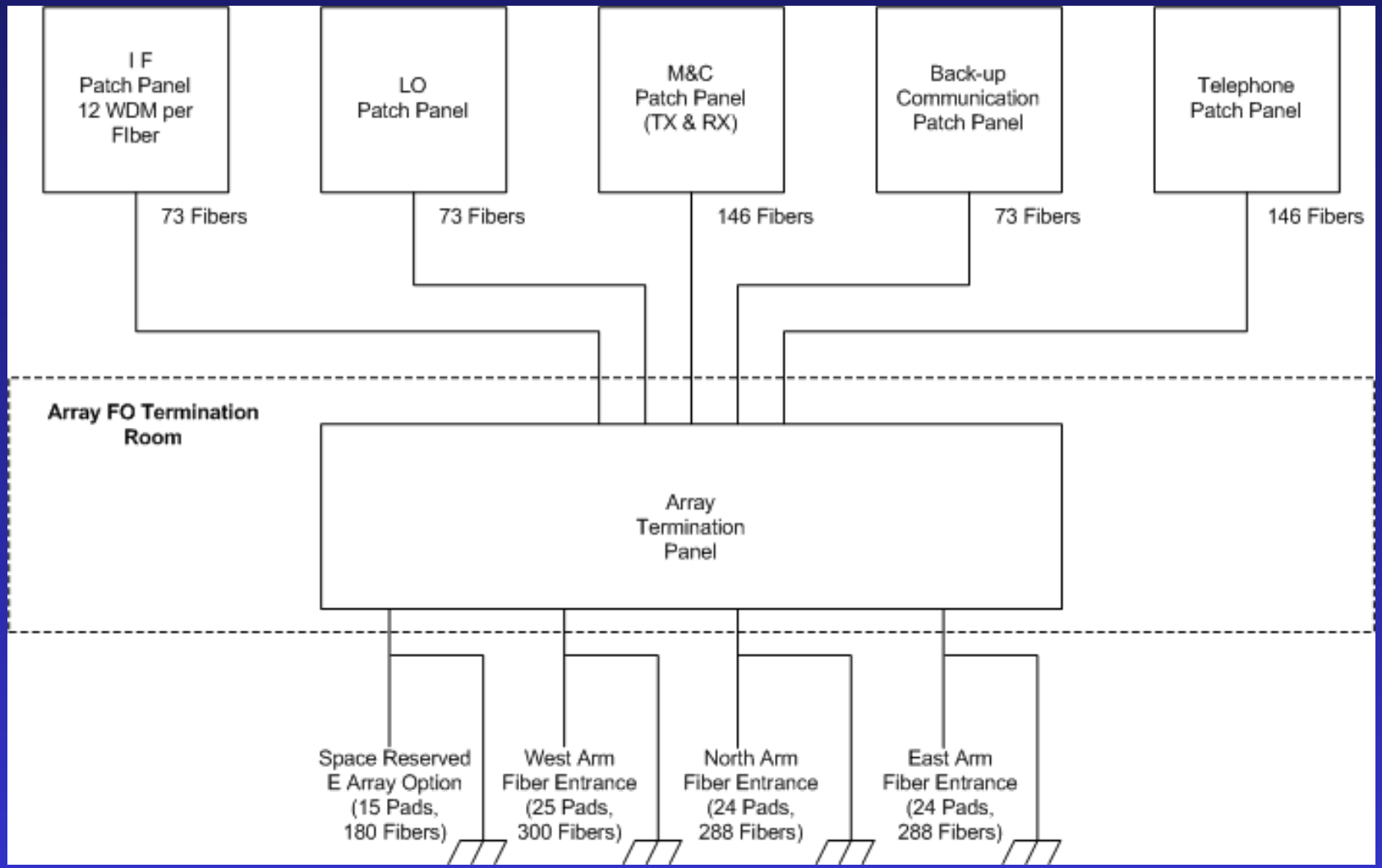
Antenna Termination

Antenna Junction Box

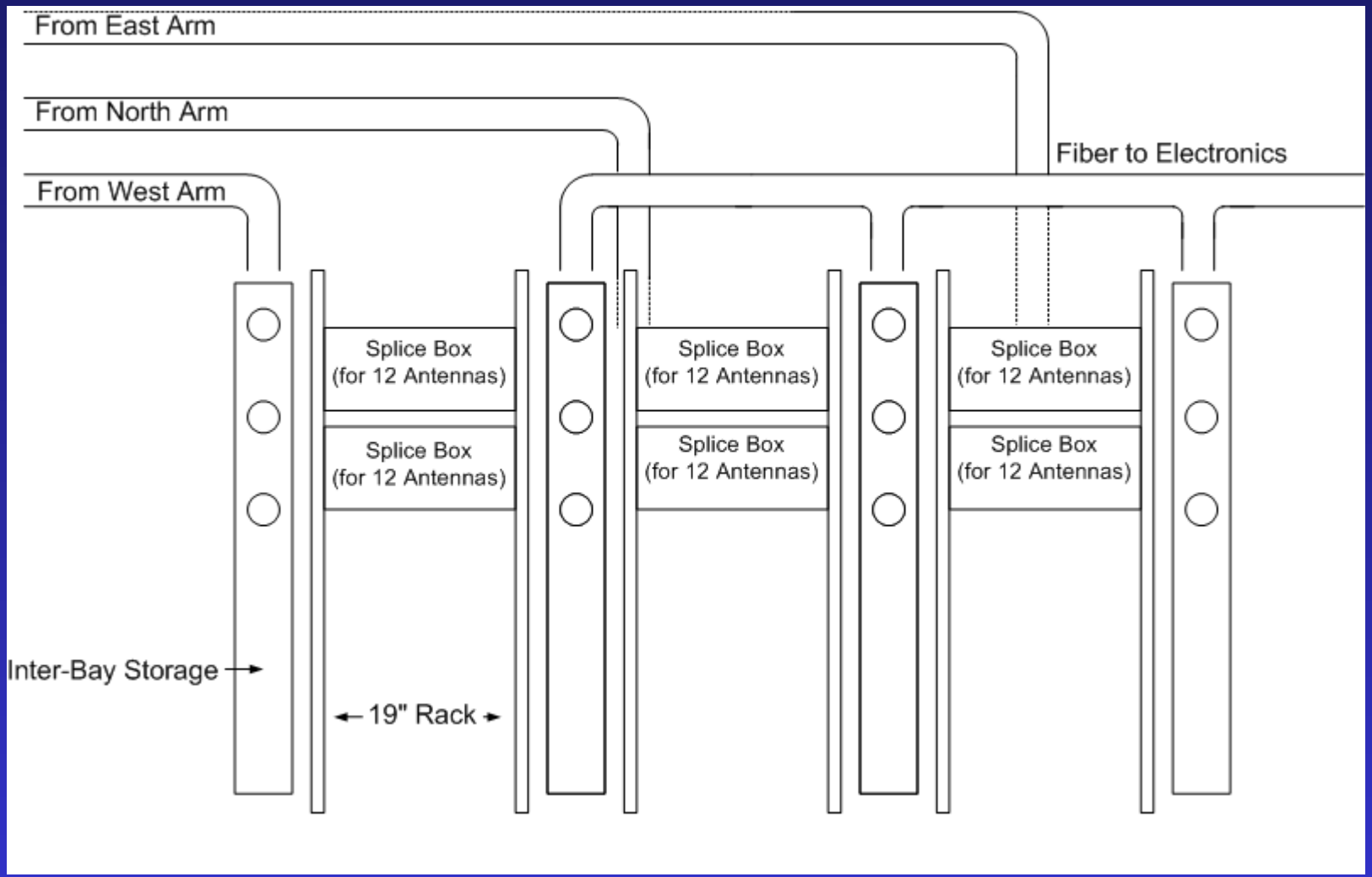
IF Signal Path



CB Main Distribution Frame



CB Main Distribution Frame
Termination Panel



CB Main Distribution Frame
Termination Panel

- Provisions for 876 fibers (73 Pads)
- Stores extra fiber for maintenance
- Space available for expansion to 1200 fibers

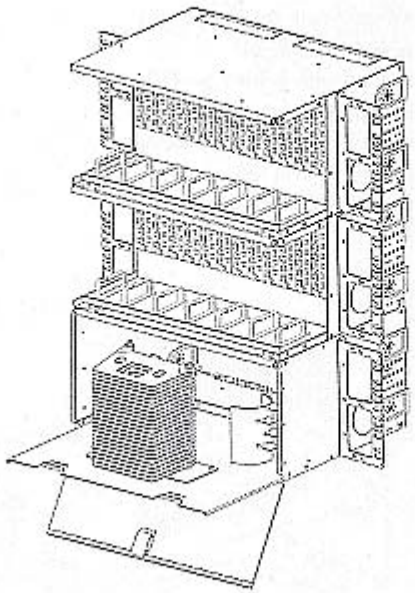
S.Durand / T.Baldwin

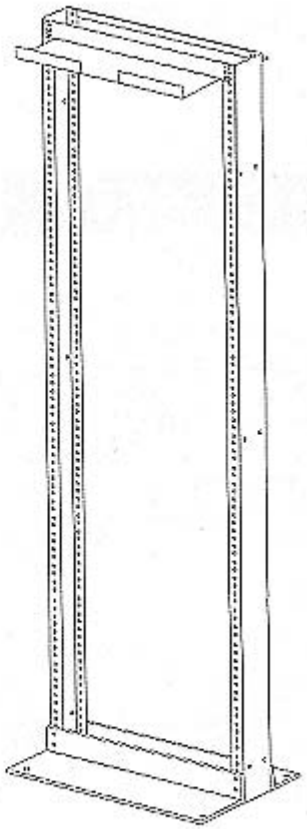
CB Main Distribution Frame
Cable Type Required

- Plenum Cable Type OCNP is required in building
- 30-Fiber tight buffer cables will be used
  - Twenty-one cables required
  - Cables organized by array arm and system

CB Main Distribution Frame

Patch Panels





Fiber Installation
Work Yet to be Accomplished

- Lightning protection
  - What material will not react with the existing cathodic protection system? Copper?
- Further development of CB fiber plan
- Further development of Antenna cabling
  - How will the cable wrap effect LO stability?
- Develop Installation Specification .
- CDR

Cable Burial Plan
Summary

- 13 Trunk Cables from CB out to the Array.
  - 60, 72 and 96 fiber cables.
  - Triple Jacket/ Double Armor.
  - Standard single-mode fiber.
- 17 splice locations
- 12-fiber cable from trunks to antennas.
- Acceptance Test before and after installation.

Cable Burial Plan
Summary

- Trenched & Installed by ES Division
- Spliced and terminated by Electronics Division
- Burial Depth - one meter minimum.
- Cable identified with marker tape.
- Splices identified with a concrete monument.
- Armor grounded at each splice or termination.

Next Topic