Thoughts on foundations, trenches and the core, for 512T infrastructure

Dave Emrich 3rd Ed. 27 Oct 2010

Field hub:

- Single concrete pad, reinforced, spec'd for:
  - weight of first transformer
  - size for both transformer and fibre patch, +500mm all sides?
  - no fence required.
- Where CSIRO MV power feed and fibre trunk from main building terminate.
- First transformer 6.6kV 80kW, expect ~ 2m x 1m x 1m steel cabinet on pad.
  - If ~1kV distribution from there
    - How many intermediate stations (1kV → 240V)?
    - Size of each? Enclosures? Pads?
    - Trench depth for 1kV?
  - If direct 240 distro
    - how much more power cable cost?
    - how much saved in trenching due to shallower?
- Fibre expect ? x ? x ? **passive** patch cabinet on same pad.
  - How to patch?
    - 384+N x 2 sockets (half trunk, half receivers), 384+K short patch leads?
    - 384+N sockets on trunk, 384+M fibres from receivers with plugs?

(Notes:)

Fibres:

- Sensible labelling scheme to assist initial patching in, and subsequent patching over bad fibres.

- Field hub to CSIRO centre ~ 5km (rough).
  - Require 6 x 64 = 384 fibres to / from receivers.
  - Bundle multiple is 72, nearest is 6 x 72 = 432, means 48 spares “for free”.
  - Pro: plenty spares, con: cost of termination of extras
    - how many spares do we terminate from day #1? (ie. 384+N above)
    - how much will it cost when we use all those up and have to start using “bare” ones? (field terminate? Test?)

- Field hub to each receiver, ~50m up to ~4km (rough)
  - Need 6 to each receiver, spares probably means 12 (nearest common size up).
  - Custom can be 7,8,10, but more expensive, might as well feed 12 to each receiver.
  - How many terminated on day #1? (ie. Relates to 384+M above)
  - Want everything to be LC connectors, small size plus easiest to patch over failures in -any- fibre.
  - Fibre penetration, ground to receiver:
    - Issues: Cost of terminations per receiver vs. unit Test PSI / install / service / replace?
    - Direct in (no connectors)
      - cheapest? (up-front, maybe, but what about on-going?)
      - bend radius vs. fragility.
      - Two options, terminate before or after node enclosures on pads.
      - Before:
        - cheaper (fusion splicing done once, by experts)
        - How to feed >6, <=12 LC's through hole in box safely?
        - Risk of single-fibre breakage when fitting off enclosures.
        - Easier for OtoC to test & “sign off clean” on installation.
      - After:
        - How OtoC to field test after power/fibres laid if un-terminated? QA?
        - Who fusion terminates LC's as receivers installed?
        - Spreads out cost of fusion splicing over entire receiver installation phase, expensive.
        - Test??
    - Connector on Rx box:
      - Cost vs. Ease of test / supply from PSI
      - How to manage “flying lead from ground” until nodes installed.
      - Easier for OtoC to give us a certificate for fibre network quality.
    - Connector on caravan post:
      - How to manage trailing lead from rx enclosure, during transport from PSI → Storage → site?
      - Impact on PSI testing, they only need one “test post” made up.
      - Much easier for OtoC to “clean sign-off” of delivery of power/fibre network.

(Notes:)

Trench:

- Sharing: Fibre right alongside power no problem.
- Length/Path: Trenches path-optimised for power distro (subterr. boulders & volt drop).
    - Power cable $ α copper weight (ie. Length * x-sect. Area).
    - Fibre cable $ α # terminations (fibres themselves practically free).
- Depth: Fibre doesn't care, so depth determined by power.
    - Between 300mm and 600mm, voltage and standards dependent.
    - OtoC thought 240V could be 300mm down.
    - Can be protected with concrete back-fill if can't make desired depth in “a few” locations.
- # Rx's per “circuit”, trade-offs:
    - cable thickness
    - number receivers
    - how many “go out” when breaker trips?

(Notes:)

Important information:
Concrete: $\rho = 2400kg / m^3$ not counting reinforcing steel.
Node: 1600mm x 1100mm footprint, 160kg mass estimate.

Receiver pads:

- Singles:
  - "Enough" mass to keep receiver from blowing over, ~900kg?
  - Apron size, ~300mm? => 2.2m x 1.7m pad. x 100mm thick => ~950kg (incl. steel).
- Clusters:
  - Single concrete pad? Would have to be poured on site.
  - Four nodes per cluster (assumed)
  - Is 300mm between nodes "enough", with 300mm apron?
    - All cables in centre of pad? (all bulkheads facing "inwards").
      - Easier / neater for slab penetrations (power + fibre).
      - Higher possibility of interference between Rx's
      - Hard to stand in centre of slab (only).
    - All cables around edges (all bulkheads facing "outwards").
      - Hard for slab penetrations (=> cost)
      - Max separation of node inputs from each other
      - Harder to access between receivers (more cables everywhere).
      - Easier(?) to route cables to tiles?
- Mounting: Desire to get above high water mark, will 100mm slab be enough?
- If not, keep slab thickness down (cost & weight), by raising node on supports.
  - Simple jig required in either case during concrete pour.
  - Long threaded rods cast in slab, nuts washers/spacers to rails under box.
    - Pro: cheap?
    - Con: is four / six "posts" enough, will receiver "bend"?
      - More fiddly to level.
      - More nuts & washers.
      - Harder to transport (eg. damage threads) if concrete poured off-site.
  - Short bolts cast in slab, two "C" sections running the length of rails.
    - Pro: Easier to assemble / level
      - full length support of box/rails (no bending)
      - looks better?
      - more protection for cables?
    - Con: cost?

(Notes:)

Node > Tile cables:

- Need to make sure routing rules from Judd's doc are consistent (especially in core).
    - Can we run two DoC (or more) twin-ax's right on top of each other for any significant length?
        - How are we going to know, without deep integrations to look for crosstalk?
        - When do we do those tests? 32T with DoC cables?
    - Can we really loop 10m of cable 1.5m away from a tile on all sides (esp for Sthly tiles)?
        - Do we need to keep the loops all on one side, or mix them up?
    - How are we *really* going to test if we need Q-shield?
- Cables made to length (please!) or terminate in field?
    - Made-to-length:
        - more expensive
        - quicker
        - safer because cables can be tested before shipping to Curtin
    - Field-made:
        - up-front cheaper
        - riskier (QC?)
        - we probably don't have resources to field terminate / test.
- Just laying the cables as the nodes roll out will be “enough” work, month-on-month-off for Dave & Brian, but who will we have as “safety buddies” during this work? What if nodes are delivered 8 per month instead of 4?
- Clusters: Impact of cluster layout on cable runs?
- DoC cable runs:
    - are we planning still on RG-11 Quad-shield on long runs?
    - What about trace-earth wire on long runs?
    - What do we need to test on X15 with current RG-6 Dual-shield to determine if we need QS and/or RG-11?

Earthing:

- Possible consequences of earthing required to meet AS3000 wiring rules for mains.
    - Receiver pad probably has to have some kind of 'earth stake' to which all mains earth (including enclosure metalwork) will be attached (distributed earthing, but effective single-point at each pad).
    - Probably one earth point for each cluster, and one for each single receiver pad.
    - Earth(s) in trench from Nodes to Hub?
    - Earthing at Hub?
- Will be running heavy earth from beam former chassis to mesh.
    - Is this in Burns' quote?
    - Cables can be pre-fabbed off-site, quickly fitted to mesh and chassis during install.
    - Significantly mitigates static-handling risks during LNA install if mesh already grounded, at least to beam former chassis, at that time.
- Decide, still running heavy earth from beam-former chassis to receiver pad earth point?
    - Lightning protection?
    - RF return path?
    - Helps with 48V return current, lower volt-drop.