Building Design guide for Telecommunications

This document's objective is to provide Architects and other designers with a design-requirements and guidelines document that will help them plan the telecommunications facilities for UCSC campus. The Scope of Work includes the telecommunication inside plant (ISP) and outside plant (OSP) cabling and support facilities required by new buildings or additions and/or upgrading of existing buildings and facilities. The document is a requirement and guidelines design guide and is not a project specifications document.

The coordination of the requirements of this document with the specifications and drawing sets of the Telecommunications, Electronic Safety and Security, Architectural, Electrical, Mechanical, and Civil Engineering design disciplines at the Schematic Design phase of project development is vital for control of change orders and greatly facilitates smooth, cooperative interaction in Design Development and Construction Document phases of the project. Examples:

A. Telecommunications Spaces wall cover and floor finish (plywood, painting, sealing, tile placement) requirement information - can be Architectural or Division 27 - Communications document set - usually Architectural.

B. Telecommunications Grounding and Bonding System requirements - must be part of Division 16 or Division 26 - Electrical document set.

C. ISP cable pathway requirements - often split between Division 26 (16) - Electrical, Division 27 - Communications (Telecommunications/ITS), and Division 28 - Electronic Safety and Security document sets. Splits are OK but need to be clearly defined as early in the project planning phases as possible.

Acronyms Used in this document:

 ADF = Area Distribution Frame

 AFF = Above Finish Floor

 AHJ = Authority Having Jurisdiction

 ASF = Assignable Square Footage

 BDF = Building Distribution Frame

 EF = Entrance Facility

 ER = Equipment Room

 ISP = Inside Plant

 IDF = Intermediate Distribution Frame

 MTGB = Main Telecommunications Grounding Busbar

 OSP = Outside Plant

 SF = Square feet

 GSF = Gross square feet

 TGB = Telecommunications Grounding Busbar

 TR = Telecommunications Room

 TR = Telecommunications Space

 WA = Work Area

 WAO = Work Area Outlet

WAP = Wireless Access Point

1. DEFINITIONS

A. Telecommunication Rooms (TR): The term TR refers to space allocated within a building to provide a secure operating environment for telecommunications cabling and termination facilities and/or network equipment. TRs shall be designed and provisioned per ANSI/TIA/EIA-569-B Commercial Building Standards for Telecommunications Pathways and Spaces and per the BICSI Telecommunications Distribution Methods Manual (TDMM), 12th edition. Depending on the building size, design, and network requirements, one or more of the functions of a TR may be combined into one space. The primary functions housed in TRs are:

1. Entrance Facility (EF).

2. Building Distribution Frame (BDF).

3. Intermediate Distribution Frame (IDF).

4. Area Distribution Frame (ADF).

B. Types of ISP TR Facilities

1. Entrance Facility (EF): Is a room that houses the termination and grounding point of OSP network service cables that enter or exit a building. It enables the joining of intra-building and inter-building backbone cabling. The EF is generally co-located in a BDF or ADF rather than being a separate room.

2. Building Distribution Frame (BDF): Is a building-serving facility. The BDF enables connection of OSP services (telecommunications) to the building and then distributes those services throughout the building to IDFs using riser cables. 3. Intermediate Distribution Frames (IDF): Are considered to be floor servicing facilities as opposed to building service facilities. The IDF provides a connection point between riser cable from the BDF and the end user Work Area Outlet (WAO) horizontal cabling. All new multi-story buildings shall have at minimum one (1) IDF on each floor of the building. More than one (1) IDF per floor may be required in larger buildings where cable lengths would otherwise be exceeded. In existing buildings of or less than 5000 GSF it is permissible for an IDF to service an adjacent floor. This exemption from the rule of one IDF per floor must be approved by the University on a case by case basis. Access switches and UPSs are equipment commonly used in IDFs.

4. Area Distribution Frame (ADF): Is a multiple-building serving facility. The ADF is the room within a building for telecommunications equipment that meets the voice, data, video, radio, and wireless needs of its building and also serves other buildings in a designated area (zone) on the UCSC campus. It generally acts as and EF and BDF but can also act as a IDF serving the floor it occupies. ADFs are generally placed on the lowest floor of a building to allow the entry of OSP cables without transition splicing and for grounding of cables.

An ADF provides a controlled environment to house telecommunications equipment, termination hardware, splice closures, Main Telecommunications Grounding Busbar (MTGB) grounding and bonding facilities, and protection apparatus where applicable. Campus telephone systems (LIMs) or MX1 equipment, local area network switches, video distribution equipment, wireless network equipment, 800MHz and police and fire VHF in-building radio equipment, in-building cellular systems, and large uninterruptible power sources with large (1 ton) battery stacks are types of telecommunication equipment found in an ADF.

ADFs are distinct from other TRs due to the nature and/or complexity of the equipment they contain. They are distribution points for the campus fiber and copper OSP cable plant.

5. The TRs described above shall be designated for the exclusive use of the following telecommunication systems:

• Voice systems.

• Data network systems; including un-interruptible Power Supplies (UPS) both rack-mount and stand-alone supporting these systems.

• Wireless network systems.

• Cellular telephone booster systems

• Video surveillance systems.

• Cable TV distribution systems.

• Access control systems.

2. TR USE RESTRICTIONS

A. No TR shall be used as passageways to other equipment rooms, power transformers, custodial equipment, or any other function that would require access for reasons other than service and maintenance of the communication equipment and cabling they house.

B. Every TR shall be dedicated to telecommunications functions and related support facilities. TRs shall not be shared with electrical equipment, building services, or other equipment. Specifically a TR shall not contain systems such as audio-visual (A/V) equipment, fire alarm panels, building management systems, or computer servers. No other building systems shall be housed within a TR without the prior written approval of Core Technologies.

3. Locating TR Facilities Within a Building

A. There are a number of factors that need to be considered when placing TRs within new or remodeled facilities. Site selection factors for the various rooms are addressed below. Of these factors, the two most important are “stacking” of the spaces and providing a location that would allow the spaces to be expanded, if required, in the future.

B. Horizontal location: The IDF shall be centrally located within the floor area it serves in order to maximize the number of horizontal cable plant WAO connections it can service. The maximum horizontal cable length allowed from the IDF termination to that cable's WAO termination is 295 feet (90 meters).

C. Vertical Location: In multi-story buildings, requiring multiple IDF rooms the IDF rooms shall be in vertical stack alignment. Offsetting an IDF on one floor from the IDF above it and below it is not allowed.

D. Avoid locations that limit expansion such as structural steel, stairwells and elevator shafts, outside walls, or other fixed building walls.

E. In locating an EF, note that unrated OSP cable shall not be exposed for a cable length of more than 50 feet (50’) per the NEC.

F. TRs should be easily accessible and accessed directly from public hallways. Access should not be through offices, other utility spaces or janitorial spaces.

G. A TR must be a rectangular room with no obstructions or protrusions (beams, columns, etc.) that decrease the usable square footage available in the room.

H. IDFs are not to service WAOs on more than one floor except as previously noted in this document with reference to existing buildings.

I. TRs and the cabling they support shall be separated from sources of electromagnetic interference such as induction devices, transformers, ballasts, power supplies, elevator equipment, generators, motors, X-ray generators, photo copiers, microwave ovens, and similar equipment nor be located near sources of mechanical vibration.

J. The location of TRs shall allow easy access to cable distribution pathways.

K. TRs shall not be located in any place that may be subject to water or steam infiltration, humidity from nearby water or steam, heat, and any other corrosive atmospheric or environmental conditions.

3. TR ROOM CONSTRUCTION GUIDELINES

A. Enclosing Walls

1. TR walls shall extend to the structural ceiling above.

2. Fire rating of TR walls shall meet all requirements of the A.H.J.

3. Penetration of rated TR walls shall be fire stopped.

B. Ceiling: A suspended, false, lay-in, or hard lid ceiling shall not be installed over any TR floor space. Minimum clear ceiling height shall be 10 feet (10').

C. Floor

1. Do not design raised floor systems for TRs whatever set of functions they perform. TR floors should be floor slab, no raised or false floor.

2. Floor finish shall be smooth, dust-free, and not susceptible to static electricity build-up. Acceptable finishes are low static composition tile, static dissipating tile (SDT), or sealed concrete.

D. Door: Provide 3 ft. 0 in. wide X 7 ft. 0 in. high door, opening outward, with a card reader lock that supports brass key access for emergency use.

E. Windows: TRs shall not have windows.

F. Water Infiltration: Measures must be taken to prevent water intrusion. Water, sewer, chemical, or drain piping of any kind shall not be routed through/within a TR.

G. Sprinkler Systems: If codes require fire protection sprinkler system heads within a TR, the sprinkler heads shall be the high heat type and shall be protected with a wire cage to prevent accidental discharge. Do not install sprinklers directly above the equipment racks.

 Note: For TRs that support the ADF or BDF functions consider installing a standalone dry pipe sprinkler system.

H. Wall Plywood Sheeting: Provide sufficient number of 4 ft. X 8 ft., ¾ in. thick Grade A-C, certified/ stamped as fire retardant and painted with two coats of white fire-retardant paint plywood sheets, to cover all four TR walls. Fire retardant stamps shall be visible after painting. Sheets shall be mounted securely to walls with 8 foot length vertical, 4 foot or less width horizontal. Bottom of sheet shall be at six inches (6") A.F.F.

4. TR Room Sizing Guidelines and two (2) Typical TR Room Layouts

A. The size of the TR is dependent upon the size of the area that the room will serve and the variety of equipment installed within the room. The TR shall provide enough space for all planned termination and electronic equipment and cables that will be installed within the telecommunications room; including any environmental control equipment, power distribution/conditioners, door access controllers and other security systems, in-building cellular equipment and uninterruptable power supply systems.

B. Based on one WAO per 100 square feet (sq. ft.), of available floor space size the IDF for each floor as follows:

1. If the GSF is 5,000 sq. ft. or less, the IDF shall be 10 ft. long X 9 ft. wide.

2. If the available floor space is between 5,000 and 8,000 sq. ft., the IDF shall be 12 ft. long X 9 ft. wide.

3. If the available floor space is between 8,000 and 10,000 sq. ft., the IDF shall be 15 ft. long X 10 ft. wide.

4. If the available floor space exceeds 10,000 sq. ft., but the horizontal cable placement run distance to the farthest WAOs does not exceed the cable distance limit of 295 ft. (90 meters), then the IDF size shall be increased in size by 0.75 sq. ft. for every additional 100 sq. ft. of available floor space the TR will support.

5. If a second IDF is required to manage the horizontal cable placement run distance limit of 295 ft. (90 meters), size the second IDF per the guidelines explained above.

6. When a TR supports the BDF and ADF functions, dimension that TR at a minimum of 20 ft. long X 10 ft. wide.

C. The TR sizes listed above are minimum guideline requirements, but they are a good starting point for a building's project programming development phase. Depending on the services and functions performed by the buildings TRs, such as serving as an ADF, or serving a large number of occupants, additional space may be required. ADFs and BDFs for larger size buildings may require additional rows of equipment racks or cabinets not accounted for in the above sizing guidelines.

D. Typical TR Layouts: The following pages include two typical TR plan view layout and one typical rack elevation. They are included to help the reader of this Design Guide visualize how UCSC utilizes TRs. It is always preferable to size TRs with enough length so that a single row of racks is sufficient to house all equipment and cabling. The following specifications reference clearances for equipment and cross-connect fields housed in TRs.

Provide the following clearances for equipment and cross-connect fields in TRs.

1. Allow a minimum of 36 inches (36") of clear working space in front and 42 inches (42") at rear of equipment racks measured from the front and rear wire managers.

2. Allow a minimum of 36 inches (36") of clear working space in front and at rear of equipment cabinets.

3. Allow for 8-inch depth off wall for wall-mounted equipment.

4. If multiple equipment rack rows are required, provide a minimum 36-inch aisle between each row of racks.

5. A minimum aisle clearance of 30-inches is required at one end of a equipment rack row. Clearance shall align with TR doorway.

6.In many cases, equipment and termination hardware may extend beyond racks and backboard mounting surfaces. Clearance is measured from the outermost surface of these devices, rather than from the mounting surface of the rack or backboard.

E. IDF/MDF Racks, Patch Panels, Fiber Panels, Cable Management design considerations.

1. 19” 7’-tall (racks are 24.75" wide) zone 4 rated seismic relay racks shall be used.

2. A 7' tall, 6" wide, double sided vertical cable manager shall be placed between racks and at the ends of each rack row.

3. 2RU, 48-port patch panels shall be used for horizontal cabling.

4. A 2RU horizontal cable manager shall be placed above and below each copper patch panel.

5. Mount 2RU, 48 port voice cross-connect patch panels below WAO station cable patch panels. The number of voice cross-connect jacks shall be equal to the number of pairs in the voice riser cable pair count.

6. A 2RU horizontal cable manager shall be placed above and below each voice cross-connect patch panel.

7. No more than five (5) 48-port station cable patch panels shall be placed in a rack.

8. The fiber connector housings shall be placed in the center rack of the row, in the top-most position of the rack. A fiber connector housing does not require its own horizontal cable managers.

9. The rack with the fiber connector housing will be loaded with one less 48-port station cabling patch-panel than other racks.

10. 2 RU fiber panels shall be used for IDFs. 4 RU fiber panels shall be used for BDFs and ADFs.

11. Fiber terminations shall be fusion spliced LC pigtails.

(update all aspects of layout)

Figure 1 Typical TR Layout that Support Both the BDF and TR/IDF Functions

 TO BE Provided

(update all aspects of layout)

Figure 2 Typical TR Layout that supports only the TR/IDF function

 TO BE Provided

(update all aspects of layout)

Figure 3: Typical idf Equipment rack elevation

 TO BE Provided

5. TR ENVIRONMENTAL REQUIREMENTS

1. HVAC

1. Each TR in a building should have its own dedicated HVAC not connected to or controlled by other building HVAC systems. A TR's HVAC must be designed for 24 hours per day, 365 days per year operation. Each TR shall have its own thermostat. If the building is supported by a standby power system, consider connecting it to the HVAC system(s) that serve each TR.

2. HVAC systems shall not use the same electrical panel that is used to support the outlets servicing the electronics housed within a TR. See TR room electrical below.

3. The temperature in a TR shall be maintained in the range of 640F to 750F.

4. The humidity range should be maintained at 30% to 55% relative humidity.

5. A TR shall ventilate at the rate of one air change per hour.

6. For HVAC sizing at program planning budget level do the following:

a) For a TR performing the IDF function only, assume 2 tons of HVAC will be required (7,032 watts, 24,000 Btu/hr).

b) For a TR performing the BDF/IDF function assume 2.5 tons of HVAC will be required (12,000 watts, 42,000 Btu/hr).

c) For a TR performing the ADF function assume 5 tons of HVAC will be required (17,580 watts, 60,000 Btu/hr).

7. The filters in the HVAC system should have an ASHRAE dust spot rating of 85% or better.

1. Lighting

1. Lighting in the TR shall provide a minimum light level of 50 fc at desktop level on all sides of the rack equipment.

2. If the building is equipped with a standby power system, TR lighting should be connected to it, or the TR should be provided with its own standby lighting in case of power failure.

6. TR ROOM ELECTRICAL

A. Sub-panels shall be provided for dedicated electrical service for all TRs. The estimated electrical load for the telecommunications space shall not exceed 80% of the panel capacity. No power outlets outside the TR shall be serviced by this panel. For initial planning, provide a 100 amp, 120/208 volt, 3 phase panel.

1. Individual branch circuits: All power circuits that supply outlets that support electronics shall be individual branch circuits from their breaker in the TR sub-panel to the outlet receptacle supplying the electronics.

2. Sub-panels: Ideally sub-panels should be located on the outside of the TR near the room entrance door and should be connected to a Standby power source. Sub-panels shall be lockable.

3. Standby power: Standby power connection is critical in the TRs that house campus telephone systems equipment or Core Routers (ADFs) to ensure voice and emergency systems remain operational during power outages that may extend past the systems battery backup capability

4. Convenience wall outlets

a. Convenience wall outlets should be mounted in each room at +18 inches A.F.F. and horizontally spaced not to exceed 6 feet around the perimeter of the room.

b. Convenience outlets shall be non-switched, 120VAC 20 Amp, duplex and divided equally on branch circuits, (i.e., all receptacles in the same room shall not all be on the same circuit). Minimum of two (2) circuits shall be provided per room alternating duplexes around room with no more than four (4) receptacles on the same circuit.

5. Outlet labeling: Label all TR outlets with breaker and panel designation.

B. Estimating Electronics Power Circuit Count for Equipment Racks

1. Provide One (1) quad device box containing two (2) duplex 20 Amp, 120V AC individual branch circuits terminated on NEMA 5-20R-spade receptacles for each equipment rack.

2. Provide One (1) quad device box on standby power containing two (2) duplex 20 Amp, 120V AC individual branch circuits terminated on NEMA 5-20R-spade receptacles for each equipment rack.

3. Device boxes should be mounted fifteen (15) inches A.F.F on the backside of each equipment rack.

4. The placement of the device box and its conduit shall not block or interfere with the rack's equipment mounting area (rails) on either side of rack.

5. For program plan estimating, assume three (3) equipment racks per TR performing the IDF function only and five (5) racks for TR performing BDF/IDF functions.

C. Estimating Electronics Power Circuit Count for Enclosed Equipment Cabinets

1. Provide two (2) quad device boxes with each device box containing two (2) duplex 20 Amp, 120V AC individual branch circuits terminated on NEMA 5-20R-spade receptacles for each equipment cabinet.

2. One (1) device box shall be mounted toward the back of the cabinet near the top inside area of the cabinet to provide electrical power to the cooling fan(s). The second device box shall be located 15 inches above the floor toward the back of the cabinet.

3. The placement of the device boxes and their conduit shall not block or interfere with the cabinet's equipment mounting area (rails) on either side of or front and rear of the cabinet.

D. The TR Performing the ADF Function - Special considerations

Four (4), 30 Amp, 220V L6-R30 outlets for ADFs containing voice equipment. Specific number and location of outlets to be confirmed with the Core Tech telecommunications engineer. Dedicated circuits shall be on emergency power.

7. The Telecommunications Grounding and Bonding System

Telecommunications grounding and bonding systems shall be installed to support the telecommunications infrastructure. The requirements for this system are specified in ANSI-J-STD-607-A: The Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

8. TR Fire Safety and Protection Requirements

Follow campus procedures for fire safety in TR rooms.

9. TELECOMMUNICATION ISP PATHWAY

A. Pathway design coordination: Clarify as early in the design planning phases as possible what pathway is required and which construction discipline will draw, specify, and construct each portion of the required pathway. There is often confusion on this issue that can cause delays and excessive change orders since telecommunication pathways detail design and build out usually requires very close coordination between the electrical/mechanical and telecommunications drawings and specifications documents so that build out supply and construction responsibilities are clearly defined from the start of the Design Development phase of a project.

B. Interior TR Pathway

1. Cablofil Wiremesh Cable Tray (or equal), should be used in TRs to provide cable run management. All cable tray shall be a minimum 12” wide. See Figures 1 and 2, Typical TR Layouts above.

2. Cable tray shall meet Zone 4 or higher seismic bracing standards.

3. Cable tray layout design shall be reviewed and approved the Core Technologies Department's Telecommunications Infrastructure Engineer.

C. Riser pathway

1. Riser pathway interconnects the TRs in a building.

2. When more than one IDF will be needed in a building, four (4), four-inch (4") sleeves will be installed from the BDF to the first IDF. Then each IDF will connect to the one above it with two (2), four-inch (4") sleeves. When the TRs are stacked this requirement is easily accomplished using only conduit riser sleeves floor/ceiling penetrations from one IDF to the next.

D. Primary horizontal cabling pathways

1. Primary horizontal cabling pathways are major pathways that transport WAO cables from the TR to secondary horizontal cabling pathway access points (see below). They are usually constructed using cable tray, Cablofil Wiremesh Cable Tray (or equal). Conduits can be used when it is necessary for the pathway to cross over a hard-lid ceiling.

2. At a minimum, primary horizontal pathways will always require pathway fire-wall penetration fire-stop technology through the TR walls into the occupied space of the floor the TR serves. Other wall penetrations may be required depending on the wall/ceiling layout of the TR's WAO service area.

3 These primary horizontal cabling pathways should be routed following building lines and major floor access routes such as corridors and hallways. They should never cross over end user work areas such as offices, conference rooms, or work cube areas.

4. Access for cabling personnel and technicians that is sufficient for easy cable placement yet causes minimal disruption to floor occupants is an important design consideration when laying out the routing of primary horizontal cabling pathway.

E. Secondary horizontal cabling pathways: to each WAO (conduits to WAO junction boxes)

1. Conduits will be installed from within 3 feet of a cable tray to each WAO in-wall junction box.

2. Junction boxes are mounted in the wall and connect to the conduit. They are used to mount the WAO faceplate that houses the cable termination jacks that are the WAO's network connection points. Generally double-gang boxes with single-gang mud rings are used.

3. There are two special cases of secondary pathway that must be accounted for in most projects.

a) Modular furniture raceway access.

b) Wall-mount access - stand alone or raceway

These secondary pathways require an understanding of the layouts and use of the areas they serve before they can be sized and specified in any detail.

3. Conduits to each WAO will be sized depending on the number of cables at the WAO, but unless otherwise noted, most WAO conduits will be 1” conduits.

4. All cable to each WAO will be homerun through the pathway systems described. The WAO cable will travel through the secondary pathway (conduit), then the primary pathway (cable tray and possibly conduits), then to the area-serving TR.

F. Pathway Fill

1. Conduit: See BICSI Telecommunications Distribution Methods Manual (TDMM), 12th edition, for pathway cable fill recommendations and restrictions.

2. Cable tray and J-hooks: See manufacture's load tables.

10. TELECOMMUNICATIONS OSP PATHWAY

A. Campus OSP Environments: Construction involving a new or existing building structure shall have an assessment of the OSP pathway connectivity infrastructure. If sufficient duct space is not available additional duct space will need to be made available through cable consolidation, duct clearing, or installation of new ducts. This assessment is of particular importance if demolition of any structure is required as part of the overall project, and/or the new project may impact an existing OSP connectivity infrastructure.

B. ADF Function Connectivity

1. All buildings, unless they contain the ADF function, must physically (note: physical includes wireless technology) connect to an ADF designated to service the campus area that a particular building is located in or the building will not be able to function as an integrated component of the UCSC telecommunications infrastructure.

2. Define as early as possible in the project planning phases how any given project will achieve its required ADF connectivity.

C. Building OSP EF (Entrance Facility)

1. A minimum of two 4” entrance conduits shall be installed into the EF of any building from the nearest existing telecommunications OSP plant connectivity access point, usually a telecommunications maintenance hole (MH). If the required OSP access point is non-existent or the use of the nearest OSP access point is impractical, the required OSP access point must be designed and built.

2. Dual OSP entrances from different OSP access points are very desirable where possible, and should be considered especially for buildings that house emergency services, data core systems, disaster recovery systems, or those buildings designated as an essential services building on campus.

D. OSP Design Reference Material

OSP shall be designed per BICSI, Outside Plan Design Reference Manual (OSPDRM), 4th Edition

11. Structured Cabling System

A. The Telecommunications/ITS spaces and pathway requirements stated above support what the Telecommunications industry calls a Structured Cabling System which includes OSP backbone, riser cable, and WAO horizontal cabling.

B. The Contracting company installing the Structured Cabling System shall be documented by the manufacturer/supplier as a certified and approved installer of the manufacture's Structured Cabling System.

C. Quantity Estimates

1. Estimate number of required OSP backbone copper pairs.

2. Estimate number of required OSP backbone fiber strands - minimum of 96 strands for non-ADF buildings and 144 strands for an ADF. All OSP fiber shall be OS2, steel armored cable.

3. Estimate number of required copper pairs for each IDF - minimum of 100 pair.

4. Estimate number of required fiber riser strands for each IDF - minimum of 24 OS2 strands per IDF.

5. Estimate quantity of WAOs on a floor by using one (1) WAO for every one hundred (100) GSF.

6. Estimate quantity of horizontal cables by using two (2) cables for each WAO as a base number. Minimum cable performance certification shall be UTP Category 6.

12. Network Wireless

A. Network wireless is 802.11N service.

B. Network wireless shall be designed per TIA/TSB 162 and BICSI Wireless Design Reference Manual (WDRM), 3rd Edition.

C. Design wireless coverage for the entire building.

D. WAP cabling and jacks are for the exclusive use of network services.

E. WAP

1. Each WAP location shall have 2 horizontal cables.

2. WAP junction boxes shall be at ceiling level and opening shall face downward.

3. WAP power is Power Over Ethernet (POE).

4. Location of WAPs.

a. Place In hallways on or near cable trays.

b. Place In conference rooms.

c. Do not place WAPs in offices or over work cube areas.

END OF DIVISION 27 DESIGN GUIDE