CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

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2. DESIGN ANALYSIS TITLE			
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14. REMARKS

Design Analysis Revision Record

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1. PURPOSE

The purpose of this design analysis is to determine the feasibility of network alternatives available to support the Exploratory Study Facilities (ESF) site characterization test data gathering activity as well as the facility control and monitoring systems. If it is found that more than one feasible alternative exists, a cost analysis will also be conducted to determine the least costly alternative.

2. QUALITY ASSURANCE

QA classification is "NONE". No QA controls are applicable.

3. METHOD

Literature searches, discussions with vendor technical representatives.

4. CODES AND STANDARDS

4.1 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) 802.3/Ethernet

4.2 AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI) ACCREDITED STANDARDS COMMITTEE (ASC) X3T9.5

5. DESIGN INPUTS

5.1 Total distance to be spanned by the network. Overall Subsurface Layout TS Level Plan, Drawing BABEAD000-01717-2100-40100 Rev 01, 7/7/94. Drawing No. YMP-025-2-MING-M133 (DOE 1991)

5.2 Number of data channels to be supported by the network. Memo (LA-EES-13-LV-06-94), June 13, 1994, from E. Fred Homuth, LANL TCO, to Dale Foust, M&O.

6. CRITERIA

6.1 If more than one network alternative is feasible, the determinant criteria shall be cost. [BFD, Rev 05, December 22, 1994, 7.4.1.IV.9, Third Bullet]"

6.2 Preference will be given to feasible network alternatives that conform to the standards listed in Section 4 above. [BFD, Rev 05, December 22, 1994, 7.4.1.III.1]"

7. ASSUMPTIONS

7.1 Validity of current construction and testing schedules.

8. REFERENCES

8.1 Digital Equipment Corporation, Networks Buyer's Guide, Annual Edition, 1992-1993.

8.2 Digital Equipment Corporation, DECdirect, Hardware, 1993 Winter Catalog

8.3 Siecor FDDI Network Cabling Design Guide, SIECOR Corporation 1989, 1990.

8.4 Siecor Premises Fiber Optic Products Catalog, Fourth Edition, SIECOR Corporation, 1993.

8.5 Ray Wilson, Digital Equipment Corporation, Networking and Systems Integration Support Staff, telephone discussion.

8.6 Conspec Controls, Ltd., General Catalog, undated loose-leaf binder.

9. COMPUTER PROGRAMS

Not Applicable.

10. DESIGN ANALYSIS

10.1 Three network alternatives appear to be available to support the data gathering and control and monitoring systems in the ESF:

IEEE 802.3/Ethernet

ANSI ASC X3T9.5 FDDI

Conspec Accessor Trunk Cable

10.2 Ethernet is a mature networking technology that has recently been given expanded capabilities through the use of fiber optic cable installations. FDDI is a newer, and significantly faster, networking technology that utilizes fiber optic cable also and is capable of handling significantly greater distances than Ethernet. The Conspec Accessor Trunk Cable is a proprietary network based on RS 485 technology that has been proven to span great distances in mining applications. Other networking alternatives, such as IEEE 802.5/Token Ring, exist, but are excluded from this analysis because of limitations that would preclude their use in the ESF.

10.3 The drawings referenced in Section 5 above have been used to estimate the distances involved in the ESF, since distance is a primary determinant of the feasibility of the networks. Including the North and South ramp extensions, the Main Test Area, the Ghost Dance Fault Drifts, and an estimated one kilometer from the North Portal to the surface host computer facility, it appears that the network must span in excess of 20 kilometers.

10.4 DEC's Network Buyer's Guide is somewhat vague on the total distance limitations imposed upon an extended fiber optic Ethernet network. For example, page 2-77 cites the following:

> "A properly configured system, implemented on a structured fiber optic cabling system consisting of 62.5/125 micron fiber, supports maximum distances of 1.5 km (4,910 feet) between a star and a fiber transceiver."

Yet on page 2-90 of the same document, it is stated that "A standard IEEE 802.3/Ethernet LAN has a limit of 2.8 km (1.7 miles) between the farthest two nodes on the network."

10.5 Similarly, DEC's Network Buyer's Guide is silent on the subject of how many Ethernet networks may be joined together with bridges and/or repeaters, yet the DECdirect hardware catalog (page 109) states that "Digital's IEEE 802.3/Ethernet bridges...are designed to transparently connect a series of up to eight 802.3/Ethernet LANs, using copper or fiber-optic cable".

10.6 In order to clear up the confusion resulting from such contradictory statements, contact was made with Ray Wilson, a Digital network specialist. Ray confirmed the following:

10.6.1 The maximum length of an IEEE 802.3/Ethernet network using fiber-optic cable is 1.5km.

10.6.2 A maximum of eight IEEE 802.3/Ethernet networks may be connected by bridges.

10.6.3 IEEE 802.3/Ethernet and FDDI use the same fiber-optic cable.

10.7 Using the above data, it is apparent that the maximum distance that can be spanned by an extended IEEE 802.3/Ethernet network comprised of eight fiber-optic cable IEEE 802.3/Ethernet networks (of 1.5km ech) sequentially connected through the ESF is 12 km. The total distance to be spanned exceeds 20KM.

10.8 FDDI networks, on the other hand, support a maximum ring circumference of 100km, which greatly exceeds the total distance to be spanned.

10.9 The data transmitting and receiving lines in the Conspec Accessor Trunk Cable can carry a communications signal for up to 2.4 kilometers (8,000 feet). With the use of a Conspec Trunk expander card, which reconditions the signal, this distance can easily be doubled. By using three expanders, communications can be maintained for over 9.6 kilometers (approximately six miles). One Accessor Trunk Cable supports up to 128 accessors, allowing the user to communicate with up to 1,000 data channels. For distances beyond 9.6 kilometers, an Accessor Trunk Extender may be used to increase the distance served by the trunk cable. In addition, Conspec supplies a Red Outstation (basically a modem), that permits the use of telephone wire to span great distances not served by a trunk cable's accessors before connecting to the trunk cable through the outstation.

This alternative is attractive because of the relatively low cost of accessor trunk cable ($.99 - $1.32/meter ($.30 - $.40/foot)) and telephone wire ($.33 - $.50/meter ($.10 - $.15/foot)) compared to fiber-optic cable ($4.30 - $6.60/meter ($1.30 - $2.00/foot)). The major limitation to the use of Accessor Trunk Cable, however, is the maximum number of data channels that can be served by a single trunk cable and the maximum number of trunk cables permitted in a single Conspec system (currently 8). The Conspec catalog lists the maximum capacity of a single trunk cable as 1,000 data channels (or 128 accessors). This is based on the use of 8 channel accessors. In specific instrumentation cases foreseen at Yucca Mountain, specifically vibrating wire, discussions with USBM and Conspec representatives have disclosed that only a single channel accessor will be available to support such instrumentation. However, for purposes of this study, the presumption will be made that, on average, 8 channel accessors will be used. This represents the best case scenario for Conspec.

Based on the current schedule of tests (and related data channels) to be performed at Yucca Mountain and an estimate of 2,600 data channels to support the underground

facilities monitoring and control (FMCS) aspects of the IDCS, the total number of data channels required in the main tunnel is 6,100 (60 construction monitoring locations at 40 data channels per location, plus 4 USGS radial borehole test locations at 140 data channels per location, plus one USGS excavation effects test location with 515 data channels, plus one plate loading test location with 25 data channels, along with the estimated 2,600 FMCS data channels). This equates to at least 6 accessor trunk cables, with the latter five run off Red Outstations with telephone wire connections to the underground control station. In addition, the North and South Ramp extensions, while currently only requiring approximately 400 data channels apiece, would likley require one trunk cable each, bringing the total number of trunk cables required to the maximum of 8. While it is possible that a wiring scheme could be devised that would eliminate one trunk cable in servicing the two ramp extensions, this would still leave at least 10,000 data channels to be serviced in the main test area (largely due to the LLNL Engineered Barrier Test to be conducted in this area with approximately 9,000 data channels estimated). In addition, should SNL adhere to present plans to extensively utilize vibrating wire instrumentation, the number of available accessor trunk cables would be exhausted before reaching the bottom of the North Ramp. (NOTE: All references to the number of data channels required to support site characterization tests are derived from a Memo (LA-EES-13-LV-06-94), June 13, 1994, from E. Fred Homuth, LANL TCO, to Dale Foust, M&O.)

10.10 Based on the above analysis, it becomes obvious that the Conspec Accessor Trunk Cable alternative is not feasible for Yucca Mountain.

11. CONCLUSIONS

FDDI is the only feasible network alternative for the ESF because of the distance and number of data channels involved. Therefore, there is no need for a cost analysis.

12. ATTACHMENTS

Not Applicable.