



Illinois Department of Transportation

2300 South Dirksen Parkway / Springfield, Illinois / 62764

June 3, 2009

SUBJECT: FAI Route 55
Project CMI-055-6 (236) 249
Section 2007-0621
Will, DuPage & Cook Counties
Contract No. 60E01
Item No. 111, June 12, 2009 Letting
Addendum A

NOTICE TO PROSPECTIVE BIDDERS:

Attached is an addendum to the plans or proposal. This addendum involves revised and/or added material.

1. Replace the Schedule of Prices.
2. Revised the Table of Contents to the Special Provisions.
3. Revised pages 2 - 5, 10 - 19, 22 - 105 & 109 - 120 of the Special Provisions.
4. Added pages 162 - 164 to the Special Provisions.
5. Revised sheets 1 - 57, 64 - 71, 73 & 74 of the Plans.
6. Added sheets 73a - 73d to the Plans.

Prime contractors must utilize the enclosed material when preparing their bid and must include any Schedule of Prices changes in their bidding proposal.

Bidders using computer-generated bids are cautioned to reflect any and all Schedule of Prices changes, if involved, into their computer programs.

Very truly yours,

Charles Ingersoll, Chief
Bureau of Design and Environment

A handwritten signature in cursive script, reading "Ted B. Walschleger" followed by a small "P.E." monogram.

By: Ted B. Walschleger, P. E.
Engineer of Project Management

cc: Diane O'Keefe, Region 1, District 1; Bill Frey, Estimates

TBW:MS:jc

ILLINOIS DEPARTMENT OF TRANSPORTATION
 SCHEDULE OF PRICES
 CONTRACT
 NUMBER - 60E01

State Job # - C-91-159-08
 PPS NBR - 1-77935-0000
 County Name - COOK- DUPAGE- WILL
 Code - 31 - 43 - 197
 District - 1 - 1 - 1
 Section Number - 2007-062I

Project Number
 CMI-0556/236/249

Route
 FAI 55

* REVISED : MAY 29, 2009

Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
XX006937	GROUND ROD 5/8 X 10	EACH	39.000				
X0323898	CCTV DOME CAMERA	EACH	39.000				
X0323914	FOC SPLICE - LATERAL	EACH	5.000				
X0323957	FOC SPLICE - MAINLINE	EACH	1.000				
X0324794	COMM SHELTER 10X12	EACH	1.000				
X0325040	FO INNERDUCT 1 1/4"	FOOT	47,740.000				
X0326459	HANDHOLE C CONC 30X48	EACH	22.000				
X0326460	CCTV EQPT WIRELESS DS	EACH	34.000				
X0326461	CCTV EQPT FBR OPT DST	EACH	5.000				
X0326462	BDGT ALWNC TWY FO CON	L SUM	1.000				
X0326463	WIRELESS VID DSTN SYS	L SUM	1.000				
X0326464	CCTV CAM STR 80 FT MT	EACH	39.000				
X0326465	MOD EX VID DSTN SYS	L SUM	1.000				
X0326641	INST CCTV CAM STR RCK	FOOT	156.000				
X0326642	INST CCTV CAM STR SOL	FOOT	312.000				

ILLINOIS DEPARTMENT OF TRANSPORTATION
 SCHEDULE OF PRICES
 CONTRACT
 NUMBER - 60E01

State Job # - C-91-159-08
 PPS NBR - 1-77935-0000
 County Name - COOK- DUPAGE- WILL
 Code - 31 - 43 - 197
 District - 1 - 1 - 1
 Section Number - 2007-0621

Project Number
 CMI-0556/236/249

Route
 FAI 55

* REVISED : MAY 29, 2009

Item Number	Pay Item Description	Unit of Measure	Quantity	x	Unit Price	=	Total Price
X7011015	TR C-PROT EXPRESSWAYS	L SUM	1.000				
X8050010	SERV INSTALL GRND MT	EACH	13.000				
X8160162	UD 2#8#10G EPRRHW 1.25	FOOT	11,803.000				
X8710028	FIB OPT CBL 6F SM	FOOT	1,380.000				
X8710035	FIB OPT CBL 96F SM	FOOT	48,740.000				
Z0076600	TRAINEES	HOUR	500.000		0.800		400.000
67000400	ENGR FIELD OFFICE A	CAL MO	9.000				
67100100	MOBILIZATION	L SUM	1.000				
70102620	TR CONT & PROT 701501	L SUM	1.000				
80400200	ELECT UTIL SERV CONN	L SUM	1.000		26,000.000		26,000.000
81000700	CON T 2 1/2 GALVS	FOOT	715.000				
81018600	CON P 2 1/2 GALVS	FOOT	1,364.000				
81018900	CON P 4 GALVS	FOOT	946.000				
81100705	CON AT ST 2.5 PVC GS	FOOT	220.000				
81101005	CON AT ST 4 PVC GALVS	FOOT	275.000				

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STANDARDS:

701001
701006
701301
701501
701901

DETAILS:

TC-10
TC-17

SPECIAL PROVISIONS:

Keeping Expressway Open to Traffic.
Traffic Control and Protection (Expressways).
Personal Protective Equipment
Reflective Sheeting on Channelizing Devices

TRAFFIC CONTROL AND PROTECTION (EXPRESSWAYS)

Effective: 3/8/96

Revised: 5/29/09

Description. This work shall include furnishing, installing, maintaining, replacing, relocating, and removing all traffic control devices used for the purpose of regulating, warning, or directing traffic. Traffic control and protection shall be provided as called for in the plans, applicable Highway Standards, District One Expressway details, Standards and Supplemental Specifications, these Special Provisions, or as directed by the Engineer.

General. The governing factor in the execution and staging of work for this project is to provide the motoring public with the safest possible travel conditions on the expressway through the construction zone. The Contractor shall arrange his operations to keep the closing of lanes and/or ramps to a minimum.

The Contractor shall be responsible for the proper location, installation, and arrangement of all traffic control devices. Special attention shall be given to existing warning signs and overhead guide signs during all construction operations. Warning signs and existing guide signs with down arrows shall be kept consistent with the barricade placement at all times. The Contractor shall immediately remove, completely cover, or turn from the motorist's view all signs which are inconsistent with lane assignment patterns.

The Contractor shall coordinate all traffic control work on this project with adjoining or overlapping projects, including barricade placement necessary to provide a uniform traffic detour pattern. When directed by the Engineer, the Contractor shall remove all traffic control devices that were furnished, installed, or maintained by him under this contract, and such devices shall remain the property of the Contractor. All traffic control devices shall remain in place until specific authorization for relocation or removal is received from the Engineer.

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Additional requirements for traffic control devices shall be as follows.

- (a) **Traffic Control Setup and Removal.** The setting and removal of barricades for the taper portion of a lane closure shall be done under the protection of a vehicle with a crash attenuator and arrow board. The attenuator vehicle shall be positioned in the live lane that is being closed or opened in advance of the workers and shall have the arrow panel directing traffic to the adjacent open lane. Failure to meet this requirement will subject to a Traffic Control Deficiency charge. The deficiency will be calculated as outlined in Article 105.03 of the Standard Specifications. Truck/trailer mounted attenuators shall comply with Article 1106.02(g) or shall meet the requirements of NCHRP 350 Test Level 3 with vehicles used in accordance with manufacturer's recommendations and requirements.
- (b) **Sign Requirements**
 - (1) **Sign Maintenance.** Prior to the beginning of construction operations, the Contractor will be provided a sign log of all existing signs within the limits of the construction zone. The Contractor is responsible for verifying the accuracy of the sign log. Throughout the duration of this project, all existing traffic signs shall be maintained by the Contractor. All provisions of Article 107.25 of the Standard Specifications shall apply except the third paragraph shall be revised to read: "The Contractor shall maintain, furnish, and replace at his own expense, any traffic sign or post which has been damaged or lost by the Contractor or a third party. The Contractor will not be held liable for third party damage to large freeway guide signs".
 - (2) **Work Zone Speed Limit Signs.** Work zone speed limit signs shall be installed as required in Article 701.14(b) and as shown in the plans and Highway Standards. Based upon the existing posted speed limit, work zone speed limits shall be established and signed as follows.
 - a. **Existing Speed Limit of 55mph or higher.** The initial work zone speed limit assembly, located approximately 3200' before the closure, shall be 55mph as shown in 701400. Additional work zone 45mph assemblies shall be used as required according to Article 701.14(b) and as shown in the Highway Standards and plans.
 - b. **Existing Speed Limit of 45mph.** The advance 55mph work zone speed limit assembly shown in 701400 shall be replaced with a 45mph assembly. Additional work zone 45mph assemblies shall be used as required according to Article 701.14(b) and as shown in the Highway Standards and plans. "Resumes" assemblies shall be eliminated. END WORK ZONE SPEED LIMIT signs are required.
 - (3) **Exit Signs.** The exit gore signs as shown in Standard 701411 shall be a minimum size of 48 inch by 48 inch with 12 inch capital letters and a 20 inch arrow. EXIT OPEN AHEAD signs shown in Standard 701411 shall be a minimum size of 48 inch by 48 inch with 8 inch capital letters.

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- (4) Uneven Lanes Signs. The Contractor shall furnish and erect "UNEVEN LANES" signs (W8-11) on both sides of the expressway, at any time when the elevation difference between adjacent lanes open to traffic equals or exceeds one inch. Signs shall be placed 500' in advance of the drop-off, within 500' of every entrance, and a minimum of every mile.
- (c) Drums/Barricades. Check barricades shall be placed in work areas perpendicular to traffic every 1000', one per lane and per shoulder, to prevent motorists from using work areas as a traveled way. Check barricades shall also be placed in advance of each open patch, or excavation, or any other hazard in the work area, the first at the edge of the open traffic lane and the second centered in the closed lane. Check barricades, either Type I or II, or drums shall be equipped with a flashing light.
- To provide sufficient lane widths (10' minimum) for traffic and also working room, the Contractor shall furnish and install vertical barricades with steady burn lights, in lieu of Type II or drums, along the cold milling and asphalt paving operations. The vertical barricades shall be placed at the same spacing as the drums.
- (d) Vertical Barricades. Vertical barricades shall not be used in lane closure tapers, lane shifts, and exit ramp gores. Also, vertical barricades shall not be used as patch barricades or check barricades. Special attention shall be given, and ballast provided per manufacture's specification, to maintain the vertical barricades in an upright position and in proper alignment.
- (e) Temporary Concrete Barrier Wall. Prismatic barrier wall reflectors shall be installed on both the face of the wall next to traffic, and the top of sections of the temporary concrete barrier wall as shown in Standard 704001. The color of these reflectors shall match the color of the edgelines (yellow on the left and crystal or white on the right). If the base of the temporary concrete barrier wall is 12 inches or less from the travel lane, then the lower slope of the wall shall also have a 6 inch wide temporary pavement marking edgeline (yellow on the left and white on the right).

Method of Measurement. This item of work will be measured on a lump sum basis for furnishing, installing, maintaining, replacing, relocating, and removing traffic control devices required in the plans and these Special Provisions. Traffic control and protection required under Standards 701101, 701400, 701401, 701402, 701406, 701411, 701416, 701426, 701446, 701901 and District details TC-8, TC-9, TC-17, TC-18 and TC-25 will be included with this item.

Basis of Payment.

- (a) This work will be paid for at the contract lump sum price for TRAFFIC CONTROL AND PROTECTION (EXPRESSWAYS). This price shall be payment in full for all labor, materials, transportation, handling, and incidental work necessary to furnish, install, maintain, replace, relocate, and remove all Expressway traffic control devices required in the plans and specifications.

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In the event the sum total value of all the work items for which traffic control and protection is required is increased or decreased by more than ten percent (10%), the contract bid price for TRAFFIC CONTROL AND PROTECTION (EXPRESSWAYS) will be adjusted as follows:

$$\text{Adjusted contract price} = .25P + .75P [1+(X-0.1)]$$

Where: "P" is the bid unit price for Traffic Control and Protection

$$\text{Where: "X" = } \left| \frac{\text{Difference between original and final sum total value of all work items for which traffic control and protection is required}}{\text{Original sum total value of all work items for which traffic control and protection is required.}} \right|$$

The value of the work items used in calculating the increase and decrease will include only items that have been added to or deducted from the contract under Article 104.02 of the Standard Specifications and only items which require use of Traffic Control and Protection.

- (b) The Engineer may require additional traffic control be installed in accordance with standards and/or designs other than those included in the plans. In such cases, the standards and/or designs will be made available to the Contractor at least one week in advance of the change in traffic control. Payment for any additional traffic control required will be in accordance with Article 109.04 of the Standard Specifications.
- (c) Revisions in the phasing of construction or maintenance operations, requested by the Contractor, may require traffic control to be installed in accordance with standards and/or designs other than those included in the plans. Revisions or modifications to the traffic control shown in the contract shall be submitted by the Contractor for approval by the Engineer. No additional payment will be made for a Contractor requested modification.
- (d) Temporary concrete barrier wall will be measured and paid for according to Section 704.
- (e) Impact attenuators, temporary bridge rail, and temporary rumble strips will be paid for separately.
- (f) Temporary pavement markings shown not shown on the Standard will be measured and paid for according to Section 703 and Section 780.
- (g) All pavement marking removal will be measured and paid for according to Section 703 or Section 783.
- (h) Temporary pavement marking on the lower slope of the temporary concrete barrier wall will be measured and paid for as TEMPORARY PAVEMENT MARKING, 6".
- (i) All prismatic barrier wall reflectors will be measured and paid for according to the Recurring Special Provision Guardrail and Barrier Wall Delineation.

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verified by the Engineer to be accurate within 100 feet. Upon verification, data collection can begin. Data collection can be made as construction progresses, or can be collected after all items are installed. If the data is unacceptable the contractor shall make corrections to the data collection equipment and or process and submit the data for review and approval as specified.

Accuracy. Data collected is to be mapping grade. A handheld mapping grade GPS device shall be used for the data collection. The receiver shall support differential correction and data shall have a minimum 5 meter accuracy after post processing.

GPS receivers integrated into cellular communication devices, recreational and automotive GPS devices are not acceptable.

The GPS shall be the product of an established major GPS manufacturer having been in the business for a minimum of 6 years.”

CCTV CAMERA STRUCTURE

Effective: June 1, 2009

Description.

This work shall consist of furnishing a CCTV camera structure complete with camera lowering device. The structure may be either a galvanized steel structure with a concrete foundation, or a spun concrete structure for direct embedment. Specifications for each type of structure are detailed in the respective section herein.

Definitions.

CCTV Camera Structure: The complete camera structure and lowering device as one integral working system.

Shaft: The camera structure shaft.

Lowering Device: The components involved with the mounting, operation, and raising and lowering of the CCTV camera.

Structure Height: The height of the structure shall be measured as indicated on the detail drawings

Materials.

Materials shall be as specified elsewhere herein.

Deflection.

The design of the structure shaft shall achieve a maximum, fully loaded deflection at the top of the structure, which is not greater than 1-inch

Submittals and Certifications.

The structure shall be designed in accordance with 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals with Appendix C wind pressure for a 90 mph wind zone with a 1.3 gust factor. The pole shall be designed for use with a single arm camera lowering device with a total effective area of 2 square feet and total weight of 95 lbs. The structure shall also be designed to accommodate the loading of the radio

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antennas as required and specified elsewhere herein. The radio antennas shall be secured to the shaft as recommended by the structure manufacturer, antenna manufacturer and as approved by the Engineer. The mounting height of the antennas shall be determined by radio equipment the contractor selects. The structure shall not exceed 1" deflection in a 30 mph (non-gust) wind.

The camera structure shall be designed and constructed so no structural member or other component is applied in excess of the manufacturer's recommended rating (when applicable) or the published rating, whichever is lower

Shop drawings, product data and certifications shall be submitted. The submitted information shall be complete and shall include information relative to all specified requirements suitable for verification of compliance.

THE SUBMITTALS SHALL BE ARRANGED AND CROSS-REFERENCED TO THE SPECIAL PROVISIONS AND STANDARD SPECIFICATIONS. FAILURE TO CROSS-REFERENCE THE SUBMITTAL INFORMATION WITH THE SPECIAL PROVISIONS WILL RESULT IN THE SUBMITTAL BEING RETURNED WITHOUT REVIEW.

The submittal information shall be dated, current, project specific, identified as to the project, and shall also include the following calculations and certifications as applicable to the material utilized:

- Shaft design calculations, including Registered Engineer Certification.
- Certification of intent to provide domestic steel in accordance with Article 106.01 of the Standard Specifications.
- Welding details and procedures.
- Letter of intent to provide specified weld inspection reports.
- Confirmation of coordination between anchor rod supplier and the structure manufacturer for adequacy of anchor rod assembly.
- Foundation Design
- Manufacturer's recommended installation procedures.
- Letter of intent to provide manufacturer's representative during installation and to provide specified installation certification.

All certifications shall be notarized.

Steel Camera Structure

Shaft:

The pole shall be a maximum of three sections for field assembly. The pole shafts shall be a round cross section and meet the requirements of ASTM A595 grade A with a minimum yield strength of 55,000 psi. The bottom section shall have a minimum .3125 wall thickness and a minimum diameter of 23". The three shafts sections shall taper at a rate of .14" per foot and have an overall height of 80'. The pole base plate shall meet the requirements of ASTM A36 and be arranged to accommodate four (4) 1 1/2" x 54" x 6" anchor bolts on a 27" bolt circle. Anchor bolts shall conform to ASTM F1554 gr. 55

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The pole assembly shall be equipped with a 6" x 27" reinforced hand hole opening with a 3 gauge cover and shall be attached with four (4) ¼"-20 hex hd s.s. screws. The bottom of the hand hole shall be located up 14" from the bottom. The hand hole frame shall meet ASTM A529 grade 50 and shall be made from ¾" x 3 ½" bar. There shall be a 3/8" diameter rod for wire tie off located at the top of the opening and 1 ¾" from the front of the hand hole frame and also a ½" tapped hole located 1 ¾" from the front of the frame at the bottom of the opening as shown on the drawing.

Six (6) 1" i.d. eye rings for power and communication cables are required as shown on the drawing. Two (2) shall be located 38" up from the bottom, two (2) located 6" below the top of the bottom shaft and two (2) 6" below the top of the center shaft.

There shall be a 3 ½" schedule 40 (4" od) pipe tenon 11 ¾" tall on a 3/8" thick plate welded to the top of the pole. The pipe tenon shall include a 1 ¾" x 5 ¼" slot and two (2) 5/8" holes as shown on the drawing to accommodate the Camera Lowering System arm assembly. A J-hook shall be included inside the top of the tenon assembly and shall include a removable cast aluminum pole top.

CCTV equipment mounting provision. The tower shaft shall include four (4) mounting standoffs welded to the tower shaft prior to finishing. The standoffs shall be configured as indicated on the drawings and shall be arranged to facilitate the installation of a standard 24" x 20" x 10" NEMA 4X stainless steel junction box as manufactured by Hoffman Enclosures (A-24H2010SSLP) or Electromate Enclosures (E-24H2010SS) as a minimum size. The contractor's selection of equipment, specified elsewhere herein, may require a larger junction box. The mounting of the box shall be fully coordinated with any other pay items. The standoffs shall be drilled and tapped to accept a 7/16" diameter bolt.

Foundation:

The structure manufacturer shall provide a pole foundation detail based on the soil conditions of the project. Soil borings from recent expressway mainline reconstruction projects are available for viewing at the District Electrical Design Section office by appointment with 48 hour notice

Concrete Camera Structure

| The pole shall be manufactured domestically.

The pole shall achieve a minimum 28-day compressive strength of 8,000 psi. Cement shall conform to the latest requirements of Type I Portland Cement in accordance with ASTM-C150. Maximum size aggregate may be ¾ inch (19mm) or ¾ of the clear spacing between reinforcing steel and surface of pole. Any water reducers, retarders, or accelerating admixtures shall conform to ASTM-C494. Water shall be free from foreign materials in amounts harmful to concrete and embedded steel.

Reinforcing Steel- Deformed steel reinforcement shall conform to requirements of ASTM-A615 for Grade 60 Rebar.

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Prestressing Steel- Prestressing steel reinforcement shall conform to uncoated 7-wire, stress relieved strand; ASTM-A416.

Spiral Reinforcement- Steel spiral reinforcement shall conform to the requirements of ASTM-A82 and shall not be less than 0.150-inch diameter.

Hardware- All structural steel shall conform to ASTM-A36 and zinc alloy AC41A shall conform to ASTM-B240. The finish shall be hot dipped galvanized in accordance with ASTM-A153.

Electrical Ground- All poles will be supplied with a #6 stranded copper ground wire cast into the wall of the pole at the handhole box location.

Any pigments used shall be non-fade iron or chromium oxides. The color shall approved by the Engineer. All poles to be etched and finished with two coats of waterproof breathing membrane of methyl methacrylate. Any deviation from this aggregate finish, color, and composition requires approval from the Engineer.

All manufacturing tolerance, details of reinforcement, and finishes shall be in accordance with the Guide Specification for Prestressed Concrete Poles as published in the May-June, 1982, issue of the Journal of the Prestressed Concrete Institute.

A concrete cylinder test shall be performed for each 100 cubic yards of concrete poured. A final quality control check shall be carried out on each pole after manufacturing is complete. All quality control procedures shall be mandated in a written manual and be submitted for review and approval.

Fabrication, General

The manufacture shall have a minimum of 15 years of experience in the design and production of centrifugally spun concrete poles. Poles shall be prestressed and the concrete placed by the centrifugal spinning process. The centrifugal spinning is to insure both a minimum 28-day compressive strength of 8,000 psi and a minimum of $\frac{3}{4}$ inch cover over the prestressing strand.

Poles shall have a smooth natural form finish, soft gray in color.

Poles shall be designed and constructed so that all wiring and grounding facilities are concealed within the pole. All handholes, couplings, thru-bolt holes and ground wire shall be cast into the pole during the manufacturing process.

CCTV equipment mounting provision. The shaft shall have a provision for mounting a standard 24" x 20" x 10" NEMA 4X stainless steel junction box as manufactured by Hoffman Enclosures (A-24H2010SSLP) or Electromate Enclosures (E-24H2010SS) as a minimum size. The contractor's selection of equipment, specified elsewhere herein, may require a larger junction box. The mounting of the box shall be fully coordinated with any other pay items.

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Poles shall be round in cross section and provide a continuous taper of .18" per foot of length and provide a minimum 3/4" of concrete coverage over the prestressing strands.

All cable entry holes shall be in accordance with the location on submittal drawings, and sizes as required, and shall be free from sharp edges for passages of electrical wiring.

- A. Two 3" x 12" conduit entrance openings centered 30" below grade.
- B. Handhole and pole top tenon as shown on the plans & per lowering device provider. Camera lowering device to mount to a special designed tenon bolted to the top of pole (see assembly drawings).

All poles shall be provided with a fish wire to facilitate cable installation.

All poles to have a minimum inside raceway dimension of 5" at tip of pole.

Handling and Installation. Prestressed concrete poles shall be lifted and supported during manufacturing, stockpiling, transporting and erection operations only at the points shown on the shop drawings.

Transportation, site handling, and erection shall be performed with acceptable equipment and methods, and by qualified personnel.

Installation. The concrete structure manufacturer shall provide a pole embedment detail based on the soil conditions of the project. Soil borings from recent expressway mainline reconstruction projects are available for viewing at the District Electrical Design Section office by appointment with 48 hour notice.

Camera Lowering Device

General:

The camera lowering system shall be designed to support and lower a standard closed circuit television camera, lens, housing, PTZ mechanism, cabling, connectors and other supporting field components without damage or causing degradation of camera operations. The camera lowering system device and the pole are interdependent; and thus, must be considered a single unit or system. The lowering system shall consist of a pole, suspension contact unit, divided support arm, and a pole adapter for attachment to a pole top tenon, pole top junction box, conduit mount adapter and camera connection box. The divided support arm and receiver brackets shall be designed to self-align the contact unit with the pole center line during installation and insure the contact unit cannot twist under high wind conditions. For maximum arm strength, round support arms are not acceptable. The camera-lowering device shall withstand wind forces of 100mph with a 30 percent gust factor using a 1.65 safety factor. The lowering device manufacturer, upon request, shall furnish independent laboratory testing documents certifying adherence to the stated wind force criteria utilizing, as a minimum effective projected area, the actual EPA or an EPA greater than that of the camera system to be attached.

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The camera-lowering device to be furnished shall be the product of manufacturers with a minimum of 3 years of experience in the successful manufacturing of camera lowering systems. The lowering device provider shall be able to identify a minimum of 3 previous projects where the purposed system has been installed successfully for over a one-year period of time each.

The lowering device manufacturer shall furnish a factory representative to assist the electrical contractor with the assembly and testing of the first lowering system onto the pole assembly. The manufacturer shall furnish the applicable DOT engineer documentation certifying that the electrical contractor has been instructed on the installation, operation and safety features of the lowering device. The contractor shall be responsible for providing applicable maintenance personnel "on site" operational instructions.

Suspension Contact Unit:

The suspension contact unit shall have a load capacity 200 lbs. with a 4 to 1 safety factor. There shall be a locking mechanism between the fixed and moveable components of the lowering device. The movable assembly shall have a minimum of 2 latches. This latching mechanism shall securely hold the device and its mounted equipment. The latching mechanism shall operate by alternately raising and lowering the assembly using the winch and lowering cable. When latched, all weight shall be removed from the lowering cable. The fixed unit shall have a heavy duty cast tracking guide and means to allow latching in the same position each time. The contact unit housing shall be weatherproof with a gasket provided to seal the interior from dust and moisture.

The prefabricated components of the lift unit support system shall be designed to preclude the lifting cable from contacting the power or video cabling. The lowering device manufacturer shall provide a conduit mount adapter for housing the lowering cable. This adapter shall have an interface to allow the connection of a contractor provided 1.25 inch PVC conduit and be located just below the cable stop block at the back of the lowering device. The Contractor shall supply internal conduit in the pole as directed by the Lowering Device provider. The only cable permitted to move within the pole or lowering device during lowering or raising shall be the stainless steel lowering cable. All other cables must remain stable and secure during lowering and raising operations.

The female and male socket contact halves of the connector block shall be made of Hypalon. The female brass socket contacts and the male high conductivity brass pin contacts shall be permanently molded into the polymer body.

The current carrying male contacts shall be 1/8 inches in diameter. There shall be two male contacts that are longer than the rest which will make first and break last providing optimum grounding performance. The number of contacts shall be a minimum of 14 and shall be fully coordinated with the camera specified elsewhere herein.

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The current carrying female contacts shall be 1/8 inches I.D. All of the contacts shall be recessed 0.125" from the face of the connector. Cored holes in the socket measuring 0.25" in diameter and 0.125" deep molded into the connector body are centered on each contact on the face of the connector to create rain-tight seals when mated with the male connector.

The wire leads from both the male and female contacts shall be permanently and integrally molded in the Hypalon body. The current carrying and signal wires molded to the connector body shall be constructed of #18/1 AWG Hypalon jacketed wire.

The contacts shall be self-wiping with a shoulder at the base of each male contact so that it will recess into the female block, thereby giving a rain-tight seal when mated. The facility manufacturing the electrical contact connector must comply with Mil Spec Q-9858 and Mil Spec I-45208.

Lowering Tool:

The camera-lowering device shall be operated by use of a portable lowering tool. The tool shall consist of a lightweight metal frame and winch assembly with cable as described herein, a quick release cable connector, an adjustable safety clutch and a variable speed industrial duty electric drill motor. This tool shall be compatible with accessing the support cable through the hand hole of the pole. The lowering tool shall attach to the pole with one single bolt. The tool will support itself and the load assuring lowering operations and provide a means to prevent freewheeling when loaded. The lowering tool shall be delivered to the State upon project completion. The lowering tool shall have a reduction gear to reduce the manual effort required to operate the lifting handle to raise and lower a capacity load. The lowering tool shall be provided with an adapter for operating the lowering device by a portable drill using a clutch mechanism. The lowering tool shall be equipped with a positive breaking mechanism to secure the cable reel during raising and lowering operations and prevent freewheeling. The manufacturer shall provide a variable speed, heavy-duty reversible drill motor and a minimum of two complete lowering tools plus any additional tools required by plan notes. The lowering tool shall be made of durable and corrosion resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment.

Camera Junction Box

The camera junction box shall be of two piece clamshell design with one hinge side and one latch side to facilitate easy opening. The general shape of the box shall be cylindrical to minimize the EPA. The Camera Junction Box shall be cast aluminum with stabilizing weights on the outside of the box to increase room on the interior. The box shall be capable of having up to 40 pounds of stabilizing weights. The bottom of the Camera Junction Box shall be drilled and tapped with a 1-1/2" NPT thread to accept industry standard dome housings and be able to be modified to accept a wide variety of other camera mountings. The junction box shall be gasketed to prevent water intrusion. The bottom of the box shall incorporate a screened and vented hole to allow airflow and reduce internal condensation.

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Materials:

All pulleys for the camera lowering device and portable lowering tool shall have sealed, self lubricated bearings, oil tight bronze bearings, or sintered- oil impregnated, bronze bushings. The lowering cable shall be a minimum 1/8-inch diameter stainless steel aircraft cable with a minimum breaking strength of 1740 pounds with (7) strands of 19 wire each.

All electrical and video coaxial connections between the fixed and lowerable portion of the contact block shall be protected from exposure to the weather by a waterproof seal to prevent degradation of the electrical contacts. The electrical connections between the fixed and movable lowering device components shall be designed to conduct high frequency data bits and one (1) volt peak-to-peak video signals as well as the power requirements for operation of dome environmental controls.

The interface and locking components shall be made of stainless steel and or aluminum. All external components of the lowering device shall be made of corrosion resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment.

The Camera Manufacturer shall provide weights and /or counterweights as necessary to assure that the alignment of pins and connectors are proper for the camera support to be raised into position without binding. The lowering unit will have sufficient weight to disengage the camera and its control components in order that it can be lowered properly

Installation of the lowering device and camera shall be included as a part of this item and shall not be paid for separately.

Method Of Measurement. CCTV camera structures shall be counted, each with all appurtenances installed.

Basis Of Payment. This item shall be paid at the contract unit each for **CLOSED CIRCUIT TELEVISION CAMERA STRUCTURE** of the mounting height specified.

HANDHOLE, COMPOSITE CONCRETE

Effective: June 1, 2009

Description.

Work under this item shall consist of constructing a composite concrete handhole a cover, in accordance with the details shown on the Plans and as specified herein.

Materials. The composite concrete handhole and vault lid shall be constructed of polymer concrete material, and shall be gray in color.

The composite concrete handhole shall be 30 inches x 48 inches and shall have an effective depth of 36 inches.

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The composite concrete handhole and cover shall have a design/test loading of 22,500/33,750 lbs respectively. The cover shall have a permanently recessed logo that reads "IDOT COMMUNICATIONS", or as otherwise designated by the Engineer. The composite concrete handhole lid shall have two ½-in x 4-in pull slots. The lid surface shall have a coefficient of friction of 0.50 in accordance with ASTM C-1028.

The Contractor shall install manufacturer-approved gasketing between the lid and the handhole to prevent water from entering the composite concrete handhole.

The composite concrete handhole lid shall be secured to the vault with two 3/8-inch NC stainless steel penta-head bolts and washers to lock the lid. In addition, a "lock tool" shall be provided for composite concrete handhole entry.

A fiber optic cable support assembly shall be recommended by the manufacturer and approved by the Engineer for fiber optic cable and splice enclosures used in the vault. Each support assembly shall consist of multiple brackets, racks, and/or rails required to suspend the required surplus cabling and any splice enclosures required.

The support assembly shall be made from or coated with weather resistant material such that there is no corrosion of the supports. The support assemblies shall be anchored to the vault using stainless steel hardware.

The fiber optic cable support assemblies shall be included in the Contract unit price for the composite concrete handhole. Void areas between openings and conduit shall be filled with self-curing caulking consisting of a permanent, flexible rubber which is unaffected by sunlight, water, oils, mild acids or alkalis. The caulking shall be mildew resistant and non-flammable. The material shall provide a permanent bond between the conduit entering the vault and the polymer concrete. The caulking shall be gray in color.

CONSTRUCTION REQUIREMENTS

Composite concrete handholes shall be installed in accordance with applicable requirements of Section 800 of the Standard Specifications and as provided herein.

A manufacturer-approved knockout punch driver shall be used to provide openings in the vaults for conduit, or the required openings may be machined at the time of stackable vault fabrication. Voids between entering conduits and punch driven or machined openings shall not exceed ½-inch.

Any void areas shall be caulked from the interior and exterior of the composite concrete handhole. The caulk shall be allowed to fully cure per the manufacturer's specifications, prior to backfilling.

The composite concrete handhole shall be placed on 12 inches of coarse aggregate, CA-5 Class A, as specified in Section 1004 of the Standard Specifications. Seal and flash test the vault per the manufacturer's recommendations.

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A minimum of 50 feet of excess cable per cable run shall be coiled in each composite concrete handhole containing splices to allow moving the splice enclosure to the splicing vehicle unless otherwise indicated in the plans.

Basis of Payment. This item will be paid for at the contract unit price each for **HANDHOLE, COMPOSITE CONCRETE**, of the size indicated, which shall be payment in full for all material and work as specified herein.

ELECTRIC UTILITY SERVICE CONNECTION (COMED)

Effective: January 1, 2002

Revised February 1, 2005

Description. This item shall consist of payment for work performed by ComEd in providing or modifying electric service as indicated. THIS MAY INVOLVE WORK AT MORE THAN ONE ELECTRIC SERVICE. For summary of the Electrical Service Drop Locations see the schedule contained elsewhere herein.

CONSTRUCTION REQUIREMENTS

General. It shall be the Contractor's responsibility to contact ComEd. The Contractor shall coordinate his work fully with the ComEd both as to the work required and the timing of the installation. No additional compensation will be granted under this or any other item for extra work caused by failure to meet this requirement. **Please contact ComEd, New Business Center Call Center, at 866 NEW ELECTRIC (1-866-639-3532) to begin the service connection process. The Call Center Representatives will create a work order for the service connection. The representative will ask the requestor for information specific to the request. The representative will assign the request based upon the location of project.**

The Contractor should make particular note of the need for the earliest attention to arrangements with ComEd for service. In the event of delay by ComEd, no extension of time will be considered applicable for the delay unless the Contractor can produce written evidence of a request for electric service within 30 days of execution.

Method Of Payment. The Contractor will be reimbursed to the exact amount of money as billed by ComEd for its services. Work provided by the Contractor for electric service will be paid separately as described under ELECTRIC SERVICE INSTALLATION. No extra compensation shall be paid to the Contractor for any incidental materials and labor required to fulfill the requirements as shown on the plans and specified herein.

For bidding purposes, this item shall be estimated as \$26,000

Basis Of Payment. This work will be paid for at the contract lump sum price for **ELECTRIC UTILITY SERVICE CONNECTION** which shall be reimbursement in full for electric utility service charges.

ELECTRIC SERVICE INSTALLATION – GROUND MOUNT

Effective: June 1, 2009

Revise Section 805 of the Standard Specifications to read:

Revised 06/03/2009

MODIFY EXISTING CONTROLLER FOR CCTV POWER

Effective: June 1, 2009

Description: This work shall consist of providing an un-switched 120 volt, 15 ampere power circuit to an existing controller for CCTV video power as shown on the plans and specified herein. The controller may be either a lighting controller, DMS sign controller, or other existing ITS control cabinet

Method Of Measurement. The modification of the existing lighting controller for CCTV power shall be counted as each.

Basis Of Payment. This work shall be paid for at the contract price each for **MODIFY EXISTING CONTROLLER FOR CCTV POWER**, which shall be payment for the work as described herein and as indicated in the plans.

BUDGETARY ALLOWANCE FOR TOLLWAY FIBER CONNECTION

Effective: June 1, 2009

DESCRIPTION:

This item is to establish a budget account to allocate funds for the payment of the Tollway Fiber Connection. A budgetary allowance has been established since the final cost is unknown.

This allowance will not be used to repair damage caused by the Contractor's operations. Damage caused by the Contractor's operations shall be repaired at not additional cost to the Contract.

This item shall be bid at a price of \$3,000.00

Basis of Payment. This item shall be paid for at the contract lump sum price or fraction thereof for **BUDGETARY ALLOWANCE FOR TOLLWAY FIBER CONNECTION**, which shall include all work as described herein.

CLOSED CIRCUIT DOME VIDEO CAMERA

Effective: February 25, 2005

1. **Description.**

This item shall consist of furnishing and installing an integrated Closed-Circuit Television (CCTV) Dome Camera Assembly as described herein and as indicated in the Plans.

2. **Definitions:**

CCTV Dome Camera	The complete camera assembly including the camera, PTZ mechanism, upper and lower dome housings, and any mounts.
Dome, lower dome, dome bubble	Clear dome (bubble) on the lower portion of the CCTV dome camera which the camera views through

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Dome dome housing, upper	The upper portion of the CCTV dome cameras which houses the camera and PTZ Mechanism.
PTZ	The motorized Pan, Tilt and Zoom mechanism
Camera	The color camera

3. **Materials.**

3.1 General. The CCTV Dome Color Camera shall be a rugged, non-pressurized, outdoor surveillance domed camera system. The CCTV Dome Camera shall be designed to perform over a wide range of environmental and lighting conditions and automatically switches from color daytime to monochrome nighttime operation. For compatibility with the existing CCTV cameras installed on this expressway, the dome cameras shall be manufactured by Phillips/Bosch or equal approved by the Engineer. The equivalent shall comply with all the requirements herein and shall provide the same operation/functionality as the installed cameras without the use of any external devices for the modification/translation of video and PTZ commands.

All equipment and materials used shall be standard components that are regularly manufactured and utilized in the manufacturer's system.

The manufacturer shall be ISO 14001 Certified. The manufacturer's quality system shall be in compliance with the I.S./ISO 9001/EN 29001, QUALITY SYSTEM. The manufacturer shall provide a three year (3) warranty. The manufacturer shall pay inbound and outbound shipping charges during the warranty period for products returned as warranty claims. The manufacturer shall also provide an advance exchange program for warranty claims.

The warranty period shall begin on the date of final acceptance of the video distribution system. This warranty shall include repair or replacement of all failed components via a factory authorized repair facility. All items sent to the repair facility for repair shall be returned within two weeks of the date of receipt at the facility. The repair facility location shall be in the United States. Any extended warranty coverage required to comply with the specified warranty period shall be provided as a part of this pay item at no additional cost to the State.

3.2 Physical construction. The CCTV Dome Camera shall be provided in a NEMA 4X or IP66 certified, rugged, weather-resistant package. The CCTV Dome Camera shall also comply with the following requirements:

Environmental	Requirement
IP Rating	IP 66
Weight (max.)	10 lbs
Overall Dimensions	10" dia. x 14"
Humidity	0 to 100%
Operating temperature	-40°C to 50°C
Mount	1 ½" NPT

The CCTV dome camera shall be equipped with a fan and heater controlled by a thermostat. The heater shall prevent internal fogging of the lower dome throughout the operating temperature range of the camera.

An optional rugged clear dome bubble shall be available from the CCTV camera manufacturer. The rugged dome shall be made from 3mm thick polycarbonate, designed to meet stringent strength standards without compromising optical clarity. The dome, by itself, shall withstand a 100 foot-pound impact. This energy is equivalent to that of a 10 lb sledgehammer being dropped from a height of 10 feet. The dome, when installed in the CCTV camera, shall exceed the UL 1598 horizontal impact standard for lighting fixtures, by a factor of 10. The submittal needs to indicate compliance with this requirement.

3.3 Power. The CCTV Dome Camera shall be designed to operate from a 120v power source. The appropriate power supply, if required for the CCTV Dome Camera to operate, shall be included as a part of this item. The power requirements for the camera shall comply with the following:

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Electrical	Requirement
Voltage	18 to 30 VAC
Load	25 VA
Heater Load	45 VA
Listing	UL Listed
FCC	Class B

Surge Suppression Requirements

Source	Minimum Requirements
Video	Peak current 10 kA (Gas Tube Arrester), peak power 1000 W (10/1000 μ)
RS-232/485, Biphase	Peak current 10 A, peak power 300 W (8/20 μ)
Alarm Inputs	Peak current 17 A, peak power 300 W (8/20 μ)
Alarm Outputs	Peak current 2 A, peak power 300 W (8/20 μ)
Relay Outputs	Peak current 7.3 A, peak power 600 W (10/1000 μ)
Power Input (Dome)	Peak current 7.3 A, peak power 600 W (10/1000 μ)
Power Output (Alarm Power Supply)	Peak current 21.4 A, peak power 1500 W(10/1000 μ)

3.4 Camera.

The CCTV Dome Camera shall incorporate a solid state CDD imaging camera with the following requirements.

- 3.4.1 The camera shall automatically switch from daylight color operation to a higher sensitivity nighttime monochrome mode when light levels fall below a user adjustable threshold level.
- 3.4.2 The camera shall provide a selectable slow shutter (frame integration) function that increases the camera's sensitivity up to 50 times by reducing the shutter speed. Selectable slow shutter speeds shall be 1/60 sec., 1/30 sec., 1/15 sec., 1/8 sec., 1/4 sec., 1/2 sec., 1 sec., and fully automatic.
- 3.4.3 Digital image stabilization shall be provided using electronic compensation that filters out vibrations caused by wind and other environmental conditions.

The camera shall also comply with the following requirements:

Camera	Requirement
Imager	1/4" HAD CCD
Effective Pixels	768H x 494V
Zoom Lens Power (Optical only)	36x
Aperture	f1.6 to f4.5
Focus	Auto / Manual
Iris	Auto / Manual
Maximum Field of View Horizontal	45°
Video Output	1.0v +/- 0.07v
Gain Control	Auto / off
Synchronization	Internal / AC line lock, phase adj. via remote control, V-Sync
Digital Zoom	12x
Horizontal Resolution	540 TVL
Signal – Noise Ratio	>50dB
White Balance	Auto / Manual
Shutter Speed	1/2 to 1/30,000

Min Illumination		Values in lux
Color	Fast Shut	2.00
	Slow Shut	0.15
B&W	Fast Shut	0.3
	Slow Shut	0.017

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3.5 PTZ Mechanical

The CCTV dome camera shall have an integrated motorized PTZ mechanism as specified herein and shall be compatible and coordinated with the control system described elsewhere herein. The camera's 360° pan rotation shall be divided into 16 independent sectors with 16-character titles per sector. Any or all of the 16 sectors may be blanked from the operator. In addition to the blanking function, a privacy masking feature shall be provided that allows creation of up to six (6) rectangular masks that prohibit areas of the field of view from being seen even if the camera is panned, tilted, or zoomed.

Mechanical (Dome Drive)		Requirement
Pan		360°
Tilt		Up to 18° above horizon
Continuous PTZ Operation		Yes
Pre-position speed	Pan	360°/sec
	Tilt	200°/sec
Accuracy		+/- 0.1°
Variable speed	Pan	80°/sec or 150°/sec
	Tilt	40°/sec

3.6 Functionality

Camera Commands

- 3.6.1 The camera shall allow the storage of up to 99 preset scenes with each preset programmable for 16 character titles. A tour function shall be available to consecutively display each of the preset scenes for a programmed dwell time. Any or all of the presets may be included or excluded from the tour.
- 3.6.2 The camera shall be capable of recording two (2) separate tours of an operator's keyboard movements consisting of, tilt, and zoom activities for a total combined duration time of 15 minutes. Recorded tours can be continuously played back.
- 3.6.3 When an operator stops manual control of the camera, and a programmed period of time is allowed to expire, the camera will execute one of the following programmable options: 1) return to preset #1 or 2) return to the automated tour previously executed or 3) do nothing and remain at the present position.
- 3.6.4 The camera shall ensure that any advanced commands required to program the camera are accessed via three levels of password protection ranging from low to high security.
- 3.6.5 The camera system shall provide a feature that automatically rotates, or pivots, the camera to simplify tracking of a person walking directly under the camera.
- 3.6.6 The camera's 360° pan rotation shall be divided into 16 independent sectors with 16-character titles per sector. Any or all of the 16 sectors may be blanked from the operator.
- 3.6.7 In addition to the blanking function, a privacy masking feature shall be provided that allows creation of up to six (6) rectangular masks that prohibit areas of the field of view from being seen even if the camera is panned, tilted, or zoomed

Visual Effects	Requirement
Sectors/Zones	8
Titling	20 characters
Max Presets	99
Motion Detection	Yes
Password Protection	Yes
On Screen Configuration Menus	Yes
Image Stabilization	Yes

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Preset Tour / max presets	
Recorded Variable PTZ Tour	2
Auto Flip	Yes
Auto Return to preset after operator inactivity	Yes
Window Blanking	
Quantity	6
Grey out	Yes
Alarms	Yes

3.6.8 The manufacturer shall fully document and provide to the Department the communication protocol implemented by the CCTV dome camera. This protocol shall be open and allow third-party development of control software. If the current protocol is not NTCIP compliant, the manufacturer shall supply upgrades to make the software compliant in the future at no cost to the Department.

3.6.9 Diagnostic software shall be provided with each CCTV camera which shall allow all camera functions accessible via a Windows XP based PC. A RS232 cable, or a USB cable if available, shall be provided to connect to CCTV dome camera assembly. A copy of the diagnostic software shall be supplied for each CCTV camera. The program shall be capable of configuring and controlling the CCTV dome camera assembly and its functions (position, zoom, focus, iris, power, color balance, etc.) from within it. This includes storing and recalling preset positions for fast system configuration.

3.7 Interface

Control System. Camera commands shall be transmitted over twisted pair, RS 232, RS 422 and RS 485. The method of transmission shall be user selectable.

The camera shall provide four (4) normally open or normally closed alarm input contacts and one (1) relay output. Any or all of the input contacts may be programmed upon activation to automatically move the camera to any preposition location, close the output relay for a programmed period of time, and display an alarm indication on the on-screen display of the display monitor.

4. Testing.

The Contractor shall test each CCTV Dome Camera Assembly in the presence of the Engineer after the camera is installed. This test may be done locally at the camera support structure.

5. Product Support.

The manufacturer shall provide technical support via email, fax and toll-free telephone. The above forms of support shall be provided Monday through Friday, 8:00am to 8:00pm EST.

6. Installation.

The Contractor shall submit shop drawings for the camera mounting adapter, and all components used for the installation. The camera shall be installed in accordance with the lowering device manufacturer's recommendations specified elsewhere herein.

7. Measurement.

Closed-Circuit Television (CCTV) Dome Cameras shall be counted as each upon successful completion of the testing describer herein for payment.

8. Basis of Payment.

This item will be paid for at the contract unit price each for **CLOSED CIRCUIT DOME TELEVISION CAMERA**, which shall be payment in full for all material and work as specified herein.

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CCTV EQUIPMENT

Effective: June 1, 2009

Description.

This item shall consist of furnishing and installing equipment for the control and distribution of CCTV video from the CCTV camera to the Communications Shelter, also identified as a Video Collection Point (VCP). Transmission for the video and control signal shall be either by radio or fiber optic cable as specified elsewhere herein and as indicated in the plans.

The transmission of the video over fiber shall include fiber transceivers at the camera location and the VCP. The video CODEC encoder specified herein shall be located in the VCP for fiber distributed cameras.

Where wireless transmission is indicated, the radio link will be provided under the Wireless Video Distribution pay item and shall be fully coordinated with this item. For wireless cameras, the CODEC encoder shall be located in the CCTV equipment enclosure at the camera as specified herein.

The CODEC encoders are specified and included as a part of this item and shall be fully coordinated with the decoders.

The CODEC decoders are specified and paid for as a part of the Modification of Existing Video Distribution System pay item and shall be fully coordinated and of the same manufacturer as the video CODEC encoders specified herein.

CODEC Quantity Tabulation

CODEC Type	Location				
	At Camera	I55 Shelter	D1 H.Q.	ITS Office	TSC
Encoder	34	5			
Decoder		1	2	2	2

Construction Requirements

General. The Contractor shall prepare and submit a shop drawing detailing the complete closed-circuit television cabinet equipment installation. The shop drawings shall identify the installation and specifications of all components to be supplied, for approval of the Engineer. Particular emphasis shall be given to the cabling and the interconnection of all of the components.

The Contractor shall demonstrate a prototype assembly using the proposed components. This demonstration shall take place at a Contractor selected and Engineer approved location. These conformance tests shall be completed prior to the delivery of any completed assemblies to the project site. Any deviations from these specifications that are identified during this testing shall be corrected prior to shipment of the assembly to the project site.

Appropriate connectors shall be furnished and installed to interface the in-cabinet components to the integrated dome camera assembly. The Contractor shall mount the in-cabinet components in the equipment cabinet and connect them to AC power, communications, and video feeds.

Testing. The Contractor shall test each installed CCTV Cabinet Equipment. The test shall be conducted from the field cabinet using the standard communication protocol and a laptop computer. The Contractor shall verify that the camera can be fully exercised and moved through the entire limits of Pan, Tilt, Zoom, Focus and Iris adjustments, using both the manual control and presets. In addition, a video monitor and an oscilloscope shall verify that the video signal meets or exceeds the specified requirements.

The Contractor shall repeat the test at the communications shelter associated with the CCTV camera. This test confirms the distribution portion of the video circuit, that is, the portion of the circuit from the CCTV camera to the digital video encoder.

The Contractor shall maintain a log of all testing and the corresponding results. A representative of the Contractor and a representative of the Engineer shall sign the log as witnessing the results. Records of all tests shall be submitted to the Engineer prior to accepting the installation.

Documentation. One copy of all operations and maintenance manuals for each CCTV component shall be delivered for each assembly installed. In addition, full documentation for all software and associated protocols shall be supplied to the Department on a 3.5-inch floppy disk(s) and a CD-ROM. The Department reserves the right to provide this documentation to other parties who may be Contracted with in order to provide overall integration or maintenance of this item.

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Warranty. The Contractor shall warranty all materials and workmanship including labor for a period of two years after the completion and acceptance of the installation, unless other warranty requirements prevail. The warranty period shall begin when the Contractor completes all construction obligations related to this item and when the components for this item have been accepted, which shall be documented as the final completion date in the construction status report. This warranty shall include repair and/or replacement of all failed components via a factory authorized depot repair service. All items sent to the depot for repair shall be returned within two weeks of the date of receipt at the facility. The depot location shall be in the United States. Repairs shall not require more then two weeks from date of receipt and the provider of the warranty shall be responsible for all return shipping costs.

The depot maintainer designated for each component shall be authorized by the original manufacturer to supply this service. A warranty certificate shall be supplied for each component from the designated depot repair site indicating the start and end dates of the warranty. The certificate shall be supplied at the conclusion of the system acceptance test and shall be for a minimum of two years after that point. The certificate shall name the Department as the recipient of the service. The Department shall have the right to transfer this service to other private parties who may be Contracted to perform overall maintenance of the facility.

Materials.

Enclosure.

CCTV Cabinet. The CCTV Cabinet, as a minimum, shall be a Hoffman Enclosures Model A24H2010SS6LP, Electromate Enclosures Model E-24H2010SSLP, or approved equal. The cabinet shall be NEMA 4X compliant. The nominal dimensions of the cabinet shall be 24 inches high by 20 inches wide by 10 inches deep. These manufacturers and model numbers are included as a guide to indicate the type of cabinet to be provided and may not be the exact manufacturer and part numbers. Due to contractor selection of equipment to be utilized, the cabinet may need to be larger. The contractor shall be responsible for providing an adequately sized cabinet and shall be included in the bid unit price for this item. The cabinet shall be fabricated of 14 gauge Type 304 or Type 316L stainless steel. All seams shall be continuously welded and ground smooth with no holes or knockouts. The cabinet shall be fabricated with a rolled lip around three sides of the door and on all sides of the enclosure openings to exclude liquids and contaminants. A stainless steel door clamp assembly shall assure a watertight seal. A seamless gasket shall be included to assure a watertight and dust-tight seal.

The cabinet shall have provisions for padlocking in the closed position. The lock shall be Corbin #2 and two keys shall be supplied to the Department with each lock. The keys shall be removable in the locked position only. A data pocket of high impact thermoplastic material shall be provided. The nominal dimensions of this pocket shall be 12 inches by 12 inches. Collar studs shall be provided for mounting the stainless steel backboard panel. The cabinet shall be unpainted. Cover, sides, top, and bottom shall have a smooth brushed finish.

Stainless Steel Panel. The cabinet shall be furnished with a stainless steel panel. This panel shall have nominal dimensions of 17 inches by 13 inches. It shall mount on the collar studs fabricated with the CCTV cabinet.

Installation. The cabinet shall be installed as indicated on the detail drawings by means compatible with the type of CCTV camera structure selected by the Contractor.

Closed Circuit Television Camera Power Supply.

The Closed Circuit Television Camera Power Supply shall supply power to the camera dome assembly. The requirements include:

Input voltage	120 VAC ± 10%
Output voltage	24 VAC ± 10%
Operating Temperature Range:	-40°C to +70°C (minimum)
Storage Temperature Range:	-40°C to +75°C (minimum)

The power supply shall include an AC power indicator with power on/off switch. All outputs shall be fused. The power supply shall be sized for the dome units being supplied, considering pan/tilt, heating, and blower requirements, and shall not be less than 100 VA.

Over-voltage Protection. Over-voltage protection shall be provided on the power conductors, camera control conductors, and the video cables. The specific protection is based on the elements being protected.

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Incoming Power Protection. The incoming power shall be protected with a filtering surge protector that absorbs power line noise and switching transients. The specified performance shall be as follows:

Peak current	20 kA (8x20 μ s waveshape)
Life Test	5% change
Clamp voltage	280 V typical @ 20 kA
Response time	\leq 5 ns
Continuous service current	10 amps max. 120 VAC/60 Hz
Operating Temperature	-40°C to +75°C (minimum)
Nominal dimensions	7.15 inches by 3.13 inches by 2.3 inches

Video Cable Protection. The coaxial cable from the camera shall be protected with gas tubes and silicon avalanche devices. The units shall include re-settable fuses to protect against sneak currents. Specific requirements include:

Frequency	0 to 20 MHz
Peak surge current	20 kA (8x20 μ s waveshape)
Technology	Hybrid, solid-state
Attenuation	0.1 dB at 10 MHz
Response time	\leq 1 ns
Protection	Line-to-shield
Input/output connectors	BNC
Impedance	75 ohms
Temperature range	-40°C to +75°C (minimum)
Humidity	0% to 95% (non-condensing)
Clamping voltage	6 V
Nominal dimensions	4.5 inches by 1.5 inches by 1.25 inches

The video cable protector shall be UL listed.

Camera Control Cable Protection. The camera control cable protector shall protect the RS-422/RS-485 signal leads going to the camera dome assembly. Specific requirements include:

Technology	Hybrid, solid-state
Response time	\leq 5 ns
Protection	Line-to-ground
Input/output connectors	terminal block
Temperature range	-40°C to +75°C (minimum)
Humidity	0% to 95% (non-condensing)
Clamping voltage	7.25 V (maximum); \leq 7.0 V (typical)
Nominal dimensions	4.5 inches by 3.3 inches by 1.8 inches

The protector shall protect a minimum of four conductors. [Transmit Data (2 wires) and Receiver Data (2 wires)]

The Contractor shall include all necessary wires and cables necessary to interconnect the components of the CCTV cabinet. The Contractor shall provide a furcation kit to break-out, protect the individual fibers of the 6-fiber cable. The Contractor shall install ST-type connectors on these fibers.

Fiber Optic Distribution

Fiber Optic Video Transceiver Pair. The CCTV Cabinet Equipment shall include a matched pair fiber optic video transceiver pair as described herein. To maintain compatibility with the previously installed transceivers on this roadway, the transceiver pair shall be manufacturer by Meridian Technologies, Series DV-1W 1MPS, IFS VT/VR1900 Series, or approved equal by the Engineer. The Approved equal shall be 100% interchangeable with the existing units.

Fiber Optic Video Transmitter. The fiber optic video transmitter shall provide simplex transmission of NTSC video from the CCTV cabinet and duplex communications of camera-control, asynchronous data. Optic video and data transmission shall use one single mode fiber operating in the 1310/1550 nm windows using simple wavelength division multiplexing.

Mechanical and environmental requirements include the following:

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Nominal dimensions:	7 inches by 5 inches by 1.5 inches
Operating Temperature Range:	-40°C to +70°C (minimum)
Storage Temperature Range:	-40°C to +75°C (minimum)
Relative Humidity Range	0% to 95% (non-condensing)
MTBF	75,000 hours (minimum)

Optical requirements include:

Connector:	ST
Optical Power Budget:	15 dB (minimum) using 9/125 μ m single mode fiber
Operational Wavelengths:	WDM using 1310/1550 nm and a single fiber

Video/data requirements include:

Video connector	BNC
Data connector:	9-pin EIA RS-232, 25-pin EIA RS-232 connector, or terminal block
Data rates	1200-9600 bps, asynchronous
Input signal	0.5 – 2.0 V pk-pk (1 V nominal)/75 ohms impedance
Bandwidth	5 Hz – 7.0 MHz (minimum)
Differential Gain	$\leq 5\%$
Differential Phase	$\leq 5^\circ$
Tilt	$\leq 1\%$
Signal-to-Noise Ratio	50 dB with 10 dB of attenuation

The equipment shall operate from 120 VAC and include a power supply manufactured by the transceiver manufacturer. Power requirements shall not exceed 15 watts.

The fiber optic video Receiver. The receiver shall receive optical simplex transmission of NTSC video from the CCTV cabinet and shall provide duplex optical communications of camera-control, asynchronous data. Optic video and data transmission shall use one single mode fiber operating in the 1310/1550 nm windows using simple wavelength division multiplexing.

Mechanical and environmental requirements include the following:

Nominal dimensions:	7 inches by 5 inches by 1.5 inches
Operating Temperature Range:	0°C to +70°C (minimum)
Storage Temperature Range:	0°C to +75°C (minimum)
Relative Humidity Range	0% to 95% (non-condensing)
MTBF	75,000 hours (minimum)

Optical requirements include:

Connector:	ST
Optical Power Budget	15 dB (minimum) using 9/125 μ m single mode fiber
Operational Wavelengths:	WDM using 1310/1550 nm and a single fiber

Video requirements include:

Connector	BNC
Input signal	0.5–2.0 V pk-pk (1 V nominal)/75 ohms impedance
Bandwidth	5 Hz – 7.0 MHz (minimum)
Differential Gain	$\leq 5\%$
Differential Phase $\leq 5^\circ$	
Tilt	$\leq 1\%$
Signal-to-Noise Ratio	50 dB with 10 dB of link attenuation

The receivers shall operate from 120 VAC. One 7 slot, 19" rack mount chassis with power supply shall be included in this item to be installed at the Nordic Communications Hut. Only one chassis shall be provided for the total quantity of equipment cabinets.

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Wireless Distribution.

Equipment used for wireless distribution and installed in the CCTV equipment cabinet is specified and paid for as a part of the Wireless Video Distribution System pay item.

Video CODEC

Video Encoders and Decoders. Video encoders and decoders (codecs) shall be dedicated hardware devices, and except for differences between encoders and decoders they shall all of the same type from the same common manufacturer. The codec shall be a single video channel type to transfer "full motion" 30 frame-per-second high quality D1 color video via H.264, MPEG-4, and MPEG-2 video compression at up to 20 Megabits per second. The units shall operate to produce a robust data communications stream that shall allow for both video and audio transmission and shall be immune to timing disruptions in the existing IP multi-cast system.

The units shall be rack-mountable, or single unit chassis for single unit installation complete with power supplies as required, operating from a 120-volt single phase AC power input. Unit mounted in VCPs or other control building shall include a standard 19" rack with dual redundant power supplies.

Encoder units shall accept NTSC video BNC input, Ethernet RJ-45 communications, and RJ45 serial data input connections.

Approvable codecs shall be compatible with and demonstrably interoperable with the standard codec product of at least one other vendor. Final approval of codec equipment shall be dependent upon a demonstration test of multi-vendor interoperability. Initial submittal information shall include documentation of this interoperability and a demonstration testing plan for approval by the Engineer.

The CODEC encoders shall be Optelecom-NKF series C-60 E-MC, or approved equal by the Engineer. The Approved equal shall be 100% interchangeable with the specified unit with respect to functionality and performance.

The encoders shall interface the serial communications port of the CCTV camera assembly through the fiber optic video link where indicated. Using the Ethernet port on the encoder and its IP address, commands shall be exchanged between the camera control computer at the Communications Center and the serial port of the CCTV camera.

Materials shall be supplied to satisfy the following:

VIDEO	Requirements
Video channels	1x PAL/NTSC (Auto/PAL/NTSC)
Input level	1 Vpp (±3 dB)
Compression algorithm	H.264 BP (ISO/IEC 14496-10) MPEG-2 (ISO/IEC 13818-2), MJPEG, MPEG-4 (ISO/IEC 14496-2, ISMA comp.)
Type of streaming	UDP/IP (multi- and/or unicast)
Number of output streams	Up to 20
Input impedance	75Ω/Hi-Z selectable
Video Motion Detection	Yes (user-defined masking)
Encoding latency	<130 ms typ.
Resolution	D1, ½D1, 2CIF, CIF, QCIF, VGA
GOP structure	I, IP (selectable/user profiles)
Frame rate	1 to 30 fps
Quad streaming	1 D1@30fps H264 + D1@30fps MPEG-2+ D1@ 30fps MPEG-4 + CIF@1fps MJPEG
Output data rate	up to 20 Mb/s (CBR or VBR selectable/user profiles)
Video settings	User profiles, contrast, brightness, color saturation, hue, sharpness
On Screen Display (OSD)	3x Text lines (configurable: position, color, border/outline color, font size), 1x image in BMP, GIF, or JPEG format (configurable: position, scaling)
Live View Encoder (MJPEG)	HTTP, FTP pull
Connector type	BNC 75Ω (gold plated center pin)

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DATA	Requirements
Number of channels	2 (full-duplex)
Number of streams	2x 3 (multi- and/or unicast)
Interfaces	1x RS232
	1x RS422/485 (2- or 4-wire)
Stream	TCP/UDP/MX configurable
Data rate	300 b/s to 230.4 kb/s
Connector type	RJ45

TRANSMISSION	Requirements
Number of interfaces	1
Interface 10/100Base-TX	Fast Ethernet
	Auto Negotiation, half-duplex/full-duplex, 10/100 Mb/SFP option
	Empty SFP slot for 100 Mbps SFP device
Protocols	H. 264 BP, MPEG-4 ES, MPEG-2 TS, MPEG-2 ES, (M)JPEG, RTP, RTCP, RTSP, TCP, UDP, IP, DHCP, IGMPv2,
	(S)NTP, MX/IP, HTTP, SNMP v2, FTP, TelNet, DiffServ, SAP, UPnP
Connector type	RJ45

Management	
LED status indicators	
DC	Power-on indicator (green)
NV	No video on input (red)
SYNC	All links are operational (green); failure in RX stream(s) (yellow); failure in TX stream(s) (red)
Ethernet port	Green LED: on=100 Mb, off=10 Mb; Amber LED: on=link okay, flashes with activity
Network Management & Control	SNMP v2, MX™, HTTP API, HTML (password protected)

Power	
Power consumption	<5W
Rack-mount units	MC 10 and MC11 power supply cabinets
Stand-alone units (/SA)	11 to 19 VDC (PSA-12 DC/25 or PSR-12 DC)

ENVIRONMENTAL	Requirements
Operating temperature	-40° F to +165° F (-40 °C to +74 °C)
Relative humidity	<95%,no condensation.

The encoders and decoders shall be UL listed and be type-accepted to 47 CFR (FCC), Part 15, Type A.

The Codecs shall be the standard product of an established North American manufacturer. The manufacturer shall have been in business for a minimum of 7 years. The manufacturer shall provide a minimum of a twelve (12) month warranty from the date of installation. The manufacturer shall provide technical support via email, fax and telephone. The above forms of support shall be provided Monday through Friday, 8:00am to 5:00pm EST. The Manufacturer shall also have a repair facility within North America.

The units shall be 19-inch rack-mountable, complete with power supplies as required for the rack configurations indicated on the plans, operating from a 120-volt single phase AC power input

The codecs shall be fully capable of transmitting the PTZ commands of the CCTV camera manufacturer being furnished under this contract as well as existing Philips/Bosch, Pelco, Vicon and Cohu camera commands. Serial data will be transmitted over TCP-IP. Each serial port must support IP addressing with the ability to select the appropriate IP socket number. The codecs must provide the ability to establish an IP connection directly from a workstation to any encoder IP address and socket number to pass serial data. Transmission of serial data must be independent of the video stream. Any serial data conversion required by the codec to communicate to the camera shall be included in this pay item and shall not be paid for separately.

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The Encoder/Decoder serial data port must support Multicast data to broadcast a single serial data input to multiple remote encoder serial data port recipient. Bi-directional data must be supported on the codecs.

A demonstration of this low speed serial data transfer shall be required before material submittal approval is given. See submittal requirements in this Special Provision.

Codec operation and management.

Each unit must support a local console accessible using one of the serial interfaces to provide access to all configuration menus of the product including the initial IP address configuration as well as for troubleshooting purposes. The interface must be menu driven for novice users.

All units (encoders and decoders) must support SNMPv2 management protocol to provide the ability to control and monitor all configuration parameters and diagnostics from any 3rd party SNMP management application.

The Encoders/Decoders must support firmware updates from a central site. Updates must be downloadable to a single unit or by bulk via a single command from a firmware utility application via the Ethernet network. The firmware utility application must provide confirmation of the successful and unsuccessful updates. Upon completing of the update, the units must resume to original configuration without the need to reload the unit configuration.

Still Picture Capture

The codec shall be capable of capturing a still image in JPEG format and automatically transferring this image to an FTP site. The resolution of the image shall be user selectable. The frequency of captures shall be user settable and shall as a minimum range from 1 picture every 30 seconds to 1 picture every five minutes..

Still picture logo placement capability. As a part of the still image capture, a graphic overlay image shall be added to the captured image. The graphic image shall be user selectable, in JPEG, BMP or GIF formats. The overlay shall also be user positionable.

Special Submittal Requirements and Operational Demonstration

As a part of the product catalog cut submittal, the Contractor shall provide a demonstration of the codecs at the time of the initial product submittal. The manufacturer shall demonstrate the following interoperability with at least one other codec manufacturer. Compatibility shall also include successful transmission of PTZ commands. The demonstration shall be comprised of the following parts:

- **Codec CCTV camera PTZ compatibility.** The demonstration shall include a pair of the proposed codecs, a proposed CCTV camera, and a CCTV camera of another manufacturer other than the proposed CCTV which is of a manufacturer already installed in the State system.
- **Video interoperability.** The demonstration shall demonstrate the following interoperability: The proposed encoder shall be capable of encoding a video stream that is decodable by at least one other Manufacturer compiling with this specification, or of a manufacturer which equipment is presently in use by IDOT District 1 at the time of bidding. The interoperability demonstration shall be conducted in multicast mode.
- **Software video decoding.** A software based video decoder with PTZ control shall be provided for viewing and controlling a video stream remotely over the IP network.
- **Video snapshot capability.** A fully functional copy of the proposed video snapshot program shall be provided for the demonstration and throughout the 10 day period described herein.

After a successful demonstration of the above requirements, the codec pair shall remain with the Department for 10 working days for further observation. After 10 working days, the Contractor may pick up the codec pair. All costs for this demonstration shall be included in the cost of this pay item. It is the Contractor's responsibly to provide all hardware (including dome CCTV cameras and Ethernet switches) and software to perform the demonstrations as specified.

Method Of Measurement. CCTV equipment shall be counted, each installed.

Basis Of Payment. This item shall be paid at the contract unit each for **CCTV EQUIPMENT** of the distribution method specified.

Revised 06/03/2009

WIRELESS VIDEO DISTRIBUTION SYSTEM

Effective: June 1, 2009

Description.

This item shall consist of furnishing, shop staging, testing and installing all radio equipment for the transmission of Ethernet data over a wireless radio system operating in the 5 GHz frequency band. The type of equipment shall be selected to comply with the performance requirements contained herein. A preliminary radio spectrum analysis has been performed with results included at the end of this Special Provision. It shall be the Contractor's responsibility to determine the type, quantity and location of radio backhaul circuits to maintain the level of performance specified herein. All radio requirements shall be fully coordinated with the other work in the contract. Coordination shall include, but not limited to, antenna and structure loading, equipment housings and mounting arrangements. Antennas and all cabling shall be included as a part of this item.

As indicated elsewhere herein, the locations of the CCTV camera installations are approximate. The contractor may adjust the locations of the installations to facilitate installation with written approval of the resident engineer and the electrical design section. All standard non-frangible setback requirements as well as clear zone requirements shall be maintained

General Requirements

The radio mesh router shall be a network enabled highly reliable system capable of distributed Ethernet switch functionality and shall support a source based routing protocol. The wireless mesh nodes shall be modular and not share any radios with access point functionality. The manufacturer shall provide one year warranty on the hardware. The wireless mesh nodes shall comply with all Ethernet transport standards.

Radio Requirements

The radio shall support up to two radios dedicated for backhaul switching capability. The mesh nodes shall support 802.11a, 802.11b, 802.11g and the licensed 4.9 GHz band on the same physical hardware. The wireless mesh nodes shall support a maximum output power of 400 mW. The wireless mesh nodes shall support the following receive sensitivities:

2.4 GHz, DSSS - 1 Mbps: -95 dBm; 11 Mbps: -88 dBm
2.4 GHz, OFDM - 6 Mbps: -90 dBm; 11 Mbps: -73 dBm
5 GHz - 6 Mbps: -90 dBm; 11 Mbps: -73 dBm

The wireless mesh nodes shall provide ability to eliminate weak radio links in the network. The radio mesh nodes shall provide the ability to configure any channel. The wireless mesh nodes shall support dynamic frequency channel selection. The wireless mesh nodes shall support transmit power control (TPC). The wireless mesh nodes shall provide software control over the two radios for different radio configurations and topologies. The two radios could be combined together to form a logical single radio. The wireless mesh nodes shall provide the ability to recover neighbor radio nodes in different bands and frequencies.

Interfaces

Radio mesh nodes shall support three 10/100BaseT Ethernet switch ports in outdoor models using environmentally sealed connectors. Radio indoor wireless mesh nodes shall provide four (4) 10/100BaseT Ethernet switch ports using RJ45 connectors. The outdoor mesh nodes shall support DC pass through on the Ethernet connectors. The wireless mesh nodes shall support 802.3af PoE standard and be able to power two devices that are capable of deriving power over Ethernet. The wireless mesh nodes shall provide a mix of radio and Ethernet interfaces over the routing domain. The wireless mesh nodes shall provide the ability to bridge multiple wireless networks using Ethernet. The mesh nodes shall support user defined & prioritized static routes to allow uni-directional flow between source node and destination node with zero or more intermediate nodes. Each static route on the Source Node can be assigned the following client traffic entering the Source Node and exiting at a Destination Node:

- All client traffic,
- All client traffic entering an Ethernet Port or
- All client traffic with a particular VLAN
- Static routes can be selected between any two source and destination nodes having max 10 hops between them. Static route should fall back to a dynamic route if the Static Route is down because of a down link.

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Throughput Requirements

The radio shall support up to 70 Mbps throughput in a bonded mode of operation with allowance for throughput degradation. The radio shall support up to 35 Mbps sustained throughput anywhere in the wireless network across multiple hops. The mesh nodes shall support low latency of the order of 1.5 msec per hop on an average and maximum of 2 msec per hop.

Quality of Service (QoS) Requirements

The mesh nodes shall have simultaneous support for video, voice and data multi services. The radio mesh nodes shall support port based QoS and 802.1p standards based QoS. The wireless mesh nodes shall support VLANs and VLAN trunking. The wireless mesh nodes shall provide load balancing on alternate routing paths between source and destination MAC addresses. The wireless mesh nodes shall provide congestion control within the network.

Management Requirements

The wireless mesh nodes shall provide management interfaces via HTTP, SNMP, GUI. The management architecture shall be a client-server architecture with multiple clients logging into the server. The management station shall provide statistics and alarms and events on a per radio basis. The hardware shall provide system status LEDs for power, mesh, faults. The wireless mesh node shall support remote software upgrade ability. The wireless mesh node shall support telnet access. The management system will provide single integrated management for both wireless mesh nodes and access points.

Security Specifications

The mesh nodes shall support user name and password security for all Ethernet and serial interfaces. The wireless mesh nodes shall support hardware based encryption. The wireless mesh nodes shall have the capability to distinguish between radios that are part of their network from radios that are not. The wireless mesh nodes shall support manufacturing based digital certificates on each node that authenticates with the network. The digital certificate mechanism shall have the ability to have user defined / signed certificates. The wireless mesh nodes shall have digitally signed firmware files. The wireless mesh nodes shall have the ability to lockout malicious users as they try to access the network. The wireless mesh nodes shall support 128 and 256-bit AES, 64/128 bit WEP, and 256-bit WPA2 encryption keys. The wireless mesh nodes shall support ESSID encryption. The radio mesh nodes shall support MAC address filtering. The hardware shall provide for physical security via a lockable mounting bracket.

Scalability Requirements

The radio mesh nodes shall support mesh networks of up to 1000 nodes. The radio mesh networks shall provide the ability to have Ethernet interfaces as part of the routing domain to make use of the wire where it is available. The wireless mesh nodes shall provide the ability to connect multiple wireless mesh networks using Ethernet bridging. The wireless mesh nodes shall support multiple gateway interconnects for large networks and increased throughput.

Mobility Requirements

The radio mesh nodes shall support mesh node mobility at high speeds with low handoff times between roaming nodes. The radio networks shall support 802.11 client mobility across multiple Layer 3 domains. The mesh network shall maintain connections while moving at speeds greater than 90 MPH (145 KmPH).

Power Requirements

All wireless hardware units shall support 90–240 VAC, 50/60 Hz, 0.9A. The hardware units shall support 16 VDC input at the same time.

Antennas.

Antennas shall be designed for outdoor use and shall be coordinated with the other equipment to achieve the specified performance. Antennas shall be mounted to the structure in a method recommended by the antenna manufacturer and structure manufacturer and as approved by the Engineer. Coax cable from the radio to the antenna shall be low loss, a minimum of LMR-1200. Surge protection shall be provided for both radio power and antenna connections. Antenna connections shall be protected with a gastube device as manufactured by Polyphaser or approved equal.

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Physical & Environmental Requirements

The wireless mesh nodes enclosure shall be rugged NEMA 4X/IP67 rated for outdoor deployments. The wireless mesh nodes shall support optional surge suppression protection. The radio mesh nodes shall be plenum rated for indoor use. The outdoor mesh nodes shall have weather proof antenna connectors. The outdoor devices shall be pole and/or wall mountable (with low profile mounting). The outdoor mesh nodes shall provide an optional sunshield for environmental protection. The indoor devices shall be ceiling, or wall mountable. The wireless mesh nodes shall be ROHS & WEEE compliant. The outdoor units shall have the following environmental specifications:

- Operating temperature: -40°C to +60°C
- Storage temperature: -40°C to +85°C
- Humidity (non-condensing) - 10% to 90%
- Storage humidity (non-condensing) - 5% to 95%
- Maximum altitude 15,000 feet (4600 meters)
- The indoor units shall comply with the following specifications –
- Operating temperature: 0°C to +60°C
- Storage temperature: -20°C to +70°C
- Humidity (non-condensing) - 10% to 90%
- Storage humidity (non-condensing) - 5% to 95%
- Maximum altitude 15,000 feet (4600 meters)

Equipment Demonstration

Prior to review and approval of the submittals for this item, the Contractor shall provide and coordinate a live demonstration of the proposed radio system using the proposed radios and proposed CODECs to simulate a minimum 3 radio hop link. This demonstration shall be included in this item at no additional cost to the contract. The demonstration shall demonstrate the features and performance requirements of the special provisions. Given space limitations for a demonstration, the radio signals will need to be attenuated appropriately to simulate the distances and terrain involved in this contract.

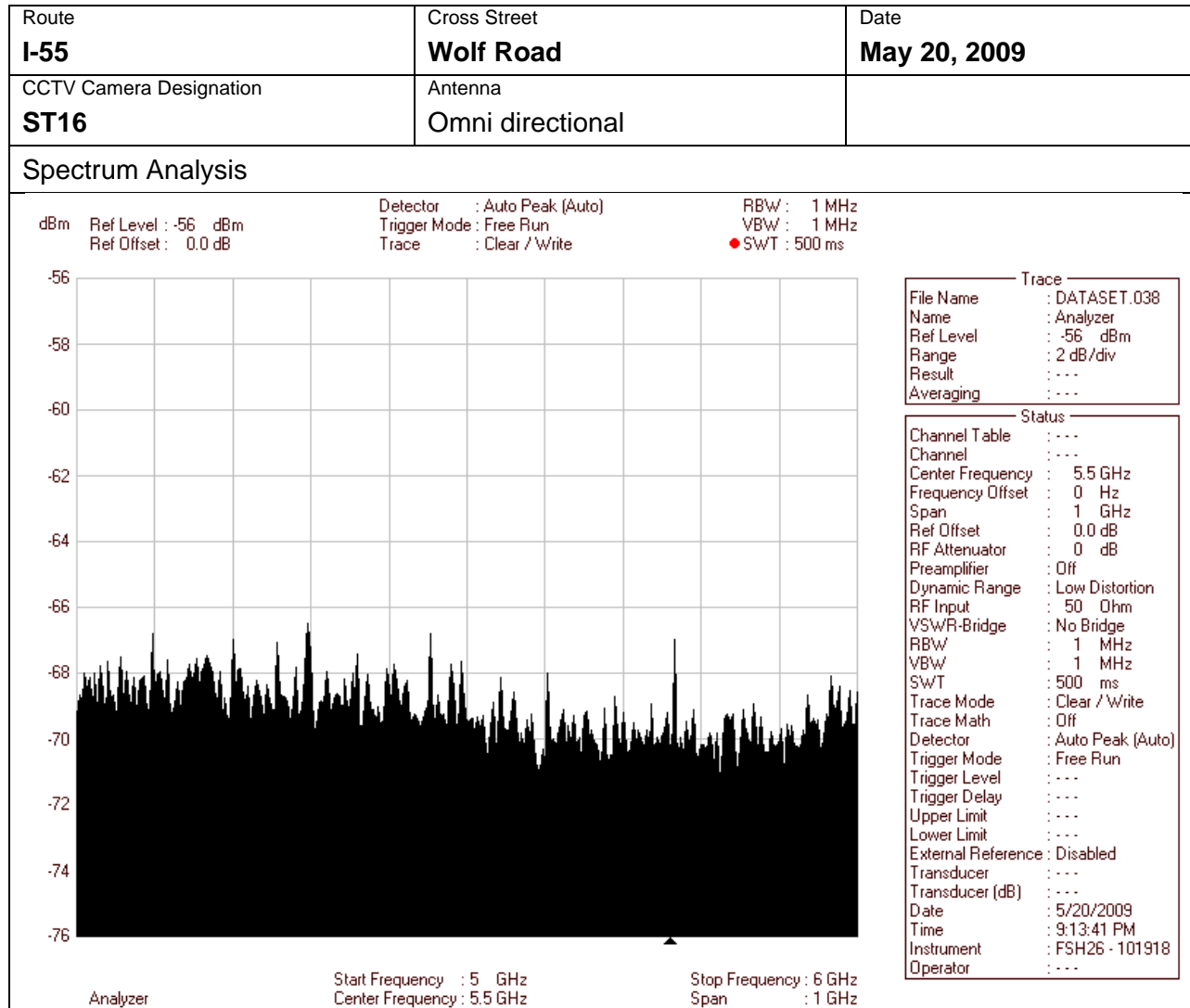
If the proposed manufacturer has an existing installation within D1 comparable to what the Contractor is proposing, the existing system may be used as the live demonstration with the approval of the Engineer. The existing system must utilize the same radios and CODECs that the Contractor is proposing for this contract and must also be able to demonstrate the performance requirements contained herein.

Method of Measurement. The System shall be counted for payment when furnished and installed, connected, field tested and accepted. A 50% payment will be allowed when the radio system is installed and operational and is transferring data and video. The remaining 50% payment will be allowed when the radio system is connected and operation with the fiber optic link to the D1 Headquarters and all documentation has been completed, delivered and approved by the Engineer.

Basis Of Payment. This work will be paid for at the contract lump sum price for **WIRELESS VIDEO DISTRIBUTION SYSTEM** which shall be for the work as specified herein.

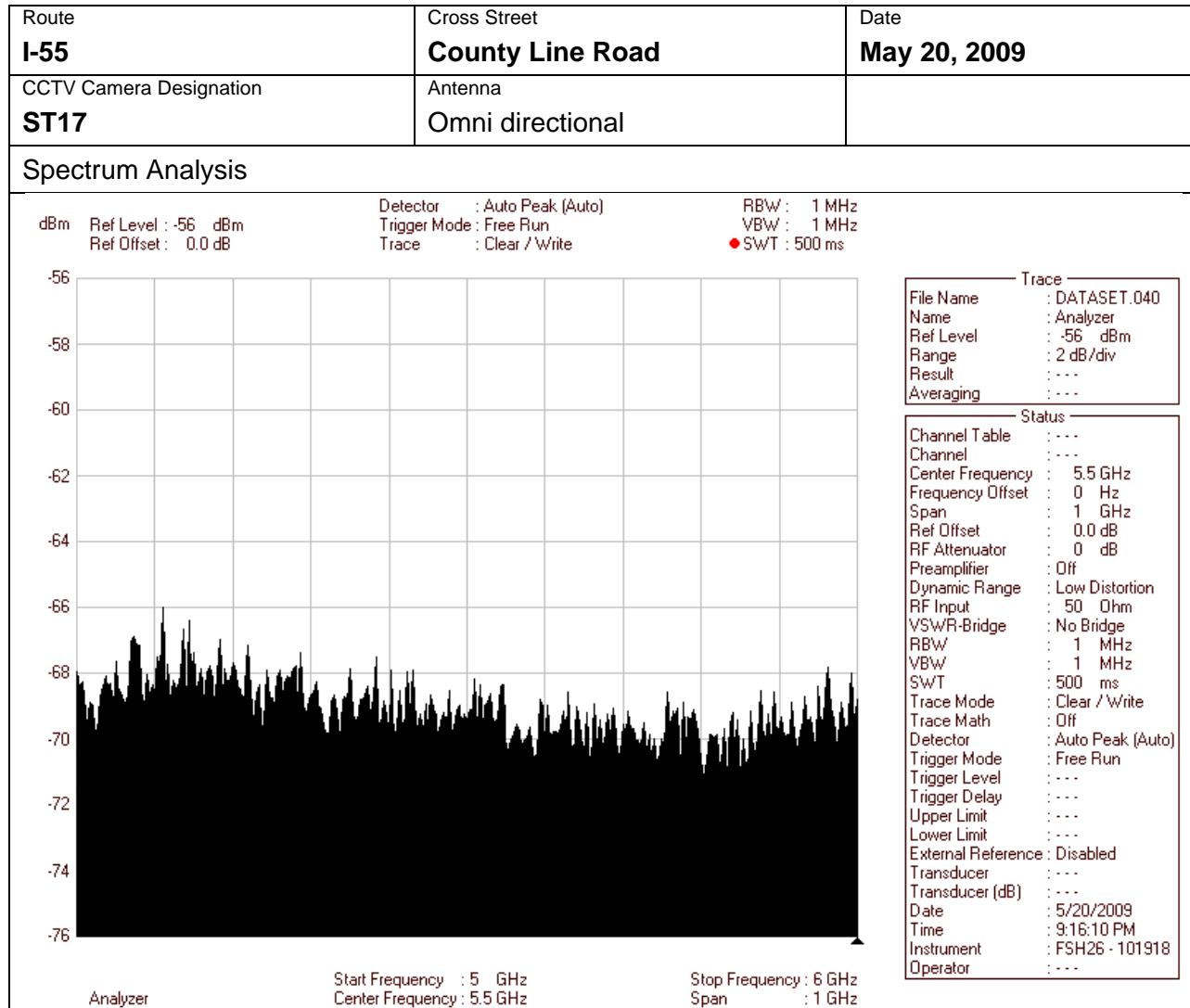
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Radio Spectrum Analysis



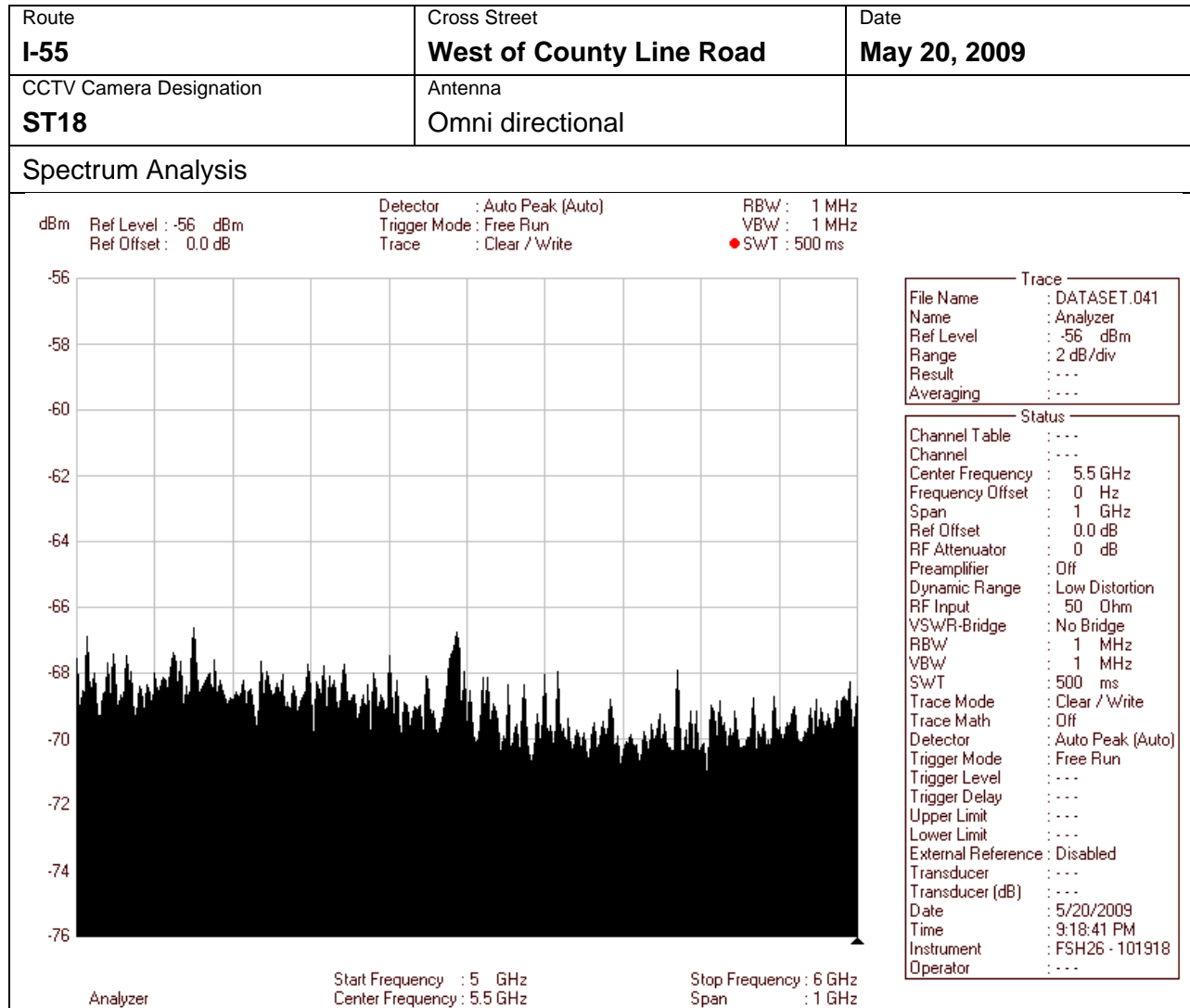
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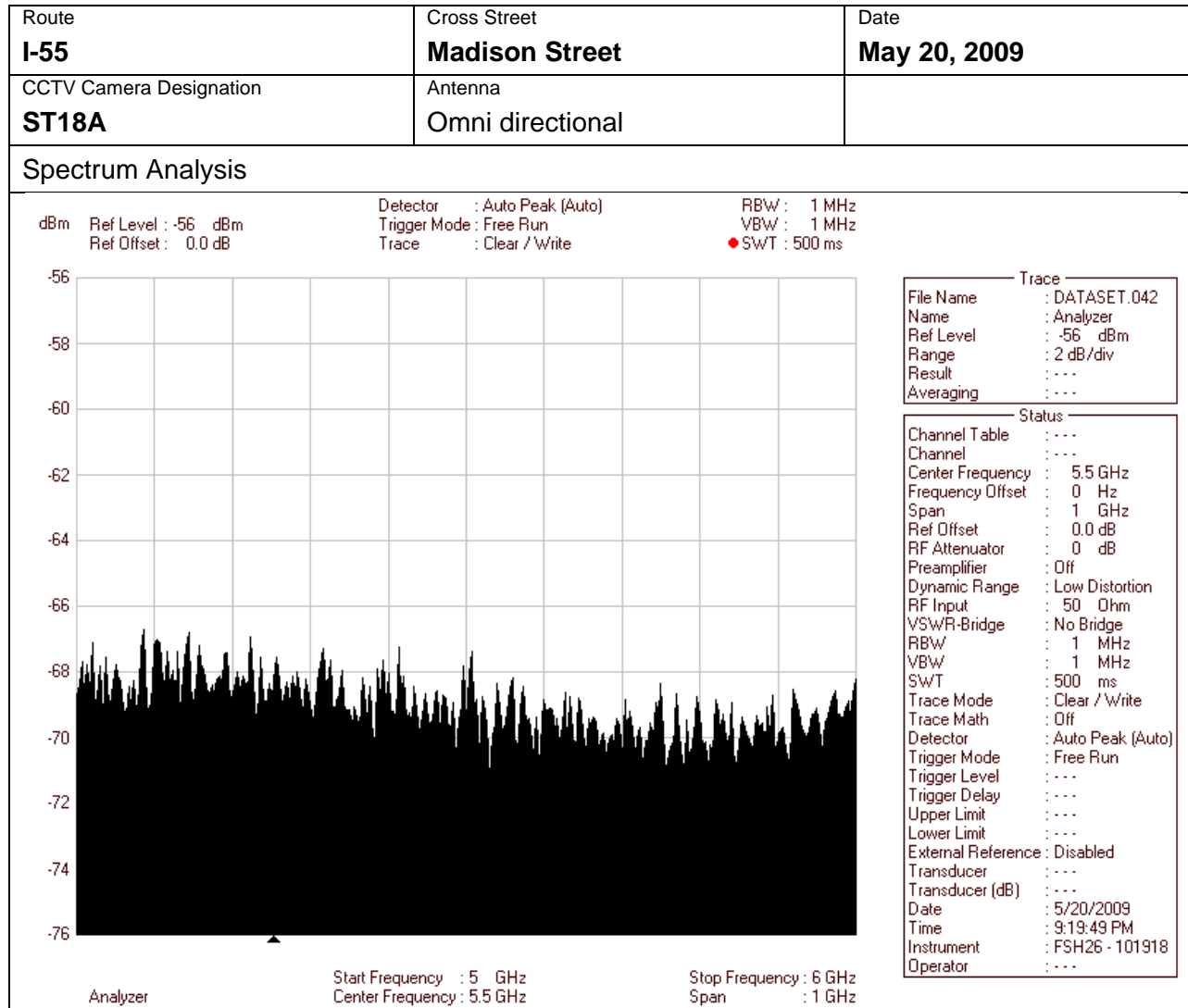
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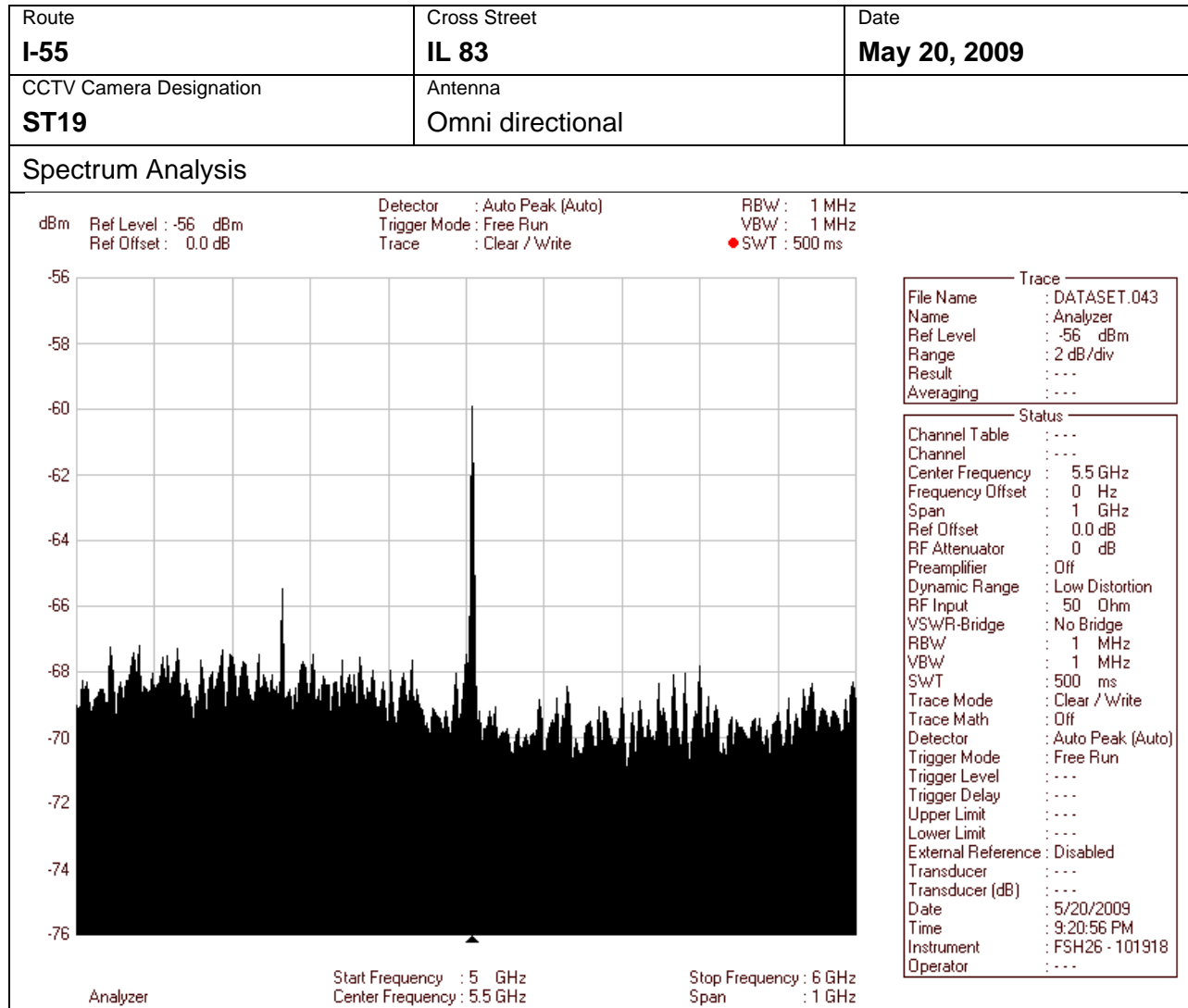
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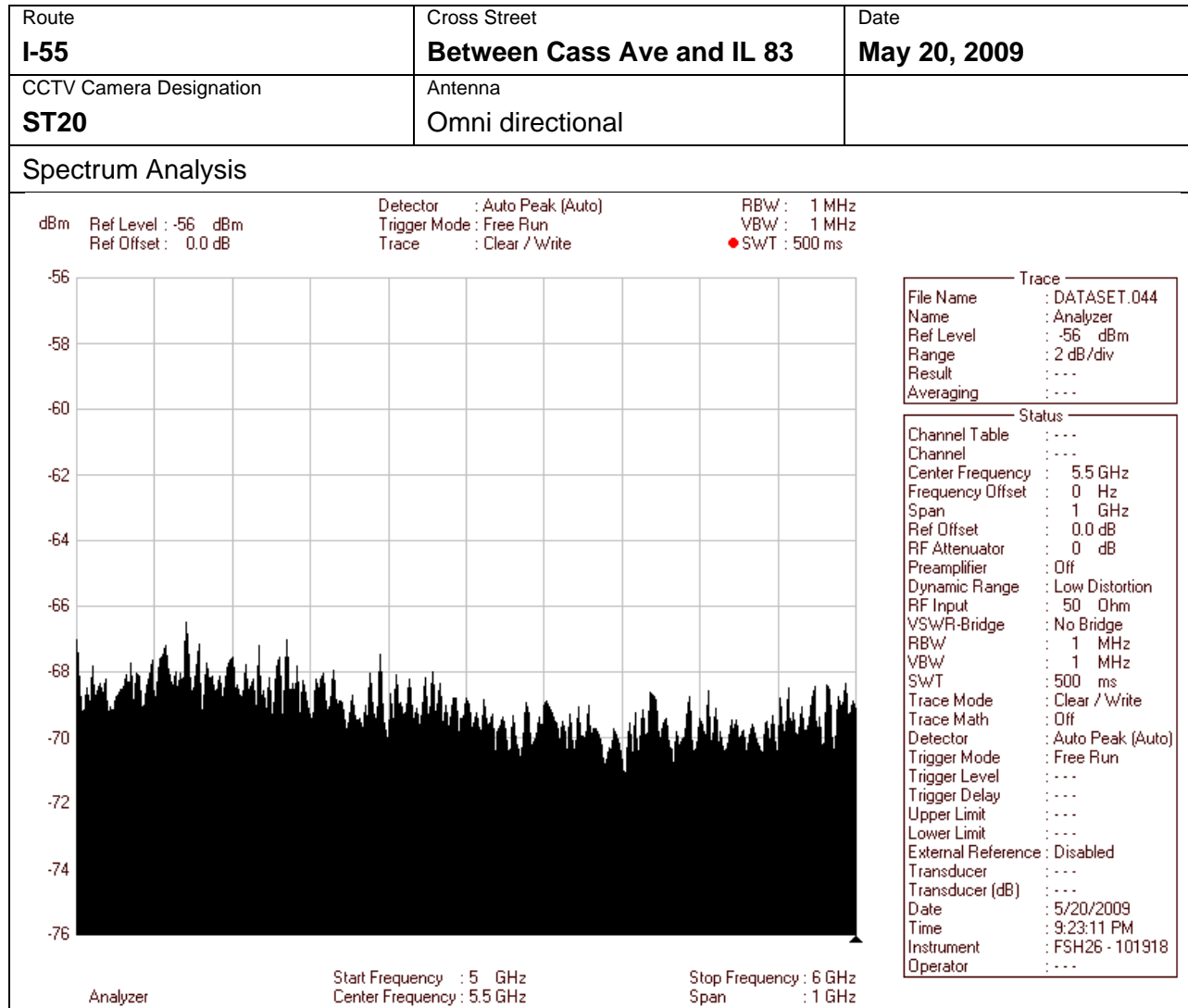
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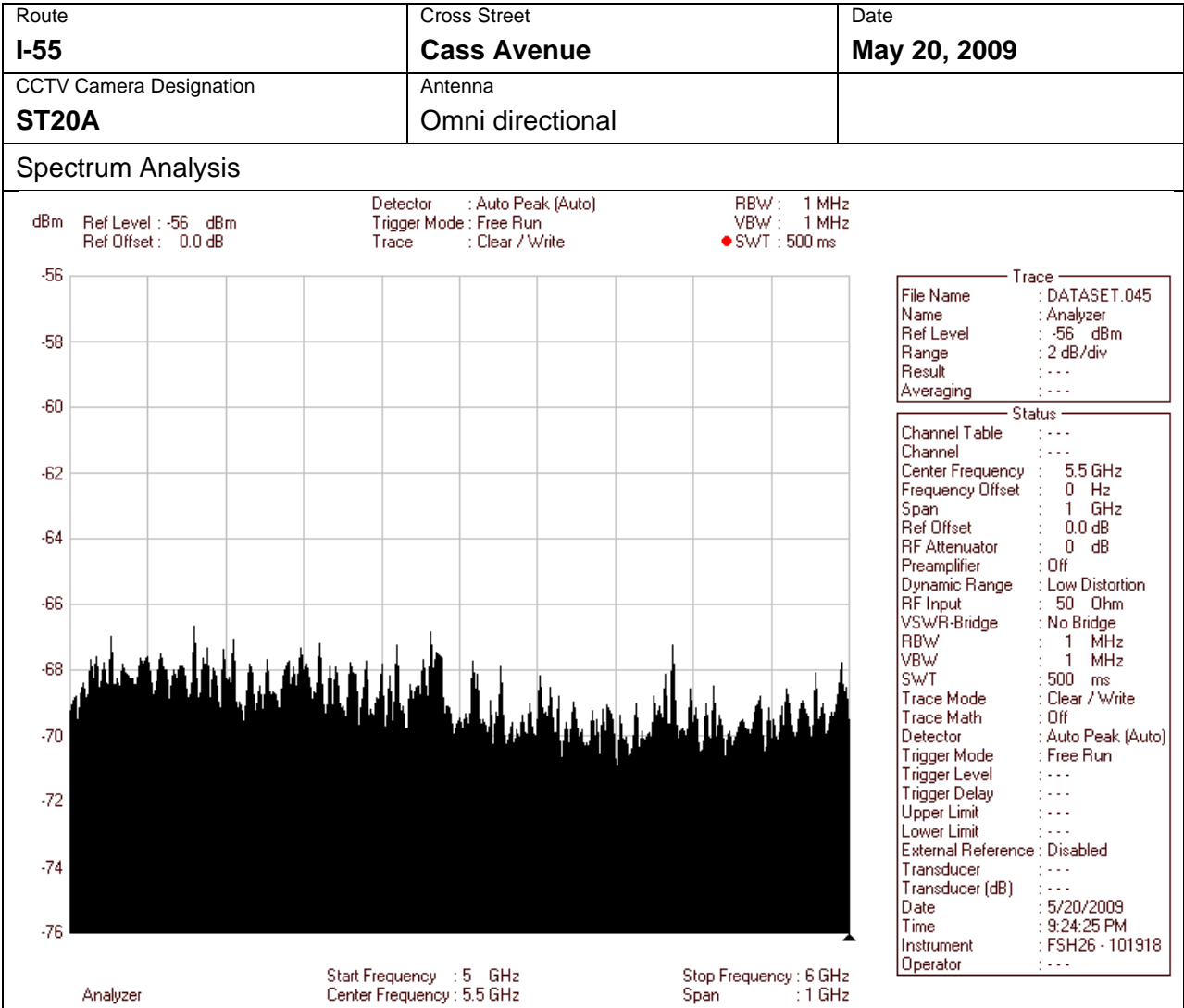
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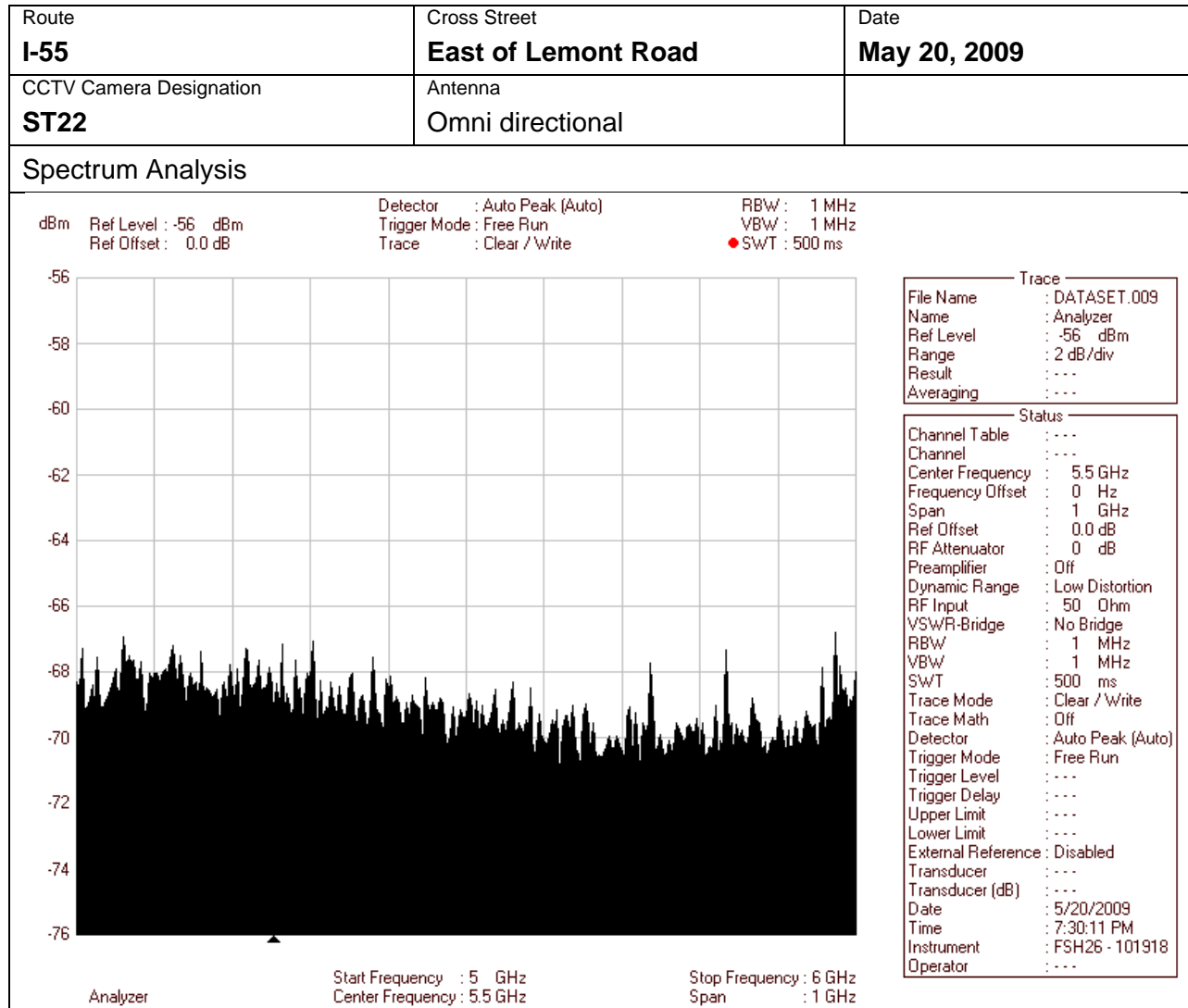
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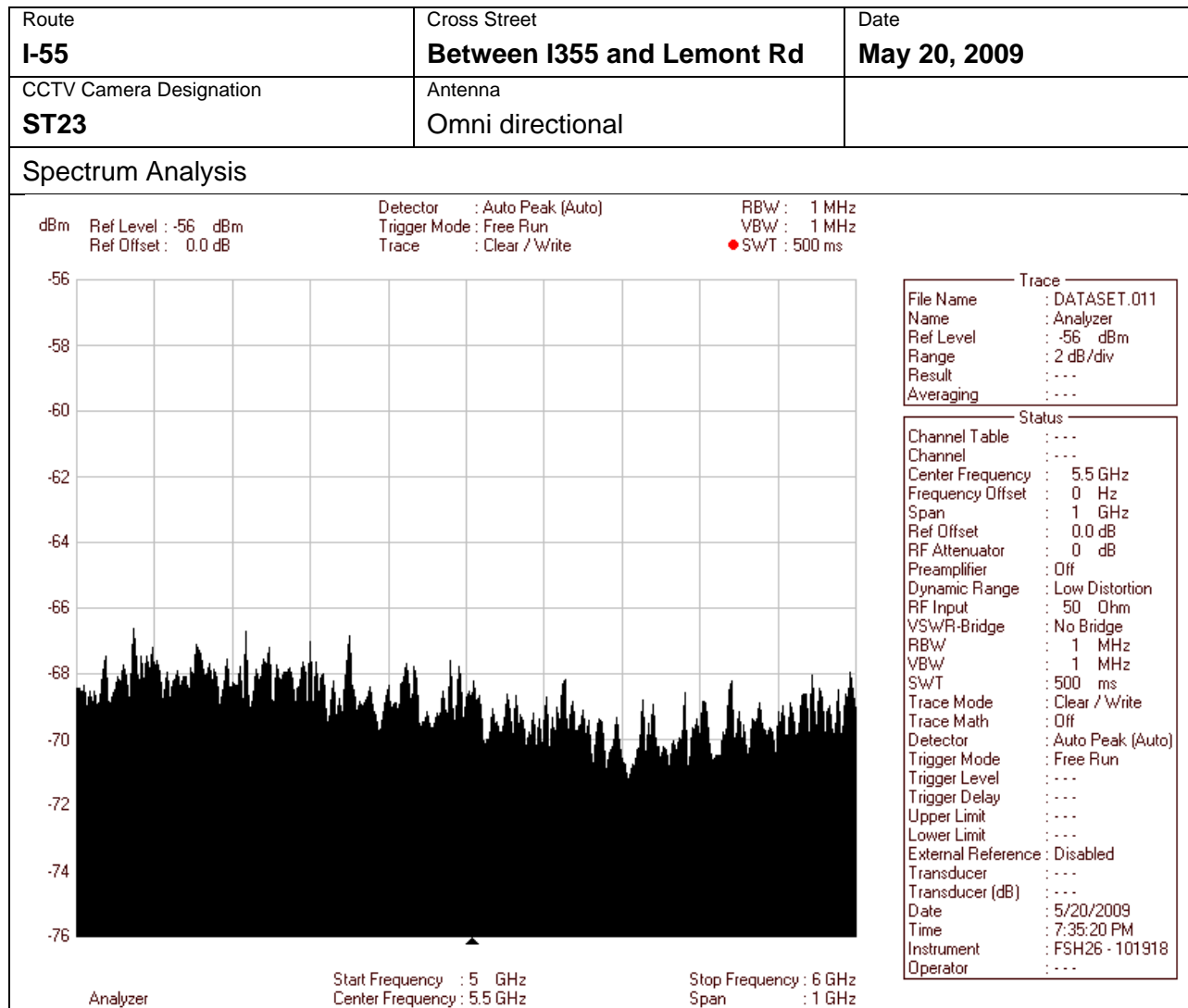
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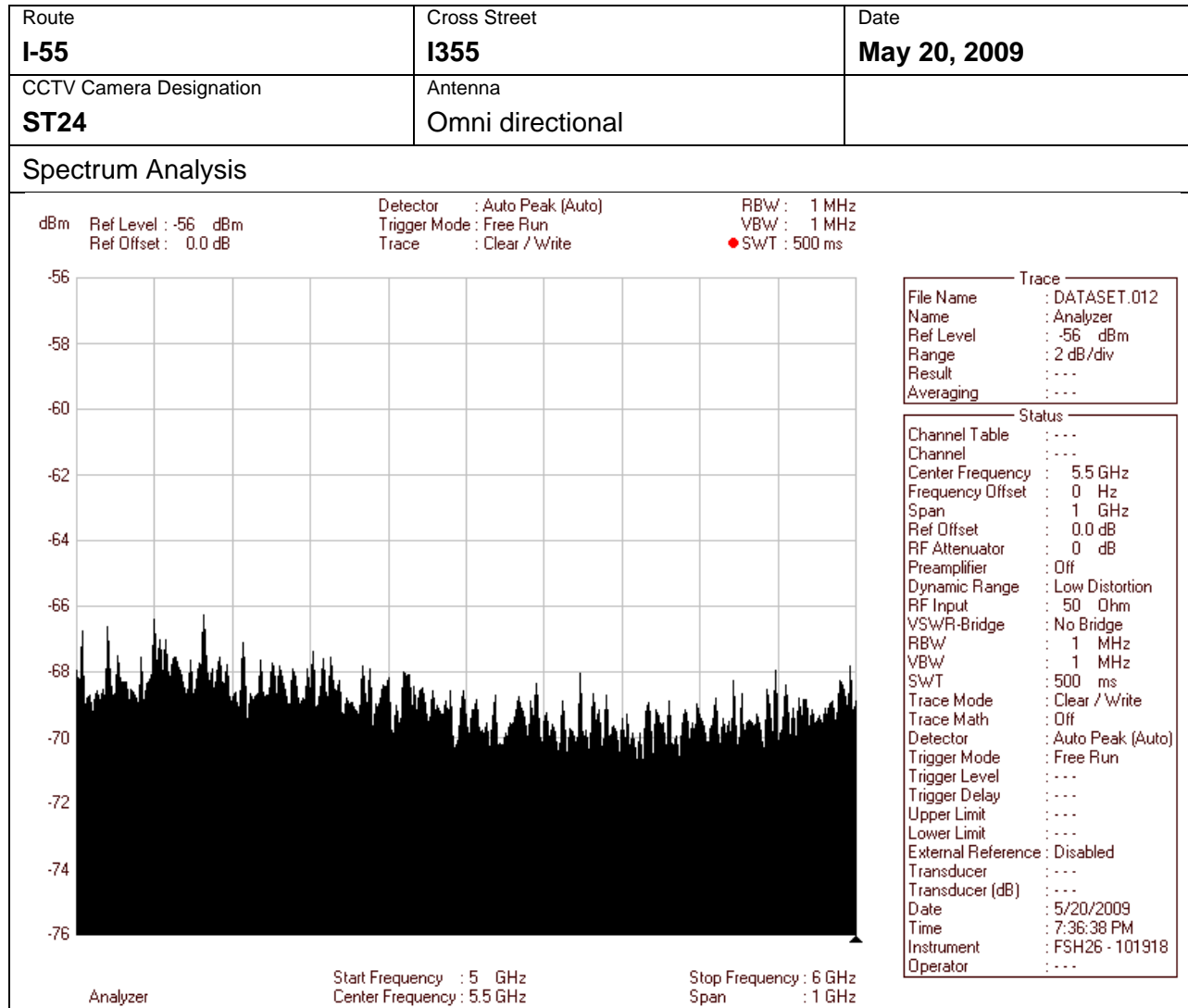
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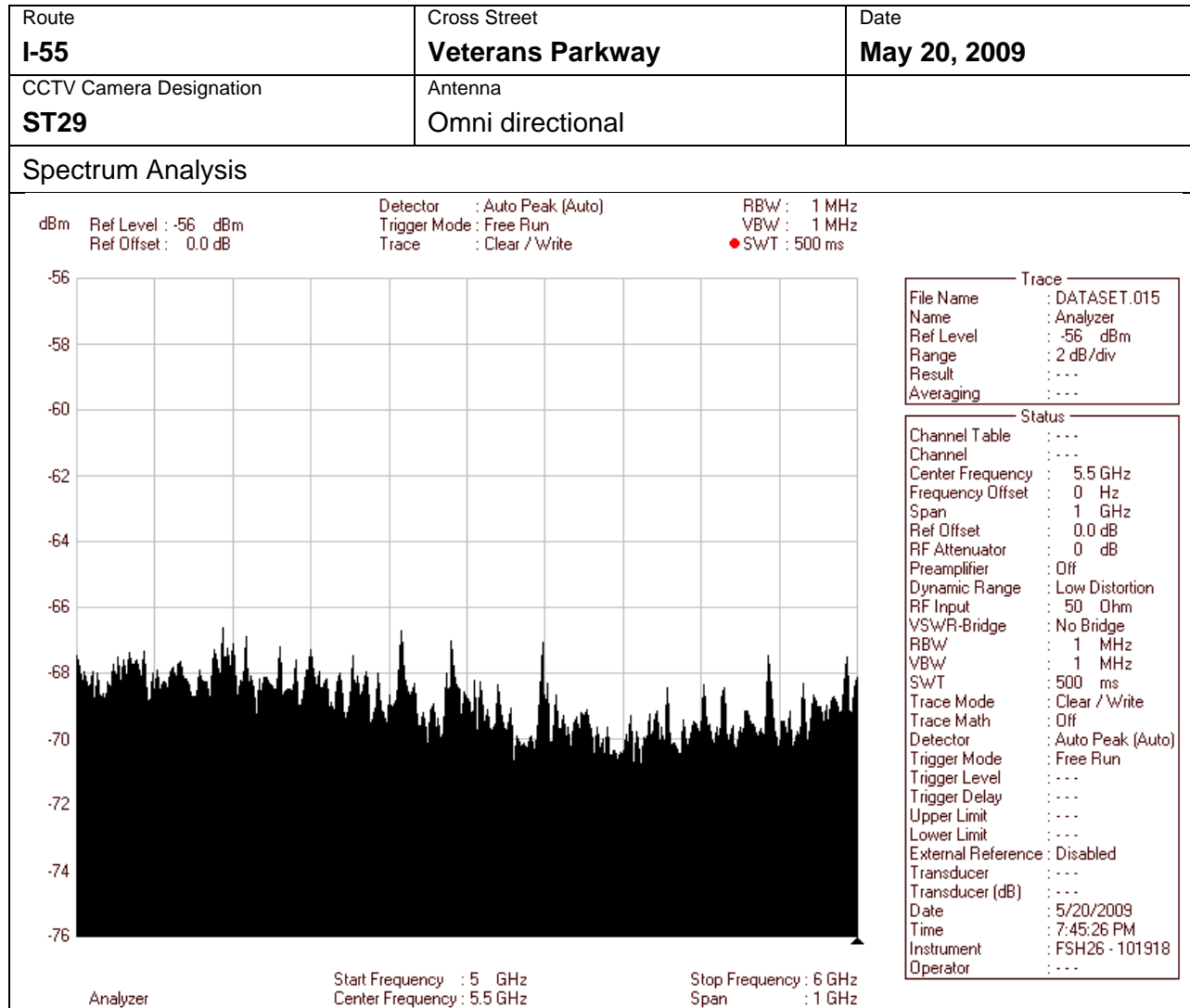
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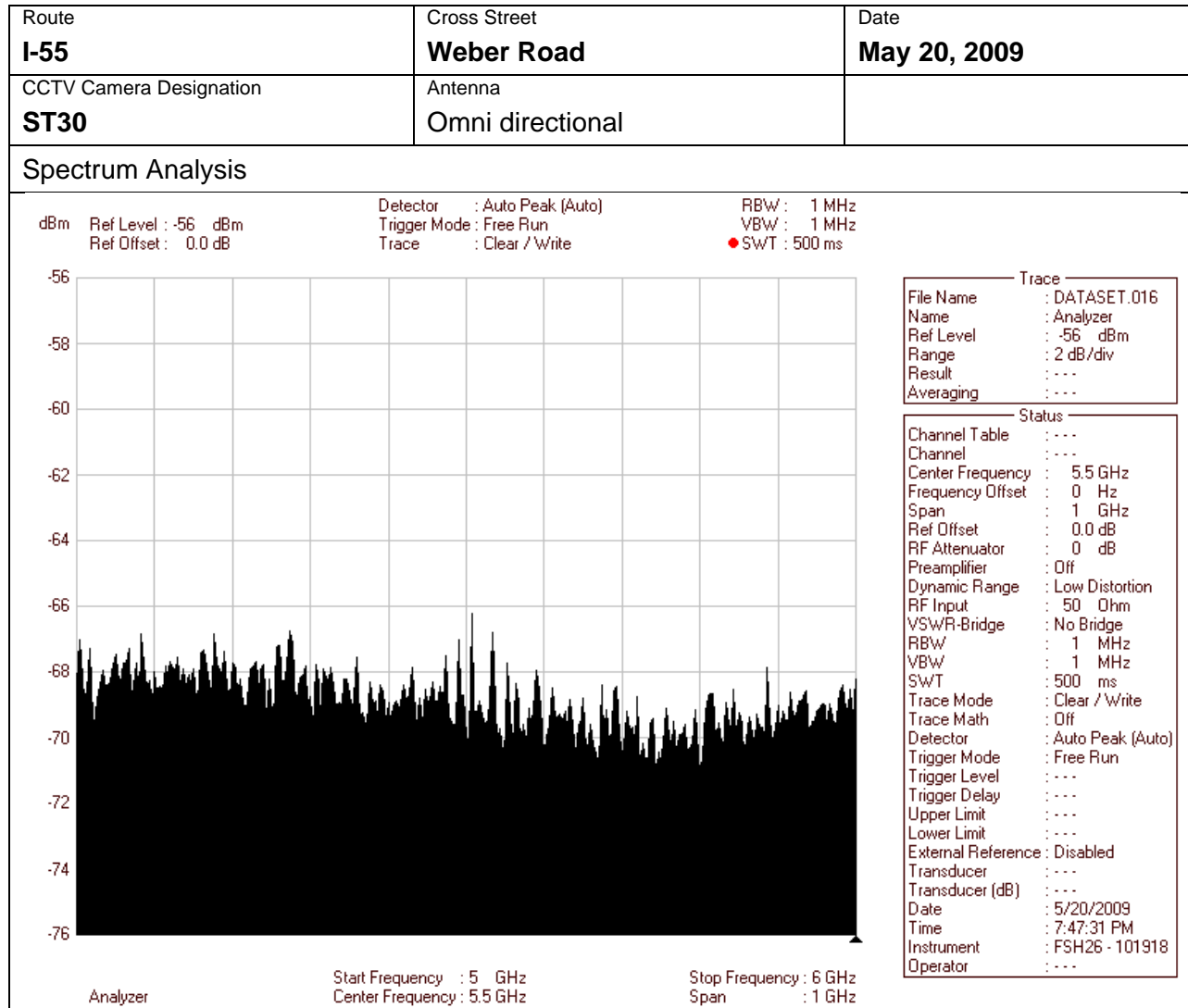
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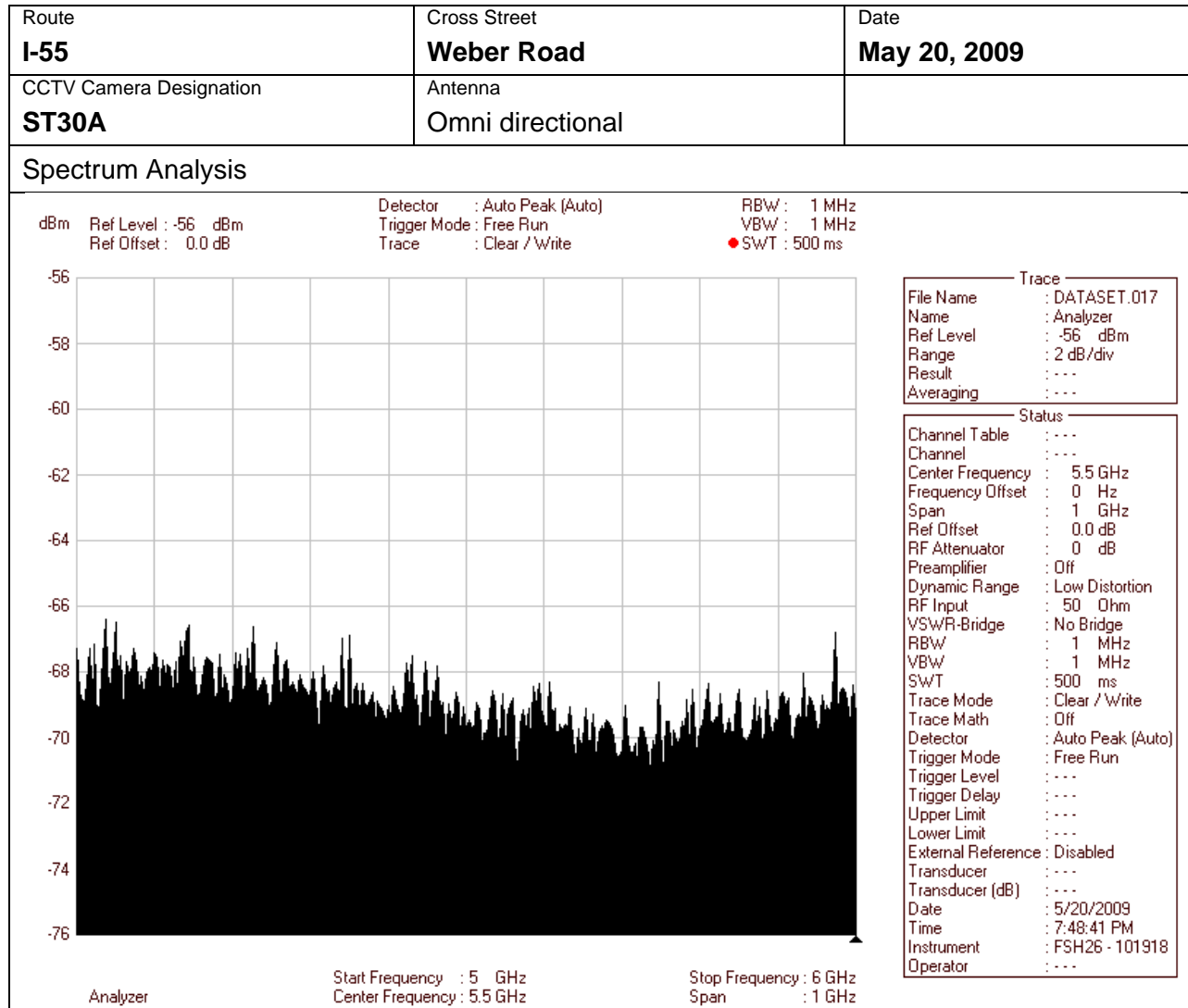
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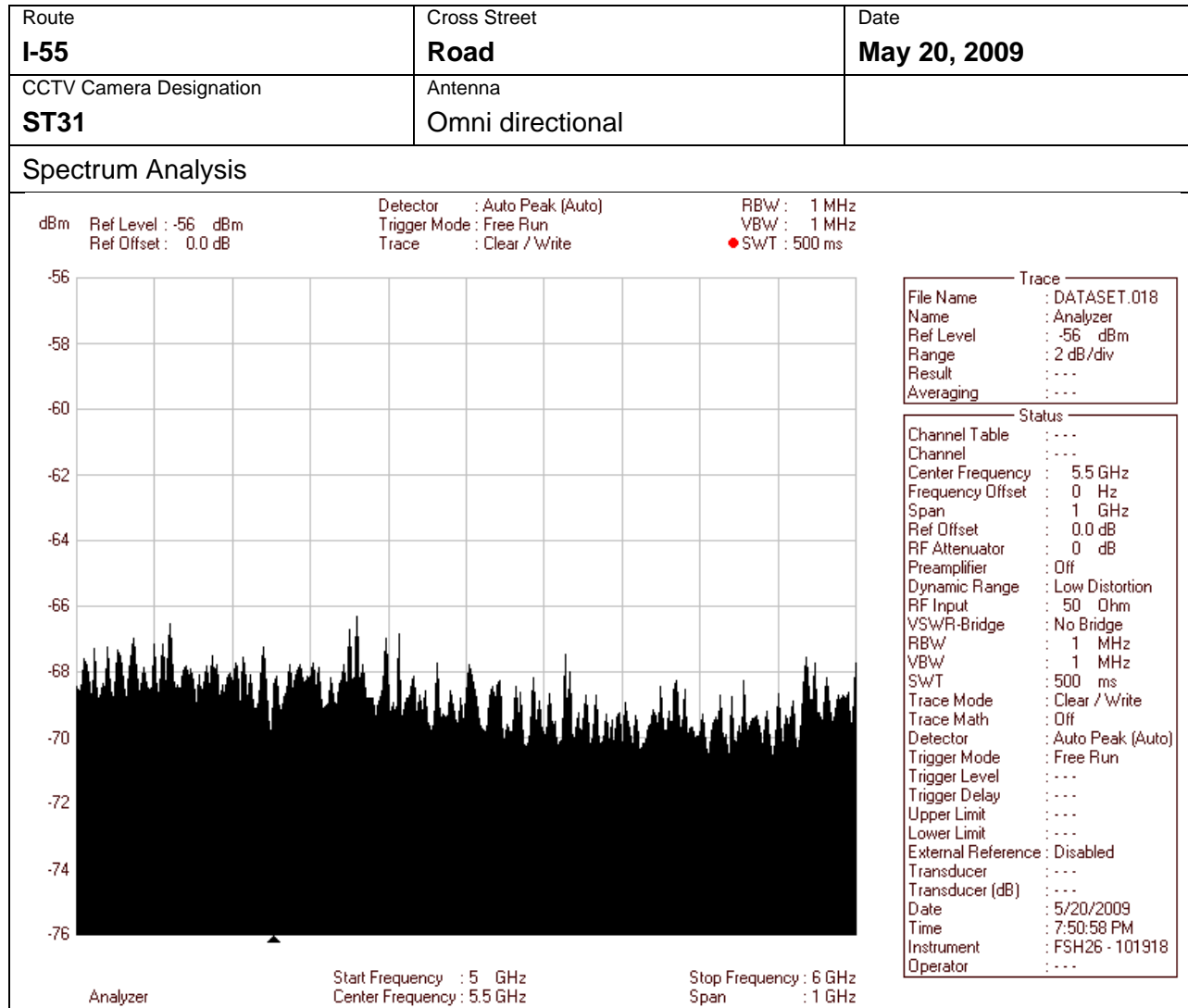
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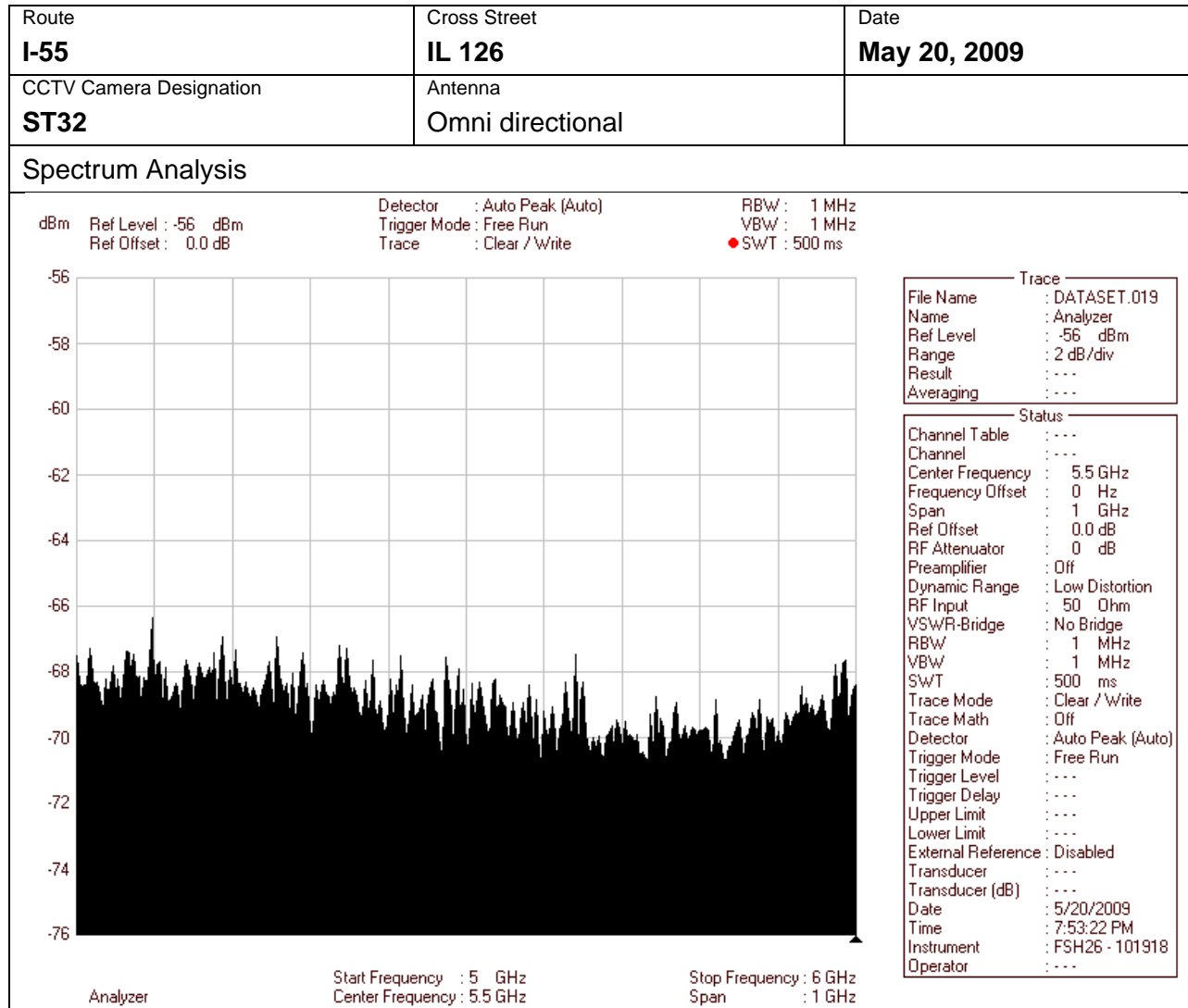
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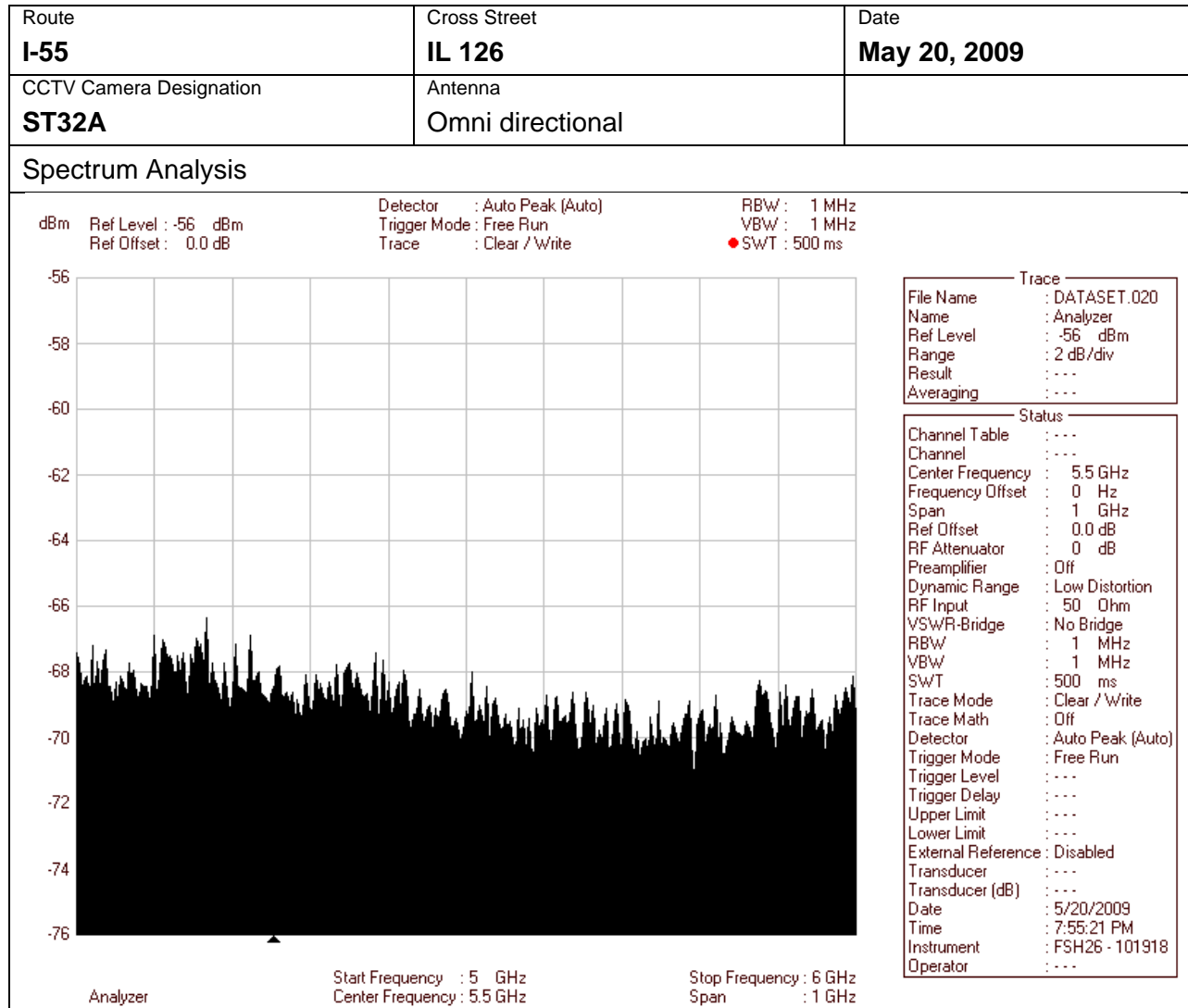
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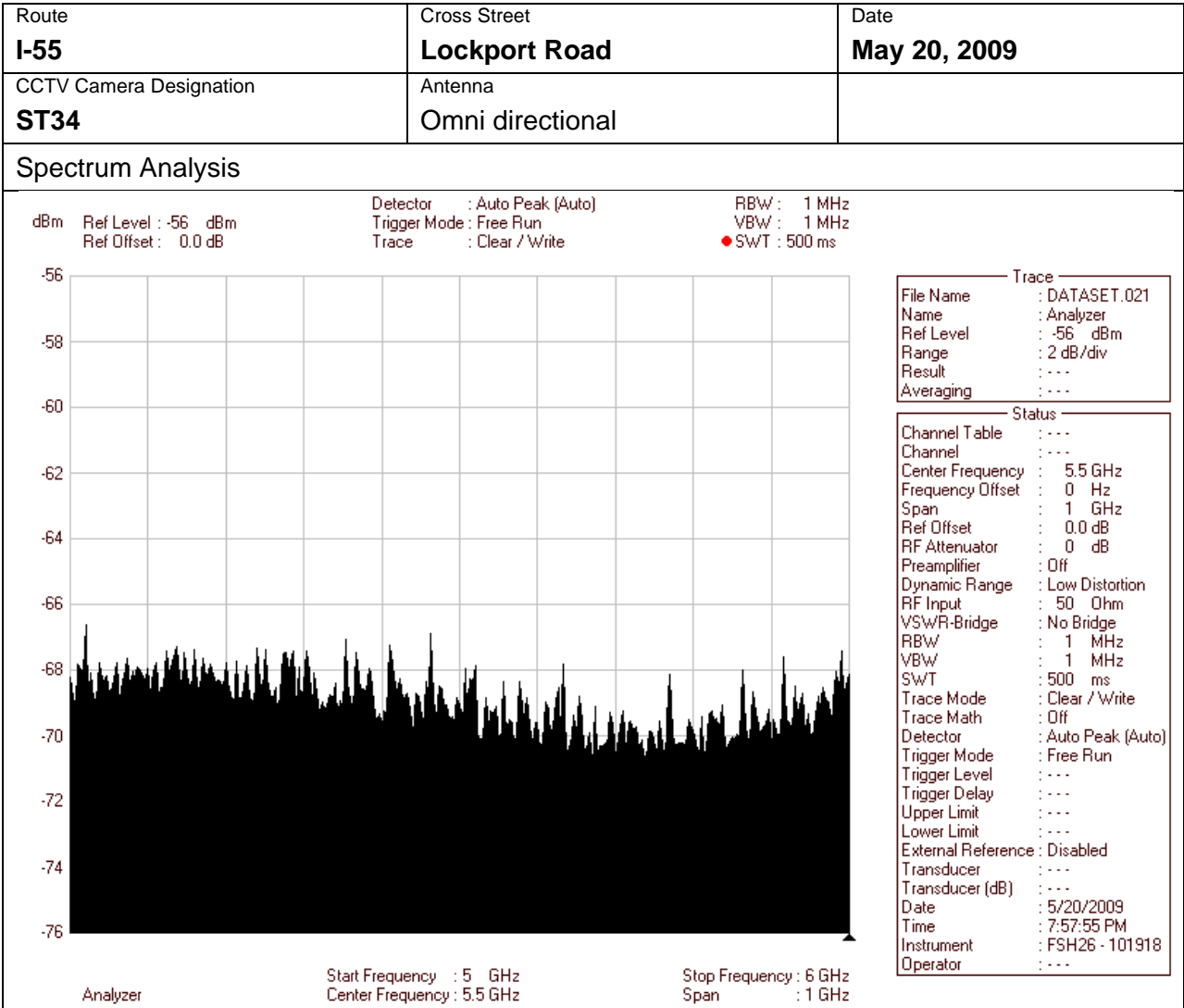
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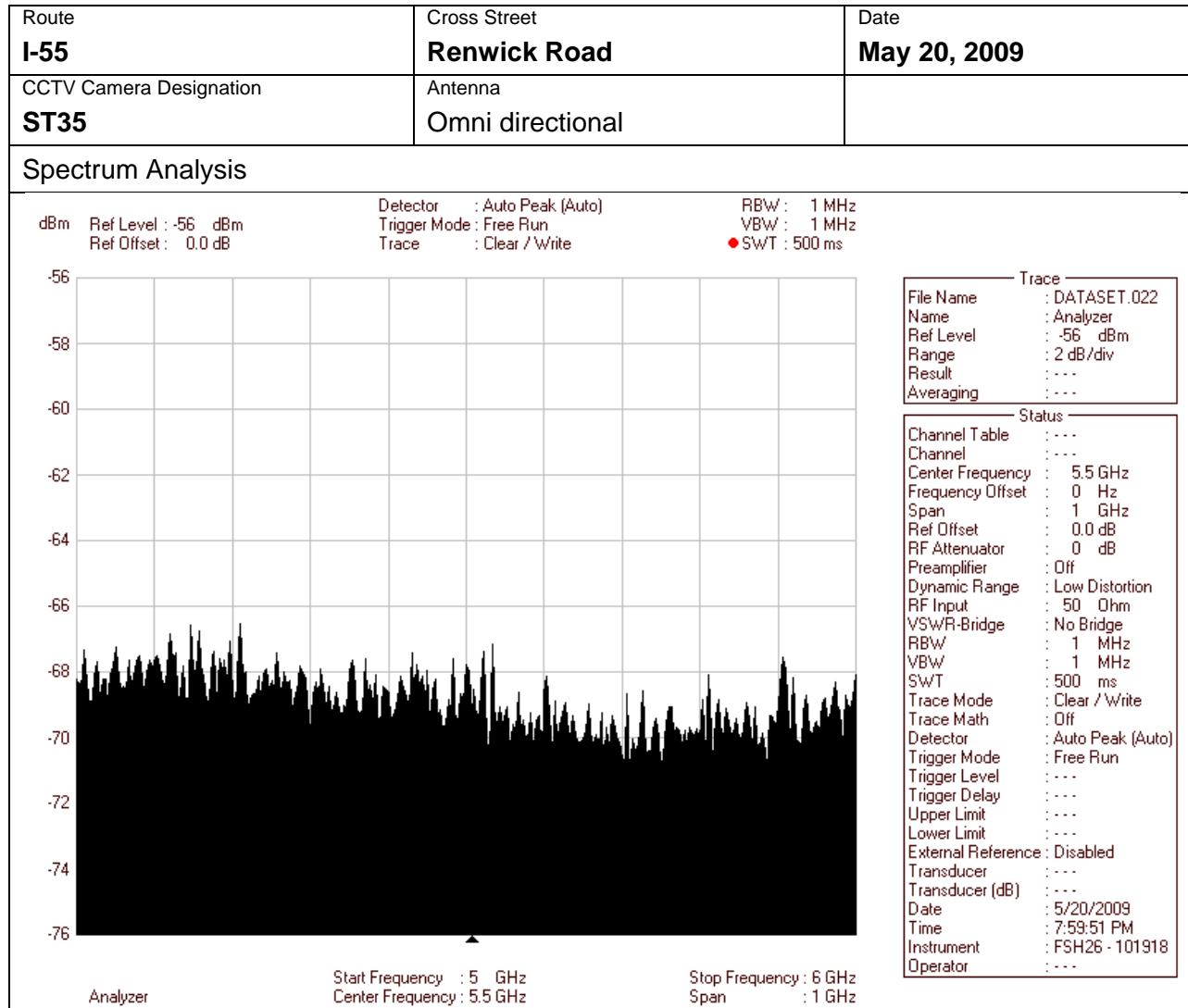
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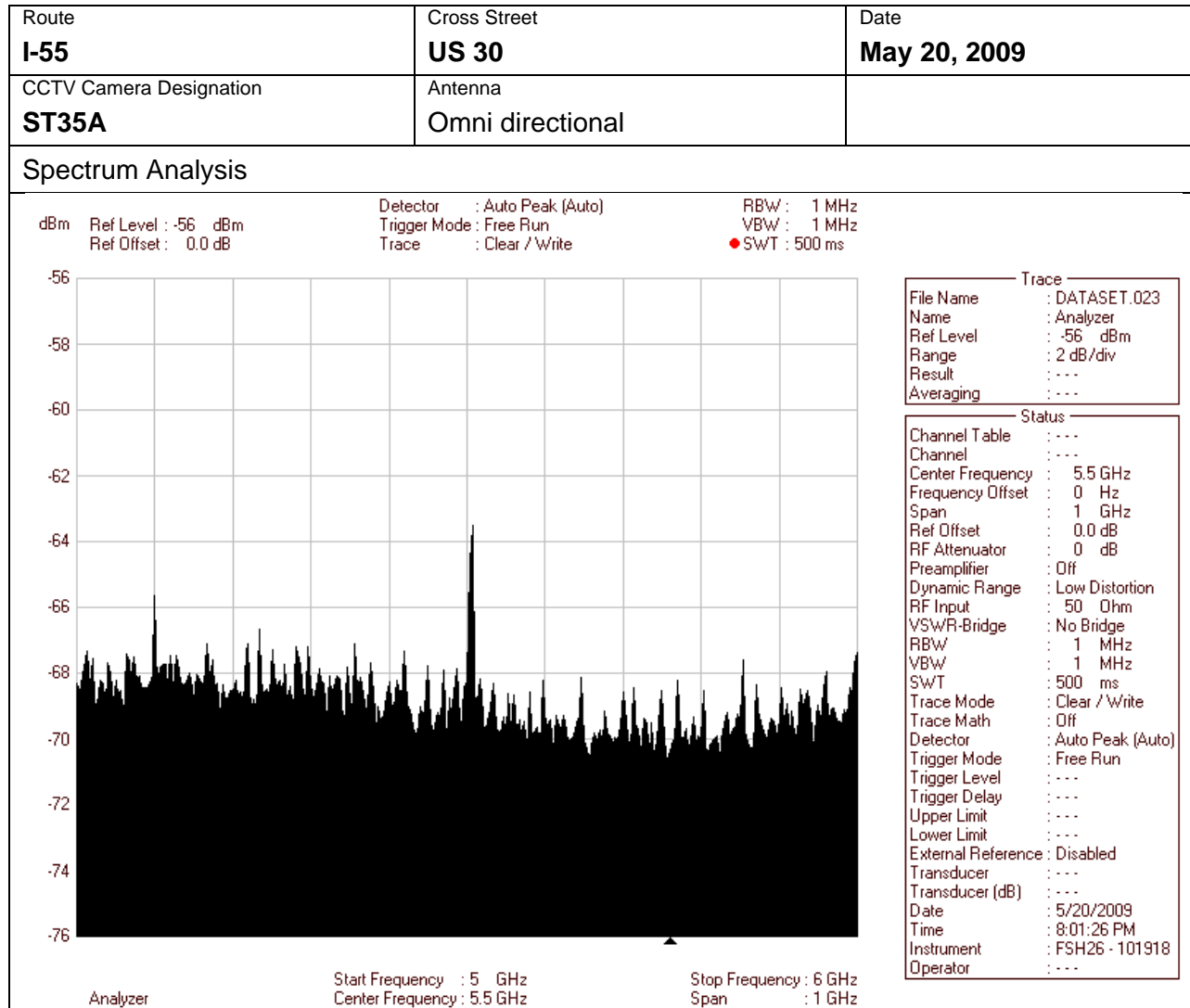
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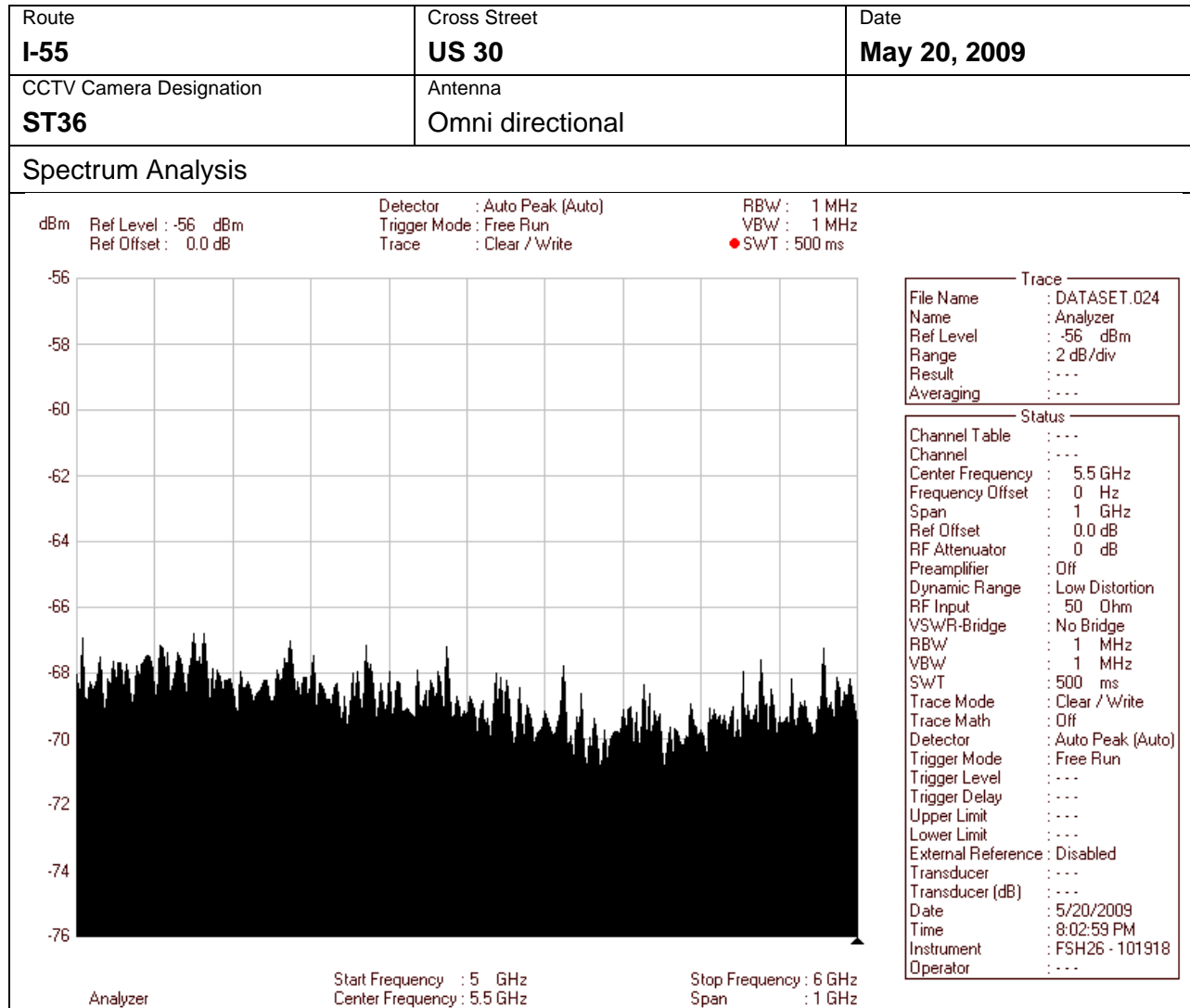
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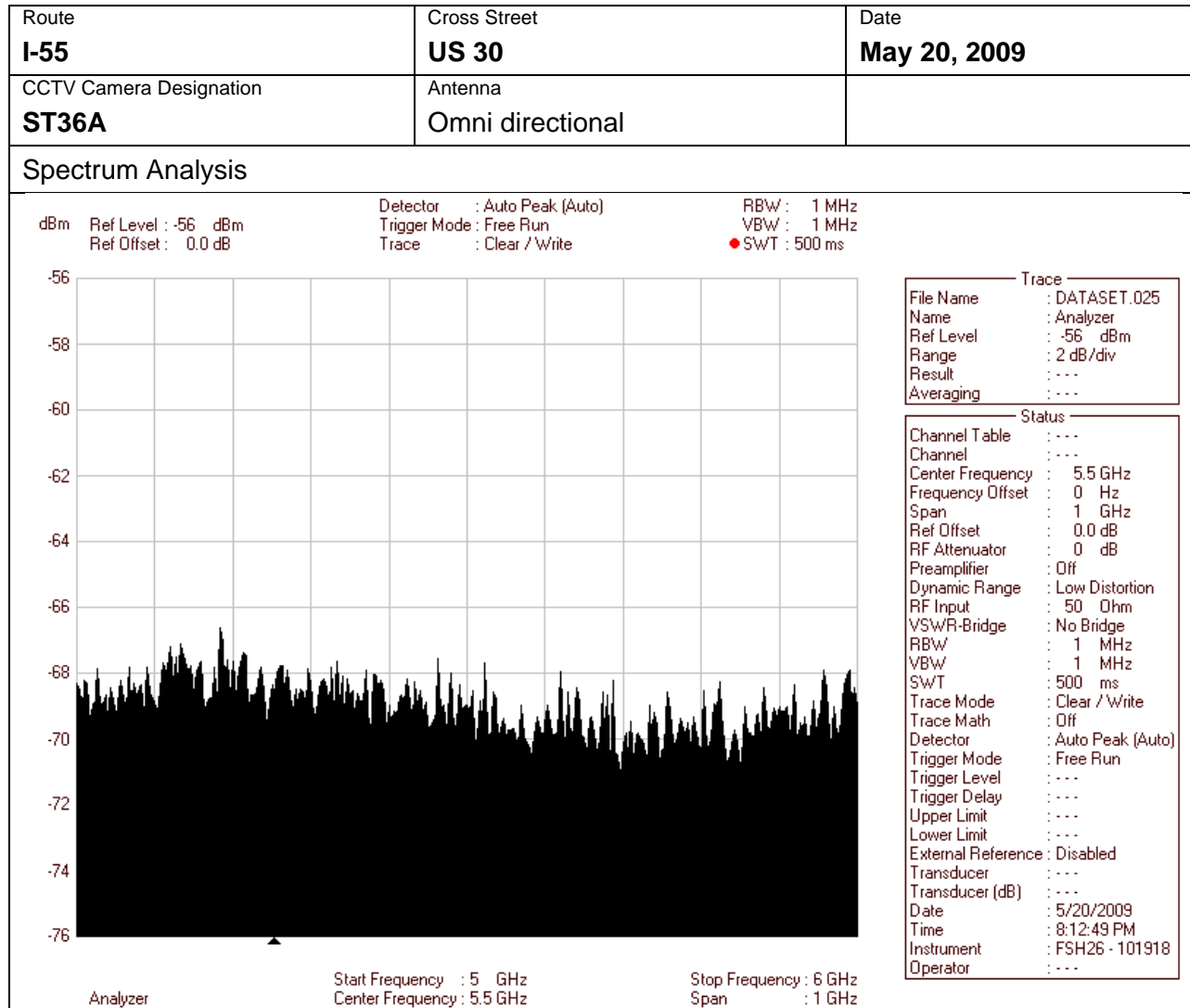
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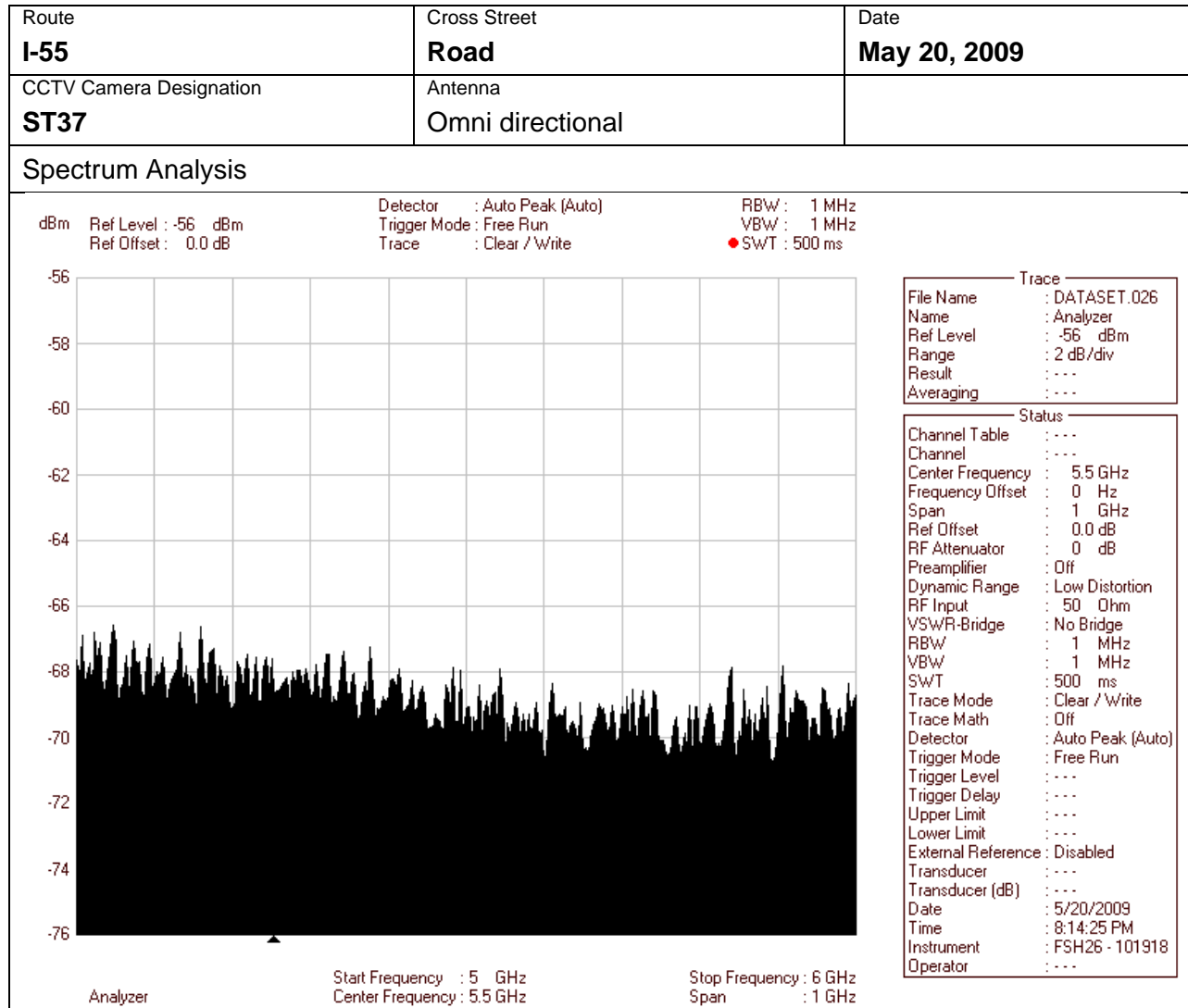
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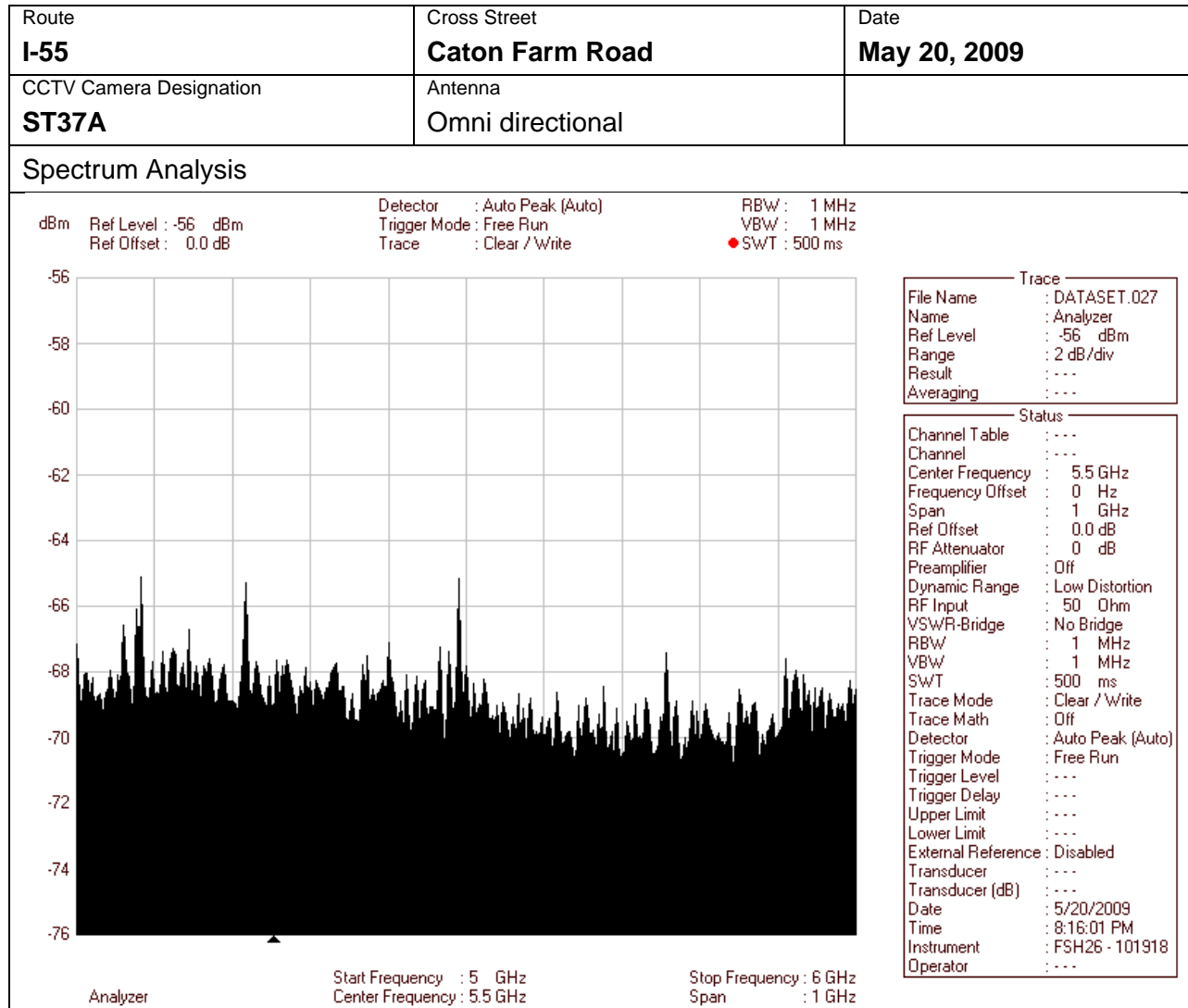
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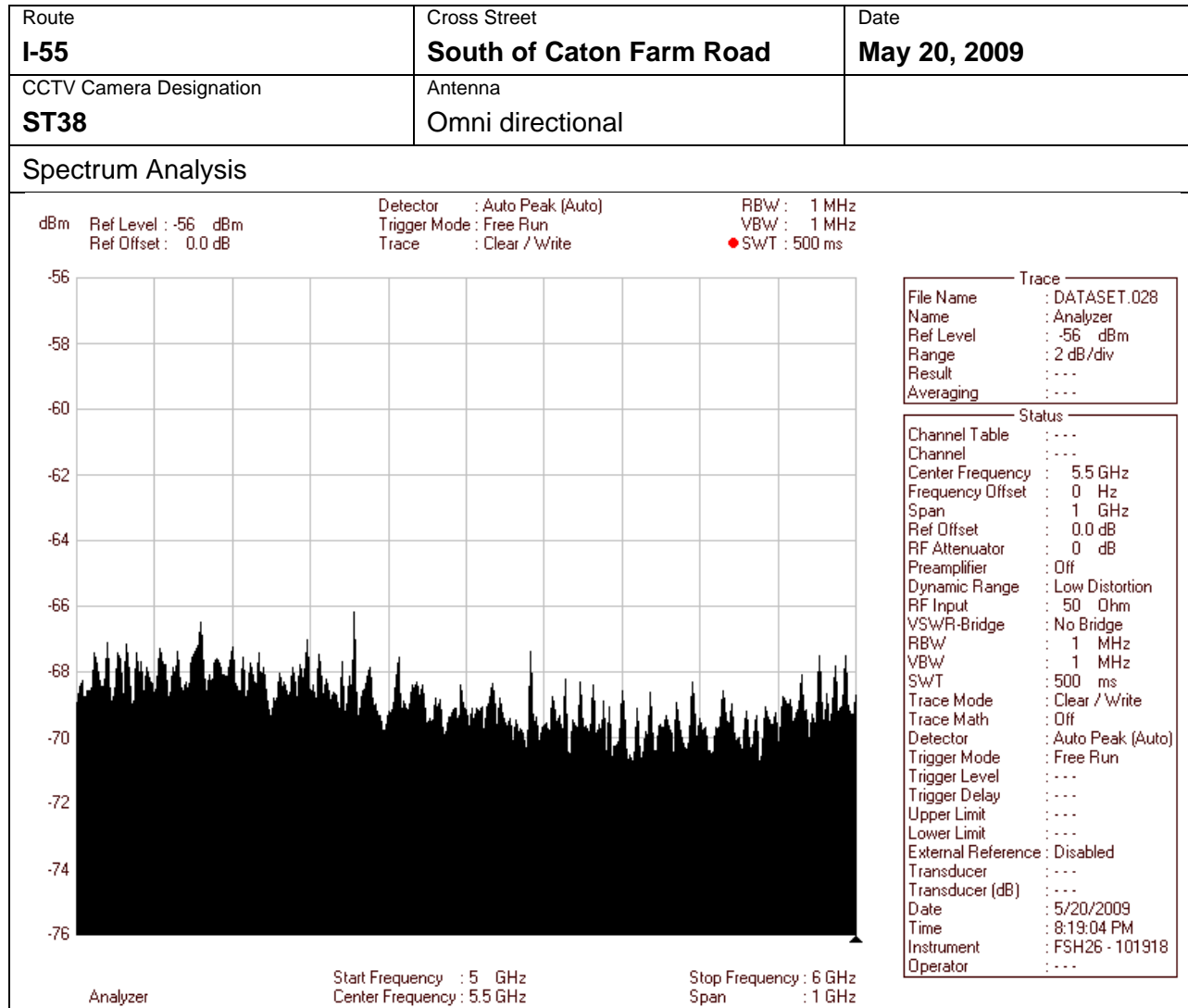
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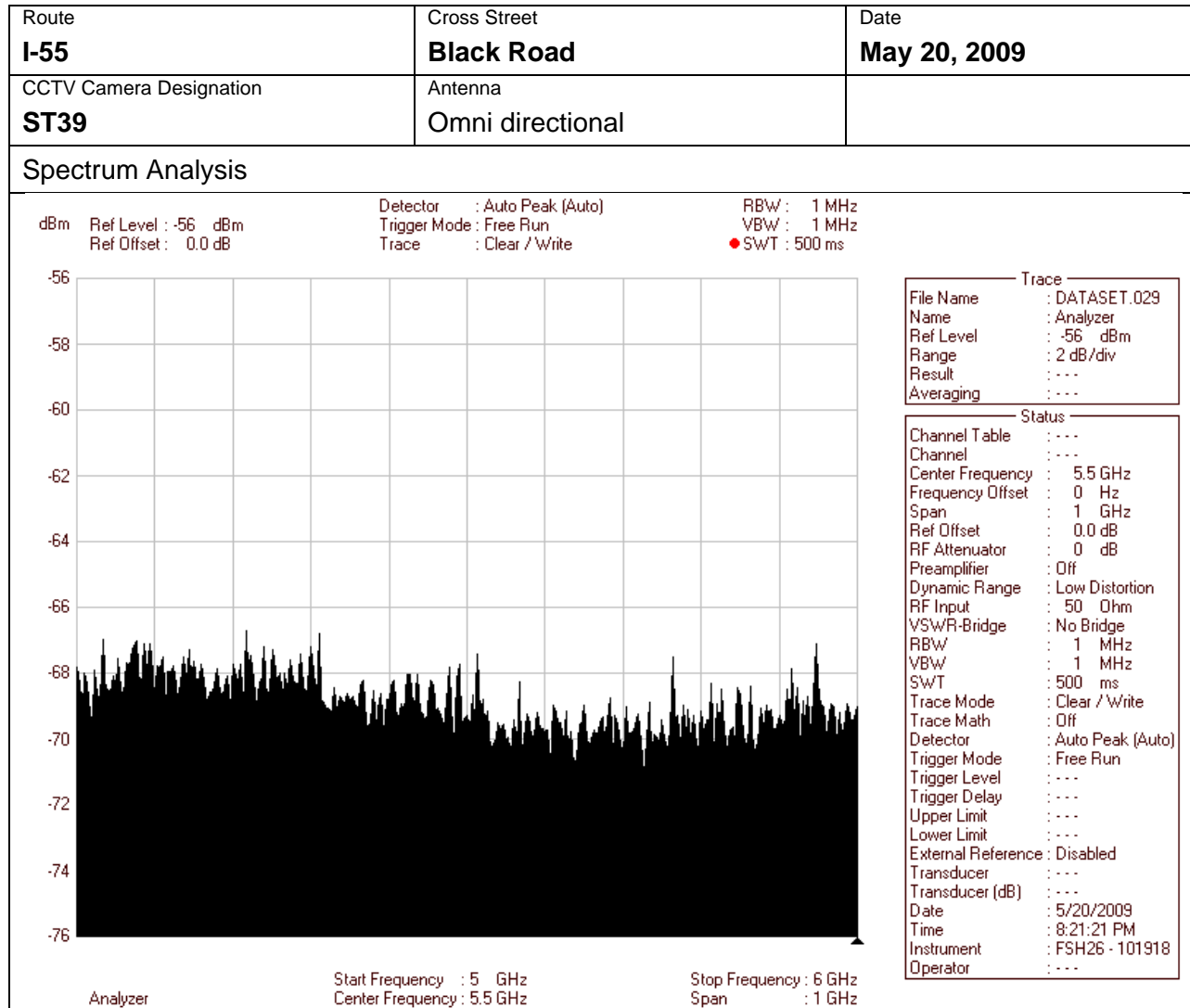
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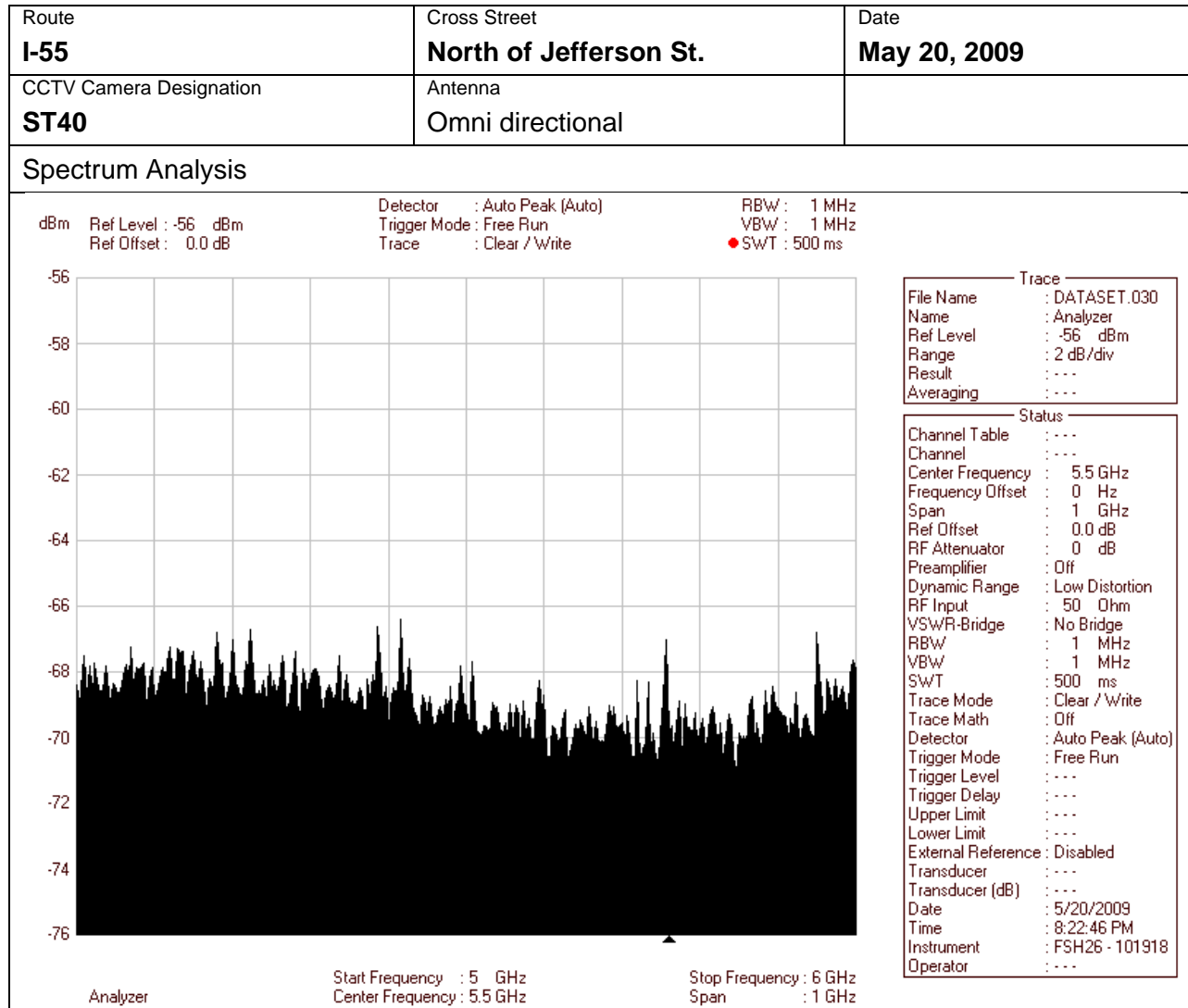
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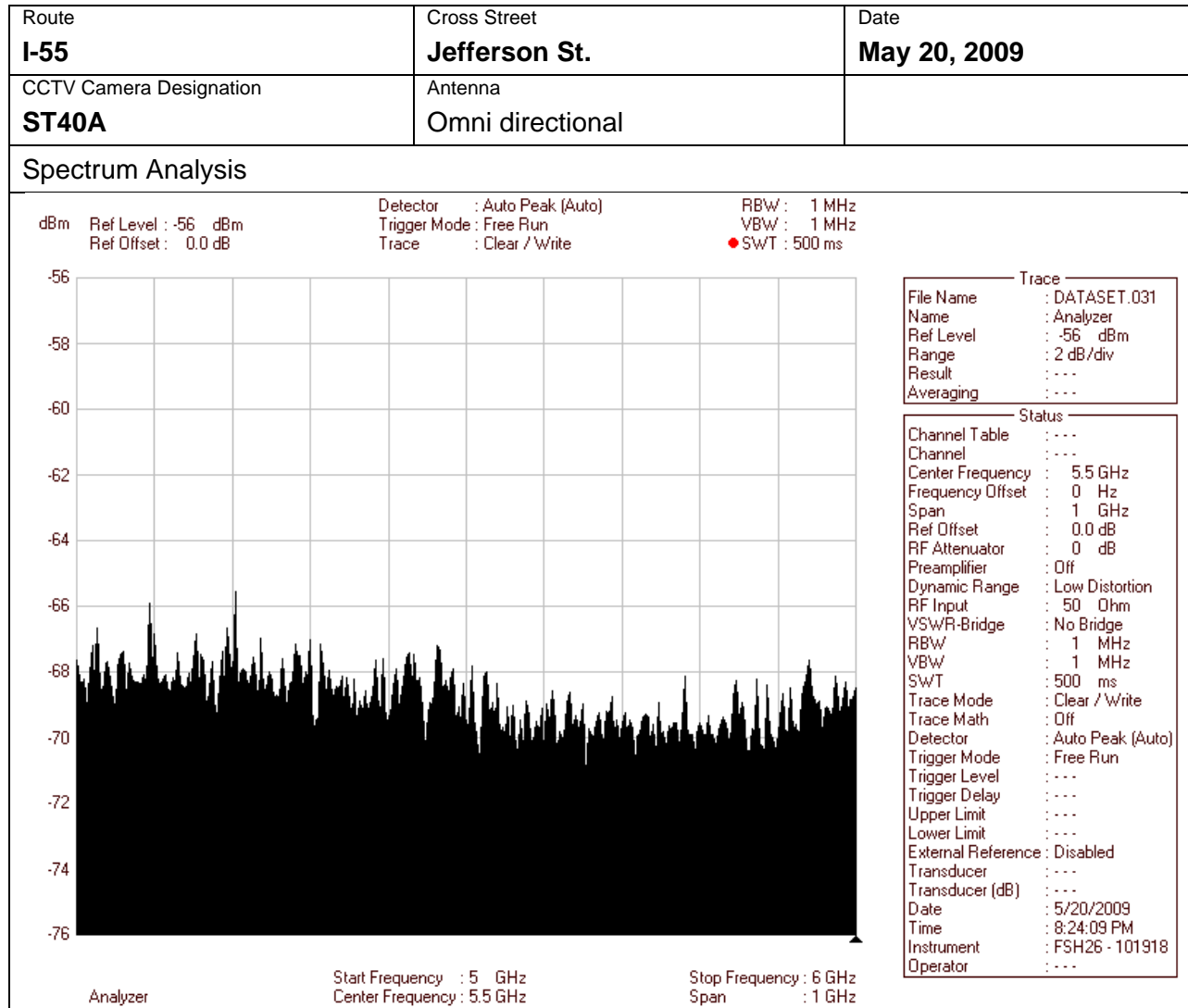
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Radio Spectrum Analysis



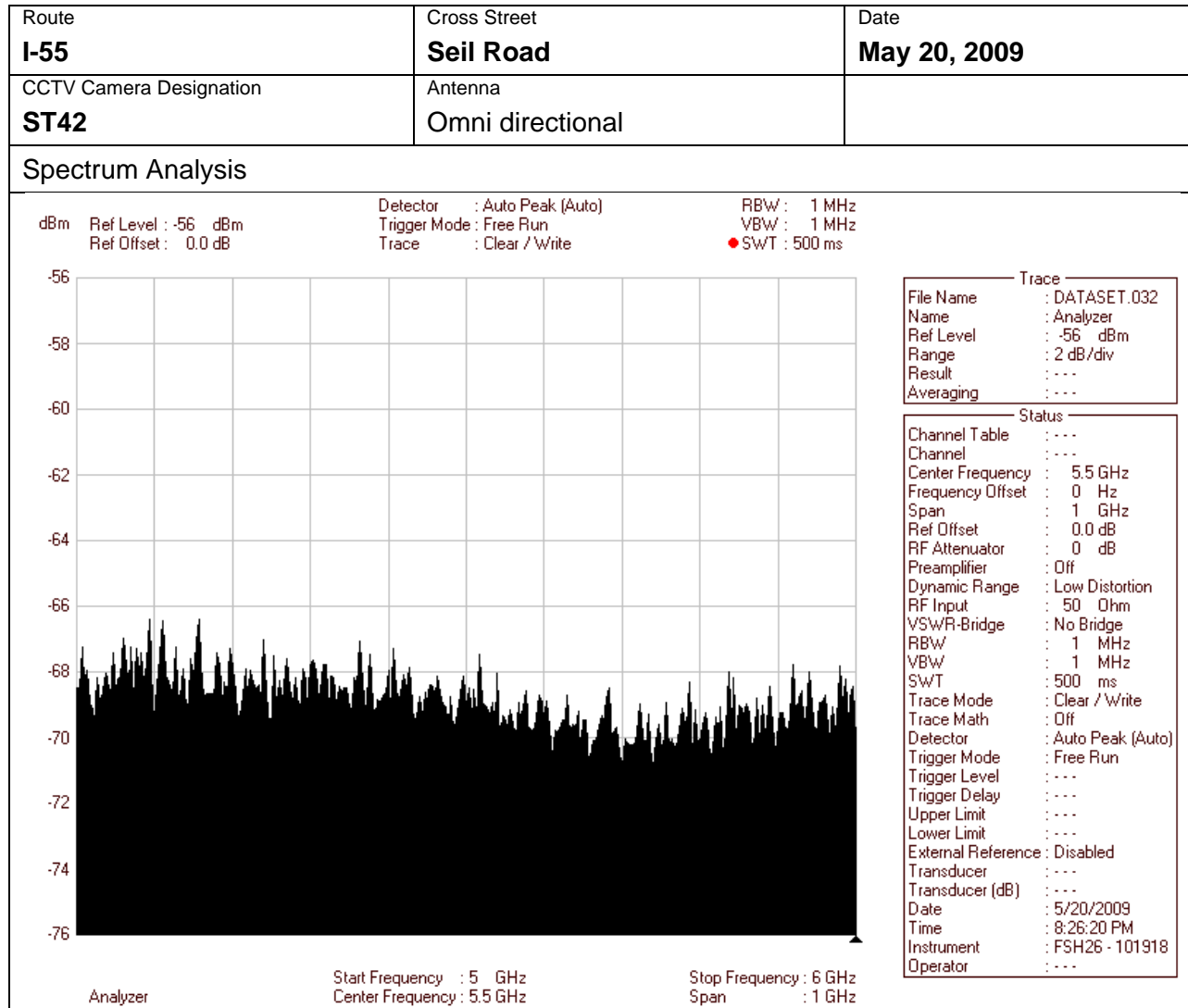
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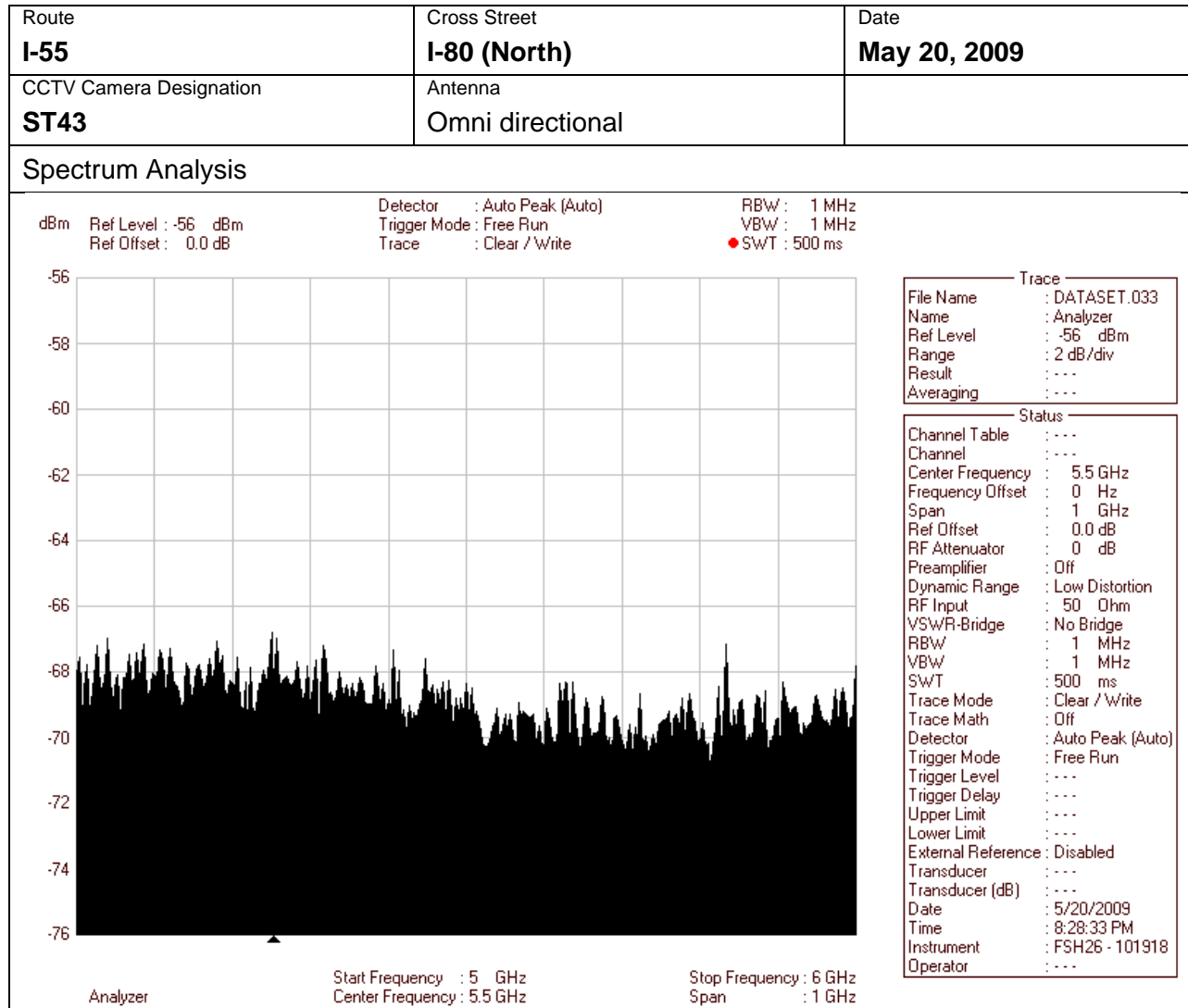
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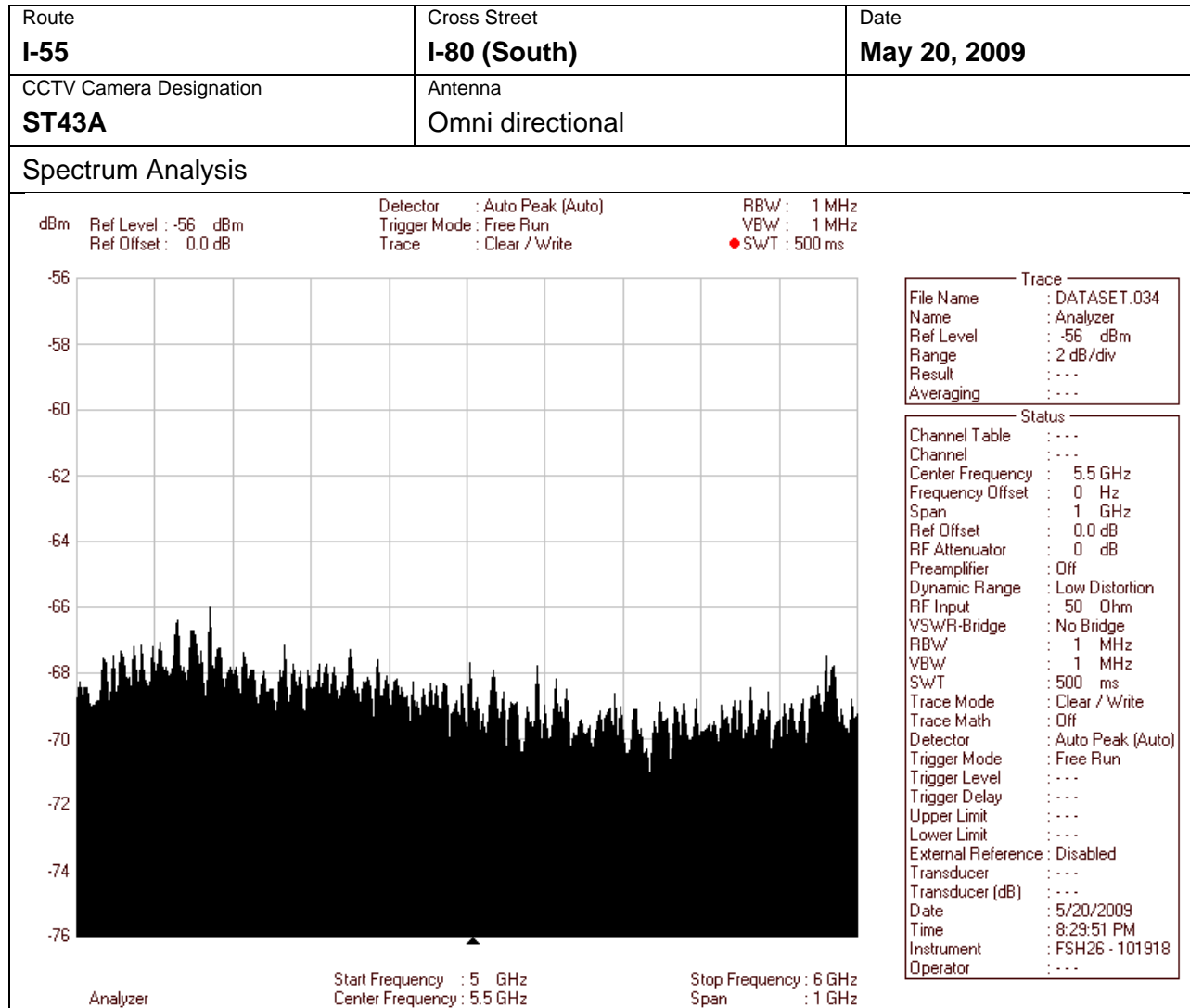
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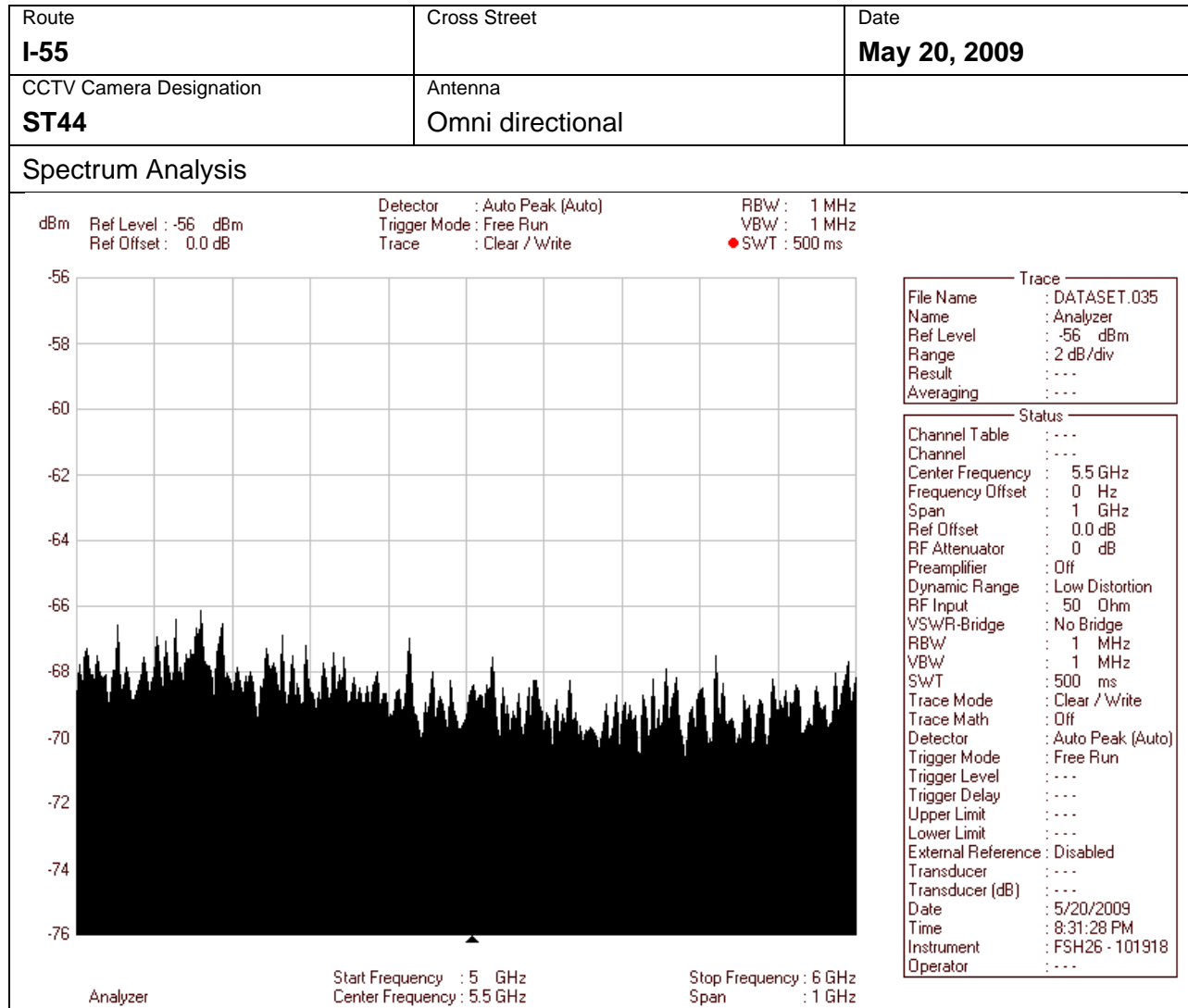
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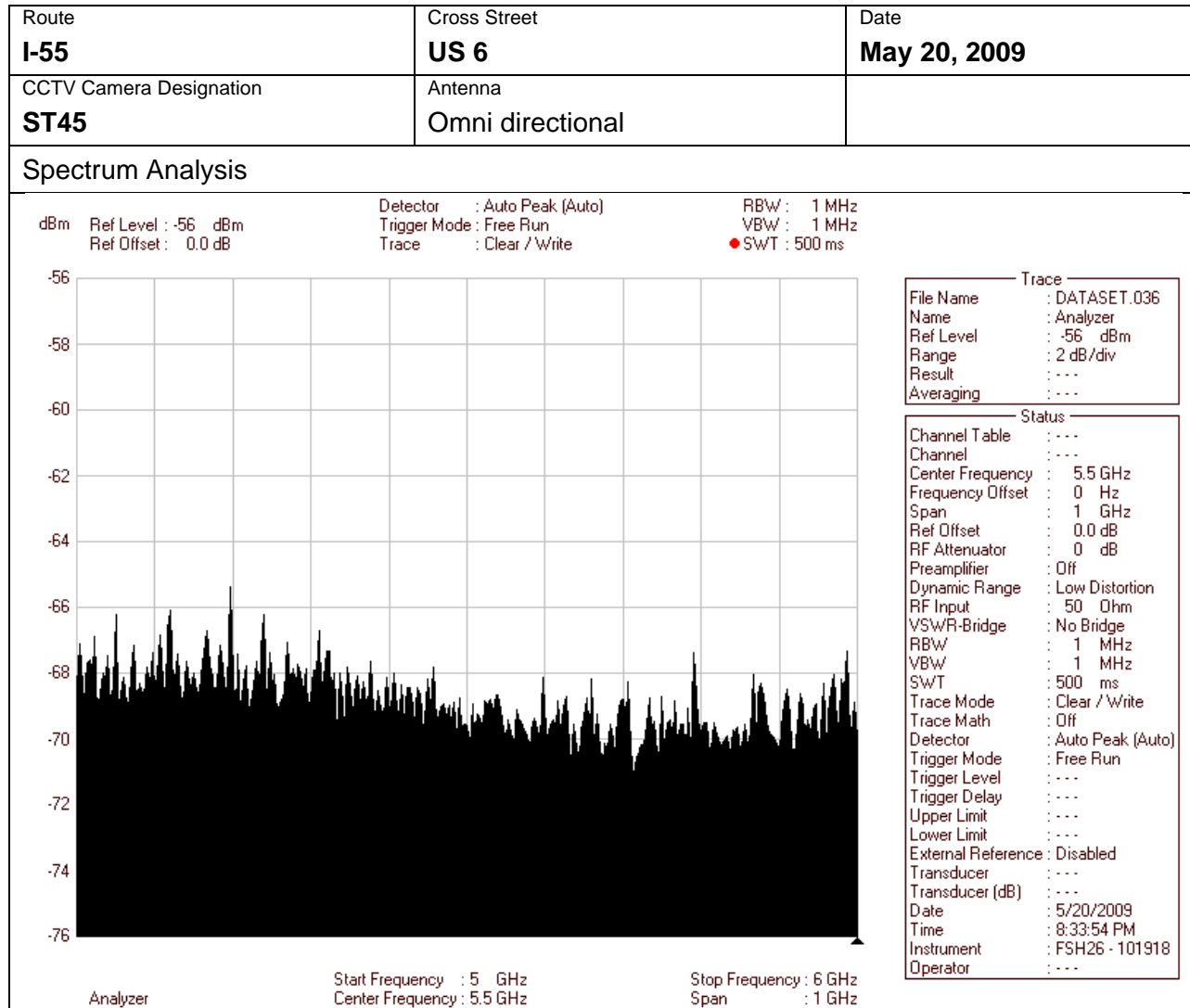
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AWG	American Wire Gauge
BCH	Bose-Chaudhuri-Hocquenghem (type of cyclic redundancy code)
CMOS	Complimentary Metal-Oxide Semiconductor
FSK	Frequency Shift Keying
IEEE	Institute of Electrical and Electronic Engineers
mA	Milliamperes
MTBF	Mean Time Between Failure
NEC	National Electrical Code
RTU	Remote Terminal Unit
TIA	Telecommunications Industry Association
UPS	Uninterruptible Power Supply

Applicable Publications. The publications listed below form a part of these Specifications to the extent referenced. The publications are referred to in the test by basic designation only. Conform to reference standards by date of issue in effect on date of Contract Advertisement.

ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings,

ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

National Electrical Code (NEC), Article 800.

IEEE Surge Withstand Capability Test C37-90-1.

Materials.

Prefabricated Equipment Shelter. The equipment shelter shall be pre-assembled, and of reinforced solid concrete construction. The shelter shall be a standard item provided by any of several manufacturers. The shelter shall come complete with a secure door; power distribution panels; a heating, ventilation, and air conditioning (HVAC) system; lightning protection; a grounding system; and any other necessary appurtenances to provide for an integrated communication shelter. The shelter shall be built and constructed to wind loads as required by local building codes. The shelter's exterior shall be provided with a concrete aggregate finish. The shelter shall have a bullet-resistant surface as required by UL 752. The shelter's exterior color shall be earth tone to blend into surroundings. The shelter's heat transfer coefficient shall not exceed 0.07 British Thermal Unit (BTU) per hour per square foot (h/ft) per degree Fahrenheit (OF) [0.3 kilocalorie (kcal) per hour per square meter (hr/M²) per degree Celsius (°C)].

Shelter floor and foundations. The equipment shelter's supporting floor shall be concrete or a concrete composite material. The communication shelter's foundation shall be a monolithic slab with a footing foundation. The foundation for the communication shelter as shown on the contract drawings shall be evaluated for the specific requirements of the site, in consideration of local soil conditions, and local building restrictions. Shelter anchor locations shall be coordinated with shelter manufacturer. The top of the foundation shall be a minimum of 1 foot [0.3 meter] above grade. Sufficient cross bracing shall be provided to prevent the equipment shelter's structure from bending or breaking during moving, towing, or hoisting, and to ensure minimum warping after the shelter has been placed on the foundation with the interior equipment installed. The equipment room's finished floor covering shall be industrial-grade vinyl flooring fastened to the sub floor with waterproof glue. The sub floor shall be 6 inch (15cm) precast reinforced concrete, insulated, and equipped with integral lifting points, and shall contain a recessed step-joint, to prevent water intrusion into the shelter. The floor shall be designed and constructed to support a minimum live load of 150 pounds per square foot (lbs/f) [7.2 kilopascals (kPa)] while on foundation.

Door. The door shall be an exterior pre-hung, fully insulated, bullet-resistant, galvanized steel door with continuous hinge, and shall be provided with baked enamel finish, and a door check and doorstop. The exterior door shall be 36 inches [0.91 meter] in width by 84 inches [2.1 meters] in length with a mortised deadbolt security common-keyed lock, consistent with other Illinois Department of Transportation (IDOT) sites. The keys to the door's lock shall be provided to the Department. Doors shall have a hydraulic door closer, and a passage style lever handle on both the inside and outside for opening and closing.

Walls. The walls shall be constructed of 4 inch (0.1cm) thick reinforced concrete, with a two-step keyway joint, to prevent water intrusion into the shelter. The walls shall be insulated using a minimum insulating factor of R11. Interior surfaces shall be sheathed with 1.5 inches (4cm) of high performance hard board insulation. The interior of the walls shall be finished with an aesthetically pleasing 0.75 inch (1.3cm) plywood panel with a white laminate coating, and molding on all corners. Total wall system shall have a thermal insulation rating of R19. All floor/wall intersections shall have 4-inch [0.1-meter] vinyl baseboards installed using waterproof glue.

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The ceiling structure shall be designed and constructed to support all of the proposed fixtures, cable trays, etc., or a minimum live load of 30 lbs/SF. (1.4 kPa).

Roof. The roof sections shall be designed and constructed of 4 inch thick reinforced concrete, with a minimum 0.25-inch per foot [3.2 millimeters per 304.8 millimeters] pitch from the center for drainage. All voided areas between the roof and the ceiling shall be sheathed with 1.5 inches (4 cm) of high performance hard board insulation with a thermal performance of R11, covered with a layer of an aesthetically pleasing 0.5 inch (1.3 cm) white laminate wood panel with a vapor shield. The exterior of the roof shall be covered with an ultraviolet resistant, reflective elastomeric coating to prevent water intrusion. The roof shall be designed and constructed to support a minimum live load of 100 lbs/f' (4.8 kPa).

Entrance Stoop. The shelter's entrance shall have a 3 foot by 5 foot reinforced concrete slab, installed so that the top of the slab matches the top of the foundation slab. The distance from the final grade to the shelter floor shall not exceed 12 inches [0.2 meter], and the entrance slab shall be separated from the foundation wall by a continuous 0.5 inch (1.3cm) pre-moulded joint filler.

Lighting. The equipment shelter shall utilize dual-bulb 40-watt fluorescent surface-mounted fixtures. The Contractor shall supply a sufficient quantity of light fixtures to provide a uniform light level of 150 footcandles, or lumens per ft² [1614.6 metercandles] or lumens per M² at 4 feet [1.2 meters] above the floor to void shadows throughout the building. An interior light switch shall be mounted adjacent to the entry door. The Contractor shall furnish and install one 35-watt high pressure sodium vandal-resistant floodlight mounted on the outside near the entrance door with a photocell and interior light switch. The Contractor shall also furnish and install an interior two-headed emergency light with rechargeable batteries, a charger pilot, and test light that are wired unswitched to the interior lighting circuit.

Heating, Ventilation, and Air Conditioning System. The Contractor shall provide exterior vertical wall-mounted air conditioners for the communication shelter. The heating, ventilation, and air conditioning (HVAC) system shall provide an alarm that indicates failure (i.e., a dry contact closure alarm point). The unit shall have an adjustable time delay initially set to five minutes to prevent compressor damage or generator stall if utility power service is prematurely restored following a power failure. The unit shall also have a hard start device installed to reduce the starting current required during a cold start or under high-head pressure conditions. The unit shall be capable of safely operating when the outside temperature falls below 60 'F [15.5 'C], allowing continuous interior equipment cooling and dehumidification in cold weather. The unit shall have sufficient capacity to cool from a 95 'F [35 'C] ambient temperature to 75 '17 [23.9 'C], including the equipment heat load.

Fire Smoke Detection and Suppression. The equipment shelter shall include one ionization and one photoelectric smoke detector operating on alternating current (AC). The smoke detector shall be mounted on the ceiling and shall include a dry contact closure that will activate during smoke detection conditions. A hand-held carbon dioxide fire extinguisher suitable for use on electrical fires shall be mounted on the wall near the door. The extinguisher shall have a valid inspection tag and be refillable.

Electrical. The standard electrical configuration for the shelter site shall be single-phase 120/240 volts of alternating current (VAQ per 60 hertz (Hz) with a 150-amp minimum service. The Contractor shall provide the necessary power service drop and site-specific power needs on to site. Provide one 225 Amp, 42-circuit distribution panel, and two 100 Amp, 24-circuit distribution panels.

AC-Powered Transient Voltage Surge Suppression Device. The shelter shall have a primary AC transient voltage surge suppression (TVSS) device that has been pre-approved in writing by the engineer. The TVSS device shall use field-replaceable modular technology and shall include a set of Normally Opened (NO) Normally Closed (NC) Form C contacts for remote alarm monitoring as detailed below.

The Contractor shall ground the TVSS device using a minimum #12 American Wire Gauge (AWG) copper wire that is exothermically welded to the interior perimeter ground. The device shall consist of primary modules using silicon avalanche diode (SAD) technology and a secondary module using the metal oxide varistor (MOV) technology. The shelter shall have a spare MOV and SAD module with each primary AC TVSS device. For substitute product approval, the Contractor shall submit a certified, signed, and sealed statement that the device meets or exceeds all requirements as detailed herein, within the plan set, and/or in the Contract from an engineer registered in the State of Illinois.

In addition, the Contractor shall submit unpotted samples of each module to the engineer for inspection. The modules shall be bolted in the TVSS device. No plug-in modules shall be permitted. The equivalent of a minimum of two SAD modules and one MOV module shall be installed from each phase conductor to the neutral conductor. One or more separate MOV modules capable of handling at least 75 kiloamperes (kA) of surge current shall be installed between the neutral and ground.

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A 200-kA ampere interrupting capacity (AIC) fused disconnect shall be installed in the TVSS device. The TVSS device shall have a surge counter that counts the number of surge current transients that are being suppressed over 150 amps. Surges in any mode and phase shall be counted. The TVSS device shall have a UL 1283 listed electromagnetic interference (EMI)/radio frequency interference (RFI) filter with a maximum attenuation of 75 decibels (dB) from 100 kilohertz (kHz) to 100 megahertz (MHz). Enclosure ratings shall be a minimum of NEMA 1, 2, 3, 3S, 4, 4X, 12, and 13, and shall be compliant with the UL 95 standard's Test 5V. The TVSS device shall be listed in the second edition of the UL 1449 standard.

The TVSS device shall comply with the specifications detailed herein, within the plan set, and/or in the Contract, including:

- A maximum surge current (8x20uS) for a SAD module that is greater than or equal to (~:) 24 kA;
- minimum energy absorption for a SAD module of 0.9 BTU [1,000 joules];
- maximum surge current (8x20uS) for a MOV module that is ~: 50 kA;
- minimum energy absorption for a MOV module of 4.7 BTUs [5,000 joules];
- maximum continuous operating voltage of 150 volts; and
- let-through voltage of 339 volts as required in the second edition of the UL 1449 standard.

Conduit Entry. The shelter shall have a rectangular floor opening to accommodate the entry of communication related conduits as shown on the contract drawings. Gaps in floor remaining between the conduit stub ups and the floor opening are to be filled solid with self-expanding sealant caulk.

The initial configuration shall contain the following inputs:

Source

Alarm Description

<ul style="list-style-type: none"> i. AC Normal Power ii. AC Reliable Power iii. Communication Shelter Door Intrusion iv. Fire Alarm Panel v. Fire Alarm Panel vi. Comm. Shelter Temp. vii. viii. HVAC #1 ix. HVAC #2 x. Generator Alarm xi. Generator Alarm xii. Generator Alarm xiii. xiv. AC Transfer Switch xv. xvi. xvii. 	<ul style="list-style-type: none"> Normal Power Failure Reliable Power Failure Comm. Shelter Key Switch General Alarm – Fire Panel Alarm – Trouble Comm Shelter Alarm – Low Temp. Comm. Shelter Temp. Comm. Shelter High -- High Temp Alarm HVAC #1 -- Malfunction HVAC #2 -- Malfunction Low Fuel Generator Malfunction Emergency Generator Running AC Transfer Switch Automatic Transfer Switch "Bypassed" AC Normal Power Failure AC Transfer Switch Automatic Transfer Switch "EM Generator Position" AC Transfer Switch Automatic Transfer Switch "Normal Power" AC Transfer Switch Automatic Transfer Switch – Malfunction
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Equipment Cabinets. Equipment cabinets shall be installed as shown in the plans. The cabinet shall have maximum dimensions of 82 inches high by 24 inches wide by 36 inches deep. The cabinet shall be capable of mounting 2,000 pounds of equipment and hardware. The cabinet shall provide a minimum of 42 standard rack units of mounting space. The cabinet shall have a black, powder-coat paint finish. The front and back of the rack shall have heavy-gauge doors of perforated metal, protecting the components in the rack but permitting the enclosed equipment to be viewed and allowing ventilation air to enter. The front and back doors shall be lockable. The front door shall be split. The equipment rack shall be APC Model 2800, Middle Atlantic MRK Series or approved equal.

Equipment racks shall be equipped with all hardware required to mount equipment that has been designed to mount in accordance with EIA-310-D.

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Interconnecting Cabling.

600 volt cable. All 120 VAC distribution wiring that is entirely within the communication hut shall be made with NEC Type THHN/THWN cable rated for 600V, with a minimum wire gauge of 12 AWG. All conduits shall be a minimum of electrical metallic tubing (EMT), and all EMT conduit fittings shall be compression, not set-screw type. Outlet and junction boxes shall all be galvanized steel with galvanized steel faceplates or covers. All switches, receptacles, and other wiring devices shall be industrial specification grade.

All power wiring (600 volt cable) shall be in electrical metallic tubing (EMT).

Two 20-Ampere circuits from the UPS panel shall be dedicated to each equipment rack, and provide a minimum of 3 duplex receptacles per circuit at evenly spaced intervals for the entire height of the each rack.

Plug Strips may be used within the equipment racks, but shall not reduce the number of duplex receptacles required per circuit. The plug strip housing shall be all metal and shall mount in the rack using the standard 19" rack and occupy no more than 1 U in height. Plug Strips shall be Tripp-Lite PDU-1220 or approved equal.

Wall-mounted plug strips shall be furnished and installed to be mounted on plywood backboards. These strips shall include a 15-ampere circuit breaker and shall include solid-state surge protection. The surge protection shall be rated for 800 joules or greater.

Power Supplies for equipment requiring other than 120 VAC shall be manufactured by or approved in writing for that use by the maker of the equipment they are to serve. Power supplies shall be rack-mounted, or shall be bolted or otherwise mechanically attached to shelving designed for mounting in the equipment rack. Connections between the power supplies and the equipment they serve shall be made with PVC-jacketed cables.

Unjacketed individual conductors shall not be permitted.

Coaxial Cable (including connectors). The coax cable shall be a Belden 1694A precision video cable, or approved equal complying with the following specifications. The center conductor shall be a 18 AWG, Solid Bare Copper conductor, the insulation shall be Gas Injected Foam High Density Polyethylene, and the shield shall consist of an Aluminum Foil-Polyester outer shield with 100% shield coverage plus tinned copper Braid Shield with 95% shield coverage. For installations in shelters, the jacket material shall be Polyvinyl Chloride, suitable for indoor and outdoor-aerial applications.

Applicable Specifications: UL/NEC CMR, C(UL) CEC CMG. Flame Resistance: UL 1666 Vertical Shaft, CSA T4.

Electrical Characteristics:

Impedance:	75 +/- 1.5 ohms
Inductance:	0.106 microH/ft.
Capacitance Conductor Shield:	16.2 pF/ft. (nominal)
Velocity Of Propagation:	82 % (nominal)
Delay:	1.24 nS/ft. (nominal)
Nom. Conductor Dc Resistance @ Deg. C:	206.4 ohms/1000 ft.
Nom. Shield Dc Resistance @ 20 Deg. C:	2.8 ohms/1000 ft.
Return Loss:	23dB minimum, 5 - 850 MHz 21dB minimum, 851 - 3000 MHz
Max. Operating Voltage:	not less than 300 Vrms (UL)

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Nominal Attenuation

MHz	dB/100 ft	MHz	dB/100 ft
1.0	.24	180	2.42
3.6	.45	270	2.97
5.0	.54	360	3.43
7.0	.63	540	4.25
10.0	.72	720	4.95
67.5	1.57	750	5.00
71.5	1.60	1000	5.89
88.5	1.75	1500	7.33
100.0	1.84	2000	8.57
135.0	2.10	2250	9.14
143.0	2.16	3000	10.67

Physical Characteristics:

Temperature Rating:	- 30 TO + 75 DEG. C
Min. Bend Radius:	10x cable O.D. or 2.75"
Max. Pulling Tension:	69 LBS
Nom. Weight/1000 ft:	40 LBS
Jacket Color:	BLACK for CMG cable; violet for CMP cable
Applicable Specifications:	UL/NEC: CMR/CMP C(UL)/CEC: CMG
Flame Resistance:	UL: 1666 VERTICAL SHAFT CSA: FT4

Coaxial connectors shall be BNC or as required by the equipment to which the cables connect. The connectors shall be attached to the cable by compression. Connectors shall be plated for corrosion resistance and good electrical connections. All BNC connectors shall be physically designed to fit the specified cable without adaptation and shall have a characteristic impedance of 75 ohms. Connectors with a characteristic impedance of 50 ohms are not acceptable.

Ethernet Cable (including connectors). Ethernet Cable shall be ANSI/TIA/EIA-568-B.2 Category 5e, UL verified to Category 5e, 4 twisted pair, 24 AWG bare copper with polyolefin insulation. The cable shall be unshielded with polyvinyl chloride (PVC) insulation. The cable shall be Belden part number 1500A or approved equal. The terminations shall be crimp-on RJ-45, Ideal Industries 85-396 or approved equal.

Cable Identification Materials. All cables, fiber optic cables, and individual conductors and fiber strands when broken out from a cable assembly shall be uniquely labeled in accordance with the Contractor's interconnection diagram. Labels shall be computer-printed and shall be waterproof and non-smearing. Labels shall be polyester adhesive wrap labels produced by the W. H. Brady Company or approved equal. The labeling shall comply with ANSI/EIA/TIA -606-A

Cable Tray. Unless otherwise indicated on the plans, the Contractor shall furnish cable tray with 3/8" x 1-1/2" high tensile tubular steel stringers and 1" x 1-1/2"x1/8" channeled cross slats. The nominal width of the tray shall be 12" and the distance between cross slats shall be 8". The Contractor shall furnish all hangers, rods, straight splices, unistrut, threaded rods, nuts, open clips, closed clips, wall anchors, J-bolt assemblies, straight clamps, corner clamps, and other hardware required to complete the assembly required by the plans. The Contractor shall include all necessary bonding and grounding hardware to bond and ground the cable tray.

Fiber Optic Termination Panel – Wall Mounted. The wall-mounted fiber optic termination panel shall be a two door, wall mounted box. The termination panel shall terminate 96 single mode fibers in ST connectors or connectors matching the terminations on the equipment. All connectors shall be identical. The left chamber of the box will contain splices between the incoming cable and the pigtailed connectors that attach to the bulkhead connectors. The right chamber will house the incoming distribution cables, connecting the incoming fibers to the terminal equipment.

Video Distribution Amplifiers. Video distribution amplifiers shall be high performance, high impedance design with an input loop-through connection. The amplifier shall include signal gain and cable equalization. The distribution amplifiers shall meet the following requirements:

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Bandwidth	29MHz (-3dB) minimum
Gain	-3dB to +3dB adjustable (0.7Vp-p to 1.5Vp-p output when input level is 1.0Vp-p)
Input levels	0.4v to 2.0v with no offset at unity gain
Connectors	BNC
Impedance	75 Ohms
Return Loss	greater than 35dB at 5 MHz
Differential Phase Error	±0.1° to 5 MHz
Differential Gain Error	±0.1% to 5 MHz
Frequency Response	±0.1 dB to 5 MHz
Input connections	1 composite video
Output connections	four (4) as indicated on plans, one (1) composite loop-through

The distribution amplifiers shall be rack mounted in 3 RU rack mounted frame with an integral power supply. Multiple single channel video distribution amplifiers placed on or fastened to a rack mount shelve will not be acceptable. Corded modular power supplies will also be unacceptable.

OUTLETS

80 KW ENGINE GENERATOR SET

Unless otherwise indicated, set ratings shall be based on 105 degrees C. characteristics and published data and equipment shall be so equipped, as a minimum. Nominal KW sizes indicated reflect minimum published ratings, but actual ratings may be higher to achieve compliance with specification requirements.

These specifications include units suitable for mounting on a concrete foundation. These specifications also include a separate remote annunciator.

SUBMITTAL INFORMATION

- Complete engine-generator set sizing calculations for all identified starting condition cases. Include a copy of any vendor software used to prepare the calculations. Calculations shall clearly demonstrate all input assumptions and conditions as well as the adequacy of the unit proposed.
- Complete manufacturer catalog information sheets, highlighted to indicate specified features and options for specification compliance.
- Complete manufacturer catalog information for annunciator panels highlighted to indicate specified features and options.
- Manufacturer information.

GENERAL:

Each Generator Package shall consist of a prefabricated assembly of a diesel engine generator set together with integral double walled fuel tank and all required auxiliary equipment mounted in a solidly-constructed weatherproof "skin-tight" housing on a structural steel frame including adjustment and testing. Auxiliary equipment shall include all items specified herein and all items required or recommended by the manufacturer for a complete operating unit. **Each** package shall be completely pre-wired and pre-piped as specified herein requiring only field mounting and power input and output connections, alarm output connection and fuel input and over flow connections. All materials found in the generator package shall conform to all aspects of this specification except as otherwise provided for within the specification

The engine generator set shall recover rapidly from instantaneous changes between no load and full load, as well as the reverse changes of load, without damage.

Each engine generator set shall be sized to meet the indicated KW rating, taken to be the minimum nominal KW rating, and to meet the particular minimum motor starting capability specified for that KW rating. Nominal KW ratings shall be not less than stand-by ratings equivalent to Fuel Stop Power ratings in accordance with ISO3046, AS2789, DIN6271 and BS5514, and all units shall accept 100% of nameplate KW rating in one step, in conformance with NFPA 110, paragraph 5-13.2.6. KW ratings shall be certified by the manufacturer, shall be based on published data, and unless otherwise indicated shall be based on 105 degree rise characteristics. Unless otherwise indicated, starting and loading requirements shall be 3-phase, concurrent auxiliary loading shall be unity power factor and all motor starting shall be across the line. **All engine generator sets shall achieve specified starting with no greater than 10% sustained RMS voltage dip during motor starting and shall achieve specified starting with no greater than the instantaneous RMS voltage dip (approximately 2-4 cycles) specified elsewhere herein for individual sizes.**

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CALCULATIONS MUST BE SUBMITTED. All generator loading and starting capabilities shall be demonstrated by means of calculations **included with the bid. Submitted calculations shall include all reference information necessary to substantiate calculations, and if a vendor's software program is used, a copy of the program shall be included with the bid.**

80 KW engine generator sets shall be capable of sequence starting and maintaining:

Case A

Two (2) 30 HP NEMA Code G motors while maintaining 5 KW of concurrent auxiliary load, with no greater than 20% **instantaneous RMS** voltage drop.

These sets shall also be capable of sequence starting and maintaining:

Case B

One (1) 50 HP Code F motor with no greater than 25% **instantaneous RMS** voltage drop.

Operating and maintenance instructions and complete manuals and wiring diagrams shall be furnished with submitted drawings. A directive set of operating instructions and a wiring diagram shall be mounted under or laminated within heavy clear plastic on the inside wall of the "skin tight" housing.

Units shall be suitable for mounting on a concrete pad or shall be trailer mounted, as selected. Manufacturer's anchoring details and pad recommendations and complete trailer information shall be submitted with this bid.

The fuel tank will be filled by the Contractor to capacity with the type of fuel specified.

Alarm annunciators are included as a part of this pay item and shall not be paid for separately.

Automatic transfer switch

The Transfer Switch shall be coordinated with the Engine Generator Package.

Switches specified herein shall be 3-pole units intended for connection of normal and emergency sources that have a common single connection of grounded circuit conductor (neutral) such that 4-pole switching is not necessary. Care must be exercised to assure that connections do not provide a multiple connection of a neutral to ground. The vendor shall provide suitable interconnection reference diagrams for this purpose.

BASIC TRANSFER SWITCH REQUIREMENTS:

Automatic transfer switches shall be air break, double throw interrupter type, electrically operated and mechanically held in both the normal and emergency positions. The switch operators shall be momentarily energized by the source to which the load is transferred. Switches shall be capable of transfer in either direction on 70% of rated voltage. Switches composed of molded case breakers, contractors, or components not specifically designed as an automatic transfer switch will not be acceptable. Switches shall be listed to UL 1008 and all accessories shall be UL listed for factory or field installation. Equipment shall comply with applicable NEMA, NFPA, and CSA requirements and standards.

Transfer time in either direction shall not exceed 0.5 second.

Switch current ratings shall be the nominal switch size rating as indicated, as a minimum, but larger switches may be derated to achieve specification compliance on other factors. Each switch shall be rated for 600 volts. Main contacts and main current carrying parts shall be insulated for 600 volts. The rating of the switch shall be a 24-hour continuous rating in a non-ventilated enclosure for all classes of loads including resistance inductive, tungsten lamp and ballast loads. Temperature rise shall conform to U/L -1008 and NEMA standards. The contact structure shall consist of a main current carrying contact which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes.

Main contacts shall be mechanically held in position by the operating linkage without the use of hooks, latches, magnets, or springs and the contacts shall be of silver alloy. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.

Not less than two auxiliary contacts, one closed on normal and one closed on emergency, rated not less than 5 amperes at 120 volts, shall be mounted and actuated by the same shaft as the main contacts. Additional relay contacts, timers, control keys, and associated wiring required for the functions indicated shall be front accessible. All wiring shall be tagged with tubular wire markers or other means approved by the state.

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The switch operation shall provide an adjustable period in a fully disconnected (neutral) position on both transfer and retransfer operations, to allow motor and transformer fields to decay before re-energization. Except for the normal functioning of the programmed neutral position, failure of any component shall not result in a neutral position where both normal and emergency contacts remain open. Also, the failure of any component shall not result in a condition where both normal and emergency contacts are closed, or attempt to close at the same time.

Transfer switches shall not have integral overcurrent or short circuit protection.

Switch components shall be easily maintainable from the front without removal of the switch from its enclosure and without disconnecting the main power cable. Adequate safety baffles and barriers shall be provided and all components shall be clearly identified.

Operation:

Operation shall be selectable as either manual or automatic.

Automatic operation shall be controlled by adjustable voltage sensing in each phase of both normal and emergency sources. Upon a fall in voltage on one or more phases of the normal source below the pre-set limit (roughly 70% of rated voltage) transfer operation shall be initiated. Delays and other transfer features shall be as specified herein. Upon restoration of voltage to all phases of the normal source (to roughly 90% of rated voltage) re-transfer to normal shall be initiated, also subject to delays and features specified herein.

Each transfer switch shall be equipped with a manual operator. Manual operation shall operate the switch in the same transfer time as normal electric operator transfer. Interlocking shall be provided to prevent electric operation of the switch when the manual operation is selected. The manual operator shall be arranged to provide adequate shielding and protection from live electrical parts for operating personnel. A manual handle shall be provided for maintenance purposes with the switch de-energized. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.

Withstand Rating, Tests and Certifications:

Each switch shall have a UL-1008 withstand and closing current rating, when coordinated with circuit breakers, at 480 volts AC of not less than 42,000 RMS symmetrical amperes.

Submittal information shall include documentation that identical switches have met the requirements of UL standard 1008 for the specified ratings. In addition, the data shall include certified copies of test documentation of the 3-cycle withstand requirements of 42,000 amperes at 480 volts.

Test results shall include a dielectric test at the conclusion of the withstand and closing tests.

After installation, the vendor shall provide installed switch operations testing and start-up adjustments. A representative of the manufacturer/vendor shall check the installation and submit to the Engineer, three (3) certified, signed statements, addressed to IDOT for each installed switch, that the equipment has been properly installed and is in good working order.

A record of all auxiliary device settings, etc. shall be provided for each installed switch.

In addition, a record of these settings shall be within a clear, heavy-duty plastic sheet protector at an appropriate location within, or upon, the switch enclosure.

Start-up testing and operating personnel training shall be provided by the equipment supplier. Training shall cover basic switch operation, auxiliary device purposes and settings, maintenance requirements and remote alarms.

Plastic-laminated step-by-step operating and test procedures, complete with schematic wiring diagrams shall be permanently attached to automatic transfer switch enclosures.

Final record drawings, recommended spare parts, and maintenance manuals shall be available for start-up.

The transfer switch shall be equipped with a microprocessor based control panel. The control panel shall perform the operational and display functions of the transfer switch. The display functions of the control panel shall include ATS position and source availability. Control settings shall not be lost during a total power outage and switch position indications shall remain viable as well.

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Special Features:

Each transfer switch shall include, as a minimum the following control features:

Emergency Transfer Time Delay. This time delay (or delays) shall delay the transfer to the emergency source for a time to allow for momentary outages. This time delay shall be adjustable with a range of roughly 0 to 5 minutes. This delay shall also delay engine generator start.

Test Switch. A test switch shall be mounted on the enclosure door to stimulate the failure of the normal source.

Indicating Lights:

The switch shall have indicating lights mounted on the enclosure to indicate the switch position (normal to emergency) and the presence of power (normal and emergency). Each shall have an engraved nameplate and color as follows:

<u>Legend</u>	<u>Color</u>
Normal Power Present	Green
Switch in Normal Position	Green
Emergency Power Present	Red
Switch in Emergency Position	Red

Adjustable Programmed Neutral Position:

The switch operation shall have a programmed, adjustable time neutral position in which neither the normal or emergency sources are connected to the load. The time period shall be adjustable from roughly 0 to 20 seconds to prevent mechanical damage to motors which are running at the time of transfer.

Override Switch. The transfer switch shall have an override switch, mounted on the enclosure door to hold transferred switch in the emergency position regardless of the status of the normal source.

Auxiliary Contacts:

The switch shall have not less than an auxiliary relay contact for each of the following functions:

- a) A contact closed when the normal source is connected to load (switch in "normal" position)
- b) A contact closed when the emergency source is connected to load (switch in "emergency" position)
- c) A contact to close to initiate engine generator start and stop
- d) A contact closed on normal source undervoltage
- e) A contact closed on emergency source undervoltage

Contacts shall be coordinated with a remote annunciator or the engine generator, as appropriate and the contacts shall be in addition to those required for specified indicating light on the switch.

Normal Retransfer Time Delay:

The switch shall have a Normal Retransfer Time Delay. This delay shall delay re-transfer to normal for an adjustable time of 0-60 minutes. If the emergency source fails during the re-transfer time delay period, the transfer switch controls shall automatically bypass the time delay and immediately initiate re-transfer to the normal source position.

The switch shall be equipped with solid state control with all-phase monitoring on each power source, surge voltage isolation, relays for all outputs, isolation transformers for AC power inputs plus adjustable voltage sensors and time delays. Controls shall provide indicators or digital display of control status.

When ordered in a coordinated package with an engine generator unit, the transfer switch may house and be integrated with a DC control voltage supply and battery charger which may also power a coordinated DC remote annunciator. The supply shall derive power from the appropriate energized source at the switch and the charger shall then service in lieu of a generator-mounted unit. Coordinated wiring diagrams shall be provided.

The control panel shall be shielded from electrical noise.

Transfer switch controls shall allow the selection or non-selection of an automatic engine generator exercise mode.

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A load/no load clock exercise shall be incorporated within the controls and shall be programmable to start the engine generator set and transfer the load (when selected) for exercise purposes on a periodic basis. The controls shall not lose settings during a power outage.

Each switch shall have a fully rated neutral bar with lugs isolated from the switch housing and other grounded parts. Each switch shall also have a suitable ground block, with lugs, and it shall be suitable for connection to a grounding electrode, equipment grounding conductors and an appropriate neutral-ground bonding jumper if both normal and emergency (generator) supplies are grounded via the transfer switch.

Each switch shall have a momentary pushbutton to bypass the time delays on transfer and retransfer and programmable commit/no commit control logic.

All relays shall be continuous duty industrial type wiping contacts. Customer interface contacts shall be rated 10 amperes minimum. Coils, relays, timers, and accessories shall be readily front accessible. The control panel and power section shall be interconnected with a harness ribbon connector and keyed disconnect plugs for maintenance.

Enclosures:

The switch shall be mounted in a NEMA 1 enclosure, with a hinged door.

Submittals:

The submittal shall include detailed information showing compliance with all transfer switch package specifications and appurtenances specified herein and they shall also include detailed drawings of the transfer switch, its wiring, the base, the superstructure, and any other information needed in the construction of the complete package. Also, component catalog information shall be included and highlighted.

Guarantees/Warranties:

The transfer switches shall have a guarantee to be free of defects in material and workmanship for one (1) year from date of delivery.

Documentation:

Not less than four (4) full sets of hardbound installation and maintenance manuals, complete with any appropriate descriptive literature and any special tools required to service transfer switches shall be provided. The material so furnished shall include complete wiring diagrams. This material shall also be furnished in PDF format of CDROM.

Plastic-laminated step-by-step operating and test procedures, complete with schematic wiring diagrams shall be permanently attached to automatic transfer switch enclosures.

Manufacturers:

The vendor shall have an established local factory authorized twenty-four hour service capability within IDOT District 1. Submittal information shall confirm this capability.

Delivery:

Switches are to be delivered to a location in the Joliet, Illinois area. Location to be designated in the Release Order.

Certification and Documentation:

Four (4) installation instructions and operation and maintenance manuals shall be provided at time of delivery. The manuals shall contain final, approved shop drawings and product data sheets (including any field additions or modifications) as well as recommended installation, testing, operation, and maintenance procedures.

After installation, the vendor shall provide installed switch operations testing and start-up adjustments and shall provide documentation of these tests and adjustments.

A representative of the manufacturer/vendor shall check the installation and submit to the Engineer, three (3) certified, signed statements, addressed to IDOT for each installed switch, stating that the equipment has been properly installed and is in good working order. A record of all auxiliary device settings, etc. shall be provided for each installed switch.

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Acceptable Products:

The transfer switch shall be as manufactured by Onan, Zenith Controls, Inc., Russelectric, or approved equal.

Each package shall incorporate an auxiliary systems panelboard as specified herein. Voltage, breaker sizing and wiring of auxiliaries shall be coordinated with the panelboard.

The engine generator unit, base tank, associated housing, shall all be factory painted with a multi-coat, corrosion resistant finish.

ENGINE:

Engine Type and Rating:

The engine shall be for service as herein specified for stationary service with or without pre-combustion chambers, water-cooled, four cycle in line or V-type and a maximum operating speed of 1800 RPM. Units for sets above 125 KW shall be full diesel direct injection and those for sets 125 KW and below may be indirect injections.

The engine may be turbocharged. The engine may be aftercooled. Bid information shall indicate where specific sizes are either turbocharged or aftercooled to achieve specified ratings.

The engine shall be able to meet the specification when operating on a #2 diesel grade of fuel oil and at the altitude where installed (1000 feet MSL) at a temperature range between -20 degrees F and 105 degrees F.

The brake horsepower of the engine shall not be less than the brake horsepower to drive the engine auxiliaries plus 1.3 times the indicated KW rating of the generator divided by the generator's efficiency expressed as a decimal. Submittal information shall include verification of this calculation.

The engine shall be capable of a continuous two hour over-load of ten percent (but **need** not exceed a total of two hours out of any 24 consecutive hours of operation). The engine shall operate under such service without "wet stacking" excessive smoke, overheating or mechanical damage. The manufacturer shall so certify.

The engine shall be able to start cold in a 40 degrees F ambient while using No. 2 diesel oil without the use of starting aids such as glow plugs, additives or other injections.

The engine shall be complete with fuel system, cooling water system, lube oil system, governor and electric engine starting system as specified herein.

Fuel System:

The fuel oil system shall be the unit/direct injector type with engine-driven fuel pumps, fuel filters and flexible fuel lines. Fuel lines between injection pumps and valves shall be heavy seamless tubing and shall be of the same length for all cylinders to eliminate irregularity of fuel injections.

Fuel injection shall be by individual injection pumps and nozzles for each cylinder. Each pump shall inject oil directly into its cylinder or pre-combustion chamber. Plungers shall be carefully lapped for precision fit and shall not require any packing. The injection system assemblies shall not contain any filters or screens which require replacement. The surplus oil shall return to the storage tank by gravity. The fuel system shall have an easily accessible fuel shut-off valve in case of emergency.

An engine-driven, positive-displacement fuel pump shall circulate fuel oil through the secondary fuel filters to the injectors and back to the tank. Pressure shall be limited by relief valves.

Fuel oil filters shall have filter elements of the cleanable or replaceable type which will entrap and remove water from the fuel oil. Filters shall be located to insure that the fuel oil will be thoroughly filtered before it reaches the injector assemblies.

The fuel tank and internal baffling shall be designed and constructed as an integral part of the base assembly which shall provide a rigid support of the engine generator set package. For mobile units, the tank and base assembly shall also be an integral part of the trailer frame. The tank assembly shall be constructed of heavy gauge corrosion-resistant sheet steel.

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The fuel storage tank shall be doubled-walled with an inner tank and an outer leak containment chamber. The fuel storage tank shall have a capacity to supply the engine for a minimum of 24 hours at full rated load. The assembly shall have internal baffles where required and any associated baffles shall have fuel transfer holes large enough to allow fuel to flow freely. The tank shall be constructed with an interior bottom pitch and a drain line with a valve shall be connected to the lowest point of the tank. The drain valve shall be located inside the overall set enclosure and the tank drainage provisions shall be vandal-proof. The fuel tank filler pipe shall not be less than two inches inside diameter and it shall include a wire mesh strainer and shall be equipped with a SAE truck-type locking cap with five (5) keys. The fuel tank shall be vented in accordance with EPA regulations and it shall not create a vacuum condition when the tank is full. The vent shall be opposite the filler pipe to maintain proper ventilation during tank filling. The assembly shall be equipped with a fuel leak detector sensor within the leak containment chamber with an alarm and a fuel level sensor and indicator of the electronic type, both as referenced elsewhere herein. The tank assembly for fixed units shall be UL listed as a closed-top, diked generator base tank and is to be installed in accordance with NFPA 30 for flammable and combustible liquids. Tanks on mobile units shall be constructed to similar or more stringent standards and otherwise be in conformance with US DOT and National Highway Safety Administration standards, in compliance with the Code of Federal Regulations, Section 571.108. Tanks shall be factory tested, including pressure testing to 3 psi, and certified to be free of leaks.

Lube Oil System:

The engine shall be equipped with a pressure lubrication system to supply oil to all surfaces requiring lubrication. Circulation shall be by means of an engine-driven, positive displacement, lube oil pump.

The lube oil system shall include a heat exchange utilizing engine cooling medium.

Immersion Heaters:

The engine shall be equipped with electric immersion heaters with protective jackets for maintaining the engine's cooling water and lube oil temperatures at values recommended by the engine manufacturer.

The heaters shall operate at 120, 208 or 240 volts single phase as selected and coordinated with the auxiliary panelboard and the associated supply to it. Unless otherwise designated, heaters shall be 240 volts single phase. The heaters shall operate continuously except when the engine is running or when the thermostats are satisfied.

Air Intake and Exhaust System:

The engine intake air filter shall be of the engine-mounted dry type with restriction indicator and shall be securely braced against vibration. The filter element shall be cleanable or replaceable while the engine is running.

The exhaust muffler shall be of a design recommended by the engine manufacturer to provide critical type silencing. The muffler shall be mounted within the housing with exhaust pipe extension with suitable insulation extended through the outer skin, outside the housing. The muffler shall include a condensation drain plug. Venting via the cooling ventilation louver will not be acceptable.

The pressure drop in the entire exhaust system shall be small enough to insure satisfactory operation when the engine-generator set is operating at 110 percent of indicated generator output. Submittal information shall document compliance with this requirement by calculation.

Governor:

The engine speed shall be controlled by a governor of the electronic type. The governor shall maintain frequency regulation not to exceed 0.5 percent from no load to full load. The governor shall have manual adjustments, which can be made with the engine running.

Engine Starting System:

The engine starting system shall consist of a heavy duty, electric cranking motor with appropriate automatic engagement and drive mechanism, battery rack, battery cables and clamps and a battery charger.

The electric cranking motor shall have sufficient capacity to crank at a speed that will start the engine for four cranking cycles as specified hereinafter without overheating. The cranking motor shall be rigidly mounted on the engine and shall start the engine from any position of the flywheel.

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The starting battery shall be a heavy duty, industrial lead acid type with the required number of cells assembled with connectors to provide proper voltage for the starting motor shall have high rate discharge performance and shall have sufficient capacity to provide two minutes total cranking time without recharging based on the specified temperature for the unit (-20 degrees F – 105 degrees F) without a battery heater.

Submittal information shall document battery type, battery capacity and temperature characteristics.

The battery charger shall be multiple rate temperature compensated and suitable for the battery shall have full wave silicon rectifiers, surge suppressers, charge rate potentiometers, charge rate indication, DC ammeter, DC voltmeter, input and output fuses and shall be self-regulated against shorted or reversed battery connections and overload currents. The charger shall have a high charging rate compatible with the battery capable of fully recharging a depleted battery in not more than 24 hours, and when the battery is brought up to full charge it shall automatically reduce the charge rate to a continuous trickle charge. The charger shall operate from a 120-volt, single phase, power source or shall operate from a transfer switch source when installed within. Submittal literature shall include complete, highlighted battery charger information

The charger shall generate the following alarm indications and outputs:

- a) Low DC voltage
- b) High DC voltage
- c) Battery Charger Malfunction

Any charger alarm shall trigger a common charger alarm output suitable for remote alarm connection. Such output shall be coordinated with the package alarm annunciator when procured together, and otherwise shall be a SPDT dry contact alarm for remote connection. When not included with an integrated automatic transfer switch as noted elsewhere herein, the battery charger shall be installed in a NEMA 12 enclosure mounted on the set and connected to the auxiliaries panelboard.

Engine Start-Stop and Safety Controls:

The engine start-stop and safety controls shall operate at low voltage DC and shall be installed in the generator control panel which shall have a NEMA 12 enclosure on shock absorbing mounts. The panel shall be a combination engine and generator control panel which shall house controls and instruments for the engine and the generators. All control instrument and alarm designations shall be in English text. Symbols alone will not be acceptable.

The control system shall be the manufacturer's most current and complete microprocessor-based system for monitoring, metering and controlling the engine generator set. The controller shall feature digital displays as well as analog meters for AC volts, AC amperes, and Frequency, as a minimum, **even if these functions are duplicated digitally**. Gauges for Engine functions, including Lube Oil Pressure and Cooling Water Temperature shall be supplied and may be incorporated in the panel or may separately mounted.

The control system shall incorporate a key-operated Run-Off-Auto switch. In the "Run" position, the engine shall start and operate at rated speed. The starting function shall include a cranking cycle of several alternate crank and rest periods in the event that several attempts are necessary. If the unit has not started by the end of the cranking cycle, the start controls shall terminate the attempts and actuate the over-crank alarm. In the "Stop" position, the engine shall be unable to start or run. The "Stop" position shall also reset lockout relays and alarm indications, or the panel may incorporate a "Reset" switch. In the "Auto" position, the engine shall start and operate at rated speed in response to a remote contact from a transfer switch or other control.

The control panel shall include selectors for phase selection and for meter scale ranges, as appropriate.

The control system shall incorporate a non-reset-able running time indicator.

The control panel shall, as a minimum, indicate alarms for the following functions:

- Overcrank
- Overspeed
- High Water Temperature – Pre-Alarm
- High Water Temperature
- Lube Oil Low Pressure – Pre-Alarm
- Lube Oil Low Pressure
- Low Fuel
- Generator Switch Not in Auto

The panel shall provide for alarm acknowledge (silence) and test functions.

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For units incorporating a unit-mounted battery charger, battery charger alarms shall also be indicated on the control panel or shall be annunciated on the battery charger. In any case, battery charger alarms shall trigger the common "Generator Malfunction" alarm.

The engine generator set shall be equipped to activate a remote coordinated annunciator. The annunciator may be procured separately under these specifications, or it may be procured at a later date. The engine generator set shall provide, as a minimum, alarm outputs for the functions noted above and it shall provide a common "Generator Malfunction" alarm output. The "Generator Malfunction" alarm shall be activated by any generator alarm condition and, even when configured as part of a powered system to a coordinated alarm annunciator, it shall also activate a SPDT electrically isolated (dry) contact to activate a separate remote alarm.

The control panel shall have all functions clearly visible in daylight or night conditions by incorporating internal and/or external lighting. The control panel shall be environmentally hardened and suitable for operation in an outdoor environment in wet weather without the entry of moisture, dust or other airborne contaminants.

The control panel shall be UL508 and ISO 8528-4 listed and shall conform to the National Electrical Code and NFPA 110.

Engine Instruments:

The engine shall be provided with an appropriate instrument panel with the following equipment mounted thereon all properly connected for the desired services:

- Pressure gauge-fuel oil (not panel mounted)
- Temperature indicator-cooling water
- Temperature indicator-lube oil

Generator:

Generator Type and Rating: The generator shall be three phase, 60 hertz, rotating field, synchronous type, with a permanent magnet exciter, a standard oversize alternator and shall have the output voltage and KW rating at 0.8 power factor as specified, shall be connected to the engine flywheel with a flexible coupling and shall have an open, drip-proof enclosure.

The generator and exciter shall have Class F insulation and shall be capable of withstanding an overspeed of percent without damage. Bearings shall be ball, double shielded, cartridge type with grease fittings. The generator shall be re-connectable by means of reconfiguring conductive straps, bars or pre-made jumpers furnished with the unit and such reconnection shall be from an accessible location that does not require disassembly of other parts of the unit. Generator output shall be re-connectable as either:

- 480/277 volt, 3 phase, 4 wire
- 480/277 volt, 3 phase, 3 wire
- 240 volt, 3 phase, 3 wire
- 208/120 volt, 3 phase, 4 wire

The generator and exciter shall be rated for operation continuously at 110 percent of rated load without exceeding insulation temperature limits of 105 percent C rise. Submittal information shall document compliance with this requirement.

Voltage Regulator:

The voltage regulator shall be static type with surge protection and shall match the characteristics of the generator and exciter. A rheostat for a maximum of plus or minus five percent voltage adjustment shall be provided.

Digital voltage regulation for maximum calibration shall not be more than plus or minus one percent from no load to full load.

Stable operating conditions shall be re-established within two seconds following any sudden change in load between full and no load. Stable generator operation is defined as operation with terminal voltage held constant within plus or minus one percent of rated voltage.

Readily accessible voltage drop, voltage level and voltage gain controls shall be provided.

The set may supply non-linear loads such as UPS systems or DC drives. The set sizing and construction shall take this into account and the set shall be immune to negative effects from such loading.

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Generator Instruments:

The generator instrument shall be panel mounted in the generator control panel and shall include:

- AC Ammeter
- AC Voltmeter
- Voltmeter/Ammeter phase selector switch
- Frequency meter dial type
- Elapsed Time meter

Generator Circuit Breaker:

Each engine generator set shall have a generator output circuit breaker mounted in an enclosure on the unit. The circuit breaker shall be a molded case, thermal magnetic type with an interchangeable trip, ambient compensated for installation outdoors in full sun. The circuit breaker shall have a frame size suitable for the maximum nominal output amperes available in the "worst-case" reconnect-able configuration. Alternate trip modules shall be provided within a tool box for all various output configurations. The circuit breaker shall be UL listed, **molded case**, rated for 600 volts and shall have an interrupting rating suitable for the available fault current of the unit.

Housing:

Each unit shall have an outdoor sound attenuating enclosure rated for 75db attenuation at 15 feet. The housing shall consist of a "skin tight" design prefabricated structure according to manufacturers dimensions bolted and sealed on the structural steel frame for mounting on a concrete pad or steel grating. Insulation shall be mineral wool or fiberglass.

The size of the housing enclosure shall be sufficient for all items mounted within and shall have adequate space to allow sufficient clearances for access and maintenance of equipment. The housing shall have standard size heavy duty primed and painted steel access doors with outside padlocking provisions and door "hold open" latches.

It shall have a fabricated steel base assembly with integral fuel tank, motorized intake and exhaust louvers, ducted radiator exhaust assembly and environmental control system including lights, heaters and convenience receptacles.

The steel base shall incorporate an integral double walled fuel tank of not less than the capacity specified and shall provide adequate support and stiffness. The base shall be bolted to the concrete pad. The steel base shall be sand blasted to a commercial finish in accordance with the manufacturer's standards.

The generator package shall be equipped with a not less than a 60 ampere **240/120 volt single phase or 208/120 volt three phase** panel board with a 60 ampere main circuit breaker and load size circuit breakers to distribute power for lighting receptacles and auxiliary items as required. **Unless otherwise designated, the panel shall be 240/120 volt single phase.** Circuit breakers shall be bolt-on type with not less than 10,000 RMS symmetrical amperes. **The vendor shall coordinate voltage configuration for each individual unit ordered.**

The housing shall be equipped with interior and exterior signs to warn of "Flammable Material" and "NO SMOKING".

Auxiliary Items:

The package shall be equipped with lighting switched from an access door to provide general lighting for maintenance and inspections.

A minimum of two duplex 120 volt G.F.I. convenience outlets with covers shall be provided in the housing as required for maintenance use.

The package shall be equipped with a thermostatically controlled 120 volt electric space heaters to prevent condensation within the housing and to maintain the house at 50 degrees F while outside temperature is 0 degrees F. The thermostat shall be accessible for adjustment.

Conduit used for wiring within the housing may be electrical metal tubing except for flexible connections where liquid-tight flexible metal conduit shall be used. Assure ground continuity with equipment ground wires.

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Annunciators:

Annunciators shall be standard manufacturer compliments to the engine generator sets as specified herein, suitable to provide remote monitoring, and visual and audible alarm of engine generator status and malfunction conditions.

Annunciators shall comply with NFPA standards for Essential Electrical Systems for Health Care Facilities and Emergency and Standby Electric Power Systems as well as National Electrical Code requirements. The annunciators shall be powered from the engine generator DC system and shall not require an additional power source for either visual or audible alarm.

Annunciators shall be mounted in a metal enclosure, with a front suitable for flush or surface wall mounting.

Annunciators shall have space for not less than 20 alarm conditions, and it shall be possible to customize designations of each space. At least 18 of the alarm spaces shall be capable of initiating the audible alarm, and each shall have the audible alarm selectable as "on" or "off". The annunciator shall be equipped with an audible alarm silence and a lamp test feature, and the vendor shall provide instructions on how to disable the audible alarm and how to substitute an output connection to a silent strobe or similar device.

Annunciators shall be of a modular design using replaceable and interchangeable LED lights. A supply of 10 green, 10 red and 10 yellow spare LEDs shall be provided with the unit. A supply of not less than 20 spare legend labels for customizing the configuration shall also be included.

Specific set alarms may be tailored to each specific installation, and specific alarm designations may be specified at the time any annunciator is ordered. In the absence of installation specific designations, each annunciator unit shall initially be shipped with the alarm functions specified herein for the engine generator set control panel; plus the battery charger alarms; plus a "Generator Running" indication; plus an alarm for Fuel Leak to Rupture Basin, generally as follows:

Condition	Color	Audible Horn	
Not in Auto	Red	No	
Battery Charger	Red	No	
Malfunction	Red	Yes	
Generator Running	Red	No	
Low Fuel	Red	Yes	
Fuel Leak –	Red	Yes	
Rupture Basin	Red	Yes	
Pre-High Coolant Temp.	Red	Yes	
High Coolant Temp.	Red	Yes	
Low Engine Temp.	Red	Yes	
Pre-Low Oil Pressure	Red	Yes	
Low Oil Pressure	Red	Yes	
Overspeed	Red	Yes	
Overcrank	Red	Yes	
Generator Overload	Red	Yes	
Pre-Alarm	Red	Yes	
Generator Overload	Red	Yes	
Shutdown	Red	Yes	
	Normal Power Present	Green	No
	Emergency Power	Red	Yes
	Present	Red	No
	Transfer Switch in Normal	Green	No
	Transfer Switch in Emergency	Red	No

Annunciators shall be UL listed.

Guarantees/Warranties:

All equipment shall be furnished complete with the Manufacturer's standard year guarantee/warranty applicable to the Illinois Department of Transportation or other appropriate procuring agency from the date of delivery. Such guarantee shall accompany final record drawings and product data.

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Delivery:

District One ordered units shall be delivered to a single site designated by IDOT within District One. Delivery date and time shall be coordinated with IDOT in advance. Off-loading will be handled by IDOT and may be witnessed by the manufacturer's representative.

After testing at the installed site, the manufacturer shall provide a certification as specified elsewhere herein.

Local Service:

The successful bidder shall have an ongoing business operation within the State of Illinois, shall provide 24-hour service capability and shall provide units for which factory-authorized service is available at various locales statewide to minimize emergency response times. A complete listing of factory-authorized service within Illinois (and adjacent bordering locales) shall be provided with the bid.

Acceptable Products:

The engine generator set shall be as manufactured by Onan, Kohler, Caterpillar, or approved equal.

TESTS:

Engine Generator Factory Test:

The engine generator set incorporated in the engine generator package must be fully tested, as specified herein at the factory and certified by the engine generator manufacturer.

The factory test(s) shall be per manufacturers standards.

All tests shall be neatly recorded, and a copy of the test results shall be given to IDOT.

The set serial number(s) shall be recorded on the test result forms.

Assembled Package Installed Tests:

The completed package assembly shall be field tested to assure proper operations and connection of the engine generator set and all other components of the assembly. The tests shall include simulations of automatic, manual, and retransfer to normal simulation of all alarm functions as well as tests of the field tank and other package auxiliary items.

The manufacturer of the Engine Generator Package shall furnish the services of an experience engineer to check the equipment and witness testing and file reports and certification and such services shall be available within 10 days of notification that installation and connection is complete and ready for testing.

The services manufacturer's representative shall be available to assist in the adjusting and testing of the engine generator set and the assembled package in the field. These adjustments shall be made in the presence of IDOT.

Tests shall demonstrate the proper operation of the set, including automatic starting and picking up of the load.

Except for the manufacturer's representative, all instruments, test equipment, fuel, lube oil, and personnel that are required for the test as confirmed with the manufacturer will be furnished by the installing Contractor. The manufacturer may provide supplemental test equipment.

The representative of the engine generator set manufacturer shall furnish certification in writing that the set has been properly installed at the site and that the trial operation has been satisfactory. Documentation shall include recorded test results. The certification shall be submitted to the owner in triplicate before final acceptance.

SUBMITTALS:

The submittal shall include calculations and other detailed information showing compliance with all generator package specifications and appurtenances specified herein and they shall also include detailed drawings of the generator, dimension weights, lift points, and rigging recommendations, its wiring, the base, the superstructure, and any other information needed in the construction of the complete package shall also be provided to the extent practical for bidding.

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In submitted calculations, bidders shall indicate all specified input parameters plus any assumed characteristics such as motor efficiency and power factor that may be germane to the calculation.

IDOT may request additional information from the successful bidder.

Also, component catalog information shall be included and highlighted.

The Contractor is responsible for highlighting and explaining any proposed deviations from specified requirements. Minor deviations relative to set appurtenances and accessories may be allowed, but deviations affecting set sizing, load capacity, noise rating, and other basic unit features will not be allowed.

DOCUMENTATION

Each unit ordered shall be delivered with two (2) sets of catalog and shop drawing information, test results and vendor certification and two (2) sets of operating and maintenance manuals.

UNINTERRUPTIBLE POWER SUPPLY

STANDARDS. The UPS shall be designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.

IEEE C62.41, Category A & B
ASME
CSA 22.2, No. 107.1
FCC Part 15, Sub Part B, Class A
National Electrical Code (NFPA 70)
NEMA PE-I
OSHA
UL Standard 1778

GENERAL. The UPS system shall consist of the appropriate number of modules for capacity and/or redundancy. All modules are to be operating simultaneously and sharing the load. In a non-redundant system, all the modules making up the UPS are required to supply the full rated load. If a power or control module should malfunction, the load is to be transferred automatically to the bypass line. If a battery module should malfunction, it is to be isolated from the system resulting in reduced back up time. For redundant operation, the UPS will have one or more modules than what is required to supply the full rated load. The malfunction of one of the modules shall cause that module to be isolated from the system and the remaining module(s) shall continue to carry the load. Replacement of a module shall be capable without disturbance to the connected load.

Modes of Operation. The UPS shall be designed to operate as a true on-line system in the following modes:

- A. Normal - The critical AC load is continuously supplied by the UPS inverter. The input converter derives power from a utility AC source and supplies DC power to the inverter. The battery charger shall maintain a float-charge on the battery.
- B. Back-up - Upon failure of utility AC power the critical AC load is supplied by the inverter, which obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
- C. Recharge - Upon restoration of utility AC power, after a utility AC power outage, the input converter shall automatically restart and resume supplying power to the inverter. Also the battery charger shall recharge the battery.
 1. Automatic Restart - Upon restoration of utility AC power, after a utility AC power outage and complete battery discharge, the UPS shall automatically restart and resume supplying power to the critical load. Also the battery charger shall automatically recharge the battery. This feature shall be enabled from the factory and shall be capable of being disabled by the user. The user shall also be able to program two auto restart delay settings: Battery capacity % level, Countdown timer

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- E. Bypass - The bypass shall provide an alternate path for power to the critical load that shall be capable of operating in the following manner:
1. Automatic - In the event of an internal failure or should the inverter overload capacity be exceeded, the UPS shall perform an automatic transfer of the critical AC load from the inverter to the bypass source.
 2. Manual - Should the UPS need to be taken out of service for limited maintenance or repair, manual activation of the bypass shall cause an immediate transfer of the critical AC load from the inverter to the bypass source. The input converter, inverter, and battery charging operations shall continue to operate, provided the control enable switch is in the " On " position.

Performance Requirements.

System

- A. Configuration: The UPS system shall be upgradeable to a 12 bay frame system, 12.0 kVA to 16kVA.
- B. Isolation. Input to output isolation shall be provided, via the output transformer, regardless of operating mode. (UPS or bypass)
- C. Remote Stop. The UPS shall provide provisions for remote stop capability.

AC Input to UPS

- A. Voltage Configuration: 208 VAC nominal, single-phase, 2-wire-plus-ground. The operating voltage range shall be variable based upon output loading percentages as follows:

% UPS Load	Input Voltage
80 – 100%	170 VAC
60 – 80%	144 VAC
30 – 60%	127 VAC
0 – 30%	110 VAC

- B. Frequency: 40 to 70 Hz.
- C. Input Current Distortion: 5% THD maximum at full load.
- D. Input Power Factor: 0.98 lagging at 100% rated load.
- E. Inrush Current: 150% of full load input current maximum for 3 cycles.
- F. Surge Protection: Sustains input surges without damage per criteria listed in IEEE C62.41, Category B.

AC Output

- A. Voltage Configuration: 208/120 VAC, single-phase, 3-wire-plus-ground. Field configurable to 240/120 VAC.
- B. Voltage Regulation: +/- 3% steady state.
- C. Frequency Regulation: 60 Hz, +/- 0.5%.
- D. Frequency Slew Rate: 5.0 Hertz per second maximum.
- E. Bypass Frequency Synchronization Range: +/- 5.0 Hertz.
- F. Voltage Distortion: 3% total harmonic distortion (THD) maximum into a 100% linear load, 7% THD maximum into a 100% non-linear load with crest factor ratio of 3:1.
- G. Load Power Factor Range: 0.5 lagging to 1.

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- H. Output Power Rating: Rated kVA at: 0.7 lagging power factor.
- I. Overload Capability: >100% - 110% indefinitely, 111% -150% for 10 seconds, 151% - 200% for 0.25 seconds, The load shall be transferred to bypass when any of the above conditions are exceeded. >201% for min. 2 cycles, then shut down of UPS. Immediate shutdown into a short circuit.
- J. Voltage Transient Response: +/- 7% maximum for any load step up to and including 100% of the UPS rating.
- K. Transient Recovery Time: To within 1% of steady state output voltage within 96 milliseconds.

Batteries

- A. Internal Battery: The battery shall consist of gas recombination, valve regulated, lead acid cells. Flame retardant batteries shall be provided, which renders the UPS suitable for installation inside a computer room per requirements of UL Standard 1778.
- B. Reserve Time: (with ambient temperature between 20 and 25 deg C) The UPS shall contain an internal battery system to provide a reserve time of 20 minutes at 100% load with an equal number of power and battery modules fitted. The UPS shall contain provisions to fit additional internal battery modules. The UPS shall also interface with an external battery cabinet to extend reserve time capabilities.
- B. Battery Recharge: To prolong battery life, the UPS shall contain temperature-compensated battery charging. When equal number of power modules and battery modules are fitted the battery charger shall be able to recharge the internal batteries to 90% charge in three to five hours at nominal input voltage and nominal ambient temperature.

ENVIRONMENTAL CONDITIONS

- A. Ambient Temperature. Operating UPS 0 deg C to +40 deg C; battery 20 deg C to 25 deg C for optimum performance. Storage: UPS -20 deg C to +60 deg C; battery -20 deg C to 25 deg C for maximum 6 months.
- B. Relative Humidity. Operating: 5 to 95% non-condensing. Storage: 5 to 95% non-condensing.
- C. Altitude. Operating: To 10,000 feet. Derating or reduced operating temperature range required for higher altitudes. Storage: To 30,000 feet.
- D. Audible Noise. Noise generated by the UPS during normal operation shall not exceed 62 dBA measured at 1 meter from the surface of the UPS.
- E. Electrostatic Discharge. The UPS shall be able to withstand a minimum 15 kV without damage and shall not affect the critical load.

USER DOCUMENTATION. The specified UPS system shall be supplied with one (1) user's manual. Manuals shall include installation drawings and instructions, a functional description of the equipment with block diagrams, safety precautions, illustrations, step by step operating procedures, and routine maintenance guidelines.

WARRANTY. The UPS manufacturer shall warrant the UPS against defects in materials and workmanship for two (2) years. The warranty shall cover all parts for two (2) years and onsite labor for ninety (90) days. With start-up provided by the manufacturer or the manufacture's authorized agent, the warranty shall cover all parts and onsite labor for two (2) years. Maintenance contract packages shall also be available.

QUALITY ASSURANCE

Manufacturer Qualifications. A minimum of thirty year's experience in the design, manufacture, and testing of solid-state UPS systems is required.

Factory Testing. Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification. These tests shall include operational discharge and recharge tests on the internal battery to guarantee rated performance.

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FABRICATION. All materials and components making up the UPS shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The UPS shall be constructed of replaceable subassemblies. All active electronic devices shall be solid-state.

Wiring. Wiring practices, materials, and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70) and other applicable codes and standards.

Cabinet. The UPS unit comprised of: power module, battery module, control module, system interconnect module and user interface module housed in a single free-standing enclosure and meets the requirements of IP20. The UPS system shall be designed such that the battery modules may be installed into any module bay in the cabinet and power modules into any module bay in the top half of the cabinet. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color. Casters and leveling feet shall be provided. UPS cabinet dimensions shall not exceed 20 inches wide, 29 inches deep, and 53 inches high (12 Bay Frame). Cooling. The UPS shall be forced air cooled by internally mounted fans.

COMPONENTS

Input Converter

- A. General. Incoming AC power shall be converted to a regulated DC output by the input converter for supplying DC power to the inverter. The input converter shall provide input power factor and input current distortion correction.
- B. AC Input Current Limit. The input converter shall be provided with AC input over current protection.
- C. Input Protection. The UPS shall have built-in protection against undervoltage, overcurrent, and overvoltage conditions including low-energy surges introduced on the primary AC source and the bypass source. The UPS shall sustain input surges without damage per criteria listed in IEEE C62.41, Category A & B. The UPS cabinet shall contain an input breaker sized to supply full 16kVA rated load and to recharge the battery at the same time.
- D. Battery Recharge. To prolong battery life, the UPS shall contain temperature-compensated battery charging. When an equal number of power modules and battery modules are fitted the battery charger shall be able to recharge the internal batteries to 90% charge in six hours at nominal input voltage and nominal ambient temperature.
- E. Charger Output Filter. The battery charger shall have an output filter to minimize ripple current into the battery.

Inverter

- A. General. The inverter shall convert DC power from the input converter output, or the battery, into precise regulated sine wave AC power for supporting the critical AC load.
- B. Overload. The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 200% of full load current. A visual indicator and audible alarm shall indicate overload operation. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses. The load shall be transferred to bypass when any of the above conditions are exceeded.
- C. Maximum Load Alarm. The user can set the alarm point to a value less than 100% rating such that the UPS will alarm before an overload condition or loss of redundancy is reached.
- D. Output Frequency. The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to +/- 0.5% for steady state and transient conditions. The inverter shall track the bypass continuously providing the bypass source maintains a frequency within the user selected synchronization range. If the bypass source fails to remain within the selected range, the inverter shall revert to the internal oscillator.

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- E. Output Protection. The UPS inverter shall employ electronic current limiting.
- F. Battery over Discharge Protection. To prevent battery damage from over discharging, the UPS control logic shall control the shutdown voltage set point. This point is dependent on the rate of discharge.

Display and Controls

- A. General. The front panel will consist of multiple status LEDs, switches, and a four line by twenty character LCD display for additional alarm/configuration information. All mimic display LEDs shall be green in color and indicate the following: AC Input, On Battery, Load On/Off, On Inverter, On Bypass.

The UPS fault indicator is used with additional indicators and audible alarms to notify the user that a UPS fault condition has occurred. The color of the fault indicator LED shall be amber in color and indicate the following: Replace Battery Module, Replace Power Module, Replace Control Module, On Bypass, Low Battery, OverTemp Warning, and UPS Shutdown.

If there is a fault condition, the UPS shall attempt to maintain conditioned power to the load, or at minimum transfer to bypass.

There shall also be indication on each module should the module fail and need to be replaced.

In addition to a visual fault signal, the UPS shall also record fault occurrences in a rolling event log. The event log on the standard unit shall record up to 255 occurrences, with the oldest events discarded first, etc. The user shall have access to the event log through the LCD display. Every alarm and/or event recorded in the event log will contain a time and date stamp.

- B. Audible Alarms. The volume of all audible alarms shall be at least 65dBA at a distance of one meter (three feet). An audible alarm shall be used in conjunction with the LED/LCD indication to indicate a change in UPS status.

The audible alarms shall enunciate for utility line loss, low battery (while on battery), and all other alarm conditions. For all alarm conditions, the user must look at the display to determine the cause of error/alarm. All alarm tones shall be a continual tone until the condition rectifies itself or the alarm is silenced. Once silenced, the audible alarm shall not sound until a new alarm condition is present.

- C. Alarm Silence Button. In addition to the load on/off switch, the user interface shall include an audible 'Alarm Silence' switch. If the alarm silence switch is pressed for one second, all current audible alarms shall be disabled. If a new alarm occurs, or a cancelled alarm condition disappears and then re-appears, the audible alarm is re-enabled.

- D. LCD Display. The LCD display shall be used to provide information to the user. The display shall also be used to program ALL information (voltage, frequency, etc.) into the UPS. Any display values that require time/date shall be 'year 2000' compliant.

Automatic Battery Test. The UPS shall initiate an automatic battery testing sequence periodically, at a programmed day and time of day, selectable by the end user. The user will be able to select the interval of the battery test and will be able to select 1, 2, 3, 4, or 6 week intervals, or can select to disable the automatic battery test.

Should a failure of the battery occur, the UPS will immediately return to normal mode and fault signals (visual, audible, and remote via serial) shall be communicated. No audible or remote (via serial/contact closures) indication of the battery test shall be communicated during the duration of the automatic battery test.

The automatic battery test factory default settings shall be enabled at a two week interval and to occur on Wednesdays at 0600hours (based on the twenty four hour clock).

Remote Emergency Power Off (REPO). The remote emergency power off function (REPO) shall allow the user to disable all UPS outputs in an emergency situation. The REPO, in order to be flexible, shall be able to interface with either normally open (N.O.) or normally closed (N.C.) systems. The REPO shall be activated when a pair of 'SELV' contacts, external to the UPS, are activated. The REPO connection shall be through a simple terminal block type connector.

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The REPO function shall not operate if no system control modules are present in the UPS or if the manual bypass switch is in the bypass position. The user must also supply a means of interfacing with the REPO circuit to allow disconnecting the UPS input feeder breaker to remove all sources of power to the UPS and the connected equipment to comply with local wiring codes/regulations.

Regardless of the UPS mode of operation when the REPO is activated, the UPS output shall not be re-enabled until the following occurs:

- REPO contacts are reset (closed if N.C. contacts are used and open if N.O. contacts are used)
- Input circuit breaker is closed
- Control enable switch is turned on
- User interface on/off switch is depressed

Bypass

A. General. A bypass circuit shall be provided as an integral part of the UPS. The bypass shall have an overload rating of 300% rated full load for 10 cycles and 1000% for sub-cycle fault clearing. The bypass control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide a transfer of the load to the bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS.

B. Automatic Transfers. The transfer control logic shall automatically activate the bypass, transferring the critical AC load to the bypass source, after the transfer logic senses one of the following conditions:

Inverter overload capacity exceeded
Inverter over temperature
UPS fault condition

For inverter overload conditions, the transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if one of the following conditions exists:

Inverter/Bypass voltage difference exceeding preset limits ($\pm 15\%$ of nominal)
Bypass frequency out of preset limits ($\pm 5\%$ of nominal frequency)

C. Automatic Retransfer. Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:

Bypass out-of-synchronization range with inverter output
Overload condition exists in excess of inverter full load rating
UPS fault condition present

D. Manual Transfer. In addition to the internal bypass function, the UPS shall have a manual bypass function. The manual bypass function shall be provided via a switch mounted on the bottom-front of the UPS, removal of the lower front bezel shall be required. The actual AC break time between inverter and bypass shall be less than four milliseconds.

The manual bypass shall also be a partial 'wrap-around' bypass, and shall be configured to wrap around the rectifier, battery charger, inverter, and battery in the same manner as the automatic bypass. The manual bypass shall not wrap around the EMI filtering, overcurrent protection or isolation transformer.

The UPS shall initiate an audible alarm upon transfer to manual bypass. The audible alarm shall be capable of being silenced by the user. The alarm shall continue to sound (unless silenced) while in bypass mode. This shall provide a reminder to the user that the load continues to be powered from utility supply alone.

Internal Battery. Flame retardant, valve regulated, gas recombination, lead acid batteries shall be used as a stored-energy source for the specified UPS system. The battery shall be housed in separate replaceable modules that slide into any open bay of the UPS cabinet, and sized to support the inverter at rated load and power factor, in

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an ambient temperature between 20° and 25° C, for a 6 minutes reserve time. The expected life of the battery shall be 3 to 5 years or a minimum 250 complete discharge cycles. For extended battery reserve time, additional battery modules may be added, if the frame size allows, external battery cabinets shall be also be available as an option.

COMMUNICATIONS. The UPS shall allow for flexibility in communications. The UPS shall be able to communicate through two communications ports simultaneously; the media of either communications port may change without affecting the operation of the UPS. The use of relay contacts shall not affect the operation of the two communications ports.

Relay Contacts. The relay contacts shall be available through at least one DB-9F communication connector, and shall be compatible with the SiteNet MultiLink system. The UPS shall communicate via relay contact closure the following information: Low Battery, On Battery. One connector to provide relay contacts shall be fitted on all UPS models as standard (designated comm port 1). Relay contacts shall be rated 48 VDC, 1 A. Additional signals (such as on bypass and summary alarm) shall be provided.

The following pins for comm port 1 shall be used:

Pin 1	Low Battery	(normally open)
Pin 4	Shutdown in battery mode	(5 – 12 VDC for 1.5 sec)
Pin 5	Common	
Pin 7	Low Battery common	
Pin 8	On Battery	(normally open)
Pin 9	On Battery common	

Serial Communications. The UPS shall be able to communicate through the following communication ports: Comm port 2 (standard on UPS). The pin-out configuration for comm port 2 shall be as follows:

Pin 2	Transmit Data
Pin 3	Receive Data
Pin 5	Common

Network Communications. The user shall have the option of installing an optional Intellislot card to provide SNMP communication over a local area network. 10/100Mbit Ethernet support shall be included.

UPS Status Information. The software shall be able to retrieve all status information present in the UPS (and available on the display). Retrieval of data shall be through either serial communications or through a network connection.

External Battery Cabinets. The UPS shall have the capability to add external battery cabinets to the base product. These external battery cabinets with chargers and front access battery terminals, shall be installed in parallel to provide backup times as required. The connections between the UPS and the extended battery cabinets shall contain DC power only. All of these shall be able to be connected or disconnected safely by the user without interrupting power to the load

Modular Extended Battery Cabinets. The Modular Battery Cabinet shall be pre-configured with 1 to 12 Battery Modules installed. Battery Cabinets with less than 12 Battery Modules shall be field upgradable using the standard Battery Module Expansion Kit. Each Extended Battery Cabinet shall include (2) Intellislot Battery Cards (IBC) and (2) 10-foot communications cables. Each Extended Battery Cabinet shall require one unused Intellislot on the UPS and a maximum of four Extended Battery Cabinets shall be used with one UPS.

Maintenance Bypass Cabinet with optional COD. The Maintenance Bypass Cabinet shall provide complete “wrap-around” protection and shall allow the UPS to be pulled from service without interrupting power to the loads. The Maintenance Bypass Cabinet controls shall include a manual break before make bypass transfer switch, UPS input disconnect switch, and a branch rated output circuit breaker. The Maintenance Bypass Cabinet controls shall be located behind a lockable front panel to provide operation security.

Maintenance Bypass Cabinet models shall be available with and without an isolation transformer in the bypass path. The Maintenance Bypass Cabinet with Transformer option shall provide isolation in the bypass path as well as total flexibility with utility voltages.

Every Maintenance Bypass Cabinet model shall be able to be ordered with up to 10 output options. These options shall include receptacles as well as conduit fittings with branch rated breakers. Each receptacle or conduit fitting shall include a power available indicator lamp.

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FIELD QUALITY CONTROL. The following inspections and test procedures shall be performed by factory trained field service personnel during the UPS start-up.

Visual Inspection

- A. Inspect equipment for signs of shipping or installation damage.
- B. Verify installation per drawings.
- C. Inspect cabinets for foreign objects.
- D. Verify neutral and ground conductors are properly sized and configured.

Mechanical Inspection

- A. Check all power modules are correctly fitted.
- B. Check all battery modules are correctly fitted.
- C. Check all terminal screws, nuts, and/or spade lugs for tightness.

Electrical Inspection

- A. Confirm input voltage and phase rotation is correct.
- B. Verify bypass voltage jumper is correct for voltages being used.

UNIT START-UP AND SITE TESTING. The manufacturer's field service personnel shall provide site testing if requested. Site testing shall consist of a complete test of the UPS system and the associated accessories supplied by the manufacturer. A partial battery discharge test shall be provided as part of the standard start-up procedure. The test results shall be documented, signed, and dated for future reference.

MANUFACTURER'S FIELD SERVICE

Service Personnel. The UPS manufacturer shall directly employ a nationwide service organization, consisting of factory trained Customer Engineers dedicated to the start-up, maintenance, and repair of UPS and power equipment. The organization shall consist of factory-trained Customer Engineers working out of District Offices in most major cities. An automated procedure shall be in place to insure that the manufacturer is dedicating the appropriate technical support resources to match escalating customer needs.

The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week, and 365 days/year. If emergency service is required, call back response time from a local Customer Engineer shall be 20 minutes or less.

Replacement Parts Stocking. Parts shall be available through an extensive network to ensure around-the-clock parts availability throughout the country. Local Customer Engineers shall stock replacement spare parts with back up available from District Service offices and the manufacturing location. Customer Support Parts Coordinators shall be on-call 24 hours a day, 7 days a week, 365 days a year for immediate parts availability.

UPS Maintenance Training. Maintenance training courses for customer employees shall be available by the UPS manufacturer. This training is in addition to the basic operator training conducted as a part of the system start-up.

The training course shall cover UPS theory, location of subassemblies, safety, battery considerations and UPS operational procedures. The course shall include AC to DC conversion and DC to AC inversion techniques as well as control and metering. Troubleshooting and fault isolation using alarm information and internal self-diagnostics shall be stressed

CONSTRUCTION REQUIREMENTS

All materials shall be furnished with the most recently developed product versions that meet or exceed these specifications. It is the Contractor's responsibility to ensure that all components comply with the performance requirements specified herein, within the plan set, and/or in the Contract. In case of conflict between the requirements of the American National Standards Institute (ANSI), the American Society for Testing and Materials (ASTM), the National Electrical Manufacturers Association (NEMA), the Underwriters Laboratories (UL) Incorporated, and local codes, permitting requirements, and requirements contained herein, within the plan set, and/or in the Contract, the most stringent specifications shall apply. All materials and practices shall comply with the applicable requirements of the United States Department of Labor's (USDOL) Occupational Safety and Health Standards.

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Contractor Requirements. The Contractor is solely responsible for all designs, equipment, materials, and services proposed. The Contractor is responsible for verifying the completeness of the materials required and the suitability of devices used to meet these specifications. The Contractor shall provide and install, without claim, any additional equipment required for operation as required herein, within the plan set, and/or in the Contract.

The Contractor shall possess the qualifications, skills, and experience necessary to accomplish the work required herein, within the plan set, and/or in the Contract to construct, furnish, and install equipment shelter. The Contractor who performs the lightning protection system installation shall document experience and competency in the proper design and installation of lightning protection systems, and be certified by the Lightning Protection Institute (LPI). This requirement is in addition to the normal contractor licensing requirements of the State of Illinois.

General Installation. Equipment shelter installation shall meet or exceed the design requirements contained herein, within the plan set, and/or in the Contract. The Contractor shall be responsible for identifying local facilities for the delivery, storage, and legal disposition of post-installation materials. The Contractor shall also be responsible for locating and protecting any existing underground utilities at the work site. The Contractor shall repair any damage to existing installations at no additional cost to the Department.

The Contractor shall submit detailed drawings of the proposed installation to the engineer for approval. All concrete work shall be performed according with IDOT's Standard Specifications for Road and Bridge Construction.

The Contractor shall supply a concrete mix design to the engineer for approval. The concrete mix design shall be signed and sealed by a professional engineer registered in the State of Illinois. When the concrete is delivered on site, the Contractor shall provide the actual mix design to the engineer for approval. If the concrete mix design does not meet the requirements of the signed and sealed concrete mix design, the Contractor shall not be permitted to use the concrete. At a minimum, the Contractor shall take five samples (i.e., cylinders) of concrete from each truckload. The Contractor is responsible for performing concrete break tests on the samples at 3-, 7-, 14-, and 28-day intervals. The Contractor shall use a fifth sample as a spare in the event one of the other samples becomes damaged. The Contractor shall submit all concrete break tests in writing to the engineer. No construction or installation may begin on a concrete foundation until the concrete break tests indicate that the concrete has reached its design strength.

The Contractor shall also perform slump and temperature tests for each truckload. If the concrete is beyond the limits of the design or IDOT requirements, the Contractor shall not be permitted to use concrete. Some sites may be located in environmentally sensitive areas and require special treatment of the waste products associated with drilled shaft excavations.

Electrical Installation. The Contractor shall be responsible for providing and connecting electrical power to the shelter. Routing of wires and cables shall be neat and orderly. Electrical connectors and all costs associated with providing power shall be the Contractor's responsibility. The Contractor shall install the power service as required by IDOT's Standard Specifications for Road and Bridge Construction. Unless otherwise specified, the Contractor shall provide underground power service.

The Contractor shall provide all electrical connections from the service drop to the shelter's receptacles. The receptacles, switches, and light fixtures shall be wired using a minimum of # 12 AWG copper wires. All wire shall be run in a minimum 0.50-inch [1.27 -centimeter] electrical metallic tubing (EMT). The electrical loads shall be divided among as many load centers as necessary to contain the quantity of circuit breakers required to protect the communication shelter facility. The load centers shall contain separate, appropriately sized circuit breakers for the HVAC units as required for each major branch, receptacle, and remaining location in the 42-circuit panel. Power outlets consisting of quad receptacles shall be mounted on unistruts fastened to the overhead cable tray, above the equipment cabinet racks. In addition, a total of five duplex outlets shall be mounted in the equipment shelter walls as shown on the contract drawings. A separate 20-amp single-pole circuit breaker shall be provided to protect the lighting circuits.

All electrical conduits shall be installed in a neat and orderly fashion. Symmetry shall be employed wherever possible. The main power shall enter the equipment shelter at a primary power switch to allow for the disconnection of commercial power and shall then be routed to an automatic transfer panel that will switch to emergency generator power in the event commercial power is lost. Emergency generator power shall also enter the equipment shelter through a power switch prior to connection to the automatic transfer panel. The main power from the automatic transfer switch shall be routed to a manual transfer switch with the mobile emergency generator connection installed on the outside of the shelter. The emergency generator connection shall allow IDOT personnel to power the site from a portable generator in the event that both the commercial power and emergency power is lost. The resulting main power shall then be routed to a 42-circuit distribution panel and through the associated AC TVSS devices as described herein, within the plan set, and/or in the Contract.

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Grounding. The purpose for installing a grounding system is to provide personnel safety and equipment lightning protection and to minimize the induced noise and static in the system. The grounding system shall comply with the specifications detailed herein, within the plan set, and/or in the Contract, and with National Electrical Code (NEC) requirements and National Fire Protection Agency (NFPA) standards detailed in NFPA-70, as well as all local grounding-related building codes.

The equipment shelter's exterior grounding system shall function as the primary ground sink. All grounds for the shelter shall be installed on the side of the shelter that the utilities, communication cables, and fiber enter. The grounding system for the surge protection devices shall be installed according to the manufacturer's recommendations and shall be connected to the existing grounding system with no less than the minimum wire size specified herein, within the plan set, and/or in the Contract, or the manufacturer's recommended wire size, whichever is larger, typically a #2 AWG stranded copper wire. The grounding system shall be bonded at a single point so that the communication cables, AC power, generator, signaling equipment, and equipment frames are connected by the shortest practical route to the grounding system. Lead lengths from each device to the device shall be protected and grounding shall be minimized for all devices according to installation requirements. The TVSS device's lead lengths shall not exceed 10 inches [0.3 meter]. Any variance from the IDOT requirements shall be submitted in writing and pre-approved by the engineer for acceptance.

All belowground connections shall use an exothermic bonding process. The Contractor shall not backfill the openings where the underground exothermic bonds are made until the engineer has inspected and approved the grounding system.

All aboveground exterior connections shall use an exothermic bonding process to bond ground conductors to the exterior of the equipment shelter. Grounding connections to interior ground bus shall be mechanical connections using two bolts on a double lug connector. After a firm connection has been made to the connectors, an application of an anti-oxidant compound shall be required.

All connections to fence posts shall be exothermic bonds. Connections to top rails and fabric shall be mechanical connections. After a firm connection has been made to the connectors, an application of an anti-oxidant compound shall be required. See IDOT Fence Grounding Specifications for additional details.

Connection of conductors to interior equipment, such as panels and cable trays, shall use tow bolts on a double lug connector, or clamps appropriate to the size and type of wire, and the requirements of the equipment being grounded. Wires connected to lugs or clamps shall be crimped and soldered for reliable electrical contact. All non-conducting surface coatings shall be removed before each connection is made. Application of an anti-oxidant compound shall be required. Star washers, or another means that accommodates the fasteners used, shall be installed to ensure reliable electrical connections. The objective is to provide reliable, low-maintenance electrical and mechanical connections that will not deteriorate.

Ground Conductor Bending. Ground conductors shall be downward coursing and vertical and shall be as short and straight as possible. The minimum bending radius for interior shelter grounds shall be 8 inches [0.2 meter]. Sharp bends and multiple bends in conductors shall be avoided in all cases. Any deviation shall be submitted in writing and pre-approved in writing by the engineer.

Interior Grounding. One "halo" ground system consisting of an interior copper ground bus bar .25 inch x 2 inch (.64cm x 5cm), approximately 6 inches (15.24cm) below the ceiling, with a vertical #2 AWG stranded copper drop through the floor at each corner, with a sufficient length of coiled wire slack at the drop to allow attachment to an exterior ring ground system.

The cable trays shall be mechanically connected to the upper interior perimeter ground using #2 AWG stranded copper wires with bolted terminal connectors at the cable tray ends. All points where cable tray sections meet shall be made electrically continuous by use of a short jumper wire with terminals attached at each end. All other metallic objects, such as door frames and doors, air conditioners, alarm systems, wall-mounted communication equipment, etc., shall be directly bonded to the closest interior upper or lower perimeter ground with the shortest possible #2 AWG stranded copper wire. The door shall be bonded to the doorframe using flexible welding cable. A bond shall be made between the lower and upper internal perimeter grounds using #2 AWG stranded copper wires at each corner of the room, and shall continue to provide a bond between the internal and external grounding systems.

Exterior Grounding. The shelter's exterior grounding system shall consist of a ground ring consisting of four ground rods placed a minimum of approximately 2 feet from the building foundation corners and enclosed within a pre-fabricated 10 inch ground inspection well. The ground rods shall be bonded together using #2 AWG stranded copper wires and an exothermic bonding process. The bonding wires shall be buried a minimum of 2 feet [0.6 meter] below the finished grade. The following items shall also be bonded to the shelter's external grounding system using #2 AWG stranded copper wires:

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- Ground rods provided by power or telephone utilities for grounding of AC power or surge protection devices, as permitted by local codes; and any metal object greater than 4 ft² [0.4 m²].

Punch Block Transient Voltage Surge Suppression Grounding. All Type 66 punch blocks shall have #2 AWG stranded copper wires installed to ground external line surge protection devices. The #2 AWG stranded copper wires shall be installed as required by the TVSS manufacturer's recommendations and shall be mechanically connected to the shelter's interior perimeter ground.

Site Preparation. IDOT shall provide site space for shelter installations. The Contractor shall install the shelter and other necessary facilities and equipment in the provided space and make all necessary electrical and mechanical connections. General site preparation, specific building tie-downs, and landscaping shall be the Contractor's responsibility. The Contractor shall comply with all environmental protection requirements and shall contact the engineer for specific information regarding shelter site preparation. The Contractor shall provide a weed barrier mat and gravel ground cover in the fenced-in compound.

Land Clearing. The Contractor shall be responsible for the clearing of brush, trees, or any other obstructions, including the removal of asphalt or concrete. The Contractor shall coordinate with the engineer as to the extent and schedule for all land clearing activities to ensure that there is no interference with concurrent operations at the site. Any tree stumps resulting from clearing shall be grubbed. The Contractor shall comply with all environmental protection requirements. The engineer shall pre-approve in writing any site clearing and tree trimming.

Debris Removal. After installation, inspection, and approval by the engineer as specified herein, within the plan set, and/or in the Contract, the Contractor shall remove all onsite debris, backfill, and compact all excavations, and return the grounds to their original condition. The Contractor shall comply with all environmental protection requirements.

Sanitary Provision. The Contractor shall provide and maintain neat and sanitary accommodations for the use of its employees as required for compliance with the Illinois Department of Health and all applicable county regulations. No nuisances shall be permitted.

Excess Garbage and Clutter Removal. The trash generated from the installation, including lunch bags and drinks, shall be stored in a neat manner until disposed of properly. The Contractor shall be responsible for removing and legally disposing of trash in a timely manner. Trash shall not be allowed to blow around or away from any construction site.

Wall Mounted Fiber Optic Termination Frame. The fiber optic termination frame shall be installed in the communication shelter as specified on the Plans. The frames shall come with cable strain relief hardware and pull out label for administrative documentation. All work shall be neat and in a workmanlike manner. Particular care shall be taken as to not crush or kink the fiber optic cable.

LOCAL FIELD ACCEPTANCE TESTS

Perform local field acceptance test in accordance with the approved test procedures and furnish a report of each test.

DOCUMENTATION

The system shall include thorough documentation of all hardware and software to be supplied. Documentation for all procured Master Station equipment shall consist of the original manufacturer's manuals (one per unit supplied). Documentation delivered for hardware and software manufactured by the RTU vendor shall be subject to approval.

HARDWARE DOCUMENTATION

System Manual. A System Manual shall be provided which includes a complete summary list of deliverable items: remote stations, spares, test equipment, consumables, and all documentation manuals and drawings.

Remote Station Manuals. The remote station manual shall include as a minimum the following items:

- Installation and startup instructions
- Instructions for expansion of the RTU module
- Theory of operation
- Maintenance and trouble shooting guidelines
- Functional block diagrams
- Layout drawings and interconnect drawings
- Schematics of each RTU module
- Replacement parts list.

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Warranty. The equipment shelter shall carry a manufacturer's warranty of one year from the date of final IDOT acceptance. Said warranty shall be transferable from the Contractor to the IDOT upon the anniversary of the Contractor's one-year warranty period.

Training. The training for this section shall be in accordance with Specification – General Provisions.

Inspection and Verification. The inspection shall be performed by the Contractor and witnessed by the engineer or a designated representative. The Contractor shall notify the engineer at least 10 calendar days prior to completion of the installation. Following shelter equipment installation, the Contractor, in conjunction with the engineer or designated personnel, shall verify that all equipment is correctly installed and functional.

For ground system inspections, the Contractor shall notify the engineer at least 2 calendar days prior to completion of the installation. Below-grade ground installations and ground connections shall not be backfilled until inspected and approved by the engineer. All test results shall be recorded in a standardized format to be determined by the Contractor and approved by the engineer prior to testing. All recorded test report data shall be dated, witnessed, and signed by at least one representative of IDOT and the Contractor. The Contractor, at no cost to IDOT shall remedy all deficiencies.

Mechanical Inspection. Equipment that is to be mounted to the shelter walls shall be inspected to ensure adequate support has been provided. The HVAC system shall be tested for adequate heating, cooling, and dehumidification. The building shall be inspected for the proper sealing of conduit ports, telephone/signal cables, and ground wire penetrations. The Contractor shall be responsible for correcting any deficiencies.

Electrical Inspection. The shelter lights and smoke detectors shall be verified for proper operation. The Contractor shall verify proper power load balances and provide a report to the engineer prior to acceptance of the site. The Contractor shall be responsible for correcting any deficiencies.

Grounding Inspections. The grounding system shall be inspected for proper connection types, tightness, workmanship, as well as conformance to the approved design. Any exothermic bonds that are deemed unsatisfactory shall be repaired with new bonds. Any mechanical connections that are deemed unsatisfactory shall be repaired or replaced.

Site Inspection. The site shall be inspected and shown to be free of debris, and proof that excavations are backfilled and restored shall be provided.

Performance Testing. Following the completion of all acceptance testing and inspections, the installed site(s) shall be subjected to a minimum 20-day performance period. For the purpose of a successful performance period, failure of operation is defined as the failure of a major site component (i.e., HVAC systems, etc.). Degradation of performance is not a failure if function and proper operation is maintained. The performance verification shall be accomplished with the engineer or his designee present. Upon acceptance of the test criteria by the engineer, the 20-day performance period shall begin.

This requirement shall be accomplished during a period of time not to exceed 45 consecutive calendar days after equipment installation, testing, and inspection. If a successful performance period cannot be accomplished within 45 consecutive calendar days after the equipment testing and inspection, IDOT reserves the right to deem the Contractor in default and enforce the provisions set forth in the contract.

Method of Measurement. The communication shelter shall be measured for payment as each is furnished, installed, configured, warranted, made fully operational, and tested according to the specifications detailed herein, within the plan set, and/or in the Contract.

Basis of Payment. This work will be paid for at the contract unit price each for **COMMUNICATIONS SHELTER**, or the size specified, which shall be reimbursement in full for the work described herein.

MODIFICATION OF EXISTING CCTV DISTRIBUTION SYSTEM

June 1, 2009

Description.

General. The CCTV (Closed Circuit Television) Distribution System is a fully integrated IP multicast system, comprised of hardware and software, providing multi-point internet protocol based video images and control over Ethernet to multiple monitoring center locations while minimizing bandwidth demand upon the system. The system shall be configured to avoid a single point of failure that could totally shut down the system.

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The system shall be generally configured as indicated on the plans to collect video images and connect control from field mounted cameras at distribution node locations and to produce video images and controls at designated distribution nodes and at three monitoring locations under this contract work.

The three monitoring locations to be addressed by this contract under this item are:

- The ComCenter at the District 1 Headquarters in Schaumburg
- The Traffic Systems Center in Oak Park
- The ITS Project Office in Schaumburg

These monitoring locations and the collection node location (I55 Weigh Station) are depicted on the plans and are as defined under this Special Provision. The system shall have capability for additional locations under future work without the need to replace existing system equipment items.

The system shall utilize existing CCTV elements, and shall include all materials and equipment necessary to integrate the new cameras into the existing system. The work under this Special Provision includes the coordination with camera equipment provided under this contract and coordination with existing CCTV equipment as indicated, including adjustments of or supplements to the remote equipment as may be required

Gigabit Ethernet Switches. Gigabit Ethernet Switches shall be provided that satisfies the following:

Environmental	
Temperature:	0 to 40 °C (32 to 104 °F)
Humidity	10% to 90% (non-condensing)
Backplane	60 Gbps full duplex 4 Gbps uplinks
Port Density	48 minimum; expandable to 240 (96 at the ETP)
Physical Characteristics	
Weight (maximum)	100 pounds
Dimensions (nominal)	17.4" x 17.3" x 12.5"; the equipment shall mount in a standard EIA 19-inch rack and occupy no more than 10 standard rack units.
Power	120VAC±10%; redundant power supplies (The power supplies shall be removable while the equipment is operating with no degradation.)
Optical Interface	GBIC; single mode long haul, 1000BASE-ZX GBIC
Link Power Budget	Minimum of 23 dB with a range of 70 km.
Network Interface	
Physical Connector	RJ-45
Network Rates	10/100/1000 MHz Ethernet
Port Density:	240
Regulatory Compliance	
Safety	UL Listed; UL 60950
EMC	47 CFR (FCC) Part 15, Type A certification
Environmental	GR-63-Core Network Equipment Building Standards
Telecom	47 CFR (FCC) Part 68 compliance
Supported protocols	
Ethernet	IEEE 802.3; 10BaseT
Fast Ethernet	IEEE 802.3u; 100BaseTX
Gigabit Ethernet	IEEE 802.3z; IEEE 802.3x; and IEEE 802.3 ab
1000Base-X (GBIC)	1000Base-SX;1000Base-LX/LH;and 1000Base-ZX
Virtual LAN trunking/tagging	IEEE 802.1Q; IEEE 802.3ad
Spanning Tree Protocol	IEEE 802.1D; IEEE 902.1w; and IEEE 802.1s
Security	IEEE 802.1x

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The Gigabit Ethernet Switches shall be Cisco Model 4506 or interchangeable equal approved by the Engineer.

The Gigabit Ethernet Switches shall operate on the District's single-mode optical fibers, as detailed in this specification. The GBIC shall provide a minimal optical link budget of 23 dB. If in-line optical attenuators are required for short links, the cost of the attenuators shall be included in this item and not paid for separately.

The Contractor shall furnish adequate 100BaseT ports to satisfy the system requirements identified in the plans and special provisions. A standard manufacturer port count shall be utilized; a minimum of 8 unused ports or additional ports as indicated on the plans shall be provided, whichever is greater.

The Contractor shall furnish adequate licenses for each switch to use the RMON agent or the Border Gateway Protocol (BGP).

The Contractor shall fully integrate the Gigabit Ethernet Switches with the existing system as a part of this item and this coordination may require technical services of the existing system integrator, AT&T, a Cisco Systems integrator and will not be paid for separately.

Video Encoders and Decoders. Video encoders and decoders (codecs) shall be dedicated hardware devices, and except for differences between encoders and decoders they shall all of the same type from the same common manufacturer. The codec shall be a single video channel type to transfer "full motion" 30 frame-per-second high quality D1 color video at up to 20 Megabits per second. The units shall operate to produce a robust data communications stream that shall allow for both video and audio transmission and shall be immune to timing disruptions in the existing IP multi-cast system.

The units shall be rack-mountable, or single unit chassis for single unit installation complete with power supplies as required, operating from a 120-volt single phase AC power input. Units mounted in VCPs or other control building shall be rack mountable and include standard 19" racks with dual redundant power supplies.

Decoders shall have multi-stream format detection, and decode H.264, MPEG-4 and MJPEG streams.

Approvable codecs shall be compatible with and demonstrably interoperable with the standard codec product of at least one other vendor. Final approval of codec equipment shall be dependent upon a demonstration test of multi-vendor interoperability. Initial submittal information shall include documentation of this interoperability and a demonstration testing plan for approval by the Engineer.

The CODEC decoders shall be Optelecom-NKF series S-60 D-MC, or approved equal by the Engineer. The Approved equal shall be 100% interchangeable with the specified unit with respect to functionality and performance.

Materials shall be supplied to satisfy the following:

Video	Requirements
Video channels	1x PAL/NTSC (Auto/PAL/NTSC)
Output level	1 Vpp (±3 dB)
Compression algorithm s	H.264 BP (ISO/IEC 14496-10), MJPEG, MPEG-4 (ISO/IEC 14496-2, ISMA comp.)
Type of streaming	UDP/IP (multi- and/or unicast)
Decoding latency	TBD
Resolution	D1, ½D1, 2CIF, CIF, QCIF, VGA
GOP structure	I, IP
Frame rate	1 to 30 fps
On Screen Display (OSD)	3x Text lines (configurable: position, color, border/outline color, font size), 1x image in BMP, GIF, or JPEG format configurable: position, scaling)
Live View encoder (MJPEG)	HTTP, FTP pull
Connector type	BNC 75Ω (gold plated center pin)

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Transmission interface	Requirements
Number of interfaces	1
Interface 10/100Base-TX	Fast Ethernet Auto Negotiation, half-duplex/full-duplex, 10/100 Mb

SFP option	Empty SFP slot for 100 Mbps SFP device
Protocols	H.264 BP, MPEG-4 ES, (M)JPEG, RTP, RTCP, RTSP, TCP, UDP, IP, DHCP, IGMPv2,(S)NTP, MX/IP, HTTP, SNMP v2, FTP, TelNet, SAP, UPnP
Connector type	RJ45

Power	Requirements
Power consumption	<5W
Rack-mount units	MC 10 and MC11 power supply cabinets
Stand-alone units (/SA)	11 to 19 VDC (PSA-12 DC/25 or PSR-12 DC)

Management	Requirements
LED status indicators	
DC	Power-on indicator (green)
SYNC	All links are operational (green); failure in RX stream(s) (yellow); failure in TX stream(s) (red)
Ethernet port	Green LED: on=100 Mb, off=10 Mb; Amber LED: on=link okay, flashes with activity
Network Management & Control	SNMP v2, MX™, HTTP API, HTML (password protected)

Environmental	Requirements
Operating temperature	+14° F to +140° F (-10 °C to +60 °C)
Relative humidity	<95% as long as there is no condensation.
MTBF	TBD
Safety & EMC	TBD

Contact Closures	Requirements
Number of channels	2x in, 2x out
Number of streams	2x 3 (multi- and/or unicast)
Output	Fail-safe, potential-free
Connector type	RJ45

Data	Requirements
Number of channels	2 (full-duplex)
Number of streams	2x 3 (multi- and/or unicast)
Interfaces	1x RS232 1x RS422/485 (2- or 4-wire)
Stream	TCP/UDP/MX configurable
Data rate	300 b/s to 230.4 kb/s
Connector type	RJ45

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Audio	Requirement
Number of channels	2 (stereo, full-duplex)
Number of streams	3 (multi- and/or unicast)
Maximum bandwidth	20 Hz to 20 kHz
Sampling resolution	8/16-bits linear PCM or G.711
Input level	Adjustable, mic or line
Output level	Adjustable, 3 Vrms max.
Input impedance	>20 kΩ or 600Ω bal.
Output impedance	<100Ω bal.
Connector type	RJ45

The decoders shall be UL listed and be type-accepted to 47 CFR (FCC), Part 15, Type A.

The Codecs shall be the standard product of an established North American manufacturer. The manufacturer shall have been in business for a minimum of 7 years. The manufacturer shall provide a minimum of a twelve (12) month warranty from the date of installation. The manufacturer shall provide technical support via email, fax and telephone. The above forms of support shall be provided Monday through Friday, 8:00am to 5:00pm EST. The Manufacturer shall also have a repair facility within North America.

The units shall be 19-inch rack-mountable, complete with power supplies as required for the rack configurations indicated on the plans, operating from a 120-volt single phase AC power input

The codecs shall be fully capable of transmitting the PTZ commands of the CCTV camera manufacturer being furnished under this contract as well as existing Philips/Bosch, Pelco, Vicon and Cohu camera commands. Serial data will be transmitted over TCP-IP. Each serial port must support IP addressing with the ability to select the appropriate IP socket number. The codecs must provide the ability to establish an IP connection directly from a workstation to any encoder IP address and socket number to pass serial data. Transmission of serial data must be independent of the video stream. Any serial data conversion required by the codec to communicate to the camera shall be included in this pay item and shall not be paid for separately.

The Encoder/Decoder serial data port must support Multicast data to broadcast a single serial data input to multiple remote encoder serial data port recipient. Bi-directional data must be supported on the codecs.

A demonstration of this low speed serial data transfer shall be required before material submittal approval is given. See submittal requirements in this Special Provision.

Codec operation and management.

Each unit must support a local console accessible using one of the serial interfaces to provide access to all configuration menus of the product including the initial IP address configuration as well as for troubleshooting purposes. The interface must be menu driven for novice users.

All units (encoders and decoders) must support SNMPv2 management protocol to provide the ability to control and monitor all configuration parameters and diagnostics from any 3rd party SNMP management application.

The Encoders/Decoders must support firmware updates from a central site. Updates must be downloadable to a single unit or by bulk via a single command from a firmware utility application via the Ethernet network. The firmware utility application must provide confirmation of the successful and unsuccessful updates. Upon completing of the update, the units must resume to original configuration without the need to reload the unit configuration.

Device Drivers. Device drivers shall be provided to communicate with any device via direct serial cable connection, IP, or modem pool. Multiple device drivers shall be able to share all or a portion of a modem pool. Each device driver shall be unique to the type of equipment it controls. The addition of a new device driver shall require no modification to the client or server application. Device drivers shall run anywhere on the network, not necessarily located where the server is installed. Device drivers shall have the capability of running as a Windows Service or as an executable.

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| The software shall operate with the existing CCTV cameras and the CCTV cameras installed under this contract.

Method of Measurement. The modification of existing video distribution system shall be measured for payment as lump sum when furnished, installed, configured, warranted, made fully operational, and tested as detailed herein.

Basis Of Payment. This work will be paid for at the contract lump sum price for **MODIFICATION OF EXISTING VIDEO DISTRIBUTION SYSTEM** which shall be for the work as specified herein.

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FIBER OPTIC CABLE INNERDUCT

Effective: April 1, 2005

1. Description.

This item shall consist of furnishing, installing, splicing, connecting and demonstrating continuity of fiber optic cable innerduct of sizes specified herein and as shown on the contract drawings. The innerduct shall be High Density Polyethylene.

3. Materials.

3.1 General:

The duct shall be a plastic duct which is intended for underground use and which can be manufactured and coiled or reeled in continuous transportable lengths and uncoiled for further processing and/or installation without adversely affecting its properties of performance.

The duct shall be made of high density polyethylene which shall meet the requirements of ASTM D 3035. The innerduct material shall be composed of high density polyethylene meeting the requirements of PE334470E/C as defined in ASTM D3350.

Submittal information shall demonstrate compliance with the details of these requirements.

3.2 Dimensions:

Duct dimensions shall conform to the standards listed in ASTM D3035, SDR-11. Submittal information shall demonstrate compliance with these requirements.

Nominal Size (Diameter)	Inside Diameter (minimum)	Outside Diameter (Average)	Wall Thickness (Min.)	Bend Radius (minimum)	Pull Strength	Weight Average (lbs/100ft.)
1"	1.030"	1.315"	0.120"	14"	500	19
1.25"	1.313"	1.660"	0.151"	17"	750	31
1.5"	1.506"	1.900"	0.173"	19"	1000	40
2"	1.885"	2.375"	0.216"	24"	1600	60

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For runs terminating at junction boxes and/or control cabinets, the vertical measurement shall be taken from the bottom of the trench, or horizontal raceway, to a point 18-inches beyond the center of the junction box or control cabinet.

For runs terminating at poles, the vertical measure shall be taken from the bottom of the trench, or horizontal raceway, to a point 18-inch beyond the center of the light pole handhole regardless of light pole mounting method

Innerduct installed in excess of the limits describes herein shall not be paid for.

8. Basis of Payment.

This item will be paid for at the contract unit price per foot for **INNERDUCT**, of the size of duct as indicated, which shall be payment in full for all material and work as specified herein.

FIBER OPTIC CABLE, SINGLE MODE

Effective: June 1, 2009

Description. The Contractor shall furnish and install loose-tube, single-mode, fiber optic cable of the number of fibers specified as shown in the plans and as directed by the Engineer.

Other ancillary components, required to complete the fiber optic cable plant, including but not limited to, moisture and water sealants, cable caps, fan-out kits, etc., shall be included in the cost of fiber optic cable and will not be paid for separately.

Materials The single-mode, fiber optic cable shall incorporate a loose, buffer-tube design. The cable shall be an accepted product of the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 and meet the requirements of ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-1999 for a single sheathed, non-armored cable, and shall be new, unused and of current design and manufacture.

Fibers.

The cables shall use dispersion unshifted fibers. The optical and physical characteristics of the un-cabled fibers shall include:

The single-mode fiber shall meet EIA/TIA-492CAAA, "Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers," and ITU recommendation G.652.D, "Characteristics of a single-mode optical fiber cable."

Physical Construction		
Requirement	Units	Value
Cladding Diameter	(μm)	125.0 \pm 0.7
Core-to-Cladding Concentricity	(μm)	\leq 0.5
Cladding Non-Circularity		\leq 0.7 %

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Mode Field Diameter	1310 nm	(μm)	9.2 ± 0.4
	1550 nm		10.4 ± 0.5
Coating Diameter		(μm)	245 ± 5
Colored Fiber Nominal Diameter		(μm)	253 - 259
Fiber Curl radius of curvature		(m)	> 4.0 m

Optical Characteristics			
Requirement		Units	Value
Cabled Fiber Attenuation	1310 nm	(dB/km)	≤ 0.4
	1550 nm		≤ 0.3
Point discontinuity	1310 nm	(dB)	≤ 0.1
	1550 nm		≤ 0.1
Macrobend Attenuation	Turns	Mandrel OD	
	1	32 ± 2 mm	< 0.05 at 1550 nm
	100	50 ± 2 mm	< 0.05 at 1310 nm
	100	50 ± 2 mm	< 0.10 at 1550 nm
	100	60 ± 2 mm	< 0.05 at 1550 nm
	100	60 ± 2 mm	< 0.05 at 1625 nm
Cable Cutoff Wavelength (λ_{cct})		(nm)	< 1260
Zero Dispersion Wavelength (λ_0)		(nm)	1302 ≤ λ_0 ≤ 1322
Zero Dispersion Slope (S_0)		(ps/(nm ² •km))	≤ 0.089
Total Dispersion	1550 nm	(ps/(nm•km))	≤ 3.5
	1285-1330 nm		≤ 17.5
	1625 nm		≤ 21.5
Cabled Polarization Mode Dispersion		(ps/km ²)	≤ 0.2
IEEE 802.3 GbE - 1300 nm Laser Distance		(m)	up to 5000
Water Peak Attenuation: 1383 ± 3 nm		(dB/km)	≤ 0.4

Cable Construction.

The number of fibers in each cable shall be as specified on the plans.

Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm. Each buffer tube shall contain up to 12 fibers. The fibers shall not adhere to the inside of the buffer tube.

Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." The fibers shall be colored with ultraviolet (UV) curable inks.

Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

For cables containing more than 12 buffer tubes, standard colors are used for tubes 1 through 12 and stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.

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In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and shall not be subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.

Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm or 3.0 mm in outer diameter.

The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod (optional steel central member). The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be overcoated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

Each buffer tube shall contain a water-swallowable yarn for water-blocking protection. The water-swallowable yarn shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn will preclude the need for other water-blocking material; the buffer-tube shall be gel-free. The optical fibers shall not require cleaning before placement into a splice tray or fan-out kit.

Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process.

Water swallowable yarn(s) shall be applied longitudinally along the central member during stranding.

Two polyester yarn binders shall be applied contrahelically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

For single layer cables, a water swallowable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swallowable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swallowable tape shall be applied longitudinally over both the inner and outer layer. The water swallowable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

The cables shall contain one ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by the central member, and additional dielectric yarns as required.

The dielectric yarns shall be helically stranded evenly around the cable core.

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The cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members (as required) and water swellable tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

The jacket or sheath shall be free of holes, splits, and blisters.

The cable jacket shall contain no metal elements and shall be of a consistent thickness.

Cable jackets shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESEC), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more co-extruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

The maximum pulling tension shall be 2700 N (608 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be -30°C to +70°C.

General Cable Performance Specifications

The fiber optic cable manufacturer shall provide documentation and certify that the fiber optic cable complies with the following EIA-455-~~xxx~~ Fiber Optic Test Procedures (FOTP):

When tested in accordance with FOTP-3, "*Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components*," the change in attenuation at extreme operational temperatures (-40°C and +70°C) shall not exceed 0.15 dB/km at 1550 nm for single-mode fiber and 0.3 dB/km at 1300 nm for multimode fiber.

When tested in accordance with FOTP-82, "*Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable*," a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

When tested in accordance with FOTP-81, "*Compound Flow (Drip) Test for Filled Fiber Optic Cable*," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 70°C.

When tested in accordance with FOTP-41, "*Compressive Loading Resistance of Fiber Optic Cables*," the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load

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shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fibers and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-104, "*Fiber Optic Cable Cyclic Flexing Test*," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-25, "*Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies*," except that the number of cycles shall be two at three locations along a one meter cable length and the impact energy shall be at least 4.4 Nm (in accordance with ICEA S-87-640)", the change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-33, "*Fiber Optic Cable Tensile Loading and Bending Test*," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670N (601 lbf) and residual load of 30% of the rated installation load. The axial fiber strain shall be $\leq 60\%$ of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load. The axial fiber strain shall be $\leq 20\%$ of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.15 dB at 1550 nm for single mode fiber and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-85, "*Fiber Optic Cable Twist Test*," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber and 0.30 dB at 1300 nm for multimode fiber.

When tested in accordance with FOTP-37, "*Low or High Temperature Bend Test for Fiber Optic Cable*," the cable shall withstand four full turns around a mandrel of ≤ 20 times the cable diameter after conditioning for four hours at test temperatures of -30°C and $+60^{\circ}\text{C}$. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or other openings. The change in attenuation shall not exceed 0.30 dB at 1550 nm for single mode fiber and 0.50 dB at 1300 nm for multimode fiber.

Quality Assurance Provision

All cabled optical fibers > 1000 meters in length shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel. The cable manufacturer shall be TL 9000 registered.

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Packaging

Top and bottom ends of the cable shall be available for testing. Both ends of the cable shall be sealed to prevent the ingress of moisture. Each reel shall have a weather resistant reel tag attached identifying the reel and cable. The reel tag shall include the following information:

- Cable Number
- Gross Weight
- Shipped Cable Length in Meters
- Job Order Number
- Product Number
- Customer Order Number
- Date Cable was Tested
- Manufacturer Order Number
- Cable Length Markings
 - a: Top (inside end of cable)
 - b: Bottom (outside end of cable)

The reel (one flange) marking shall include:

- Manufacturer
- Country of origin
- An arrow indicating proper direction of roll when handling
- Fork lift-handling illustration
- Handling Warnings.

Each cable shall be accompanied by a cable data sheet. The cable data sheet shall include the following information:

- Manufacturer Cable Number
- Manufacturer Product Number
- Manufacturer Factory Order Number
- Customer Name
- Customer Cable Number
- Customer Purchase Order Number
- Mark for Information
- Ordered Length
- Maximum Billable Length
- Actual Shipped Length
- Measured Attenuation of Each Fiber

The cable shall be capable of withstanding a minimum-bending radius of 20 times its outer diameter during installation and 10 times its outer diameter during operation without changing the characteristics of the optical fibers.

The cable shall meet all of specified requirements under the following conditions:

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- Shipping/storage temperature: -58° F to +158° F (-50° C to +70° C)
- Installation temperature: -22° F to +158° F (-30° C to +70° C)
- Operating temperature: -40° F to +158° F (-40° C to +70° C)
- Relative humidity from 0% to 95%, non-condensing

Optical Patch Cords and Pigtails.

The optical patch cords and pigtails shall comply with the following:

- The optical patch cords shall consist of a section of single fiber, jacketed cable equipped with optical connectors at both ends.
- The factory installed connector furnished as part of the optical patch cords and pigtails shall meet or exceed the requirements for approved connectors specified herein.
- The fiber portion of each patch cord and pigtail shall be a single, jacketed fiber with optical properties identical to the optical cable furnished under this contract.
- The twelve fiber single-mode fiber optic cable shall be installed as a pigtail with factory installed ST compatible connectors.
- The patch cords shall comply with Telcordia GR-326-CORE

Connectors.

The optical connectors shall comply with the following:

- All connectors shall be factory installed ST compatible connectors. Field installed connectors shall not be allowed.
- Maximum attenuation 0.4dB, typical 0.2dB.
- No more than 0.2dB increase in attenuation after 1000 insertions.
- Attenuation of all connectors will be checked and recorded at the time of installation with an insertion test minimum 5 times checked with an OTDR.
- All fibers shall be connectorized at each end.
- All fibers shall terminate at a fiber patch panel
- Unused fibers will be protected with a plastic cap to eliminate dust and moisture.
- Termination shall be facilitated by splicing factory OEM pigtails on the end of the bare fiber utilizing the fusion splicing method. Pigtails shall be one meter in length.

CONSTRUCTION REQUIREMENTS

Experience Requirements.

Personnel involved in the installation, splicing and testing of the fiber optic cables shall meet the following requirements:

- A minimum of three (3) years experience in the installation of fiber optic cables, including fusion splicing, terminating and testing single mode fibers.

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- Install two systems where fiber optic cables are outdoors in conduit and where the systems have been in continuous satisfactory operation for at least two years. The Contractor shall submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the installed fiber optic systems.
- One fiber optic cable system (which may be one of the two in the preceding paragraph), which the Contractor can arrange for demonstration to the Department representatives and the Engineer.

Installers shall be familiar with the cable manufacturer's recommended procedures for installing the cable. This shall include knowledge of splicing procedures for the fusion splicer being used on this project and knowledge of all hardware such as breakout (furcation) kits and splice closures. The Contractor shall submit documented procedures to the Engineer for approval and to be used by Construction inspectors.

Personnel involved in testing shall have been trained by the manufacturer of the fiber optic cable test equipment to be used, in fiber optic cable testing procedures. Proof of this training shall be submitted to the Engineer for approval. In addition, the Contractor shall submit documentation of the testing procedures and a copy of the test equipment operation manual for approval by the Engineer.

Installation in Raceways.

The Contractor shall provide a cable-pulling plan, identifying where the cable will enter the underground system and the direction of pull. This plan will address locations where the cable is pulled out of a handhole, coiled in a figure eight, and pulled back into the hand hole. The plan shall address the physical protection of the cable during installation and during periods of downtime. The cable-pulling plan shall be provided to the Engineer for approval a minimum of 15 working days prior to the start of installation. The Engineer's approval shall be for the operation on the freeway and does not include an endorsement of the proposed procedures. The Contractor is responsible for the technical adequacy of the proposed procedures.

During cable pulling operations, the Contractor shall ensure that the minimum bending of the cable is maintained during the unreeling and pulling operations. Entry guide chutes shall be used to guide the cable into the handhole conduit ports. Lubricating compound shall be used to minimize friction. Corner rollers (wheels), if used, shall not have radii less than the minimum installation-bending radius of the cable. A series array of smaller wheels can be used for accomplishing the bend if the cable manufacturers specifically approve the array.

The pulling tension shall be continuously measured and shall not be allowed to exceed the maximum tension specified by the manufacturer of the cable. Fuse links and breaks can be used to ensure that the cable tensile strength is not exceeded. The pulling system shall have an audible alarm that sounds whenever a pre-selected tension level is reached. Tension levels shall be recorded continuously and shall be given to the Engineer.

The cable shall be pulled into the conduit as a single component, absorbing the pulling force in all tension elements. The central strength member and Aramid yarn shall be attached directly to the pulling eye during cable pulling. "Basket grip" or "Chinese-finger type" attachments, which

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only attach to the cable's outer jacket, shall not be permitted. A breakaway swivel, rated at 95% of the cable manufacturer's approved maximum tensile loading, shall be used on all pulls. When simultaneously pulling fiber optic cable with other cables, separate grooved rollers shall be used for each cable.

To minimize the exposure of the backbone cable and to facilitate the longer lengths of fiber optic cable, the Contractor shall use a "blown cable" (pneumatically assisted) technique to place the fiber optic cable.

Where cable is to be pulled through existing conduit which contains existing cables, optical or other, the existing cables shall be removed and reinstalled with the fiber optic cable as indicated on the plans. The removal of the cable(s) shall be paid for separately. Reinstallation of the existing cables, if indicated on the plans, along with the fiber optic cable shall be included in this item for payment.

Construction Documentation Requirements

Installation Practices for Outdoor Fiber Optic Cable Systems

The Contractor shall examine the proposed cable plant design. At least one month prior to starting installation of the fiber optic cable plant, the Contractor shall prepare and submit to the Engineer for review and approval, ten (10) copies of the Contractor's "Installation Practices for Outdoor Fiber Optic Cable Systems" manual. This manual shall address the Contractor's proposed practices covering all aspects of the fiber optic cable plant. This submittal shall include all proposed procedures, list of installation equipment, and splicing and test equipment. Test and quality control procedures shall be detailed as well as procedures for corrective action.

Operation and Maintenance Documentation

After the fiber optic cable plant has been installed, ten (10) complete sets of Operation and Maintenance Documentation shall be provided. The documentation shall, as a minimum, include the following:

- Complete and accurate as-built diagrams showing the entire fiber optic cable plant including locations of all splices.
- Final copies of all approved test procedures
- Complete performance data of the cable plant showing the losses at each splice location and each terminal connector.
- Complete parts list including names of vendors.

Testing Requirements

The Contractor shall submit detailed test procedures for approval by the Engineer. All fibers (terminated and unterminated) shall be tested bi-directionally at both 1310 nm and 1550 nm with both an Optical Time Domain Reflectometer (OTDR) and a power meter with an optical source. For testing, intermediate breakout fibers may be concatenated and tested end-to-end. Any discrepancies between the measured results and these specifications will be resolved to the satisfaction of the Engineer. Unterminated (non-connectorized) fibers shall be tested with an approved bare fiber adapter.

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The Contractor shall provide the date, time and location of any tests required by this specification to the Engineer at least 5 days before performing the test. Upon completion of the cable installation, splicing, and termination, the Contractor shall test all fibers for continuity, events above 0.1 dB, and total attenuation of the cable. The test procedure shall be as follows:

A Certified Technician utilizing an Optical Time Domain Reflectometer (OTDR) and Optical Source/Power Meter shall conduct the installation test. The Technician is directed to conduct the test using the standard operating procedures defined by the manufacturer of the test equipment. All fibers installed shall be tested in both directions.

A fiber ring or fiber box shall be used to connect the OTDR to the fiber optic cable under test at both the launch and receive ends. The tests shall be conducted at 1310 and 1550 nm for all fibers.

At the completion of the test, the Contractor shall provide two copies of documentation of the test results to the Project Engineer. The test documentation shall be submitted as both a bound copy and a CDROM and shall include the following:

Cable & Fiber Identification:

- Cable ID
- Cable Location - beginning and end point
- Fiber ID, including tube and fiber color
- Wavelength
- Pulse width (OTDR)
- Refractory index (OTDR)
- Operator Name
- Date & Time
- Setup Parameters
- Range (OTDR)
- Scale (OTDR)
- Setup Option chosen to pass OTDR "dead zone"

Test Results shall include:

- OTDR Test results
- Total Fiber Trace
- Splice Loss/Gain
- Events > 0.10 dB
- Measured Length (Cable Marking)
- Total Length (OTDR)
- Optical Source/Power Meter Total Attenuation (dB/km)

Sample Power Meter Tabulation:

Power Meter Measurements (dB)									
Location		Fiber No.	Cable Length (km)	A to B		B to A		Bidirectional Average	
A	B			1310 nm	1550 nm	1310 nm	1550 nm	1310 nm	1550 nm
		1							
		2							
Maximum Loss									
Minimum Loss									

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The OTDR test results file format must be Bellcore/Telcordia compliant according to GR-196-CORE Issue 2, OTDR Data Standard, GR 196, Revision 1.0, GR 196, Revision 1.1, GR 196, Revision 2.0 (SR-4731) in a “.SOR” file format. These results shall also be provided in tabular form, see sample below:

Sample OTDR Summary					
Cable Designation:	<i>TCF-1K-03</i>	OTDR Location:	<i>Pump Sta. 67</i>	Date:	<i>1/1/00</i>
Fiber Number	Event Type	Event Location	Event Loss (dB)		
			1310 nm	1550 nm	
<i>1</i>	<i>Splice</i>	<i>23500 Ft.</i>	<i>.082</i>	<i>.078</i>	
<i>1</i>	<i>Splice</i>	<i>29000 Ft.</i>	<i>.075</i>	<i>.063</i>	
<i>2</i>	<i>Splice</i>	<i>29000 Ft.</i>	<i>.091</i>	<i>.082</i>	
<i>3</i>	<i>Splice</i>	<i>26000 Ft.</i>	<i>.072</i>	<i>.061</i>	
<i>3</i>	<i>Bend</i>	<i>27000 Ft.</i>	<i>.010</i>	<i>.009</i>	

The following shall be the criteria for the acceptance of the cable:

The test results shall show that the dB/km loss does not exceed +3% of the factory test or 1% of the cable's published production loss. However, no event shall exceed 0.10 dB. If any event is detected above 0.10 dB, the Contractor shall replace or repair the fiber including that event point.

The total loss of the cable (dB), less events, shall not exceed the manufacturer's production specifications as follows: 0.5 dB/km at both 1310 and 1550 nm.

If the total loss exceeds these specifications, the Contractor shall replace or repair that cable run at the no additional cost to the state, both labor and materials. Elevated attenuation due to exceeding the pulling tension during installation shall require the replacement of the cable run at no additional cost to the State, including labor and materials.

Splicing Requirements

Splices shall be made at locations shown on the Plans. Any other splices shall be permitted only with the approval of the Engineer. Splices will be paid for separately.

Slack Storage of Fiber Optic Cables.

Included as a part of this item, slack fiber shall be supplied as necessary to allow splicing the fiber optic cables in a controlled environment, such as a splicing van or tent. After splicing has been completed, the slack fiber shall be stored underground in handholes or in the raised base adapters of ground mounted cabinets in accordance with the fiber optic cable manufacturer's guidelines. Fiber optic cable slack shall be 100 feet for each cable at each splice location, above or below ground. Fiber optic cable slack shall be 50 feet for each cable at access points, above or below ground, where splicing is not involved. This slack shall be measured for payment.

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Fiber optic cable shall be tagged inside handholes with yellow tape containing the text: "CAUTION - FIBER OPTIC CABLE." In addition, permanent tags, as approved by the engineer, shall be attached to all cable in a hand hole or other break-out environment. These tags shall be stainless steel, nominally 0.75" by 1.72", and permanently embossed. These tags shall be attached with stainless steel straps, and shall identify the cable number, the number of fibers, and the specific fiber count. Tags and straps shall be Panduit or approved equal.

Label the destination of each trunk cable onto the cable in each handhole, vault or cable termination panel.

Method of Measurement Fiber optic cable will be measured for payment in feet in place installed and tested. Fiber optic cable will be measured horizontally and vertically between the changes in direction, including slack cable. The entire lengths of cables installed in buildings will be measured for payment

Basis of Payment This work will be paid for at the contract unit price per foot for **FIBER OPTIC CABLE** of the type, size, and number of fibers specified. Payment shall not be made until the cable is installed, spliced and tested in compliance with these special provisions.

FIBER OPTIC SPLICE

Effective: April 1, 2005

Description. The Contractor will splice optical fibers from different cable sheaths and protect them with a splice closure at the locations shown on the Plans. Fiber splicing consists of in-line fusion splices for all fibers described in the cable plan at the particular location.

Two splices are identified. A mainline splice includes all fibers in the cable sheath. In a lateral splice, the buffer tubes in the mainline cable are dressed out and those fibers identified on the plans are accessed in and spliced to lateral cables.

Materials.

Splice Closures. Splice Closures shall be designed for use under the most severe conditions such as moisture, vibration, impact, cable stress and flex temperature extremes as demonstrated by successfully passing the factory test procedures and minimum specifications listed below:

Physical Requirements. The closures shall provide ingress for up to four cables in a butt configuration. The closure shall prevent the intrusion of water without the use of encapsulates.

The closure shall be capable of accommodating splice organizer trays that accept mechanical, or fusion splices. The splice closure shall have provisions for storing fiber splices in an orderly manner, mountings for splice organizer assemblies, and space for excess or un-spliced fiber. Splice organizers shall be re-enterable. The splice case shall be UL rated.

Closure re-entry and subsequent reassembly shall not require specialized tools or equipment. Further, these operations shall not require the use of additional parts.

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INSTALLATION OF CCTV CAMERA STRUCTURE

Effective: June 1, 2009

Description.

This work shall consist of all work necessary to install a CCTV camera structure, as required for the type of pole selected by the contractor in accordance with the pole parameters indicated by the contract and in conformance with AASHTO requirements and loading as specified. The work is expected to include excavation in both soil and rock, at times at the same location, the structure manufacturer design shall take this into consideration, and respective units are to be measured accordingly.

Materials. Materials shall be according to the following.

Item	Article/Section	
(a)	Portland Cement Concrete, Class SI	1020
(b)	Light Tower Anchor Rod Assembly	1070.03
(c)	Fine Aggregate	1003.04
(d)	Reinforcement Bars	1006.10(a)

General

The manufacturer of the CCTV Camera Structure shall be responsible for the design of the anchoring provisions in accordance with AASHTO requirements for loading, including the associated wireless equipment at the top of the structure. The design shall be fully coordinated with the Structure. The design shall be stamped and sealed by a Licensed Engineer in the State of Illinois and the manufacturer shall provide a signed certification to the Department that the Structures have been installed properly.

The design shall be based on soil conditions occurring throughout the project. Soil boring logs from recent Department expressway mainline reconstruction projects are available for examination at the Department's District One Headquarters Electrical Design Section office by appointment with 48 hour notice. The contractor may, with permission of the Engineer, obtain additional complete or selective soil borings, at the contractor's discretion and expense at the various sites. The design engineer shall attest to the safety factor applied in the design. The design documents submitted shall include, for each location, design and maximum depths for the expected ground type based on borings (allowing for differing soil at different sites) and with 25% incremental combinations and permutations of the two ground types.

Design shall include consideration of raceways for cable entry and their orientation, and each location shall be coordinated such that camera lowering device support arms shall place the camera at the optimum position for unobstructed viewing along the expressway mainline (generally with the arm perpendicular to the centerline of the mainline.) In addition, the design shall provide for the positioning of any handholes such that when facing the handhole, one is also generally facing the nearest oncoming traffic.

Added 06/03/2009

The contractor shall provide a complete submittal of the proposed installation, complete with all associated appurtenances and installation procedures as recommended by the Manufacturer, for approval by the Engineer.

The contractor shall be responsible for all materials, labor and equipment necessary to provide the installation of each /structure plumb and without damage in accordance with the approved design and in accordance with the recommendations of the vendor.

The contractor shall be responsible for marking and staking the proposed location and establishing camera arm and handhole orientations for verification and approval by the Engineer, and such approval shall be obtained before any excavation or other installation work proceeds. This shall be documented in an organized table and included in project documentation.

Where a portion of the foundation is to be installed in rock, rock excavation shall be in accordance with the Standard Specifications except payment is included in this item and shall not be made separately, with the distance appropriately measured for the portion within rock. As excavation is done and rock is encountered, the Engineer shall be notified and shall determine the appropriate depths and measurement distances for the application of the appropriate pay item. In no case shall a foundation be poured or a structure be installed without the Engineer first confirming and documenting the appropriate ground types, distances and overall depth

Special Requirements For Steel Poles/Supports/Structures

Steel structures shall be installed upon steel-reinforced concrete foundations poured in place, complete with anchor rods, raceways, grounding and all associated hardware. Anchor rods and all hardware shall be as recommended by the structure manufacturer and shall otherwise be in accordance with these Special Provisions, the Standard Specifications and shall be completely hot-dip galvanized steel. Raceways shall be Schedule 40 PVC, a minimum of 2½" in diameter, and not less than three per foundation, extending not less than 2 inches above the top of the concrete foundation. After cable installation, raceways shall be sealed with approved duct seal. Poles/supports/structures shall be supported with the base plate above the top of the concrete foundation, double-nutted with suitable nuts and washers and with an expanded metal stainless steel screen around the base, secured with a stainless steel band. The anchor rods shall be installed and coordinated such that there is a 1-inch anchor rod projection remaining after all nuts and washers are installed. Failure to conform to this requirement will require the non-conforming foundation to be demolished, to the satisfaction of the Engineer, and a new foundation installed at no additional cost to the Department. No payment will be made for non-conforming foundations.

Grounding shall include a 5/8-inch copper-clad steel ground rod, 10 feet in length not less than 10 feet from the outer edge of the foundation, driven with the top 24 inches below grade, and connected to the reinforcing cage with a No 2 stranded copper wire with an approved ground clamp and to the rod with an exothermic weld. The top of the rod shall be made accessible in a polymer-concrete access well with a bolted cover.

Added 06/03/2009

The anchor rod assembly may be factory fabricated with the reinforcing cage or it may be field assembled. The cage shall be hand tied, tack welding will be not be allowed. Anchor rods shall sufficiently overlap with the reinforcing cage to develop full holding strength. Anchor rods that extend the full length of the cage or foundation shall not be used unless approved by the Engineer.

The top portion of the foundation shall be formed to a depth not less than 18 inches below grade. The reinforcing cage, anchor rods and raceways shall be accurately held in place by the form or by other means and the anchor rods shall be held plumb during concrete placement and cure.

Excavation shall include any dewatering that is necessary, and unless concrete is poured the same day as excavation, the foundation hole shall be marked and covered to the satisfaction of the Engineer, with a minimum time allowed until concrete is subsequently poured.

Concrete shall develop the specified strength, as approved by the Engineer, before the structures are installed.

Special Requirements For Concrete Structures

The concrete structure manufacturer shall provide a pole embedment detail based on the soil conditions of the project. In general the minimum auger size for the embedment hole shall be 8 to 10" greater in diameter than pole butt, but may differ based on manufacturer recommendations. Backfill shall be as recommended by the manufacturer and approved by the Bureau of Materials.

Nylon slings shall be used to position and install the poles. Backfill shall be placed tamping every 4", with the poles checked for plumbness using a plumb bob or other method approved by the Engineer.

Excavation shall include any dewatering that is necessary, and the structure shall be set the same day as excavation.

Method of Measurement

This work shall be measured for payment in linear feet of anchoring, as excavated below grade, of the ground type encountered in various segments of each excavation, rounded to the nearest foot or fraction thereof for fractions greater than 0.25 foot. A single installation may involve the use of both ground types (soil and rock).

Basis of Payment

This work will be paid for at the contract unit price per foot for **INSTALLATION OF CCTV-CAMERA STRUCTURE** of the type of ground (soil or rock) encountered and measured for payment as specified.

Added 06/03/2009