

Project Completion Report



Project No. SLI-001-016
December 2003



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Electrical System Modifications Phase II

PLANT ENGINEERING DIVISION
ENGINEERING & CONSTRUCTION SERVICES

BROOKHAVEN NATIONAL LABORATORY BROOKHAVEN SCIENCE ASSOCIATES

(09/2004)

Brookhaven National Laboratory
U.S. Department of Energy

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APPENDIX A – PHOTOGRAPHS

1. PLANNED BABBO CHART @ \$6,770K

 managed by Brookhaven Science Associates for the U.S. Department of Energy	PROJECT COMPLETION DOCUMENTATION	DECEMBER 2003
	ELECTRICAL SYSTEM MODIFICATIONS PHASE II PROJECT SLI-001-016	

WBS ITEM	\$	FY 2001				FY 2002				FY 2003															
		1 st Q	2 nd Q	3 rd Q	4 th Q	1 st Q	2 nd Q	3 rd Q	4 th Q	1 st Q	2 nd Q	3 rd Q	4 th Q												
		O	N	D	J	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
1.1 PROJECT SUPPORT	\$ 924																								
1.1.1 PROJECT MANAGEMENT	188			60/60					68/68																60/60
1.1.2 PROJECT ENGINEERING	601			405/300					156/240																40/61
1.1.3 QUALITY ASSURANCE	135			50/50					50/50																35/35
1.2 GENERAL CONSTRUCTION	\$5,074								1422/1422																
1.2.1 SUBSTATION (CP-1)	1,422																								
1.2.2 FEEDER TO BLDG. 901 (CP-1)	845																								845/845
1.2.3 FEEDER REPLACEMENT (CP-1)	990																								990/990
1.2.4 FEEDER TO AGS (CP-1)	913								804/320																109/593
1.3 480V SWITCHGEAR REFURB	\$904								500/200																404/704
CONTINGENCY	\$772			40/40					300/200																432/532
TOTAL BABBO	\$6,770			555/450					3300/2500																2915/3820

Based on CD-2 baseline.

2. **PLANNED BABBO CHART @ \$6,734K – BCP**

 <p>managed by Brookhaven Science Associates for the U.S. Department of Energy</p>	<p>FY 2001 SLI PROJECT COMPLETION DOCUMENTATION</p> <p>ELECTRICAL SYSTEM MODIFICATIONS PHASE II PROJECT SLI-001-016</p>	<p>DECEMBER 2003</p>
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WBS ITEM	FY 2001	FY 2002				FY 2003							
		1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q				
		O N D	J F M	A M J	J J A	O N D	J F M	A M J	J J A				
1.1 PROJECT SUPPORT	\$ 947												
1.1.1 PROJECT MANAGEMENT	207	100/75				57/50				50/82			
1.1.2 PROJECT ENGINEERING	610	435/262				120/160				55/188			
1.1.3 QUALITY ASSURANCE	130	20/20				90/90				20/20			
1.2 GENERAL CONSTRUCTION (CP-1)	\$5,096												
1.2.1 SUBSTATION (CP-1)	885					579/550				306/335			
1.2.2 FEEDER TO BLDG. 901 (CP-1)	1,004					800/700				204/304			
1.2.3 FEEDER REPLACEMENT (CP-1)	427									427/427			
1.2.4 FEEDER TO AGS (CP-1)	954					554/450				400/504			
1.3 FEEDERS/SWITCHES (CP-2)	\$600									600/600			
1.4 480V SWITCHGEAR REFURB	\$1,226					800/560				426/666			
CONTINGENCY	\$691									391/391			
TOTAL BABBO	\$6,734												
		555/357				3300/2860				2879/3517			

3. ACTUAL BABO CHART @ \$6,734K

 managed by Brookhaven Science Associates for the U.S. Department of Energy	FY 2001 SLI PROJECT COMPLETION DOCUMENTATION		DECEMBER 2003
	ELECTRICAL SYSTEM MODIFICATIONS PHASE II PROJECT SLI-001-016		

WBS ITEM	FY 2001	FY 2002				FY 2003				FY 2004															
		1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q												
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
1.1 PROJECT SUPPORT	\$1,404																								
1.1.1 PROJECT MANAGEMENT	678																								
		120/75				257/250				301/348				0/5											
		330/308				220/160				461/28															
1.1.2 PROJECT ENGINEERING	596																								
		20/20				90/90				20/20															
1.1.3 QUALITY ASSURANCE	130																								
1.2 GENERAL CONSTRUCTION (CP-1)	\$5,330																								
1.2.1 SUBSTATION (CP-1)	925																								
						579/550				346/375															
1.2.2 FEEDER TO BLDG. 901 (CP-1)	1,044																								
						800/750				244/294															
1.2.3 FEEDER REPLACEMENT (CP-1)	467																								
										467/467															
1.2.4 FEEDER TO AGS (CP-1)	994																								
						554/505				440/489															
1.3 FEEDERS/SWITCHES (CP-2)	\$630																								
										630/630															
1.4 480V SWITCHGEAR REFURB	\$1,270																								
						796/761				474/509															
CONTINGENCY	\$0																								
TOTAL BABO	\$6,734																								
		470/403				3296/3066				2968/3260				0/5											

4. SUMMARY OF FUNDING CHANGES

The original project Total Estimated Cost (TEC) was approved at \$6,770K. Funding was reduced in fiscal 2003 by \$36K for an actual TEC of \$6734K.

In addition to the original scope, extra work was performed as authorized by Baseline Change Proposal (BCP) in September 2002.

5. SUMMARY OF SCOPE CHANGES

The additional work consisted of installing 4 – 5kV sectionalizing switches, removing 11 underground link boxes and oil switches, replacing 5300ft. of damaged cable and refurbishing Substation 51. This work was completed within the original schedule and without an increase in the TEC. Successful planning for temporary power and value engineering applications resulted in the savings invested in the additional work approved by the baseline change.

6. CONTINGENCY FUNDS

Contingency funds were used on change orders resulting from unforeseen field conditions and extensive weekend outages required to support user community power requirements. No further contingency funds remain.

7. PHOTOGRAPHS

Photographs of the project have been taken and are attached as part of this report: (See Appendix A)

Photograph 1: **New Electrical Substation 616**

This photograph shows the 13.8/2.4kV Electrical Substation, Building 616. As part of construction contract CP-1, the project replaced the old substation and associated switch.

Photograph 2: **Substation 616 Under Construction**

This photograph shows the 13.8/2.4kV Electrical Substation, Building 616 under construction. As part of CP-1, the old substation was demolished and the new switchgear was installed including new fence and lighting.

Photograph 3: **New Electrical Substation 617**

This photograph shows the new 13.8/2.4kV Electrical Substation 617 with associated 13.8kV switch.

Photograph 4: **Substation 617 Demolition**

This photograph shows old switchgear and 13.8kV switch removed.

Photograph 5: **New Electrical Ductbank Construction on Pennsylvania Street**

This photograph shows new ductbank installed as part of CP-1.

Photograph 6: **Substation 51 Complete**

This photograph shows completed Substation 51.

Photograph 7: **Typical New SF-6 Switch**

This photograph shows a typical above ground SF-6 switch installed in CP-1 and CP-2 construction packages. These switches play an important role in enhancing safety, reliability, protection and operability of BNL's electrical distribution system.

Photograph 8: **Reconditioning of Circuit Breaker**

This photograph shows a Switchgear Breaker being reconditioned. As part of the project scope.

8. PROJECT SUMMARY

Electrical distribution system of Brookhaven National Laboratory consists of two major 69kV-13.8kV substations in Bldgs.603 and 631. The 13.8kV distribution feeders emanating from the main switchgears are run in underground ductbanks to distribution transformers throughout the site. The site also has four 13.8kV-2.4kV substations at Bldgs.603, 661, 616 and 617, which forms an interconnected distribution system providing power to the south - east portion of the laboratory. The distribution system dates primarily from the late 1940's when BNL was transformed from an army base to a National Laboratory.

The 13.8kV feeders are configured in a primary selective arrangement on certain critical loads and radial connections are made to other loads. The 2.4kV feeders are sectionalized through oil switches and link boxes located in underground manholes.

Under the switchgear replacement program of the project, two new switchgears were prepurchased, the existing substations 616 and 617 about 40 years old, were demolished and removed, and the substations were completely refurbished with new gear, lights and fence.

A smaller substation in Bldg. 51 was also completely refurbished; replacing single-phase potential transformers with new three phase unit and new outdoor panelboard , providing control for individual loads.

The distribution in Bldg. 30 was reconfigured, eliminating three oil filled indoor potential transformers and the loads were redistributed.

In all locations, temporary power for the loads was provided during the construction period.

The new substations are a vast improvement in selectivity and reliability of the breaker operation, relaying and fault detection.

Feeder and ductbank installation of 13.8kV and 2.4kV systems replaced deteriorated cables, circumvented portions of collapsed ductbank, added feeder redundancy and reconfigured the distribution system via newly installed switches.

In Bldg. 901, existing oil switch was replaced by a three-position load break SF-6 switch to provide for a redundant feeder. The new feeder created a loop feed and added 13.8kV power available for future growth on Brookhaven Avenue area, while circumventing the collapsed "C" and "D" ductbanks on Cornell Avenue. This will benefit various buildings, such as, NSLS, 515, 355, 510,555, etc.

In Substation 928, a 13.8kV redundant feeder was installed. The new feeder originated from substation 638. This arrangement also circumvents collapsed duct bank in Cornell Avenue and provides accessibility of power from a separate substation. Addition of a three position, six-way load break switch in this route makes this redundant 13.8kV power available to other feeders for Collider-Accelerator complex.

Replacement of the old faulted 2.4kV Upton Road feeder and addition of the above ground switching considerably improved the reliability and selectivity to this system.

Installation of new above ground, load break switches in 2.4kV distribution, made the system easier to maintain and safer to operate. The distribution system was sectionalized to make shutdowns in a more localized fashion. The underground oil switches and link boxes were removed, which were environmental hazards and could not be operated in energized condition.

BNL is actively reconditioning and replacing its inventory of circuit breakers, which dates back to 1940's and 50's. A breaker's useful life is dependent upon many factors, including the number of operations, service environment, and maintenance history. 13.8kV circuit breakers are old General Electric's Magna blast type. Low voltage breakers at BNL, were manufactured by a variety of manufacturers, including: General Electric, Westinghouse, ITE, Brown-Boveri, Siemens Allis, Federal Pacific, Square D, and Challenger Electric. Spare parts, when available, are supplied from the original manufacturer or from specialty vendors dealing in these items. Often the specialty vendors are equipped to manufacture parts for obsolete breakers.

Many of the older breakers rely on dashpots, an old technology form of electro-mechanical trip devices. Calibration of these aged trip devices is difficult to obtain and maintain, decreasing safety and reliability, and increasing the possibility of misoperation, property damage or personnel injury. This project reconditioned 50, 480 V and 10 13.8kV circuit breakers on site. This restored the breakers, back to their proper protection requirements.

9. COST ESTIMATE DETAILS

9.1 Details of Cost Estimate (Plan Based on CD-2 Baseline)

	<u>Item Cost</u>	<u>Total Cost</u>
1. Design and Management Costs		\$924
a) Engineering, design, inspection and quality assurance at approximately 11% of total costs	\$736	
b) Project management at approximately 3% of total costs	\$188	
2. Construction Costs		\$5,074
a) Substation.....	\$1,422	
b) Feeder to Bldg. 901.....	\$845	
c) Feeder replacement	\$990	
d) Feeder to AGS	\$913	
e) Breaker refurbishment.....	\$904	
3. Contingency @ approx. 11% of total cost		<u>\$772</u>
Total:		\$6,770

9.2 Details of Planned Costs (On Revised TEC of \$6,734K) – BCP

	<u>Item Cost</u>	<u>Total Cost</u>
1. Design and Management Costs		\$947
a) Engineering, design, inspection and quality assurance at approximately 12.6% of construction costs	\$740	
b) Project management at approximately 3.3% of construction and engineering costs	\$207	
2. Construction Costs		\$5,096
a) Substation.....	\$885	
b) Feeder to Bldg. 901.....	\$1,004	
c) Feeder replacement	\$427	
d) Feeder to AGS	\$954	
e) Feeders/Switches – BCP	\$600	
f) Breaker refurbishment.....	\$1,226	
3. Contingency @ approx. 10.7% of total cost		<u>\$691</u>
Total:		\$6,734

9.3 Details of Actual Costs (On Revised TEC of \$6,734K)

	<u>Item Cost</u>	<u>Total Cost</u>
1. Design and Management Costs		\$1,404
a) Engineering, design, inspection and quality assurance at approximately 13.6% of construction costs	\$726	
b) Project management at approximately 12.7% of construction and engineering costs	\$678	
2. Construction Costs		\$5,330
a) Substation.....	\$925	
b) Feeder to Bldg. 901.....	\$1,044	
c) Feeder replacement	\$467	
d) Feeder to AGS	\$994	
e) Feeders/Switches – BCP	\$630	
f) Breaker refurbishment.....	\$1,270	
3. Contingency		<u>0</u>
Total:		\$6,734

10. BENEFITS OF COMPLETED PROJECT

An extensive refurbishment of the BNL electrical infrastructure was achieved with this project. The project replaced a number of major antiquated and damaged equipment throughout the electrical distribution system while improving the design, service, safety and operational conditions of the 13.8kV and 2.4kV distribution system. The following improvements were made.

Two 2.4 kV switchgears were replaced, new 13.8 kV and 2.4 kV ductbanks and feeders were installed, and 13.8 kV and 480 V breakers were reconditioned. Installation of the new sectionalizing switches reconfigured and improved the electrical distribution system as well. During construction many underground oil filled switches and link boxes were removed, eliminating a possible environmental hazard. In addition to the initial scope (Items 1–5), additional work was performed (Items 6 and7) under a Baseline Change Proposal with no increase in the project TEC:

- 1) Replaced existing 2.4 kV switchgear at Substations 616 and 617.
- 2) Installed 23,000 feet of new 13.8 kV cable to serve Building 901 and created a loop feed by extending Brookhaven Avenue ductbank "E".
- 3) Replaced 13,500 feet of deteriorating 2.4 kV underground feeder along Upton Road with a new, larger feeder and installed six aboveground padmount switches.
- 4) Installed 14,000 feet of cable to create an alternate feeder to AGS Main Magnet Power Supply (MMPS) Substation 928, the Radio Frequency Power Supply (RF) Substation 929, and extended the "F" ductbank along Thompson Road, south to Rutherford Drive.
- 5) Reconditioned ten 13.8 kV and fifty 480 V circuit breakers.
- 6) Installed four 5 kV sectionalizing switches eliminating 11 link boxes and oil switches (CP-2).
- 7) Replaced 5,300 feet of damaged 5 kV cable and refurbished the Building 51 substation (CP-2).

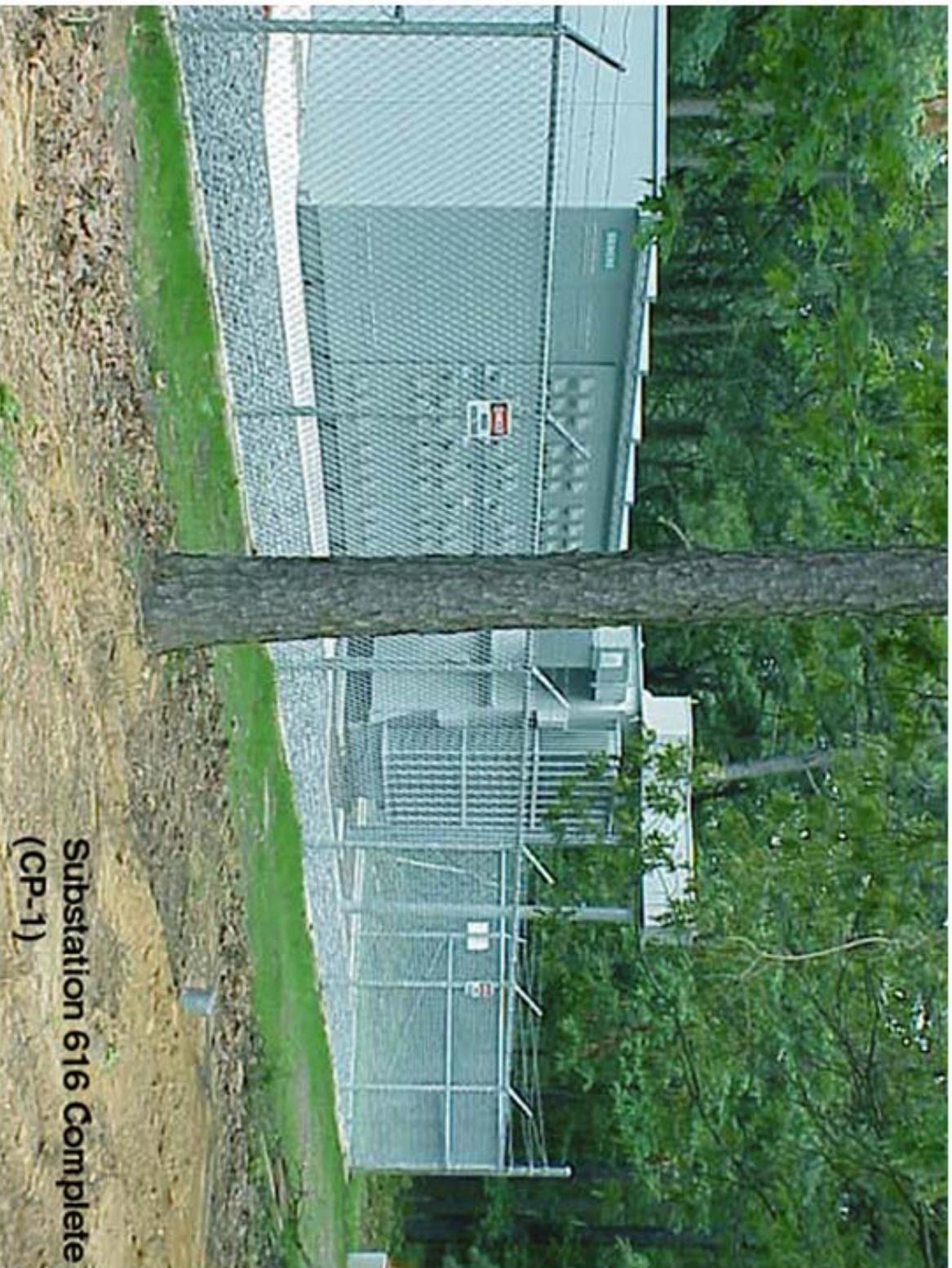
With completion of this project, BNL's electrical infrastructure has been greatly improved, bringing it to compliance with the applicable federal, state, local and environmental workplace standards.

11. PRESS RELEASE FOR PROJECT COMPLETION

This \$6.734 million project was completed on schedule and within budget by Brookhaven National Laboratory. The project improves the safety, service and operational conditions of the 13.8kV and 2.4kV system of the laboratory. A number of antiquated substations and damaged cables were replaced. Power cables and ductbanks were installed to provide redundancy and to alleviate operating conditions in some areas. The restored circuit breakers improve reliability and protection requirements.

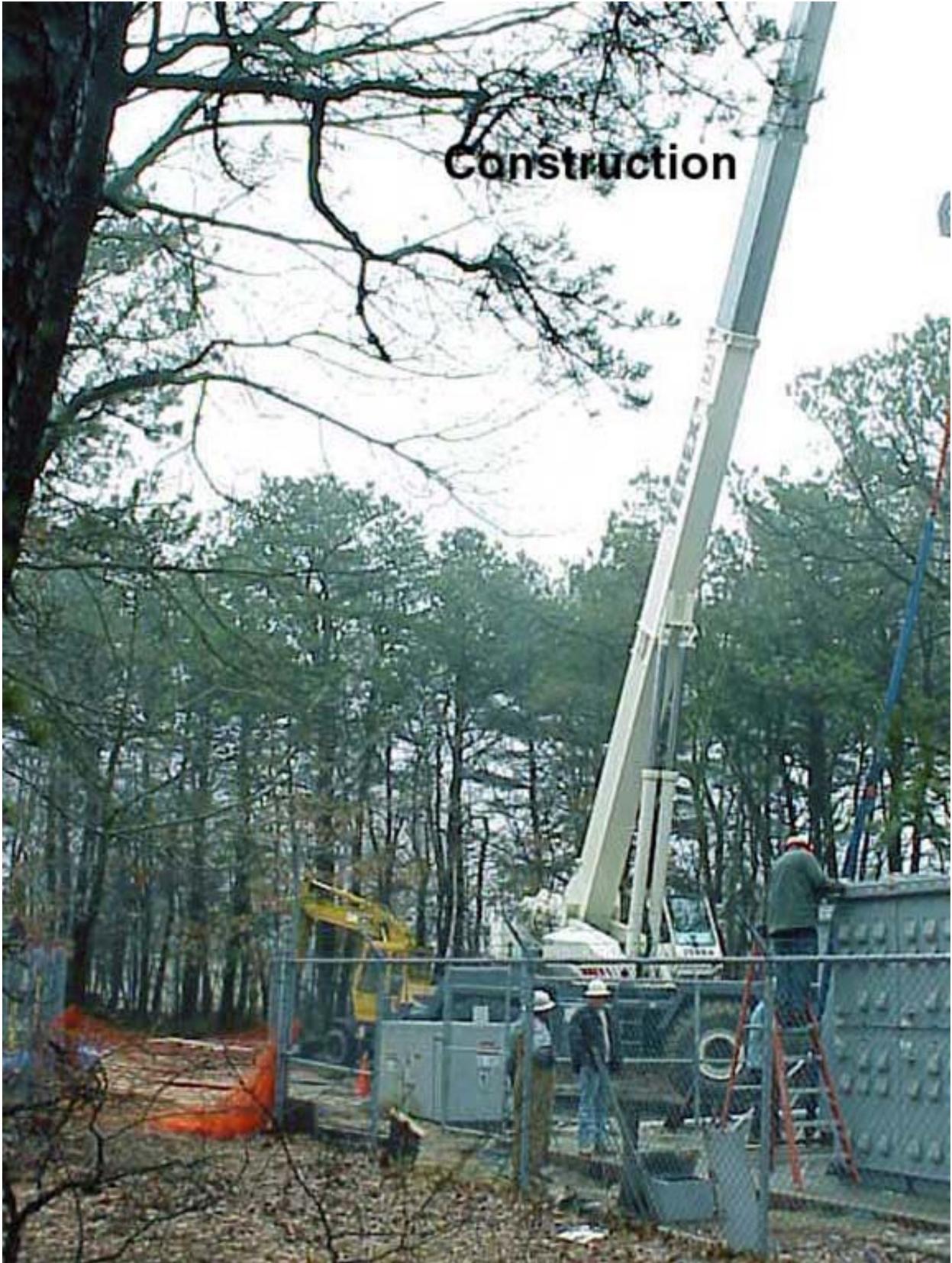
The project was sponsored by the Office of Science Division under Science Laboratory Infrastructure (SLI) program. BNL's Plant Engineering Division provided Engineering Design and Project Management.

APPENDIX A
Photographs



**Substation 616 Complete
(CP-1)**

Construction







Substation 617 demolition



Ductbank Construction



Substation 51 Complete

Typical SF-6 Switch



