

# Georgia Tech Sponsored Research

<b>Project</b>	E-21-R47
<b>Project director</b>	Patel                      Shashikant
<b>Research unit</b>	ECE
<b>Title</b>	Development of Gravel Resistivity Meter
<b>Project date</b>	1/15/1999

E21-R47

2

Mr. Jerry Melcher  
EPRI  
Power Delivery Group  
3412 Hillview Avenue,  
P.O.Box 10412  
Palo Alto, CA 94303

December 3, 1997

Subject: Progress Report and Contract Cost Performance Report Covering the months of August, 1997 through November 1997 for "Development of Gravel Resistivity Meter" Project.

Dear Mr. Melcher

Please find attached the CCPR covering the period from August, 1997 through November, 1997 for the above project.

To date we have completed the first three tasks viz. Preliminary Investigation and Testing, Preparation of Specifications and Design. Due to holiday season coming up, we feel that the project will not be completed by the end of this year as scheduled. Looking at the remaining tasks, I am requesting a no-cost extension of this project to March 1998. The CCPR being sent to you reflects this change. A letter from your contract division will suffice for us to proceed with the remainder of the project.

If you have any questions, please feel free to call me on 770-675-1886 or contact on E-mail [Shashi.Patel@neetrac.gatech.edu](mailto:Shashi.Patel@neetrac.gatech.edu).

Sincerely,



Shashi Patel, Research Engineer

XC: Stan Harper

# CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 8/92R

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b> NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b> FROM <u>08/01/97</u> TO <u>11/30/97</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal.

**NOTE:** \* Instructions for completing this form are on the reverse side.  
 \* Figures NOT in U.S. dollars are to be shown in exact amounts, specifying type of currency.  
 \* Figures in U. S. dollars are to be shown in whole thousands.  
 \* Show EPRI portion of the contract only. Do not include contractor cost sharing.

Prior Year(s) Actual	(1)
3,000	

Actual (booked) cost  
in the current Year  
19 97

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Actual	(2)
2,000	7,000	3,000	6,000	4,000	4,000	4,000	0	0	1,000	4,000		35,000	

Forecast to complete  
the current Year  
19 97

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Forecast	(3)
											4,500	4,500	

Remarks:

\* Comment on significant variances from previous report.

\* Unbooked Liabilities/Other comments:

Forecast to  
complete the  
future Year(s)

1998	19	19	19	Remaining Year(s)	Future Years Forecast	(4)
32,000					32,000	
<b>Grand total of lines (1) + (2) + (3) + (4)</b>						
						74,500

**PREPARED BY:**

**PRINT NAME** Shashi Patel

**DATE** 12/03/97

**TITLE** Research Engineer

Please check if person preparing CCPR has changed from previous submittal.

IMPORTANT: THIS FORM IS NOT TO BE USED AS OFFICIAL NOTIFICATION TO EPRI FOR INCREASED FUNDING REQUIREMENTS. REFER TO SECTION 3.3 OF THE CONTRACT AGREEMENT.

# CONTRACTOR COST PERFORMANCE REPORT

E-21-1247  
5/10

EPRI 177 8/92R

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b>  NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b>  FROM <u>12/01/97</u> TO <u>03/31/98</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal.

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<b>Prior Year(s)</b>	(1)
<b>Actual</b>	
<b>38,000</b>	

Actual (booked) cost  
in the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	<b>Current Year Actual</b>	(2)
3,000	10,000	3,000										16,000	

Forecast to complete  
the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	<b>Current Year Forecast</b>	(3)
			1,000	4,000	10,000	3,000	2,500					20,500	

**Remarks:**  
 \* Comment on significant variances from previous report  
  
  
  
 \* Unbooked Liabilities/Other comments:

Forecast to complete the future Year(s)

1999	19	19	19	Remaining Year(s)	<b>Future Years Forecast</b>	(4)
<b>Grand total of lines (1) + (2) + (3) + (4)</b>					<b>74,500</b>	

**PREPARED BY:**  
**PRINT NAME** Shashi Patel **DATE** 04/24/98  
  
**TITLE** Research Engineer  
  
 Please check if person preparing CCPR has changed from previous submittal.

**IMPORTANT: THIS FORM IS NOT TO BE USED AS OFFICIAL NOTIFICATION TO EPRI FOR INCREASED FUNDING REQUIREMENTS. REFER TO SECTION 3.3 OF THE CONTRACT AGREEMENT.**

MAY 11 '98 01:16PM GA TECH NEETRAC

# CONTRACTOR COST PERFORMANCE REPORT

E-21-R47  
7, 8, 9

EPRI 177 8/92R

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b>  NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b>  FROM <u>04/01/98</u> TO <u>06/30/98</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal.

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Prior Year(s) Actual	(1)
38,000	

Actual (booked) cost  
in the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Actual	(2)
3,000	10,000	3,000	1,000	0	0							17,000	

Forecast to complete  
the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Forecast	(3)
						3,000	16,500					19,500	

**Remarks:**

\* Comment on significant variances from previous report

\* Unbooked Liabilities/Other comments:

Forecast to  
complete the  
future Year(s)

1999	19	19	19	Remaining Year(s)	Future Years Forecast	(4)
<b>Grand total of lines (1) + (2) + (3) + (4)</b>						<b>74,500</b>

**PREPARED BY:**

**PRINT NAME** Shashi Patel

**DATE** 07/16/98

**TITLE** Research Engineer

Please check if person preparing CCPR has changed from previous submittal.

IMPORTANT: THIS FORM IS NOT TO BE USED AS OFFICIAL NOTIFICATION TO EPRI FOR INCREASED FUNDING REQUIREMENTS. REFER TO SECTION 3.3 OF THE CONTRACT AGREEMENT.

# CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 8/92R

E-21-R44 # 10

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b> NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b> FROM <u>07/01/98</u> TO <u>08/31/98</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal.

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<b>Prior Year(s)</b>	(1)
<b>Actual</b>	
<b>38,000</b>	

Actual (booked) cost  
in the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Actual	(2)
3,000	10,000	3,000	1,000	0	0	5,500	9,000					31,500	

Forecast to complete  
the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Forecast	(3)
								2,500	2,500			5,000	

**Remarks:**

\* Comment on significant variances from previous report.

\* Unbooked Liabilities/Other comments:

Forecast to  
complete the  
future Year(s)

1999	19	19	19	Remaining Year(s)	Future Years Forecast	(4)
<b>Grand total of lines (1) + (2) + (3) + (4)</b>						<b>74,500</b>

**PREPARED BY:**

**PRINT NAME** Shashi Patel

**DATE** 09/18/98

**TITLE** Research Engineer

Please check if person preparing CCPR has changed from previous submittal.

IMPORTANT: THIS FORM IS NOT TO BE USED AS OFFICIAL NOTIFICATION TO EPRI FOR INCREASED FUNDING REQUIREMENTS. REFER TO SECTION 3.3 OF THE CONTRACT AGREEMENT.

# CONTRACTOR COST PERFORMANCE REPORT

E.21.R47  
11

EPRI 177 8/92R

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b> NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b> FROM <u>07/01/98</u> TO <u>08/31/98</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal.

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<b>Prior Year(s)</b>	(1)
Actual	
38,000	

Actual (booked) cost  
in the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Actual	(2)
3,000	10,000	3,000	1,000	0	0	5,500	9,000					31,500	

Forecast to complete  
the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Forecast	(3)
								2,500	2,500			5,000	

**Remarks:**  
 \* Comment on significant variances from previous report.

\* Unbooked Liabilities/Other comments:

Forecast to complete the future Year(s)

1999	19	19	19	Remaining Year(s)	Future Years Forecast	(4)
<b>Grand total of lines (1) + (2) + (3) + (4)</b>						<b>74,500</b>

**PREPARED BY:**  
**PRINT NAME** Shashi Patel **DATE** 09/18/98  
**TITLE** Research Engineer

Please check if person preparing CCPR has changed from previous submittal.

**IMPORTANT: THIS FORM IS NOT TO BE USED AS OFFICIAL NOTIFICATION TO EPRI FOR INCREASED FUNDING REQUIREMENTS. REFER TO SECTION 3.3 OF THE CONTRACT AGREEMENT.**



E-21-R47 #13

# CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 8/92R

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b> NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b> FROM <u>10/01/98</u> TO <u>10/31/98</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal.

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Prior Year(s) Actual	(1)
38,000	

Actual (booked) cost  
in the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Actual	(2)
3,000	10,000	3,000	1,000	0	0	5,500	9,000	1,500	1,000			34,000	

Forecast to complete  
the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Forecast	(3)
										2,500		2,500	

**Remarks:**

\* Comment on significant variances from previous report

\* Unbooked Liabilities/Other comments:

Forecast to  
complete the  
future Year(s)

1999	19	19	19	Remaining Year(s)	Future Years Forecast	(4)

**Grand total of lines (1) + (2) + (3) + (4)**

74,500
--------

**PREPARED BY:**

**PRINT NAME** Shashi Patel                      **DATE** 11/05/98

**TITLE**        Research Engineer

Please check if person preparing CCPR has changed from previous submittal.

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E21-R47

1

August 29, 1997

Mr. Jerry Melcher  
EPRI  
Power Delivery Group  
3412 Hillview Avenue,  
P.O.Box 10412  
Palo Alto, CA 94303


Subject:  
Progress Report and Contract Cost Performance Report Covering the Months of  
November, 1996 through July 1997 for Development of Gravel Resistivity Meter Project.

Dear Mr. Melcher

Please find attached an interim report for the above project. Also attached is the CCPR for the project. To date we have completed the first two tasks viz. Preliminary Investigation and Testing and Preparation of Specifications. Utility Tools and Services, Inc. is presently finalizing on the design of the meter. At this point it seems that we would be completing the project as scheduled.

If you have any questions, please feel free to call me on 770-675-1886 or contact me through E-Mail. My E-Mail address is [shashi.patel@neetrac.gatech.edu](mailto:shashi.patel@neetrac.gatech.edu).

Sincerely,

  
Shashi Patel, Research Engineer

XC: Stan Harper w/o attachments

# **Development of a Procedure and Instrumentation to Measure the Electrical Resistivity of Samples of Surfacing Materials**

## **Prepared for:**

EPRI  
Power Delivery Group  
3412 Hillview Avenue  
P.O. Box 10412  
Palo Alto, CA 94303

## **Prepared by:**

Shashi Patel  
NEETRAC, A Center of Georgia Tech  
62 Lake Mirror Road, B-3  
Forest Park, GA 30050

Zack Brown  
Utility Tools and Services, Inc.  
2743 Longlake Drive  
Roswell, GA 30075

August 28, 1997

# 1

## Preliminary Investigation and Testing

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### Test Samples

Preliminary laboratory tests were made on numerous samples to establish procedures for reliably measuring the samples' resistivity both in the laboratory and in the field. Granite gravel samples were selected to cover the range gradations that would be encountered in normal use. One cohesive soil sample was also included. Since the samples were tested dry and wet with water, the sample also provided a large range of resistivity. The test samples are described in Table 1-1.

### Test Parameters

The tests were designed to evaluate the affect of the following parameters on the resistivity measurements.

- **Test Voltage and Waveform:** It is possible that both the voltage magnitude and waveform may affect the resistivity measurements. Tests were made at voltages from 120 to 575 Volts to evaluate the effect of voltage magnitude. Test were also made with dc and 60 Hertz to evaluate the effect of voltage waveform.
- **Sample Size:** To design a practical field test instrument, it is necessary to determine the minimum sample size necessary to obtain reliable measurements. Tests were made in test containers ranging from 6 inches to 36 inches in diameter and from 12 to 36 inches in height.
- **Electrode Interface:** Because of the irregular surface of the samples, it is likely that a conforming interface material will be required between the electrode and the sample. Test were conducted with various interface configurations.
- **Contact Pressure.** The amount of pressure applied to the sample will affect the contact resistance and the measured resistivity. Tests were conducted with various contact pressures.

# CONTRACTOR COST PERFORMANCE REPORT

E-21-R47 #14

EPRI 177 8

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b>  NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b>  FROM <u>10/31/98</u> TO <u>12/31/98</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal

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<b>Prior Year(s)</b>
<b>Actual</b>
38,000

Actual (booked) cost  
in the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Actual
3,000	10,000	3,000	1,000	0	0	5,500	9,000	1,500	1,000	2,500	2,500	39,000

Forecast to complete  
the current Year  
19 98

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Forecast

**Remarks:**

\* Comment on significant variances from previous report.

\* Unbooked Liabilities/Other comments:

Forecast to  
complete the  
future Year(s)

1999	19	19	19	Remaining Year(s)	Future Years Forecast

Grand total of lines (1) + (2) + (3) + (4)

77,000
--------

**PREPARED BY:**

**PRINT NAME** Shashi Patel

**DATE** 01/25/99

**TITLE** Research Engineer

Please check if person preparing CCPR has changed from previous submittal.

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## Development of a Gravel Resistivity Meter

E21-R47, NEETRAC Project 96-393

### **FINAL REPORT**

Prepared by Shashi Patel

EPRI requested NEETRAC to develop a gravel and soil resistivity (electrical) meter which can be used to measure the resistivity of a large number of gravel and soil types. Different types of gravel are typically used in substations as surfacing materials. The resistivity of these gravels substantially influences the safety in substations. Presently, a field-type instrument is not available.

The deliverable for this contract consisted of proprietary specifications and engineering drawings of a prototype instrument. One prototype meter was also build and delivered to EPRI.

# CONTRACTOR COST PERFORMANCE REPORT

E-21-R47  
#3

EPRI 177 8/92R

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b> NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b> FROM <u>01/01/98</u> TO <u>12/31/98</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal.

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<b>Prior Year(s)</b>	(1)
Actual	
38,000	

Actual (booked) cost  
in the current Year  
19 98

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Actual	(2)
	3,000	10,000	3,000	1,000	0	0	5,500	9,000	1,500	1,000	2,500	2,500	39,000	

Forecast to complete  
the current Year  
19 98

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Current Year Forecast	(3)

**Remarks:**

\* Comment on significant variances from previous report

\* Unbooked Liabilities/Other comments:

Forecast to  
complete the  
future Year(s)

1999	19	19	19	Remaining Year(s)	Future Years Forecast	(4)

**Grand total of lines (1) + (2) + (3) + (4)**

77,000
--------

**PREPARED BY:**

**PRINT NAME** Shashi Patel **DATE** 01/25/99

**TITLE** Research Engineer

Please check if person preparing CCPR has changed from previous submittal.

**IMPORTANT: THIS FORM IS NOT TO BE USED AS OFFICIAL NOTIFICATION TO EPRI FOR INCREASED FUNDING REQUIREMENTS. REFER TO SECTION 3.3 OF THE CONTRACT AGREEMENT.**

# CONTRACTOR COST PERFORMANCE REPORT

EPRI 177 8/92R

<b>EPRI CONTRACT NUMBER</b> Deve of Gravel Resistivity Meter EPRI WO#1494-04	<b>NEETRAC PROJECT NUMBER</b> 96393	<b>CONTRACTOR NAME:</b> NEETRAC <b>ADDRESS:</b> 62 Lake Mirror Road, Building #3 Forest Park, Georgia 30297
<b>EPRI PROJECT MANAGER</b>  NAME <u>Jerry Melcher</u>	<b>PERIOD OF PERFORMANCE</b>  FROM <u>01/01/97</u> TO <u>12/31/97</u>	<b>TELEPHONE NO:</b> (404) 675-1886 <b>FAX NO:</b> (404) 675-1820 <input type="checkbox"/> Please check if address has changed from previous submittal.

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<b>Prior Year(s)</b>	(1)
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3,000	

Actual (booked) cost  
in the current Year  
19 97

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	<b>Current Year Actual</b>	(2)
	2,000	7,000	3,000	6,000	4,000	4,000	4,000	0	0	1,000	4,000		35,000	

Forecast to complete  
the current Year  
19 97

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	<b>Current Year Forecast</b>	(3)
												4,500	4,500	

**Remarks:**

\* Comment on significant variances from previous report.

\* Unbooked Liabilities/Other comments:

Forecast to  
complete the  
future Year(s)

	1998	19	19	19	<b>Remaining Year(s)</b>	<b>Future Years Forecast</b>	(4)
	32,000					32,000	
<b>Grand total of lines (1) + (2) + (3) + (4)</b>						<b>74,500</b>	

**PREPARED BY:**

**PRINT NAME** Shashi Patel

**DATE** 12/03/97

**TITLE** Research Engineer

Please check if person preparing CCPR has changed from previous submittal.

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