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A Comparison of Sandia Laboratories Technical Institute Equivalents and Technical Institute Recruits From FY 66 Through FY 74

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A COMPARISON OF SANDIA LABORATORIES TECHNICAL INSTITUTE EQUIVALENTS AND TECHNICAL INSTITUTE RECRUITS FROM FY 66 THROUGH FY 74

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ABSTRACT

This study compared TIE's and TIR's to determine if any important differences exist between them. Salaries, performance ratings, supervisors' opinions, schools, and amount of time to advance from one PEP level to another were compared for the TIE's and TIR's. No Statistically significant differences were found.

The TIE program provides an important opportunity for members of minority groups and females to move into ESA/SAT level work.

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1.0 INTRODUCTION

As suggested in a letter from K. A. Smith, 3100, to H. M. Willis, 3130 (Appendix A), a study was undertaken to compare Technical Institute Equivalents (TIE's) and Technical Institute Recruits (TIR's). Until the last few years, there were very few TIE graduates and a considerable number of TI recruits, with the result that most of the Laboratories' needs for TI's were met by recruiting. Since FY 72, the situation has changed considerably. The hiring of TIR's has been reduced somewhat, and, at the same time, the number of TIE graduates has increased so that now a much higher proportion of TI needs is being supplied by TIE's. This fact is causing no one great concern, but it does raise some questions. How do TIE's and TIR's compare? Should Sandia continue with this present proportion of TIE's and TIR's, or should one or the other be increased or decreased? Since the TIE program is an important program for the upward mobility of lower level employees, does it produce a graduate that is competitive on the job? This report concerns itself primarily with the first question, although some of the data collected will be relevant to the other questions.

Since TIE's and TIR's are a subset of the total SAT/SAD and ESA/EDA populations, it is important to keep in mind specifically who the TIE's and TIR's are and their relationship to the total technician population. The report begins, then, by identifying and defining the two groups. This is followed by a number of characteristics and comparisons with the results, and finally, a summary and conclusions.

2.0 WHO ARE THE TIE'S AND TIR'S?

2.1 TIE's. By definition, A TIE is an employee who has taken prescribed Out-of-Hours courses in pursuit of one of Sandia's two-year, associate degree-level curricula. Although special curricula are available to suit line organization and individual needs, the main ones are:

Electronics Technology
Electro-Mechanical Technology
Mechanical Technology
Materials Technology
Design Drafting Technology

Each curriculum consists of approximately 20 courses and requires five to seven years to complete depending on how ambitious the student is and the scheduling problems encountered. A list of the required courses for each curriculum is given in Appendix B.

After an employee has successfully completed all of the courses in a curriculum, a certificate of completion is presented by the line director, and the educational degree code is changed to TIA (Technical Institute Associate degree)--the same as all other TI graduates. The TIE is identified in the education file of Sandia's personnel data system as "School" equal to "Sandia TI." There has been a total of 81 employees graduated with one or more certificates, with 75 of these on roll as of September 1974.

2.2 TIR's. A TIR is an employee whose "Employment Source" code is a "T" or "C" in the personnel data system and whose job classification is either 4501, 4511, 4503, or 4513. "T" is defined as "an associate degree level technician and/or draftsman candidate who applies for employment as a result of personal contact with a technical institute recruitment interviewer while recruiting on campus," and "C" is defined as "a bachelor of science in technology candidate who applies for employment as a result of personal contact with a recruitment interviewer while recruiting on campus," This definition, then, excludes lobby drop-ins, mail or phone contacts, and referrals who might also be from the same schools, with the same degree date, and same degree status. It is also very restrictive and includes only a small portion of the total technician population, as will be shown in the next section. It was used, however, for two compelling reasons. First, the letter (Appendix A) specifically cited recruits as the group of interest and second, data retrieval is straightforward and once retrieved, do not require extensive "hand massaging" in order to insure that they are reliable and valid. There has been a total of 353 TI graduates recruited under the above criteria during the time period of interest, and there are 226 on roll.

2.3 The TIE's and TIR's in Relation to all Technicians. The total number of on-roll technicians as of November 1974 (TIE's, TIR's, and all others) is distributed as follows.

Number of Technicians

Job Class	SLA	SLL	Total
4501 (SAT)	188	8	196
4511 (ESA)	798	134	932
4503 (SAD)	40	3	43
4513 (EDA)	156	41	200
	1185	186	1371

These figures include both those with and without TI degrees. Of the 1371, the distribution of just those technicians with a TI Equivalency or a TI degree (coded TIA in the data file) is as follows.

Number Coded with TIA Degrees

Job Class	SLA	SLL	Total	% TIA's
4501	23	2	25	12.8
4511	489	91	580	62.2
4503	10	0	10	23.2
4513	100	35	135	67.5
	622	128	750	

Within job class, the percentage of employees with TI degrees is given under that heading. Notice that only a little more than half (55%) of the on-roll technicians have TI degrees, and of the 750 technicians with TI degrees, 75 are TIE's--all at SLA--and 226 are TIR's--189 at SLA and 37 at SLL. This means that only 5.5% of all technicians are TIE's and 16.5% are TIR's, and 10.0% of TI graduates are TIE's and 30.1% are TIR's.

3.0 CHARACTERISTICS OF TIE AND TIR POPULATIONS

3.1 Number and Kinds of TIE Certificates Given. There have been a total of 86 TIE's certificates given to 81 employees from the first one in February 1966 through June 1974. Six employees have terminated. This leaves a total of 75 on-roll graduates with one or more TIE certificates.

The distribution of the 75 TIE's by curriculum area and fiscal year is given in Table I. The number of graduates increased sharply in FY 72. This was the result of the 100-point drafting trainee program, implemented in FY 70. In FY 73 and FY 74, there were no drafting trainee graduates, but the enrollment program was stimulated by the Materials OJT Program, so the number of graduates remained relatively high.

3.2 Distribution of TIR's by Curriculum Area. Sorting the TIR's by curriculum area and fiscal year gives the distribution in Table II. This is, of course, also a display of the hiring of TIR's by fiscal year who are still on roll. 88 percent of all TIR's are in either electronics or drafting.

3.3 BIOSA and Sex Distribution. The BIOSA and sex distribution of TIE's and TIR's during the time of interest is as follows.

	BIOSA Code					Sex		Total	Percent	
Group	1	2	3	4	5	F	M		Minority	F
TIE	0	1	2	21	57	4	77	81	29.6	4.9
TIR	14	6	5	23	305	6	347	353	13.6	1.7

Of special interest here is the fact that the minority/female percentage participation of the TIE's is more than twice that of the TIR's; thus, it appears that the TIE program has an important part in providing members of minority groups and females the opportunity to move into engineering technician (ESA) work.

4.0 COMPARISON OF TIE'S AND TIR'S

There are a number of different ways to compare the TIE's and TIR's; however, the comparisons made are:

1. Termination rate,
2. Reclassification rate,
3. Number of degrees beyond TI,
4. Salary,
5. Performance rating, and
6. Time to PEP advancement.

4.1 Termination Rate. Table III gives the number of terminations by fiscal year for TIE's and TIR's. As indicated above, six TIE's have terminated, for an average rate of 7.4%. Of the 353 TIR's, 127 have terminated for an average rate of 36%. It would appear that these figures support the notion that TIR's with degrees from accredited schools tend to be more mobile than the TIE's (or as one individual pointed out, less loyal.) Notice the decreasing trend for TIR's in the 1970's--no doubt a reflection of the economy, both local and national.

4.2 Reclassifications to a Higher Level. There have been no reclassifications of TIR's to supervision; however, there have been two reclassifications to staff member and one to staff associate after they continued to get additional education. Two of the TIE's have been reclassified to section supervisor and five have been reclassified to staff associate. No TIE's have been reclassified to staff member. Table IV gives the reclassifications along with the hire-in classification, the date of hire-in, the date

they received the TI Equivalency Certificate, the date they became a staff aide, and the length of time it took them to be reclassified to their class as of September 1974 from the staff aide classification. All are of a technical nature except for one TIE, employee B, who is administrative.

4.3 Degrees Beyond the TI. None of the TIE's have completed the bachelor's degree, but eight are currently taking courses under the EAP program toward a bachelor's. Seven TIR's have received additional degrees as shown in Table V, six are bachelors including the BST and one is a masters. Nineteen TIR's are taking courses under EAP. Notice one important point illustrated by Table V. The types of degrees and GPA's are commensurate with those of outside hires, i.e., they are (or would be) competitive with the outside market and, although not all TIR's with degrees have been reclassified, the three who have been had the proper educational credentials for staff level positions.

4.4 Salary. A statistical comparison of salary was studied. Suspecting, however, that salary level is related to service time, the first task was to assess the relationship between these two factors. Figures 1 and 2 are graphs of annual salary versus time for the TIE's and TIR's, respectively. Time is defined to be that period (in months) for which the employee has been a Staff Aide (ESA/EDA or SAT/SAD) or higher. For TIR's this is simply the service time, but for TIE's it is the time they have been classified as a Staff Aide. Typically, TIE's hire-in at some graded level and are then reclassified into the Staff Aide level, with the PEP entry level varying. Some enter at the 150-point level; others enter at the 180-point level. TIR's typically enter at the 150-point level.

As evident from these graphs, there is a positive relationship between time (as defined above) and salary, with the average time for TIE's and TIR's being 76.4 and 58.7 months, respectively. Because of this relationship, then, a direct comparison of average salary is not appropriate. Rather, the two averages should be adjusted for the difference in effective staff aide time. This adjustment is accomplished by a statistical technique called covariance analysis and was performed with the following results.

The difference in salary means is $755 per year in favor of the TIE's; however, adjusting for the salary/time relation, the difference is only $185 per year. The significance level associated with the adjusted difference is about 0.3, which implies that the difference in average salaries is simply reflecting random variation and is not a true important difference.

4.5 Performance Rating. The second statistical comparison was made on performance rating. Performance rating can have values ranging from 1 to 5, with 1 being outstanding. For performance rating, no relation with time was discovered. Therefore, there was no need to adjust the performance averages for time, and the analysis of variance was used.

In Figures 3 and 4, graphs of performance rating versus time are shown for TIE's and TIR's. The results of the analysis of variance are summarized below. The difference in averages is 0.09, with a corresponding significance level of 0.25. Again, there is no reason to believe that an important difference exists in Performance rating.

Results of Analysis on Performance Ratings

Statistic	TIE	TIR	Difference
Mean performance ratings	2.88	2.97	0.09
Standard deviation	0.87	0.88	

In addition to the statistical analysis of the performance ratings, a survey was also made to obtain the opinions of line supervisors about TIE's and TIR's. To obtain the desired data, both groups were sorted by departments, and those departments with both TIE's and TIR's were selected for further study. Opinion data were then solicited by letter (Sample letter in Appendix C) and followed up by interviews and telephone conversations. Summarizing the responses in four general areas of Quality of Education, On-the-Job Performance, Motivation and Overall Caliber of Employees gives the results in Table VI. Taking another approach and classifying the responses as to "TIE Advantage," "TIR Advantage," or "No Discernible Difference," the results in Table VII were obtained. Realizing that the symmetry of the data in Table VI may raise some questions, the "unadultrated" results are given in Appendix D. The data are self-explanatory, and the reader is encouraged to examine the data and read the responses at this point.

In general, line supervision favors both groups about equally. This conclusion agrees with the analysis of numerical performance ratings.

4.6 Time to PEP Advancement. The amount of time required to advance within the PEP structure was analyzed to determine if a difference exists between the TIR's and TIE's. The averages, differences in averages, and standard deviation (in months) to advance from one PEP level to another are shown in Table VIII. There is no statistical evidence of an important difference in average time to advancement between TIR's and TIE's.

4.7 TIR's Compared to Non-TVI TIE's. Within the TIE's, there is a group of TVI drafting students that were hired in at the 100 point level (newly created at that time) with the stipulation that they would take eight prescribed out-of-hours courses to come up to full TIE equivalency. Since this is a fairly large group with a somewhat different background, the question was raised, "Would the results of comparing TIE-TIR salary and performance change significantly if the TVI graduates were removed from the TIE group?" The covariance analysis was repeated, with the seventeen TVI people removed.

Unadjusted for time, the TIE average annual salary is $1315 higher than the TIR mean. The adjusted difference is $308. This is a larger difference than that including TVI's; however, it is still not an important difference based on statistical considerations. The significance level is about 0.12.

4.8 Comparison by Schools for TIR's. Next, the TIR's were sorted by school, and the five with the largest number of on-roll graduates were compared with the non-TVI TIE's. Table IX gives the results. The six unadjusted annual salary means were used to compute a grand mean. The grand mean was then compared to the individual means with an adjustment made for the time factor. This yielded the adjusted differenced in means recorded under that heading. The surprising fact that emerged is that DeVry graduates made $617 per year less than the average even after an adjustment was made for time. The unadjusted difference is $1,136 per year less. This result led to further investigation and to Table X which shows the PEP distribution along with performance rating. Notice there are twenty-two 150-point DeVry graduates who are relatively new hires with service time of less than eight months. Since the adjustment is only linear, a relatively large number of people with small service times can distort the adjusted differences. This would largely explain the $617 difference. In fact, this group is readily identified in Figure 2 as the lowest salary, shortest time cluster in the lower left portion of the graph.

The result of Table X led to Table XI which is a comparison of schools within the four main PEP levels. The unadjusted difference in mean salaries within PEP levels along with the sample size and the unadjusted difference from the grand mean (from Table IX) for the school and its associated sample size are given. Table XII is a tabulation of the same schools and PEP levels for mean performance ratings.

Since there are several empty cells in Tables XI and XII and some others have small sample sizes, the schools were recombined into the previous grouping of TIR's and TIE's and the analysis of covariance program run to determined if differences between the

TIE's and TIR's within PEP levels were significant. The results are given in Table XIII. The only difference that is statistically significant is for salary at 150 points. The explanation for this was given above.

4.9 Salary vs GPA for TIR's. One last question was posed to satisfy the curiosity and/or suspicion of the authors, et al.,: "Is there a correlation of grade-point average (GPA) with salary or performance rating?" The answer is, "No, there does not seem to be, at least for TIR's." Figures 5 and 6 are graphs of GPA versus salary and GPA versus performance rating, respectively, for TIR's. GPA is not computed or recorded for TIE's because not all courses are graded on the A, B, C, D, and F scale.

5.0 CONCLUSIONS

This study compared on-roll TIE and TIR engineering technicians. There are 75 TIE's and 226 TIR's on-roll; this represents 5.5% and 16.5%, respectively, of the total technician population.

5.1 One Important Difference. The TIE program presents an important opportunity for members of minority groups and females to move into ESA/SAT work.

5.2 No Significant Differences. The following comparisons showed no significant differences between TIE's and TIR's.

1. Annual salary.
2. Performance rating.
3. Amount of time required to move from one PEP level to another.
4. Opinions of supervisors.
5. Salary and performance ratings when TIR's are subdivided by schools.

5.3 Some Differences. The following differences exist, but the level or degree of importance is left to the reader's judgement.

1. The termination rate of TIE's is 7.4% as compared to 36% for TIR's.
2. There have been 7 (9.3%) TIE's reclassified to staff associate or higher as compared to 3 (1.3%) TIR's.
3. Seven TIR's have continued their formal education and have received bachelors degrees or higher. No TIE's have received the bachelors degree.

TABLE I

On-Roll TIE Graduates with One or More Certificates

	Fiscal Year									
Curriculum Area	66	67	68	69	70	71	72	73	74	Totals
Electronics				1	3	2	4	5		15
Mechanical	2	2	1	1	1	2	4	2	5	20
Electro-Mech.									1	1
Materials Science								5	7	12
NC Programming									1	1
Administrative				2	1			1		4
Design Drafting		1		1	2		14	3	1	22
Totals	2	3	1	5	7	4	22	16	15	75

TABLE II

TIR's by FY and Curriculum Area

	Fiscal Year									
Current Area	66	67	68	69	70	71	72	73	74	Totals
Electronics	11	35	1	16	22	14	15	1	31	146
Mechanical	2			1				1	2	6
Drafting	6	14	10	10	7		2		4	53
Photography					1	1				2
Materials/Chemistry									2	2
Electro-Mech.	2	3			1	1	1		1	9
Other										8
Total										226

TABLE III

Number of Terminations of TIE's and TIR's

	Fiscal Year										
Group	66	67	68	69	70	71	72	73	74	Totals	Percent
TIE					1			1	4*	1	7.4
TIR	21	38	13	17	13	10	9	5	1	127	36.0

*Includes one TIE that terminated September 1974.

TABLE IV

Reclassifications

Employee*	Hire-In Class	Hire-In Date	TIE Date	Staff Aide Date	Reclass. Date From Staff Aide	Job Class as of September 1974	Time to Reclass. SA to Sept. 1974 Class (Yrs)
TIE							
A	Gr 2	12/48	6/67	2/56	6/64	5501	8.3
B	Gr 36	12/56	10/68	5/58	5/70	5502	12.0
C	Gr 7	5/50	12/68	5/56	3/58	5501	1.8
D	Gr 10	11/56	10/71	6/58	4/67	5501	8.8
E	Gr 8	9/54	2/66	10/64	1/69	5501	4.3
F	Gr 4	8/55	1/70	3/66	11/69	600	3.7
G	Gr 20	9/62	6/71	8/69	10/73	600	4.2
TIR							
H	4501	6/67	5/67	6/67	10/73	5006	6.3
I	4501	1/67	1/67	1/67	7/73	5001	6.5
J	4501	2/69	1/69	2/69	10/71	5501	2.7

*Although data are on individual employees, names have been omitted to protect the privacy of the employees and to make the report non-private.

TABLE V

TIR's with Additional Degrees

	Degree Level at Employment		Degree Level as of September 1974				
Employee	Degree	Date	Degree	School	Date	Field	GPA
K	TIA	1/66	BST	Devry	6/70	Electronics	3.6
L	TIA	12/66	BS	UNM	5/73	EE	-
H*	TIA	5/67	BS	UNM	12/72	EE	3.0
M	TIA	9/66	BS	UNM	5/73	Univ. Studies	-
I*	TIA	1/67	MAS	UNM	5/73	EE	3.8
N	TIA	6/67	BS	U of A	5/72	Chemistry	3.6
O	TIA	6/68	BST	So. CO	4/72	Industrial	3.2

*Same employee as in Table IV.

TABLE VI

A Comparison of TI Recruits and TI Equivalents

Quality of Education

TIR Advantage	TIE Advantage
Our problem with TIE's is to upgrade their technical knowledge since courses offered at Sandia are not directly applicable to our work.	...conversely, our problem with TIR's is to train them in our procedures and see that they obtain field experience as rapidly as possible.
TIR's have excellent academic backgrounds... TIR's younger and more up-to-date on latest technology.	TIE's academic background ranges from good to excellent.
...better schools have done excellent job in keeping up with the needs of industry.	...problem is merging formal study into work situation...find that six to 18 months may pass before a TIR will be settled in the job...TIE on completion has a good formal background as well as day-to-day work experience.

On-the-Job Performance

...within 6 months to a year our TIR's (assuming good performance) are beginning to outperform the TIE's technically.	...experience is extremely important and it is essential to know how construction is accomplished to be effective as a designer. For this reason, TIE's are immediately productive in our area from the first day they report, but not the TIR's unless they have had applicable work experience.
Four of the six TIR's can do high level technical work with little or no engineering direction, help or guidance...The TIE operates only under close engineering guidance. Evidence today indicates that the TIE, although he will improve with added experience will most likely never catch the TIR group in capability.	TIE's have more practical experience...better in doing or directing assembly, wiring or fabrication work and at interfacing with the shop.
Due to differences in the time required to achieve a TIR vs TIE, it is generally conceded the technical know-how of the TIR can be assimilated in the work force at a faster rate than the TIE.	...The TIE's have a definite practical orientation which not all of the TIR's have--at least at time zero...They are also initially better at getting things done at Sandia Laboratories since they know how our system works.
	...Our OJT specialty graduates do have the initial advantage of rotational experience in several areas such as ceramics, glass, hybrids, etc. This experience gives them a good comprehension of the state-of-the-art of several SLA technologies and first-hand experience in who to go to for help in these areas.

TABLE VI (cont)

Motivation

TIR Advantage	TIE Advantage
In summary, I feel that generally speaking those who first seek out and then graduate from a tougher school are more highly motivated in the first place and this motivation generally is carried over into their Sandia jobs.	There are exceptions and these are recognized in that some TVI people have done very well. A "TVI" tag is certainly not a "bad" tag per se.
Generally, the motivation to excel along technical lines is greater in TIR's than in TIE's.	This is not to say the TIE is not capable of excelling. The number of candidates is small and further limited by personal desires, interests, and ambitions. ...TIE route requires special attributes and tenacity.

Over-all Caliber of Employees

(TIR has) a select quality with high potential requiring primarily experience and opportunity to mature.	(TIE has) a bit more maturity and considerable more familiarity on how the lab functions and how to utilize the various services provided.
TI grads, generally speaking, are above average compared to non-TI grades in comparable age groups.	...Based on our experience with them (two older TIE's) we can conclude that the TIE makes just as desirable an employee as the TIR.
Although our TIE's have worked out well for us thus far, we still feel that at the present time with all things being equal, if we had the choice we would probably hire the appropriate TIR rather than the TIE.	(A telecon statement reinforcing comments made in memo indicated preference for hire would be TIE.) ...I feel a person who has earned a TIE is certainly equal to a TIR and in this specific case, better than the average TIR. TIE people fit and can be adequately utilized, though in smaller numbers than TIR's...fits affirmative action plans and goals. ...I would have to conclude that TIE's are at least as good, if not better, than TIR's.

TABLE VII

TIE vs TIR Summary of Responses
by Department*

Department	No Difference	TIE Advantage	TIR Advantage
1130	1	1	1
2110	0	2	1
2320	1	1	1
2330	2	0	0
2510	1	1	1
2640	1	0	0
3620	0	1	0
5130	1	0	0
5160	1	1	0
5640	1	0	0
5830	1	0	0
5840	1	0	0
9320			
9330	1	0	0
9340	1	0	0
9510	1	0	0
9520	1	2	2
9620	1	0	0
9630	1	0	0
9650	0	0	3
9740	1	1	1
	17	10	10

*Of 22 Departments contacted, 21 responded. Note: Some respondents made comments which were classified in more than one category; some departments included comments from several divisions.

TABLE VIII

Advancement Time Statistics

Time - in - Level
(mos)

PEP Levels	TIR	TIE	Difference (TIR-TIE)
100 to 150			
Mean $\bar{x}$	——	25.5	
Standard Deviation s	——	9.0	
Number n	0	17	
150 to 180			
$\bar{x}$	22.9	24.2	-1.3
s	9.8	16.5	
n	149	15	
150 to 210			
$\bar{x}$	32.9	33.0	-0.1
s	7.2	0	
n	17	2	
180 to 210			
$\bar{x}$	31.8	27.7	+4.1
s	16.2	15.2	
n	163	25	
210 to 250			
$\bar{x}$	35.5	40.5	-5.0
s	11.5	18.3	
n	24	10	

TABLE IX

Annual Salary ($) Comparison of Selected Schools

School	N	Unadjusted Salary Difference from Grand Mean	Adjusted Difference from Grand Mean
Penn. State Univ.	26	+ 695	+ 328
Central Technical Institute	17	+ 519	+ 182
Sandia TI (TIE)	58	+ 834	+ 145
N. American Tech. Institute	22	- 122	+ 46
Valpariso Tech Institute	13	- 438	- 84
DeVry Tech. Inst.	58	- 1136	- 617

TABLE X

Mean Performance Rating and PEP Distribution by School

School	Mean Perf. Rating	N	Distribution of N by PEP Points				
			150	180	210	250	340
N. Amer.	2.68	22	1	0	20	1	0
Sandia TI (TIE)	2.88	75	23	4	30	10	8
DeVry	2.88	58	22	0	29	7	0
Valpariso	2.89	13	4	0	6	2	1
Central Tech	2.94	17	0	0	14	3	0
Penn. State	3.00	26	0	1	23	2	0

TABLE XI

Annual Salary ($) Comparison within PEP Levels

School	PEP Level				Unadjusted Difference from Grand Mean
	150	180	210	250	
Penn. State	-	- 82	+ 375	+ 573	+ 695
N	-	1	23	2	26
Central Tech.	-	-	+ 31	- 237	+ 519
N	-	-	14	3	17
Sandia TI (TIE)	+ 1267	+ 20	+ 145	+ 340	+ 834
N	13	4	23	10	58
N. American	+ 1200	-	- 365	+ 753	- 122
N	1	-	20	1	22
Valpariso	- 894	-	+ 193	- 532	- 438
N	4	-	6	2	13
DeVry	- 641	-	- 215	- 505	- 1136
N	22	-	29	7	58

TABLE XII

Performance Comparisons within PEP Levels

School	PEP Level 150	180	210	250	Overall Mean
Penn. State	-	3.00	3.13	1.5	3.00
Central Tech	-	-	3.00	2.67	2.94
Sandia TI (NON-TVI)	2.86	3.00	3.18	1.89	2.80
N. American	2.00	-	2.75	2.00	2.68
Valpariso	-	-	3.00	2.50	2.89
DeVry	3.5	-	2.90	2.43	2.88

TABLE XIII

Annual Salary ($) Difference
and Performance Comparisons within PEP Levels

Annual Salary	PEP Levels 150	180	210	250
Difference (TIE-TIR)	1,782	102	227	703
Adjusted Difference	1,786	54	9	140
Performance				
Means				
TIE (non-TVI)	2.86	3.00	3.18	1.88
TIR	3.12	3.00	3.03	2.31
Difference (TIE-TIR)	-.26	0.00	.15	-.43

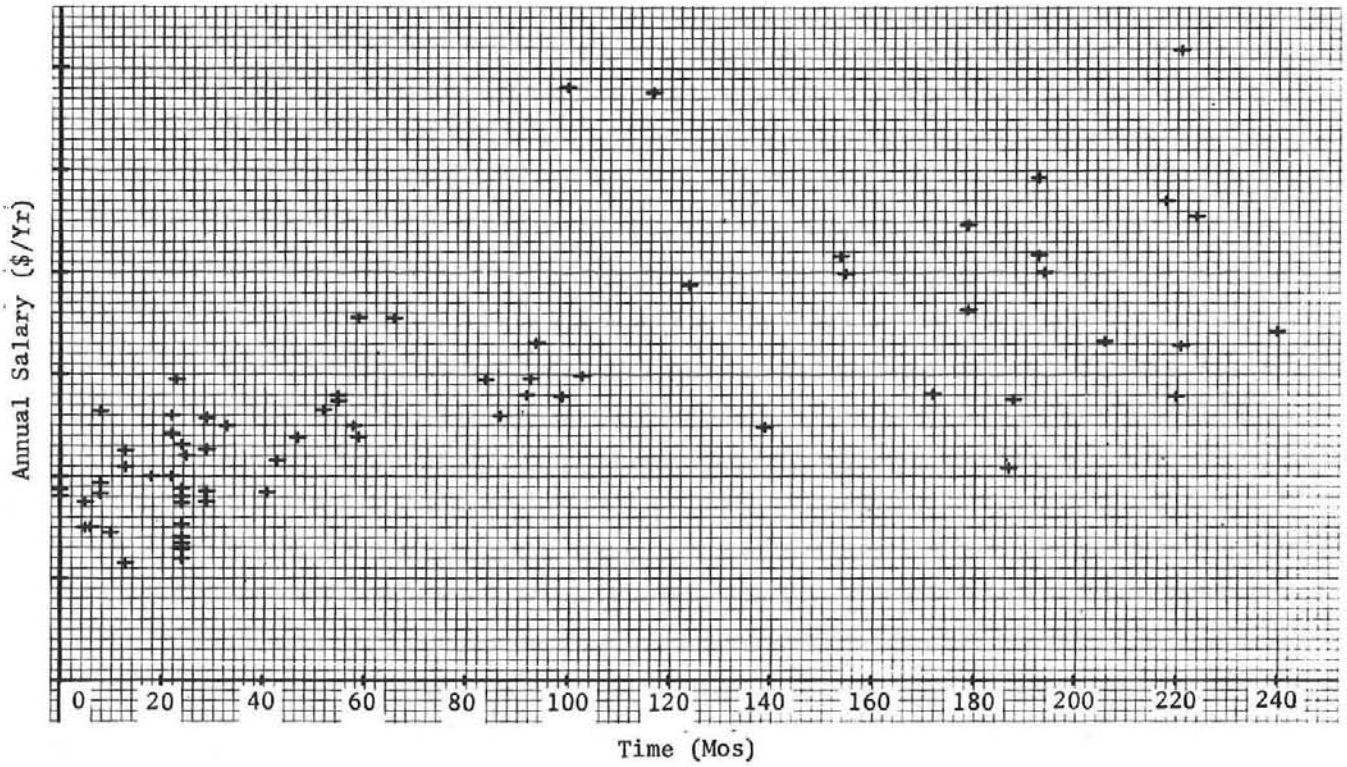

Figure 1. TIE's Salary vs Time

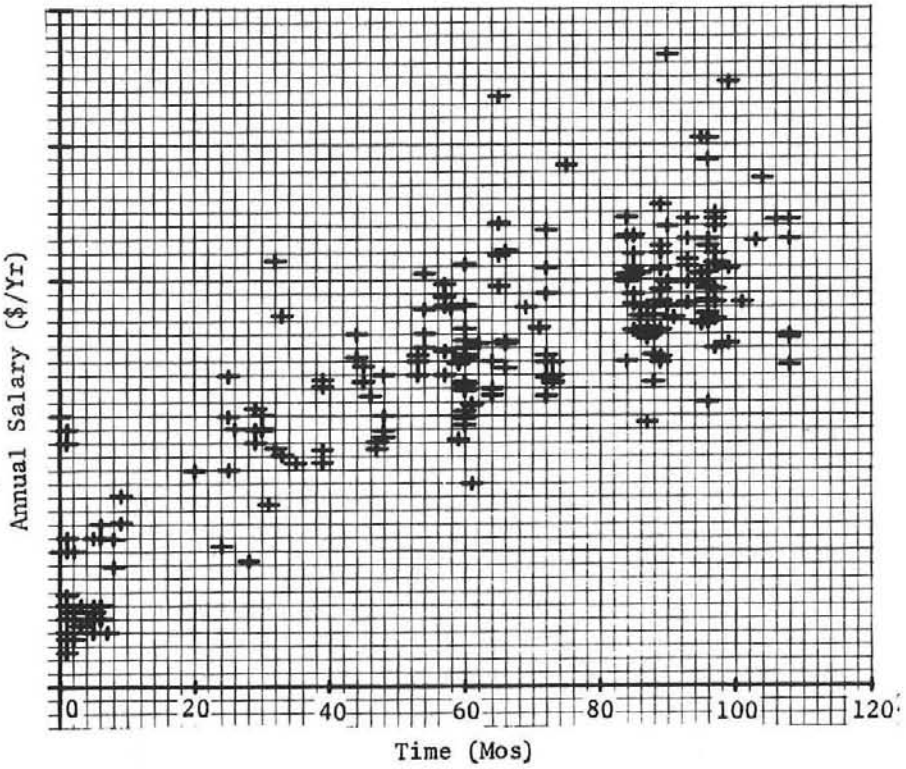

Figure 2. TIR's Salary vs Time

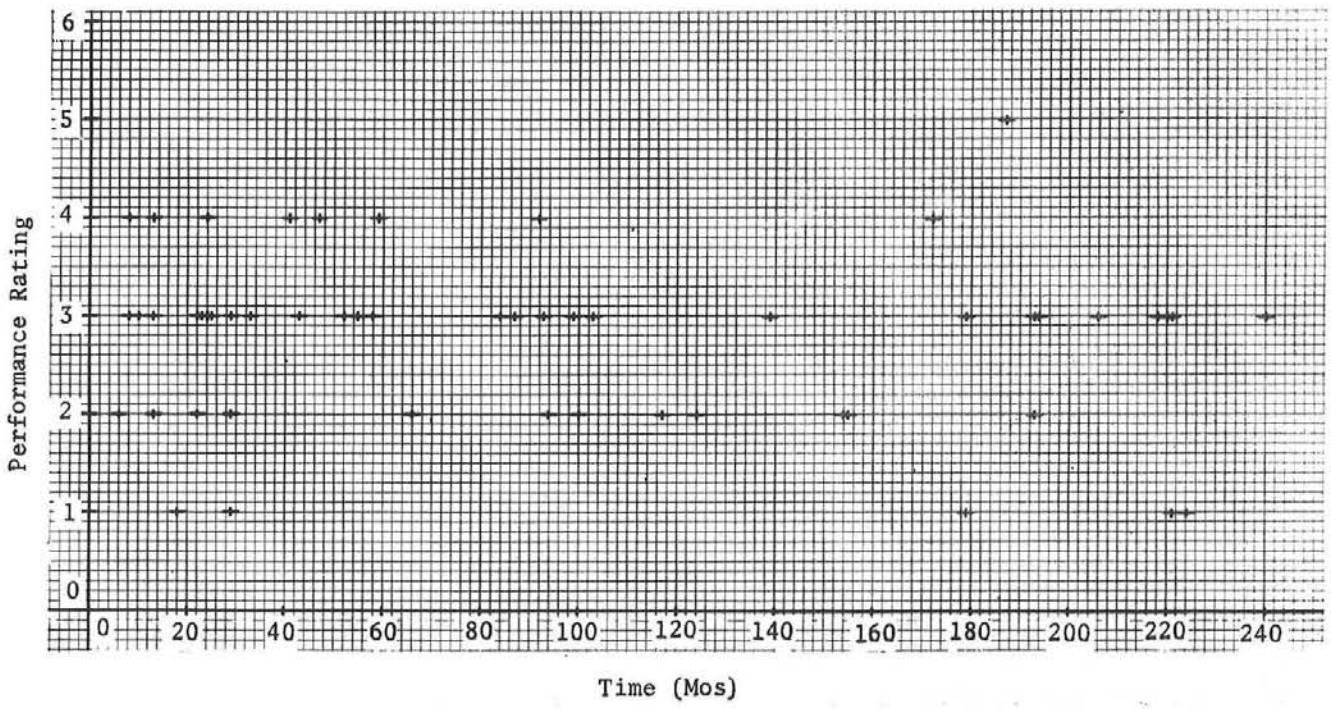

Figure 3. TIE's Performance Rating vs Time

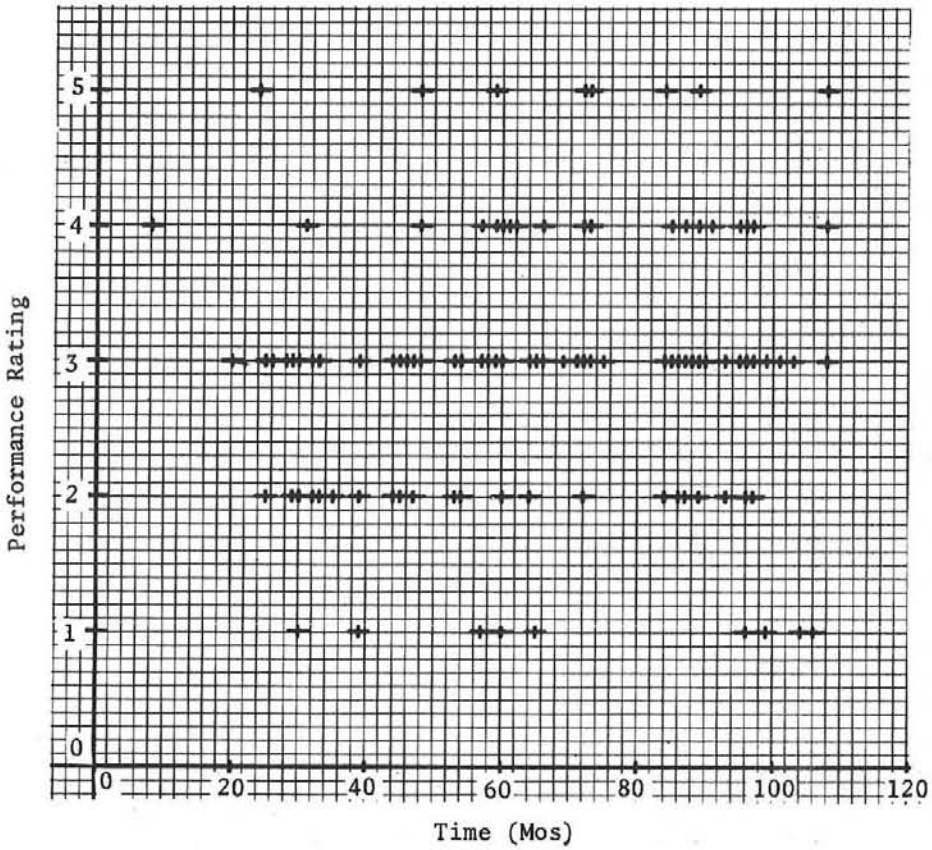

Figure 4. TIR's Performance Rating vs Time

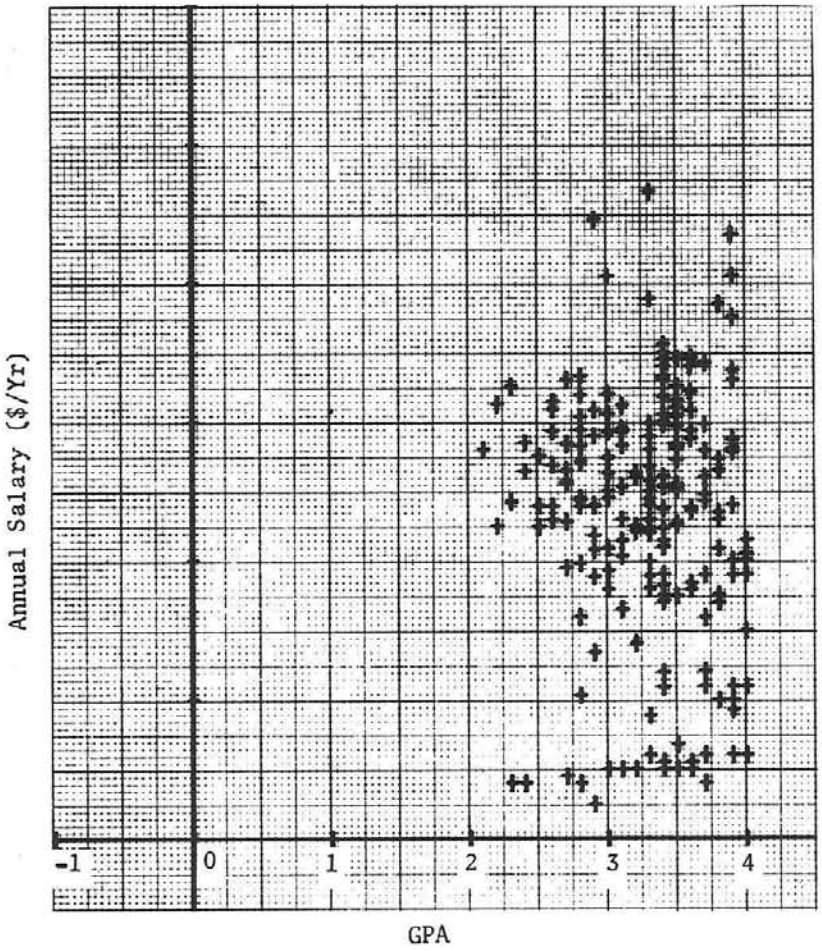

Figure 5. TIR Salary vs GPA

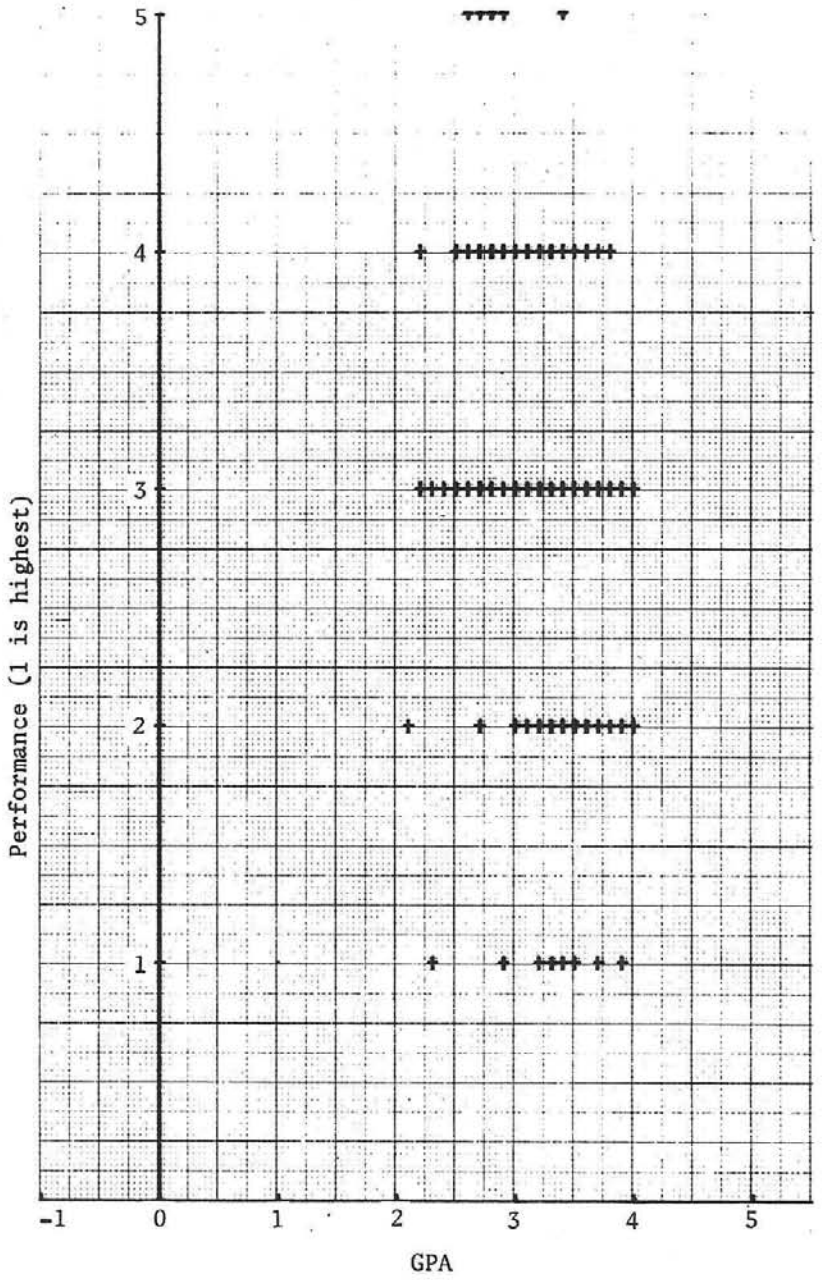

Figure 6. TIR Performance Rating vs GPA

APPENDIX A

Letter Requesting Study

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: September 27, 1974

to: H. M. Willis - 3130

K. A. Smith

from: K. A. Smith - 3100

subject: Possible Large Staff Agenda Item, Spring 1975

W. J. Howard has asked whether an evaluation of our TI Equivalents against the regular TI Recruits would make an appropriate Large Staff Conference subject. In fact he suggested the November 1, 1974 conference meeting as a possible time for it. I told him that I much preferred the meeting next spring so that you would have more time for a complete analysis, and an evaluation of your findings to decide first whether the subject is appropriate. Jack agreed; he actually had some personal reservations about the subject appropriateness, but does want us to pursue it.

In view of the above, please begin a study that will show such things as:

- Numbers of each type over a period of time
- Field (discipline)
- Jobs they're doing
- Performance comparisons
- Salary comparisons
- Number in supervision, and at what levels
- Number who became staff associates
- Number who went on for professional degree
- Through interviews of supervisors, personal opinions of differences in the two types. (This one, Jack suggested.)
- And, whatever else you think is pertinent to a good, valid, complete comparison.

I've already told Jack that if the subject is worth a presentation, you'd be making it. He has agreed. He'll start thinking about the spring Large Staff conference after the first of the year so let's shoot for finishing the study, and our evaluation of it as a subject, by 1/1/75.

KAS:am
Copy to:
3000 R. B. Powell
3100 K. A. Smith

APPENDIX B

List of Required Courses for Each Curriculum

TECHNICAL INSTITUTE PROGRAM

SANDIA LABORATORIES TRAINING & EDUCATION DIVISION

ELECTRONICS TECHNOLOGY

DATE

NAME | SOCIAL SECURITY NO. | ENG. | PHONE

COURSE NO.	COURSE TITLE	DATE COMPLETED	GRADE
MA-110A	Math I, Algebra & Trigonometry		
MA-111A	Math II, Algebra & Trigonometry, Advanced		
MA-114A	Math III, Calculus for Electronics		
MA-114B	Math III, Calculus for Electronics		
PH-120A	Physics I/Laboratory		
PH-120B	Physics II/Laboratory		
PH-123A	Physics IV, Modern Physics		
LA-100A	Technical English		
LA-101A	Technical Report Writing		
CS-202A	Small Computer Systems		
EE-121A	Electronics I/Laboratory		
EE-122A	Electronics II/Laboratory		
EE-123A	Electronic Circuits/Laboratory		
EE-158A	Electronic Circuit Analysis		
EE-100A	Semiconductor Circuit Analysis		
EE-101A	Semiconductor Pulse Circuits		
EE-114A	Transistor Circuits & Applications/Lab		
EE-115A	Digital Electronics/Laboratory		
EE-128A	Communications I		
EE-129A	Communications II		

DATE PROGRAM COMPLETED	GRADE POINT AVERAGE	COUNSELOR'S APPROVAL
DIVISION APPROVAL		DEPARTMENT APPROVAL

TECHNICAL INSTITUTE PROGRAM

SANDIA LABORATORIES TRAINING & EDUCATION DIVISION

ELECTRO - MECHANICAL TECHNOLOGY

NAME	SOCIAL SECURITY NO.	DATE ORG.	PHONE

COURSE NO.	COURSE TITLE	DATE COMPLETED	GRADE
MA-110A	Math I, Algebra & Trigonometry		
MA-111A	Math II, Algebra & Trigonometry, Advanced		
MA-112A	Math III, Calculus for Mechanical		
MA-112B	Math III, Calculus for Mechanical		
PH-120A	Physics I/Laboratory		
PH-120B	Physics II/Laboratory		
PH-123A	Physics IV, Modern Physics		
LA-100A	Technical English		
LA-101A	Technical Report Writing		
CS-202A	Small Computer Systems		
EE-114A	Transistor Circuits & Applications/Lab		
EE-115A	Digital Electronics/Laboratory		
EE-121A	Electronics I/Laboratory		
EE-122A	Electronics II/Laboratory		
EE-123A	Electronic Circuits/Laboratory		
MT-125A	Metallurgy		
ME-129A	Machine Design		
ME-133A	Manufacturing Processes I		
ME-137A	Statics		
ME-176A	Strength of Materials		

DATE PROGRAM COMPLETED	GRADE POINT AVERAGE	COUNSELOR'S APPROVAL
DIVISION APPROVAL		DEPARTMENT APPROVAL

TECHNICAL INSTITUTE PROGRAM

SANDIA LABORATORIES · TRAINING & EDUCATION DIVISION

MECHANICAL TECHNOLOGY

DATE			
NAME	SOCIAL SECURITY NO.	ORG.	PHONE

COURSE NO.	COURSE TITLE	DATE COMPLETED	GRADE
MA-110A	Math I, Algebra & Trigonometry		
MA-111A	Math II, Algebra & Trigonometry, Advanced		
MA-112A	Math III, Calculus with Mechanical Appl.		
MA-112B	Math III, Calculus with Mechanical Appl.		
PH-120A	Physics I/Laboratory		
PH-120B	Physics II/Laboratory		
PH-123A	Physics IV, Modern Physics		
LA-100A	Technical English		
LA-101A	Technical Report Writing		
EE-121A	Electronics I/Laboratory		
EE-122A	Electronics II/Laboratory		
MT-125A	Metallurgy		
ME-128A	Mechanisms		
ME-129A	Machine Design		
ME-133A	Manufacturing Processes I		
ME-137A	Statics		
ME-126A	Dynamics		
ME-176A	Strength of Materials		
ME-138A	Engineering Materials		
CS-170A	APT I		
CS-243A	Basic Computer Principles		

DATE PROGRAM COMPLETED	GRADE POINT AVERAGE	COUNSELOR'S APPROVAL
DIVISION APPROVAL		DEPARTMENT APPROVAL

TECHNICAL INSTITUTE PROGRAM

SANDIA LABORATORIES TRAINING & EDUCATION DIVISION

MATERIALS TECHNOLOGY

NAME	SOCIAL SECURITY NO.	DATE ORG.	PHONE

COURSE NO.	CORE COURSES: COURSE TITLE	DATE COMPLETED	GRADE
MA-110A	Math, Algebra & Trigonometry		
MA-111A	Math II, Algebra & Trigonometry, Advanced		
MA-112A	Math III, Calculus with Mech. Applications		
MA-112B	Math III, Calculus with Mech. Applications		
MA-273A	Introduction to Statistics		
LA-100A	Technical English		
LA-101A	Technical Report Writing		
PH-120A	Physics I/Laboratory		
PH-120B	Physics II/Laboratory		
CH-122A	Chemistry I/Laboratory		
CH-122B	Chemistry II/Laboratory		
MS-102A	Material Science I		
MS-102B	Material Science II		
GA-134A	Basic Drawing & True Position Dimensioning		
ME-133A	Manufacturing Processes I		
Plus	Five Restricted Electives from below:		
	RESTRICTED ELECTIVES:		
SP-211A	Ceramics for Engineers		
ME-138A	Engineering Materials		
ME-176A	Strength of Materials		
ME-137A	Statics		
ME-126A	Dynamics		
CS-202A	Small Computer Applications (PDP-8)		
MT-216A	Metallurgy of Welding, Brazing & Soldering		
MT-125A	Metallurgy I		
MT-300A	Introduction to Powder Metallurgy (In-hours)		
EE-121A	DC Fundamentals		
EE-122A	AC Fundamentals		
PH-306A	Modern Methods of Material Characterization		

DATE PROGRAM COMPLETED	GRADE POINT AVERAGE	COUNSELOR'S APPROVAL
DIVISION APPROVAL		DEPARTMENT APPROVAL

TECHNICAL INSTITUTE PROGRAM
SANDIA LABORATORIES TRAINING & EDUCATION DIVISION

DRAFTING AND DESIGN TECHNOLOGY

DATE

NAME	SOCIAL SECURITY NO.	ORG.	PHONE

COURSE NO.	COURSE TITLE	DATE COMPLETED	GRADE
MA110A	Math I		
MA111A	Math II		
MA112A	Calculus, Part I		
MA112B	Calculus, Part II		
PH120A	Physics I/Lab		
PH120B	Physics II/Lab		
IA100A	Technical English		
IA101A	Technical Report Writing		
GA132A	TPD		
SK370	Drafting I (TVI)		
SK371	Drafting II (TVI)		
ME125A	Design for Fabrication		
ME137A	Statics		
ME176A	Strength of Materials		
ME129A	Machine Design		
	plus five restricted electives*		
	*The restricted electives are selected and approved		
	by the 9600 Organization, Grade 85, Selection Committee		
	in cooperation with the line supervisor and the student.		

DATE PROGRAM COMPLETED	GRADE POINT AVERAGE	COUNSELOR'S APPROVAL
DIVISION APPROVAL		DEPARTMENT APPROVAL

APPENDIX C

Letter Soliciting Opinions of TIR's and TIE's

SAMPLE

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: January 17, 1975

to:

from: H. M. Willis - 3130

subject: **Comparison of TI Recruits and TI Equivalents**

We are doing a comparison study of TI recruits (TIR's) and TI equivalents (TIE's). Jack Howard has suggested that this study include "personal opinions from the supervisors of differences in the two types."

Following is a list of graduates of each type for your department from FY 66 through FY 74. Please give us any opinions, criticisms, attitudes, or feelings you may have about either or both groups.

TIE's	TIR's

Your results will be synthesized with the others. The whole, in turn, will be summarized and may be presented at the Large Staff Spring Conference.

We would like to have your response by January 24, 1975. In the next few weeks, Gene Bates may contact some of you for further discussion regarding your responses.

OGBates:3132:hgt

Copy to:
3132 O. G. Bates
3130 H. M. Willis

APPENDIX D

A Comparison of TI Recruits and TI Equivalents

In January 1975, a memorandum was sent to 22 departments who had both TI recruits (TIR's) and TI equivalents (TIE's) working in their organizations. The memorandum solicited "personal opinions from the supervisors of differences in the two types." Responses were categorized as "No Discernable Difference," "TIE Advantage," and "TIR Advantage." Approximately 46% of the comments indicated No Discernable Difference, 27% gave the advantage to TIE's, and 27% the advantage to TIR's. (Note: Some departments gave responses from several divisions; also, many respondents gave supportive comments for all three positions!)

Comments in support of the positions taken by the respondents are as follows.

No Discernable Difference

No particular advantage to either method of obtaining the formal training course work....believe both avenues are worthy of maintaining if we expect a continuing need for technicians. The Tech Institute provides a much larger field from which we can continue to select only the best. The TIE's should produce technicians of comparable skills since only the best usually survive, but the number of quality performers from which to select may be limited.

There are TIE's with academic ability rivaling TIR's and there are TIR's who are excellent at doing and interfacing as well as theory.

Unanimous gut feeling that what leads to a good or valuable ESA has little to do with such subtleties as TIR vs TIE.

...Once the TI grad or TIE employee has been on roll for a year or two, I see little difference that can be ascribed to training.

We have not noticed any difference in drive or in motivation of the people which we feel can be attributed to training. We believe that this is largely a matter of the individual's personality.

...re TIE's and TIR's...have one of each,..both are super. Feel that the candidates for both programs are carefully screened and selected and only top-notch SA's result.

...No direct comparison possible...Performance of 5 TIR's compared to 1 TIE all satisfactory. Interests and responsibilities differ between the 5 TIR's and 1 TIE.

We can tell no consistent differences between TIE's and TIR's.

Both (TIE and TIR) are excellent....If both programs generate people of this caliber on a regular basis, then Sandia shouldn't worry about any small differences in qualifications between graduates of the two groups.

....I find no difference in work attitudes, abilities, or general "style" that can be attributed to a TIE or TIR status. Differences in these people seem to be simply human in nature not a result of different educational background.

...I can discern no significant differences.

...Both types of TI's appear to be extremely useful in the jobs to which they are assigned.

...I see no significant difference. Personnel in both groups are above average performers. Slight variation in performance does not appear to be due to difference in type of educational background but rather individual make-up and amount of on the job experience.

...I say they (1 TIE and 1 TIR) are both highly qualified and personable people. I like them both and think they are good for Sandia Laboratories.

...Both methods produce excellent talent. Both the TIE and TIR are, in my opinion, excellent ways to achieve a common objective.

Our problem with TIE's is to upgrade their technical knowledge since courses offered at Sandia are not directly applicable to our work...conversely, our problem with TIR's is to train them in our procedures and see that they obtain field experience as rapidly as possible...Since we require both career ESA's as well as designers who will progress to LSA and MLS categories in the future, we can utilize both TIE's and TIR's.

Not too much difference in the two groups. Very similar in overall performance.

TIE Advantage

(TIE has) a bit more maturity and considerable more familiarity on how the lab functions and how to utilize the various services provided.

...I feel a person who has earned a TIE is certainly equal to a TIR and in this specific case, better than the average TIR.

TIE people fit and can be adequately utilized, though in smaller numbers than TIR's...fits affirmative action plans and goals.

TIE's academic background ranges from good to excellent. TIE's have more practical experience...better in doing or directing assembly, wiring or fabrication work and at interfacing with the shop. Attainment of TIE indicates perserverance.

...The TIE's have a definite practical orientation which not all of the TIR's have--at least at time zero...They are also initially better at getting things done at Sanida Laboratories since they know how our system works.

...Our OJT specialty graduates do have the initial advantage of rotational experience in several areas such as ceramics, glass, hybrids, etc. This experience gives them a good comprehension of the state-of-the-art of several SLA technologies and first hand experience in who to go to for help in these areas. (This remark later reinforced by telecon statement indicating preference for hire would be TIE.)

...I would have to conclude that TIE's are at least as good, if not better, than TIR's.

...TIE route required special attributes and tenacity...TIE on completion has a good formal background as well as a day-to-day work experience...Sandia may be somewhat of a special case. Here we have a well integrated training opportunity, good technical staff availability, and a favorable climate to complement the formal with the work effort.

...Based on our experience with them (two older TIE's) we can conclude that the TIE makes just as desirable an employee as the TIR.

Our experience with TIR's and TIE's leads us to expect different career performances from the two groups...experience is extremely important and it is essential to know how construction is accomplished to be effective as a designer. For this reason, TIE's are

immediately productive in our area from the first day they report, but not TIR's unless they have had applicable work experience.

TIR Advantage

(TIR has) a select quality with high potential requiring primarily experience and opportunity to mature.

Four of the six TIR's can do high level technical work with little or no engineering direction, help or guidance. They are outstanding. The other two are slightly below the level of the other four. The TIE operates only under close engineering guidance. Evidence today indicates that the TIE, although he will improve with added experience will most likely never catch the TIR group in capability...TIE group doesn't get the same kind of people in the program (top 10% of TIR group).

TIR's have excellent academic backgrounds...TIR's younger and more up-to-date on latest technology.

Although our TIE's have worked out well for us thus far, we still feel that at the present time with all things being equal, if we had the choice we would probably hire the appropriate TIR rather than the TIE.

...better schools have done excellent job in keeping up with the needs of industry... problem is merging formal study into work situation...find that six to 18 months may pass before a TIR will be settled in the job. (TIE ad?)

TI grads, generally speaking, are above average compared to non-TI grads in comparable age groups.

...Although there are exceptions, it would appear that the TI equivalent personnel are somewhat behind the TI graduates in initiative, motivation, industriousness, conscientiousness, and the ability to accept responsibility. This may result from the grade point screening of TI graduates. Possibly they should only be compared to the top 10% of the TIE graduates.

In summary, I feel that generally speaking those who first seek out and then graduate from a tougher school are more highly motivated in the first place and this motivation generally is carried over into their Sandia jobs. There are exceptions and these are recognized in that some TVI people have done very well. A "TVI" tag is certainly not a "bad" tag per se.

...Generally, the motivation to excel along technical lines is greater in TIR's than in TIE's. This is not to say the TIE is not capable of excelling. The number of candidates is small and further limited by personal desires, interests, and ambitions. Due to differences in the time required to achieve a TIR vs TIE, it is generally conceded the technical know-how of the TIR can be assimilated in the work force at a faster rate than the TIE...The ratio of TIR's to TIE's should be in keeping with this desired capability.

...within 6 months to a year our TIR's (assuming good performance) are beginning to outperform the TIE's technically.

In addition to the foregoing comments, the following comments were made regarding continuing education, specific problems, and suggestions.

Other Comments

One problem with many TI grads is that they soon realize they "sold themselves short" by not taking a full engineering degree, and thus may face dead-end careers as technicians. Many of the ablest TIR's soon move on; often back to school to earn that BS or higher degree, or into jobs where promotion paths are less structured.

Both TI grads and non-TI grads (TIE's) seem about equally likely to take steps to further their education.

Normally the TIE will work within his classification for his entire career but we can expect many of the TIR's to continue their education.

Another comment made was that the TIR's tend to be the ones to go on for further schooling. Our statistics on these names indicated that the seeking of advance education was about equal for both groups.

General Observations, Problems and Suggestions

The reasons for the differences in the two groups (TIR vs TIE)...lies in the likelihood that the TIE group doesn't get the same kind of people in that program as compared to the people that are in the top 10% of the TIR group--i.e., the two programs don't get the same kind in, so you don't get the same kind out.

A suggestion we would make toward the education of our TIE's is that the curriculum be strengthened in the appropriate basic areas of technology, e.g., physics, chemistry, mechanics or electronics.

I feel that at Sandia the TIE route opportunities are generous and complementary to the work effort if supervision takes advantage of the possibilities. The TIE by time he has finished his formal education should be well integrated in the work situation.

We at Sandia select only the upper strata of TI graduates which further concentrates on academic motivation as well as natural mental capacity. This is reflected in job performance at Sandia since our problem-solving challenges exercise much the same motivation and mental capacity as the schools do.

When comparing TIR's and TIE's, consideration must be given to the time allotted for achieving these goals as well as the emphasis applied in the educational process. The TIR follows an ECPD accredited curriculum of technical subjects concentrated in a two-year time frame...Several career occupations are available to these graduates in the field of Engineering Technology. Engineering Design is only one of these occupations. It stands to reason that the TIR is a well rounded individual and adequately prepared to face a technical challenge...The TIE candidate, however, is usually a graduate of TVI where emphasis is placed on drafting careers...Once on roll, the TVI graduate must enroll in additional technical (core) courses if he desires to achieve a TI equivalency.

(This comment also documented under "No Discernable Advantage)...Our problem with TIE's is to upgrade their technical knowledge since courses offered at Sandia are not directly applicable to our work...conversely, our problem with TIR's is to train them in our procedures and see that they obtain field experience as rapidly as possible.

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