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ACCESSION NBR: 9411010214      DOC. DATE: 94/10/21      NOTARIZED: NO      DOCKET #  
 FACIL: 50-251 Turkey Point Plant, Unit 4, Florida Power and Light C      05000251  
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 PLUNKETT, T.E.      Florida Power & Light Co.  
 RECIP. NAME      RECIPIENT AFFILIATION

SUBJECT: LER 94-004-00: on 940923, Unit 4 tripped automatically from rated power. Caused by faulty regulator transistor. Faulty backup power supply replaced & maint history for power supplies reviewed. W/941021 ltr.

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L-94-245  
10 CFR 50.73

U. S. Nuclear Regulatory Commission  
Attn: Document Control Desk  
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Gentlemen:

Re: Turkey Point Unit 4  
Docket No. 50-251  
Reportable Event: 94-004-00  
Automatic Reactor Trip Due to Loss of Power to Rod  
Control Cabinet 1AC

The attached Licensee Event Report 251/94-004-00 is being provided  
in accordance with 10 CFR 50.73(a)(2)(iv).

If there are any questions, please contact us.

Very truly yours,

T. F. Plunkett  
Vice President  
Turkey Point Plant

TFP/CLM/cm

enclosure

cc: Stewart D. Ebner, Regional Administrator, Region II,  
USNRC  
Thomas P. Johnson, Senior Resident Inspector, Turkey Point  
Plant, USNRC

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# LICENSEE EVENT REPORT (LER)

FACILITY NAME (1) <b>TURKEY POINT UNIT 4</b>										DOCKET NUMBER (2) <b>05000251</b>		PAGE (3) <b>1</b> OF <b>5</b>	
TITLE (4) <b>AUTOMATIC REACTOR TRIP DUE TO LOSS OF POWER TO ROD CONTROL CABINET</b>													
EVENT DATE (5)			LER NUMBER (6)			RPT DATE (7)			OTHER FACILITIES INV. (8)				
MON	DAY	YR	YR	SEQ #	R#	MON	DAY	YR	FACILITY NAMES			DOCKET # (5)	
09	23	94	94	004	00	10	21	94					
OPERATING MODE (9)		1		<u>10 CFR 50.73(a)(2)(iv)</u>									
POWER LEVEL (10)		100%											
LICENSEE CONTACT FOR THIS LER (12)													
C. L. Mowrey, Operating Experience Feedback Engineer/Analyst										TELEPHONE NUMBER 305-246-6204			
COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)													
CAUSE	SYSTEM	COMPONENT	MANUFACTURER			NPRDS?	CAUSE	SYSTEM	COMPONENT	MANUFACTURER			NPRDS?
B	AA	RJX	L045										
SUPPLEMENTAL REPORT EXPECTED (14) NO <input checked="" type="checkbox"/> YES <input type="checkbox"/>								EXPECTED SUBMISSION DATE (15)		MONTH	DAY	YEAR	
(if yes, complete EXPECTED SUBMISSION DATE)													
<p>ABSTRACT (16)</p> <p>On September 23, 1994, Unit 4 tripped automatically from 100% rated power. Personnel working in the 4C 4160 VAC bus switchgear inadvertently caused a bus lockout, resulting in a loss of the backup power supply to the rod control system. The normal power supply to the IAC rod control cabinet (already degraded), also failed, and 12 rods dropped. The resultant pressure drop and negative flux difference lowered the OTAT setpoint below actual <math>\Delta T</math>, and the reactor tripped on OTAT.</p> <p>The C bus lockout was caused by the jarring of a differential relay, due to an interference between a breaker cubicle door and the wall of the switchgear room. The backup power supply failure was due to a faulty regulator transistor.</p> <p>The reactor trip on OTAT progressed as expected, and therefore did not impact the health and safety of the public.</p> <p>The faulty backup power supply was replaced, and 15 similar power supplies were inspected. Maintenance history for the power supplies was reviewed. Replacement power supplies are being evaluated. The interference between the cubicle door and the wall is being removed. The differential relays, as well as others with the potential to cause a spurious bus lockout, are being relocated off the cubicle doors.</p>													

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# LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME TURKEY POINT UNIT 4	DOCKET NUMBER 05000251	LER NUMBER 94-004-00	PAGE NO. 02 OF 05
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## I. DESCRIPTION OF THE EVENT

On September 23, 1994, Florida Power & Light Company's (FPL) Turkey Point Unit 4 was running at 100% reactor power. Three FPL electricians (non-licensed utility personnel) were performing an 18 month inspection of breaker 4AC01 in the 4C 4160 VAC (non-vital) bus switchgear [EA:swgr, brkr]. Several times throughout the day, the electricians opened and closed the breaker cubicle door, accessing the cubicle to use DC power for testing. Care was taken with the door operations, and no events occurred. At about 2:47 p.m., a relay was jarred when they closed the door to cubicle 4AC01, generating a C bus lockout signal. Power was lost to the C bus loads, among them one of two auctioneered power supplies to the Rod Control System power cabinets [AA:cab, rjx]. Twelve rods dropped into the core, and an Overtemperature Delta-T (OTAT) reactor trip was generated. The remaining rods tripped as expected.

With three exceptions, all plant equipment functioned as designed on the reactor trip. The 4A steam dump to atmosphere, valve CV-4-1606 [SB:pcv], should have opened automatically when the turbine tripped. The valve would not open in Automatic or in Manual, due to a leaking fitting. Relief valve RV-4-1418 [SJ:rv] opened as expected, but did not reseal. This valve relieves from the condensate header to the 4A steam generator feedwater pump. Turbine drain valve CV-4-3717 [SM:lcv] did not open automatically as it should have on the turbine trip.

The NRCOC was notified at 1603 on September 23, 1994. This event is being reported in accordance with 10 CFR 50.73(a)(iv), as an automatic actuation of the reactor protection system.

## II. CAUSE OF THE EVENT

The immediate cause of the reactor trip was a lowering of the OTAT trip setpoint to the actual core  $\Delta t$ , due to (1) the drop in Reactor Coolant System (RCS) [AB] pressure caused by the reduction in reactor power below turbine power, and (2) the large axial power imbalance (negative  $\Delta I$ ) caused by the dropped rods.

The intermediate cause of the trip was loss of both power supplies to the 1AC Rod Control Power Cabinet, resulting in the drop of all rods whose control rod drive mechanisms were controlled by the 1AC power cabinet. In each power cabinet, power supplies PS-1 and PS-2 are auctioneered together to provide 24 VDC to the power cabinet controls. Power supplies PS-3 and PS-4 are auctioneered together to provide -24 VDC to the power cabinet controls. PS-1 and PS-3 are fed from the Rod Drive Motor Generator set output. PS-2 and PS-4 are fed (ultimately) from the C bus.

The cause of the loss of the normal power to the 1AC cabinet was a faulty internal -24 VDC power supply. Power supply PS-3 in Cabinet 1AC was found at approximately -21 VDC when in parallel with PS-4 (both powered). When PS-4 was depowered (as it was when the C bus was lost), PS-3 was loaded and the output of PS-3 dropped to approximately -5 VDC. This shows that PS-4 was carrying the -24 VDC load during normal operation. Note that PS-3 was therefore running unloaded during normal operation, with PS-4 carrying the load. The unloaded -21 VDC output of PS-3 was not low enough to trigger the non-urgent failure alarm circuit in the Rod Control system. Normally this alarm would be triggered in the event of a failure of either of the two auctioneered power supplies.





# LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME	DOCKET NUMBER	LER NUMBER	PAGE NO.
TURKEY POINT UNIT 4	05000251	94-004-00	03 OF 05

When the 4C 4KV bus tripped, PS-4 was deenergized. PS-3 was supposed to pick up the load but dropped to approximately -5 VDC when loaded. This caused the -24 VDC normally supplied to the cabinet's five regulation cards to drop unacceptably low. As three of the five regulation cards are used to control the stationary gripper coils of twelve control rods, loss of the power supply caused the stationary gripper coils to deenergize, at which point the twelve control rods dropped into the core.

The root cause of the faulty power supply PS-3 was determined to be a faulty series regulator transistor, and appears to be an end-of-life failure. Sixteen of these power supplies are in use. Review of the maintenance history for the power supplies indicates one or two previous similar failures. Replacement power supplies with higher reliability are being evaluated.

The cause of the loss of normal power to the 1AC cabinet was a loss of the 4C bus as a result of the inadvertent actuation of the 187 4CBT1 C0 differential relay, when the door to breaker cubicle 4AC01 was bumped against a protruding bolt head.

The root cause of the jarring of the relay was inadequate clearance between the cubicle door and the wall of the switchgear room. When the Event Response Team evaluating the loss of the C bus entered the switchgear room and opened the 4AC01 cubicle door, contact was observed between the door and the west wall of the room. The switchgear room is built of a single sheet of stainless steel. The contact was with an overlap joint of the wall, and with a protruding bolt head on the overlap joint. The contact did not "torque" the door, but could cause sufficient jarring to actuate the relay. The team also noticed that the west wall, left of the door, was too hot to touch, while the right side of the door (where the 4AC01 cubicle is) was only warm. The sun had moved and the structures west of the 4C bus were shading the right side of the wall. It is probable that earlier, with direct sun on the right wall, the hotter right side would expand inward and cause binding of the door. If so, this effect would explain why door movements earlier in the day had not resulted in an event. The protruding bolt head described above was on a recently installed bolt, installed when the C bus switchgear was refurbished during the last refueling outage. The interference between the bolt head and the cubicle door was not recognized, although the sensitivity of the relays to jarring was known and publicized via signs on the switchgear cubicle warning of the consequences of jarring the relays. The signs were posted following a similar reactor trip about ten years ago, also caused by interference between the cubicle door and a protrusion.

### III. ANALYSIS OF THE EVENT

Although a multiple control rod drop is not an event specifically analyzed in the Turkey Point Updated Final Safety Analysis Report, a single rod drop is analyzed, with two possible rod worths. These analyses show that a dropped rod worth 600 pcm will result in an equilibrated plant at about 84% power in about 75 seconds, whereas a dropped rod worth 75 pcm is expected to result in an OTAT reactor trip in about 83 seconds. The OTAT trip results from reactor power (and therefore  $\Delta T$ ) gradually increasing above turbine power, so that the OTAT setpoint is reached.



# LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME  
TURKEY POINT UNIT 4

DOCKET NUMBER  
05000251

LER NUMBER  
94-004-00

PAGE NO.  
04 OF 05

In the event described in this report, the OTAT setpoint dropped faster than the actual  $\Delta T$  changed, when more than one quarter (12 of 45) control rods dropped into the core. The immediate suppression of flux into the bottom of the core caused the axial flux difference ( $\Delta I$ ) to become very negative. An axial power imbalance imposes a "penalty" on the OTAT setpoint, because the setpoint is predicated on a relatively uniform axial power distribution. Simultaneously, the immediate drop in reactor power without a concurrent drop in turbine power resulted in a drop in RCS pressure as Tavg dropped. Decreasing pressure also imposes a penalty on the OTAT setpoint, because lowering pressure lowers the reactor coolant boiling point, thereby increasing the potential for departure from nucleate boiling. The combination of penalties from the drop in RCS pressure and the large negative  $\Delta I$  resulted in the OTAT setpoint and the actual  $\Delta T$  converging in about 2 seconds, resulting in the reactor trip.

The scenario described above is a specific application of the purpose for which the OTAT reactor trip was designed, and it functioned as designed.

## IV. CORRECTIVE ACTIONS

1. Plant response to the reactor trip was verified to be as predicted, using the emergency operating procedures.
2. Relief valve RV-4-1418 was replaced, and steam dump valve CV-4-1606 was repaired. The other steam dump valves were checked for similar problems; none were found.
3. Work Request # 94014247 was written to have CV-4-3717 repaired during the present refueling outage.
4. The operation of the C bus breaker cubicle doors was investigated along with any interference with the floor or walls. The only interference found was between the cubicle door and the west wall of the switchgear enclosure.
5. The AC portion of the phase differential relay (all three phases), along with the associated current transformers, was inspected. No problems were found.
6. The C bus was reenergized after the phase differential relay and the lockout were reset.
7. The differential relays will be checked during the present refueling outage to determine the amount of spring tension necessary to actuate the target relays on all three phases.



# LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME  
TURKEY POINT UNIT 4

DOCKET NUMBER  
05000251

LER NUMBER  
94-004-00

PAGE NO.  
05 OF 05

8. Clearance tags were hung on the breaker cubicle doors 4AC01 and 3AC01 to prevent them from being opened without permission of the Plant General Manager.
9. The 4C switchgear side heating and resultant warpage will be investigated during the refueling outage, with consideration for increasing the clearance between cubicle doors and the outer skin.
10. The phase differential relays, and other relays which can initiate a spurious bus lockout are being relocated off the breaker cubicle doors.
11. The faulty PS-3 power supply in rod control power cabinet 1AC was replaced, and the root cause has been determined. A determination will be made if periodic replacement of the power supply or its components is warranted. Replacement power supplies are being evaluated.
12. The maintenance history for the sixteen rod control power cabinet power supplies was reviewed; evidence was found of one or two similar failures. The other fifteen power supplies were inspected; none showed signs of failure.

## V. ADDITIONAL INFORMATION

EIIS Codes are shown in the format [EIIS SYSTEM: IEEE component function identifier, second component function identifier (if appropriate)].

The failed power supply is manufactured by Lambda Electronics, with an expected mean time between failure, as defined by Lambda, of approximately five years.



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	12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