UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

June 3, 1991

Docket No.: 50-390

MEMORANDUM FOR: Scott Newberry, Chief
Instrumentation and Control Systems Branch
Division of Systems Technology

THRU: Evangelos C. Marinos, Section Chief
Section C
Instrumentation and Control Systems Branch

FROM: Hukam C. Garg, Sr. Electrical Engineer
Section C
Instrumentation and Control Systems Branch

SUBJECT: TRIP REPORT - ELECTRICAL CABLE ISSUES, WATTS BAR NUCLEAR PLANT, UNIT 1 (TAC NO. 71917)

During the weeks of December 10 thru 14, 1990 and January 7 thru 11, 1991, the NRC staff and two consultants, J.B. Gardner and D. Ford, conducted inspections at Watts Bar to asses the cable installation integrity at the plant. By memorandum dated April 22, 1991, we issued a safety evaluation report to the project on the corrective action program plan for the cable issues.

During the inspections we reviewed calculations of the worst case cable pullbys and walkdown information of installed conditions for cables vertical support and bend radius. We also walked down some conduits to verify the adequacy of TVA walkdowns. The results of our inspection for the week of December 10-14, 1990 is contained in enclosure 1 and for the week of January 7-11, 1991 is contained in enclosure 2. Subsequent to our inspection, we were able to close one of the open items identified in enclosure 1. Closure of this item is contained in enclosure 3.

Contact: Hukam Garg (SICB)
X20929

9106060292 910603
PDR ADOCK 05000390
P PDR

We plan to conduct more inspections at Watts Bar to close out open items identified in the inspections. During the future inspections, we will also perform walkdowns for conduits related to cable jamming and conduits running in close proximity to hot pipes.

HGarg

Hukam C. Garg
Sr. Electrical Engineer, Section C
Instrumentation and Control Systems Branch

cc: F. Hebdon
A. Thadani
P. Tam
G. Walton
K. Barr, RII

ENCLOSURE 1

January 14, 1991

(115)

To: Angelo Marinos
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission

From: J.B. Gardner
Daniel C. Ford

Subject: Special Assessment Report
Evaluation of Elements Involved in Bounding the Cable Pullby Damage Issue at Watts Bar Nuclear Station

OBJECTIVE

Verify that certain screening mechanics agreed upon by the NRC have been executed such that Class 1E conduit and cable rework and associated Hi Pot testing have adequately bounded the cable pullby damage issue. The issues targeted in the audit of December 10-14, 1990 were verification of the accuracy of conduit run features recorded by TVA walkdowns and the proper use of the derived information in calculating the relative ranking of lower risk conduit. This audit, together with previous screening elements previously discussed and agreed to by the NRC staff, would confirm that the TVA program provides adequate assurance that Class 1E cables, as they remain in the station, do not exhibit pullby damage of a degree that would result in failure to pass the Hi Pot voltage test.

ASSESSMENT AUDIT METHODOLOGY

1. Review of overall screening/disposition programs to confirm content of low risk category.

2. Selection and physical examination of sample low risk conduit runs for confirmation walkdowns.

3. Verification of TVA derived computer input data from conduit isometrics.

4. Verification of TVA derived installation sequence data for pullbys in the conduits.

5. Confirmation of TVA tension/SWBP calculations for the ranking of low risk conduits.

6. Review of Hi Pot Voltage test procedures and documentation.

7. General Comments

DISCUSSION

1. PROGRAMMATIC REVIEW OF SCREENING AND DISPOSITION OF RISK CLASSIFICATIONS.

With the assistance of many TVA engineers, the overall program of screening was reviewed. Its function was to initially sort all Class 1E conduits required for Unit 1 into high, medium and low risk categories for pullby damage; to further analyze high and medium risk into rework, low risk, and no pullby (accept as is) categories; and finally to rank by risk of damage the resulting 85 low risk conduits for voltage testing in order to demonstrate that the problem had been properly bounded. The highest ranked 20 conduits with V_1 and V_2 cables and 20 with V_3 and V_4 cables were selected for DC Hi Pot test.

TVA requested relief from consideration of pullbys of two moderate risk circuits (Trane A and B) to the pump house on the basis that their inspection of the installation gave convincing evidence that no pullby would have been possible even though installation records or lack of them implied that pullbys were possible. The cables and conduits (A 4096-B and A 4095-A) were inspected at the pump house and adjacent manholes by Mr. Marinos and the two consultant inspectors who were unanimous in judging one conduit (A 4095-A) as not able to be a pullby but the other (A 4096-B) as giving definite evidence of having been a pullby. The latter therefore was judged as requiring a dry Hi Pot test (shielded cables) or replacement.

Conclusion

No problems in the program's overall logic and validity were uncovered in this summary review. Most individual elements had been described by TVA in prior TVA/NRC meetings and, with the below noted exception, had been approved by NRC staff. (Refer to Section 6)

2. SELECTION AND PHYSICAL EXAMINATION OF LOW RISK CONDUITS TO VERIFY THE ACCURACY OF TVA WALKDOWN DATA

In order to ascertain the accuracy of the TVA isometric drawings utilized for low risk conduit calculations, the inspectors selected a sample of four (4) conduit runs for physical examination. The samples were chosen based upon risk classification, voltage category, and various complexities of the detailed conduit isometric. The following samples were selected:

CONDUIT#	RISK CLASSIFICATION	PROGRAM RANK	VOLTAGE
1PLC3359B	Low	12	V1, V2
1VC2963B	Low	25	V3, V4
1PM6350G	Low	56	V1, V2
2PLC1286B	Low	09	V3, V4

Cables for three of the four samples selected were tested in accordance with the requirements of the TVA program. The fourth sample, conduit 1PM6350G, was ranked below the top twenty of each voltage level and thus was not Hi Pot tested. Examination of the selected conduits was accomplished by detailed physical walkdown of

plant components. Aspects of component configuration which could directly impact the associated cable damage calculation were recorded and compared with TVA isometric drawings.

In general, the inspectors noted that the isometric drawings developed by TVA accurately reflected the physical configuration of the selected Class 1E conduit systems. Physical attributes such as conduit size, length, configuration, and fittings were found to have been accurately depicted on the subject isometrics.

During the walkdown, inspectors identified several discrepancies between the isometric and the installed configuration of conduit 1PM6350G.

- Beginning at the intersection of junction box 1-JB-292-1200 approximately 45 feet of the conduit is physically labeled 1PM5560G instead of 1PM6350G as shown on the isometric.

- Sections (A-A) through (C-C) shown on page 60 of the isometric do not accurately reflect the installed configuration of the subject conduit. The physical configuration exhibits a junction box, LB fitting, and 90 degree bend which are not shown on the isometric.

In response to these observations, TVA engineering personnel provided the inspectors a copy of Design Change Notice (DCN) 10469-A. This document specified the rework of the subject conduit to resolve a violation of separation criteria between the conduit and hot pipe. The inspectors noted that the design change does reflect the physical configuration observed in the field as well as the change in conduit labeling. Additionally, the review of associated work packages indicates that conduit rework had not been accomplished at the time of the TVA cable damage isometric walkdown. Consequently, the inspectors believe that the isometric in question did accurately reflect field conditions when initiated. No additional discrepancies were noted.

Conclusion

The TVA program for walkdown of low risk conduits appears to have been effectively and thoroughly implemented for the eighty-five conduits determined by the screening process to require detailed analysis. Conduit isometrics developed during the walkdown were comprehensive and found by sampling to accurately reflect the installed configuration of Class 1E conduits.

3. VERIFICATION OF TVA DERIVED DATA TAKEN FROM CONDUITS ISOMETRICS

The data necessary for pulling tension and side wall bearing pressure (SWBP) calculations, as given in the document Input Walkdown Data for CBLPUL Program (Attachment D WBPEVAR 9006013 dated 07/16/90), was checked against the isometric drawings of the four selected conduits. One error was found which would have a very minor effect on the calculations. An omitted dimension on one isometric was found to be properly entered into the data (as verified from the walkdown audit).

Conclusion

Data from walkdown isometrics was being properly documented for the tension/SWBP computer calculations.

4. VERIFICATION OF TVA DATA FOR PULLBY CONFIGURATIONS IN THE CONDUITS

Packets of cable pull data were assembled for the inspectors to use during the manual calculation of tension/SWBP off sight. These consisted of release slips and pull slips (Attachment 1 is a sample) issued to construction forces, and summary sheets listing the cable groupings (Attachment 1). Examination of the release and pull slips did not confirm all the pull dates listed in summary sheets from which the groupings were inferred, but there also were no conflicting dates. It had been indicated during the discussions that when pull slip dates were missing, then other sources of data sometimes assisted in establishing dates of pull, but if this information was in the packets, the inspector (J.B. Gardner) was not able to decipher it. Note further relevant comments in Section 7 below.

Conclusion

All of the cable pulling data that could be found on release and pull slips supplied did confirm the cable groupings upon which higher risk pullbys were judged and upon which calculated tensions/SWBPs were based. However, the inability of the inspector to verify some dates at this writing requires this issue to be an open item.

5. CONFIRMATION OF TVA TENSION/SWBP CALCULATIONS FOR THE RANKING OF 85 LOW RISK CONDUITS

TVA calculations were done with a computer program, the details of which were not examined. Using assumptions on friction and weight correction factors previously agreed upon and cable and conduit data confirmed as noted above, manual calculations of tensions and SWBP were performed for the severest pullbys in each of the 4 selected conduits. Three of the four pulls checked closely with TVA listed results. (See Attachment 2 for sample calculation) For the fourth conduit (2PLC1286B), ranked #9, the manual calculation resulted in tensions 11% under the TVA listed value. It was then assumed that the computer data entry may have mistakenly entered one short segment of the run as an upward rather than downward pull. Doing so resulted in manual calculation agreeing with TVA value within 1%, well within computational error. Such a data entry error would be quite understandable even for work that is QA checked as it entails much concentration in interpreting data for cable pulls in two directions where upward for one calculation changes to downward for the other. The manual calculation resulted in the ranking of #12 instead of #9 which would not effect the overall selection of highest risk 20s for Hi Pot test bounding of the issue.

Conclusion

Our manual calculations indicate that the basic assumptions necessary for, and the TVA computer calculations of tension and SWBP

were proper and as agreed with NRC during prior meetings. We believe the one difference found between manual and computer calculation may have been the result of a readily understood mistake of data entry. Such errors could affect the relative ranking of other conduits. Until the data processing issue is resolved, this issue remains open.

6. REVIEW OF HI POT TEST PROCEDURES AND DOCUMENTATION

To determine the effectiveness of TVA's implementation of the cable testing program, the inspectors reviewed test data sheets for several low risk conduits. Testing was performed in accordance with Site Instruction TI-43 "Test Procedure for High Potential Testing of Low Voltage Cables." The review focused on critical aspects of test implementation and the accuracy of subsequent results. In general, the inspectors concluded that testing had been accomplished in accordance with requirements and that appropriate test data was recorded and reviewed. No concerns were identified in this area.

The adequacy of the TVA High Potential testing program was previously evaluated by the NRC and is not within the scope of this assessment. However, the inspectors did raise concerns with regard to TVA's decision to eliminate testing of eight cases of abandoned and spare cables. This issue will remain an open item pending further NRC evaluation.

7. GENERAL COMMENTS

The location of all relevant documentation for details of conduit configuration, cable pulling, screening procedures/calculations/ results, and test procedures and results was a formidable task for anyone not closely involved with the voluminous archives (a five foot high stack for this one cable issue). Through the very helpful assistance of several engineers who were intimately familiar with the records and the compiling methods, all information requested by the inspectors was retrieved with only occasional delay.

Retrieval in the future, when personnel may have shifted situations, could prove difficult. This suggests that some effort might best be made by TVA to write brief keys to the records to benefit anyone needing to retrieve recorded information at a later time.

It should be recognized that no absolute conclusions about possible remaining cable pullby damage can be drawn from the screening/testing/rework program being completed. The NRC has agreed to the basic logic assumed in determining the relative risk of various features in cable pulling but it is based on subjective judgments and actual installation practices are unknown. The overall experience validates the conservative policy that TVA has now adopted for all future pullby situations.

CONCLUSION

On the basis of discussion with TVA engineers, examination of procedural documents and recorded data, physical walkdown of sample conduit runs, and manual calculations to check computer generated

results, we believe the overall screening procedures and Hi Pot testing by TVA were properly carried out. With the resolution of the open item of testing abandoned and spare cables, we believe the objective verification has been made.

Respectfully submitted,

J.B. Gardner, Consultant
Daniel C. Ford, Consultant

Attachments:

1. Sample Cable Grouping List and Pull and Release Slips Packet
2. Sample Manual Calculation
3. Isometrics of Sample Runs
4. Personnel Assisting Audit
5. List of Documents

ATTACHMENT #4

Personnel Present or Assisting in December 10-14, 1990 Audit

Laureen Dohan	TVA Licensing
Roger Hall	Electrical Engineering
Jim Hutsan	Electrical Engineering
Daniel C. Ford	NRC Consultant
J.B. Gardner	NRC Consultant
Angelos Marinos	NRC
Hukam Garg	NRC
Glenn A. Walton	NRC Resident
K.W. Brown	TVA
Houshong Hemmaiti Arass	TVA Construction
Paul Reilly	TVA
Tom Hughes	TVA
Dennis Lashley	TVA
Jim Kelnosky	S & L (TVA)
Mike Bricky	TVA Lead EE
Jon Hehls	S & L
Terry Hall	TVA

ATTACHMENT #5

List of Significant Documents Reviewed

Inspector: Daniel C. Ford Report No.:_____ Page: 1

Number	Revision	Full Title	Date
WBPEVAR8912002	0	TVA Calculation, Cable Damage-Resolution for High Risk Conduits	12/4/89
WBPEVAR8912012	0	TVA Calculation, Cable Damage-Resolution for Moderate Risk Conduits	12/22/89
WBPEVAR9006013 (with lettered attachments)	0	TVA Calculation, Evaluation of Low Risk Conduits Which Meet Program Screening Criteria	7/17/90
TI-43	0	Site Instruction-Test Procedure for High Potential Testing of Low Voltage Conduits	7/13/90
WDO13	0	Walkdown of Low Risk Conduits Associated With the WBN Cable Damage Issue for Selecting Test Samples	N/A
DCN M-08093-A		Moderate and High Risk Cable & Conduit Replacement	2/1/90
PLG-0744	1	An Evaluation of Cable Damage Susceptibility From Pullby Events at the Watts Bar Nuclear Plant	12/89
LETTER	N/A	TVA Responses to NRC Comments Resulting from August 1-3, 1990 Meeting	10/11/90
LETTER	N/A	Electrical Cable Damage-Assessment And Resolution Plan (1st Letter of three of same date)	6/15/90
QIR EEBWBN89003	0	Pull Charts for Use in Cable Pullby Resolution	12/11/89

WBN CABLE PULL

Date: 07/16/90
Time: 18:47:57

CABLE GROUPINGS FOR LOW RISK CONDUITS

SORTED BY: Conduit, Cable Group

Conduit	Size	From	To	Est Length	VL	Tot Cabs	Cable No	Number Cables	Mark Number	Mark No Overide	Comments	Sys	Pull Slip	Install Date	Release Date	From	Insp	Pull Group
1PLC1976B	-CONT																	
							1PL 6330B	1	WGC-1			3		07/25/81	/ /	10	99	3
							1PL 6330B	1	WGC-1			3		12/09/83	/ /	156	61	4
							1ABN 681B	1	WLO		FOR 1-4PL-67-3920-B	285		03/08/84	/ /	12	58	5
							1PL 3011B	1	WFC-1			30		01/12/85	/ /	12	186	6
							1PL 3920B	1	WFC-1			67		10/06/86	/ /	2	65	7
1PLC2852A	3.0	0-3TRY-292-2314/2313-A A3T/757	0-JB-292-3411-A A3Q/757	50	3A	11	SP 828A	1	WHJ		FOR 1-3PL-31-4021-A	285		08/10/79	/ /	20	95	1
							SP 827A	1	WHG		FOR 1-3PL-31-4022-A	285		08/25/79	/ /	4	59	2
							1PL 3243A	1	WHG			31		03/11/80	/ /	31	120	3
							1PL 3304A	1	WHG			31		03/11/80	/ /	31	120	3
							1PL 3783A	1	WHG			31		03/11/80	/ /	31	120	3
							V 1181A	1	WGC-2			31		03/19/80	/ /	49	85	4
							V 1196A	1	WGB-2			31		03/20/80	/ /	29	59	5
							1PL 3242A	1	WHE-1			31		08/06/80	/ /	1	137	6
							V 1195A	1	WGB-1			31		04/10/82	/ /	30	98	7
							V 1242A	1	WHB-1			31		06/30/82	/ /	2	69	8
							1PL 3302A	1	WHG-1			31		08/13/82	/ /	48	117	9
1PLC3345B	3.0	0-JB-292-3420-B A1Q/757	1-MCC-214-B1/11-B A3R/757	50	4B	5	1PL 3263B	1	WLO			90		04/24/79	/ /	33	78	1
							2PL 3819B	1	WLO			90		06/07/79	/ /	33	78	2
							1PL 4040B	1	WMT			31		08/10/79	/ /	32	95	3
							1PL 3308B	1	WFA-4			31		12/13/79	/ /	29	120	4
							1PL 3795B	1	WLC			31		03/05/80	/ /	29	98	5
1PLC3359B	2.0	1-JB-292-4981-B A1T/737	0-4TRY-292-2183/2184-B A1R/757	70	4B	7	1PL 6152B	1	WFC-1			62		08/29/79	/ /	27	85	1
							1PL 3011B	1	WFC-1			30		/ /	11/22/79	27	131	2
							1PL 6330B	1	WGC-1			3		07/25/81	/ /	10	99	3
							1PL 6330B	1	WGC-1			3		12/09/83	/ /	156	61	4
							1ABN 681B	1	WLO		FOR 1-4PL-67-3920-B	285		03/08/84	/ /	12	58	5
							1PL 3011B	1	WFC-1			30		01/12/85	/ /	12	186	6
							1PL 3920B	1	WFC-1			67		10/06/86	/ /	2	65	7
1PLC3484B	2.0	0-3TRY-292-2274/2275-B A4S/757	0-JB-292-4020-B A4T/757	55	3B	9	1PL 5521B	1	WGE			31		02/20/80	/ /	31	120	1
							1PL 3612B	1	WHC			31		03/13/80	/ /	29	98	2
							1M 3005B	1	WHB-1			31		11/22/80	/ /	10	99	3
							1PL 5203B	1	WHC			31		10/14/82	/ /	54	69	4
							1PL 5204B	1	WHB-1			31		10/16/82	/ /	54	69	4
							1PL 5206B	1	WHC			31		10/16/82	/ /	54	69	4
							V 2083B	1	WGD			31		11/07/82	/ /	129	81	5
							V 2084B	1	WGD			31		11/08/82	/ /	129	69	6
							V 2085B	1	WGD			31		12/10/82	/ /	129	72	7
1PM 5661E	3.0	1-PENT-293-19-E R-Z17/734	1-JB-293-5057-E R-Z316/751.9	90	2E	8	1ABN 746E	1	WVB		FOR 1-2PM-68-5135-E	285		12/13/82	/ /	124	60	1
							1ABN 747E	1	WVB		FOR 1-2PM-68-5137-E	285		12/13/82	/ /	124	60	1
							1PM 5133E	1	WVB			68		12/13/82	/ /	124	60	1
							1PM 5139E	1	WVB			68		12/13/82	/ /	124	60	1
							1PM 5141E	1	WVB			68		12/13/82	/ /	124	60	1
							1PM 5143E	1	WVB			68		12/13/82	/ /	124	60	1
							1PM 5145E	1	WVB			68		12/13/82	/ /	124	60	1
							1PM 5349E	1	WVB			68		02/27/84	/ /	47	117	2
1PM 6256J	3.0	1-JB-290-TEE-J C50/708	1-JB-290-4043-J C5P/741	50	2J	16	1PM 3874J	1	WVA			63		/ /	02/23/79	20	66	1
							1PM 598J	1	WVA			68		09/17/79	/ /	20	95	2

ATTACHMENT E
WBPEVAR9006013
REVISION 0
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?

Not verified from pull card given to us

1/15/91 Attachment 1

A-1

This appears to be pull #1 /29
into 33.59 B
See no data /109

1-→PL-12-6152-6
REV: R1 CONDS 1-30 SIZE 12 ~~5~~ 77A INSTALLATION CABLE
TYPE LC
LGTH 00619
CONN 45D1769
CONN 45D1769
LV 4L
LOC 143 772
LOC 143 492
1/4
F/-
LC277A ? /109
TRY:
2491, 2492, 2493, 2474, 2473, 2472, 2471, 2470, 2469, 2411,
2415, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207,
2103, 2122, 2030, 2029, 2028, 2027, 2026, 2001, 2002,

PULL

+185

ATTACHMENT I
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WBNP-QCP-3.5

CABLE PULL INSTRUCTIONS

MAXIMUM ALLOWABLE PULL TENSION 157 LBS.

ROPE PULL DEVICE SIZE _____ ☐ YES ☒ NO

POWER ASSIST PULL REQ'D. ☐ YES ☒ NO

SPECIAL PULL INSTRUCTIONS: WBFI-E- N/A

DATA BY: D. Ray DATE: 7-20-79

CABLE PULL DATA

START FT MK 87102 STOP FT MK 87750

REEL WB6242 INST LENGTH 648

FOREMAN [illegible]

ENGINEER HKR 8-24-79 W. Gautier

Release date 7/29

ATTACHMENT I

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Modifications and Additions Instruction

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MAI-3
Data Sheet 1
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DATA SHEET 1

CABLE INSTALLATION SHEET

Appears may be pull group 6/139.

5.1 Cable No.: 1-4PL-62-6152-B Revision: 1 Workplan No.: 4965
Mark No.: WFC-1 Size: 10 AWG/MCM Conds: 1-3C
Routed Length: 648 ft. Allowed Bend Radius: 1.948 Max. Pull Tension: 249
FROM: Equip. ID: 1-MCCC-213-B1/4D-B Location: A4S/772
TO: Equip. ID: 1-MTR-62-AOP-B Location: A4U/692
FOR: Cent. Charging Pump 1B-B Aux Oil Pump 1B-B Supply ECN: 5229

Conduit: 1PLC755B, *1PLC3359B, *☆1PLC1976B, *1PLC598B, *1PLC277B

Tray: 2490, 2491, 2492, 2493, *2474, *2473, *2472, *2471, *2470, *2469, *2411, 2222, *2220, *2185, *2184, *2183, *2067, *2065, *2068, *2069

Reel # & lengths do not agree with attached slips/139.

5.5 Reel No.: WB13084
Start ft. Mark: 02182 Stop ft. Mark: 01532 Installed Length: 650'
Rope Pull Device Size: ~~1/8 FDN 168~~ 240/85 Dynamometer ID: NA CWJ 2-21-85 Cal Due Date: NA CWJ 2-21-85

5.7 Work Performed by: Harley H. Rivin 1-10-85
Craft Foreman Date

Date does not agree exactly with list/139

6.1 Cable Installation Acceptable: ☆ W. Bonn 1-9-85
QC Inspector Date

Remarks: Walked Route of Cable down and verified trays 2473 thru 2471 by Dwg (tray's missing) 2-45 in 885-63 R5 all other's found acceptable WB 1-8-85
also verified Cable Reel + type Cable WB 1-8-85
* Verified Cable route through these trays + Conduit WB 1-9-85 ~~*1PLC 1976 half done~~ WB 1-9-85
* Verified these trays & Conduit MMM 1-9-85
☆ Completed the rest of run WB 1-9-85

WORKPLAN 4965

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B-(

Cable 3357 + 1/2

No Data

1-4PL-30-3011-B

REV: RO CONDS 1-3C SIZE 10 5471A INSTALLATION CABLE

FROM 1-MCC-214-B1/10A-B TYP WLC LGTH 00475

TO: 1-MTR-30-182/-B LOC A3R 757 CONN 4581772 0A

FOR: CNTFGL CHRG PMP B-B RM CLR FAN SUP LOC A4U 692 CONN 4581772 0A

NV 4B

CND: 1PLC2780B,1PLC244B

TRY: 2219,2187,2188,2189,2190,2191,2192,2193,2194,2148,2113, 12
2111,2063,2030,2029,2028,2027,2000,2001,2002,2003

PULL

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WBNP-QCP-3.5

CABLE PULL INSTRUCTIONS

MAXIMUM ALLOWABLE PULL TENSION 250 LBS.

ROPE PULL DEVICE SIZE _____ ☐ YES ☒ NO

POWER ASSIST PULL REQ'D. ☐ YES ☒ NO

SPECIAL PULL INSTRUCTIONS: WBFI-E- N/A

DATA BY: D. R. McCall DATE NOV 22 1979

CABLE PULL DATA

START FT MK [illegible] STOP FT MK 15648

REEL W[illegible] INST LENGTH 596

FOREMAN Clemmy Summers

ENGINEER Gary Rittenhouse

Release 11/22/79 /pg.

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C-1

1-APL-67-3920-B

[illegible] pulled into MCC

[illegible]-67-3920-B DATE: 08/08/85 773 INSTALLATION CABLE ACTY:
RU CONDS 1-3C SIZE 10 TYP WLD, WPC-1 LGTH 03331
1-MCC-214-81/6B-B LOC A2R 737 CONN 4581772-6B
1-MTR-67-108/-B LOC K-7- 722 CONN 45W1772-6
[illegible] STRAINER B-B SUP NV 48,48,48,48
[illegible] COL MAX.PULL 1249 MIN.BEND 0002.338 PA-2

?

LC27638, 1PLC33892, 1PLC19768, 1PLC33958, 1PLC8718, 1PLC246
LC47-

[illegible]

A CABLE WITH THIS NUMBER HAS BEEN ABANDONED AND ASSIGNED NUMBER 1-4ABN-285-0681-B
A NEW CABLE ASSIGNED THIS NUMBER AND THE ABANDONED CABLE ARE INSTALLED IN THE CONDUITS AND TRAY LISTED ABOVE.

MB 6.21.90

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DATA SHEET 1

CABLE INSTALLATION SHEET

5.1 Cable No.: 1-4PL-30-3011-B Revision: 1 Workplan No.: 4965
Mark No.: WFC-1 Size: 10 AWG/MCM Conds: 1-3C
Routed Length: 596 ft. Allowed Bend Radius: 1.948 Max. Pull Tension: 249
FROM: Equip. ID: 1-MCCC-214-B1/10A-B Location: A3R/757
TO: Equip. ID: 1-MTR-30-182-B Location: A411/692
FOR: Cent. Charging Pump 1B-B Room Cooler Fan Supply ECN: 5229

Conduit: 1PLC2780B, 1PLC3359B, 1PLC1976B, 1PLC598B, 1PLC244B

Tray: 2219, 2187, 2186, 2185, 2184, 2183, 2067, 2065, 2068, 2069

CONDUIT CONTAINING ID

5.5 Reel No.: WB 13084
Start ft. Mark: C1530 Stop ft. Mark: 00930 Installed Length: 600'
Rope Pull Device Size: PDN-166 240 lbs Dynamometer ID: N/A Cal Due Date: N/A
5.7 Work Performed by: Harly W. Rice / 1-12-85
Craft Foreman Date

6.1 Cable Installation Acceptable: Jim P. Prince / 1/12/85
QC Inspector Date

Remarks: N/A's Pulled By Hand WJS 1-11-84
Verified Route WJS 1-11-84 Also wire Type & Reel
* Pulled Cable in those Conduit & tray WJS 1-11-84
* Pulled Cable thru wall AUX Bldg 4410 WJS 1-11-84
* VERIFIED CABLE THROUGH 1PLC3359B (757 GLB) INTO CABLE TRAY 2183, 2184, 2185, 2186, 2187, AND 2219 THROUGH 1PLC2780B TO 1-MCC-214-B1/10A-B. 1-11-84
** VERIFIED CABLE THRU 4B2065, 4B2068, 4B2069, 1-PLC-598-B, AND 1-PLC-244-B TO 1-MTR-30-182-B 1-12-85

WORKPLAN 4965

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P.O. NO. 283

C-2

1-4PL-67-3920-B 77B

LOP

WBNP-QCP-3.5

CABLE PULL INSTRUCTIONS

Info. Transferred from file Copy 9/9/85

VERIFIED: WFC-1 ON CABLE AT MCC. Milburn A. Collins 9/4/85

MAXIMUM ALLOWABLE PULL TENSION 249 LBS.

ROPE PULL DEVICE SIZE _____ ☐ YES ☑ NO

POWER ASSIST PULL REQ'D. ☐ YES ☑ NO

SPECIAL PULL INSTRUCTIONS: WBFI-E- NA

DATA BY: P. Martin DATE: 2-24-84

CABLE PULL DATA

START FT MK 04368 STOP FT MK 03640

REEL WB 8039 INST LENGTH 728

FOREMAN Harvey D. Davis

ENGINEER James Austin 3/8/84

DYNAMOMETER NO. _____

MEASURED BEND RADIUS NA

INSP PER QCP-3.05 REV 19

Appears to be pull gp. #5

ATTACHMENT I

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C-3

1-4PL-67-3920-B 774 INSTALLATION CABLE
REV: R1 CONDS 1-3C SIZE 10 TYP WIRE LGTH 02970
FROM 1-MCC-214-B1/6B-B LOC A2 CONN 458177
TO: 1-MTR-67-10B/-B LOC K-10 722 CONN-
FOR: ERCW STRAINER B-B SUP NV 4B

QC&R JUL 2 1982

4 CONDUITS ADDED ECN 2849

CND: 1PLC2763B, 1PLC24B, 1PLC47B

TRY: 2218, 2219, 2187, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2147,
2123, 2122, 2064, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037,
2039, 2040, 2041, 2054, 2109, 2102, 2103, 2104, 2105, 3878, 3623,
3630, 3632, [illegible] 3642, 3644, 3646, 3651, 3656, 3658, 3660, 3665,
3672, 3674, 3679, [illegible] 3688, 3693, 3698, 3700, 3702, 3707,
3714, 3716, 3721, [illegible] 3735, 3740, 3742, 3744, 3749,
3526

PULL

Pile #3

Deleted

ATTACHMENT F
WBNEVAR5016013
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THIS PULL CARD DELETED.
SEE R0 PULL CARD
MAB 6.21.90

Cont

Reel	1st	2nd	Total
WB 6847	74508	75277	1231
			2300
			3531

WBNP-QCP-3.5

CABLE PULL INSTRUCTIONS

MAXIMUM ALLOWABLE PULL TENSION 250 LBS.

ROPE PULL DEVICE SIZE 7 [X] YES [ ] NO

POWER ASSIST PULL REQ'D. [X] YES [ ] NO

SPECIAL PULL INSTRUCTIONS: WBFI-E- N/A

DATA BY: D. Ray DATE: 7-12

CABLE PULL DATA

START FT MK 00002 STOP FT MK 02302

REEL WB 2931 INST LENGTH 2,300 + 1231 = 3531 total

FOREMAN [illegible]

ENGINEER Peggy Hilson

Pull completed to MH 4B only

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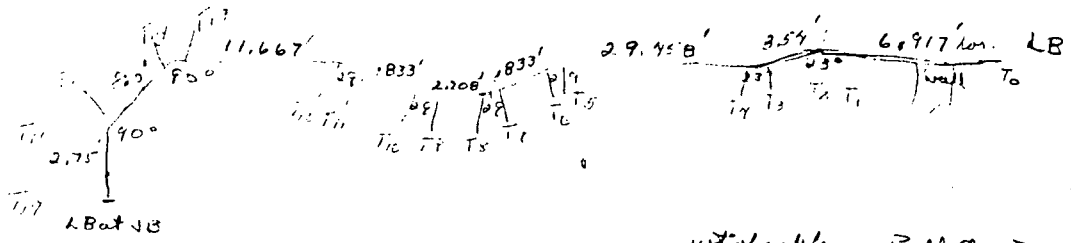
1/[illegible]/91 Attachment #2 12/21/90
Sample Manual Calculation J. Gardner

WBN SWBP Calc

Item 12 1PLC3359B Conduit Segment #1 2" conduit R = 8.47" = .7058

Reverse pull with 2 90's near the end should be worst case.



wt of cable. Pull qn 2.

WFC-1 3/c #10 PXHS .2460#/1

Cable being pulled over like cable.

K = .75 Wc = 1.0 (single cable

θ = 23° = .4014 Rad, cos θ = .3907, sin θ =

θ = 29° = .5061, cos θ = .4848, sin θ =

θ = 90 = 1.5708,

$T_1 = 6.917 \times .246 \times .75 = \underline{1.276}$ lbs

$T_2 = 1.276\, e^{.75 \times .4014} = \underline{1.9063}$ lbs (1.494)

$T_3 = 1.9063 - 3.54 \times .246\,(.3907 - .75 \times .246 \times .9205) = \underline{1.7139}$ lbs (.2207, .16983)

$T_4 = 1.7139 \times 1.494 = \underline{2.5606}$ lbs

$T_5 = 2.5606 + 29.458 \times .75 \times .2460 = \underline{7.9956}$ lbs. (7.135)

$T_6 = 7.9956 \times e^{.75 \times .5061} = \underline{11.686}$ lbs (1.4617, .3797)

$T_7 = 11.686 - .833 \times .2406\,(.4848 - .75 \times .8746) = \underline{11.7203}$ lbs (-.1712, 1.03413)

$T_8 = 11.7203 \times 1.4617 = \underline{17.1316}$ lbs

$T_9 = 17.1316 + 2.208 \times .75 \times .2460 = \underline{17.5390}$ lbs (.4074, .1845, .2460)

$T_{10} = 17.5390 \times 1.4617 = \underline{25.6367}$ lbs

$T_{11} = 25.6367 + .833 \times .2406\,(.4848 + .75 \times .8746) = \underline{25.8653}$ lbs (1.1407)

$T_{12} = 25.8653 \times 1.4617 = \underline{37.8073}$ lbs

$T_{13} = 37.8073 + 11.667 \times .1845 = \underline{39.9598}$ lbs (2.1525)

$T_{14} = 39.9598\, e^{.75 \times 1.5708} = \underline{129.795}$ lbs (3.2482, 1.1781)

$T_{15} = 129.795 + 8.0 \times .1845 = \underline{131.271}$ lbs

$T_{16} = 131.271 \times 3.2482 = \underline{426.39}$ lbs. compared to 431 by Summary T. (1% Difference)

$T_{17} = 426.39 - 2.7$ not needed.

$SWBP = \frac{T}{R} \times 1. = \frac{426.4}{.7058} \times 1 = 604.\#/1$ [illegible] and 611#/1

1% Difference

1/14 Attachment #3
4 Conduits (8 pp)

WALKDOWN OF LOW RISK CONDUITS ASSOCIATED WITH THE WBN CABLE DAMAGE ISSUE FOR SELECTING TEST SAMPLES	WD013 Rev. 0

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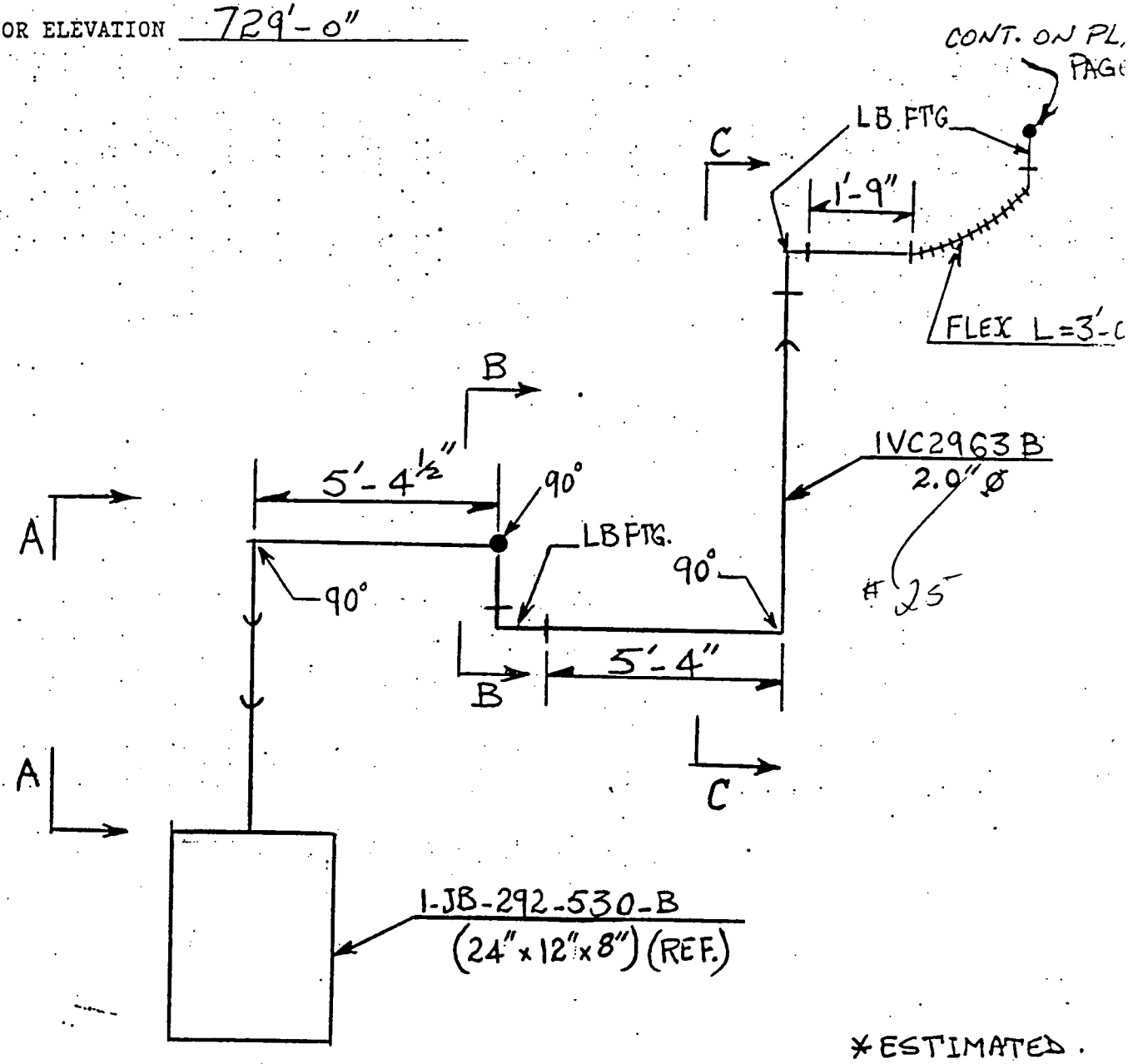
CONDUIT WALKDOWN SKETCH SHEET

SKETCH NUMBER _____ BUILDING LOCATION MSVR (A2U) (SOUTH)

FLOOR ELEVATION 729'-0"



*ESTIMATED.

ELEVATION

George F. Romano, 6-20-90
First-Party Verifier Date

Michael Hutzin, 06-20-90
Second-Party Verifier Date

WALKDOWN OF LOW RISK CONDUITS ASSOCIATED WITH THE WBN CABLE DAMAGE ISSUE FOR SELECTING TEST SAMPLES	WD013 Rev. 0

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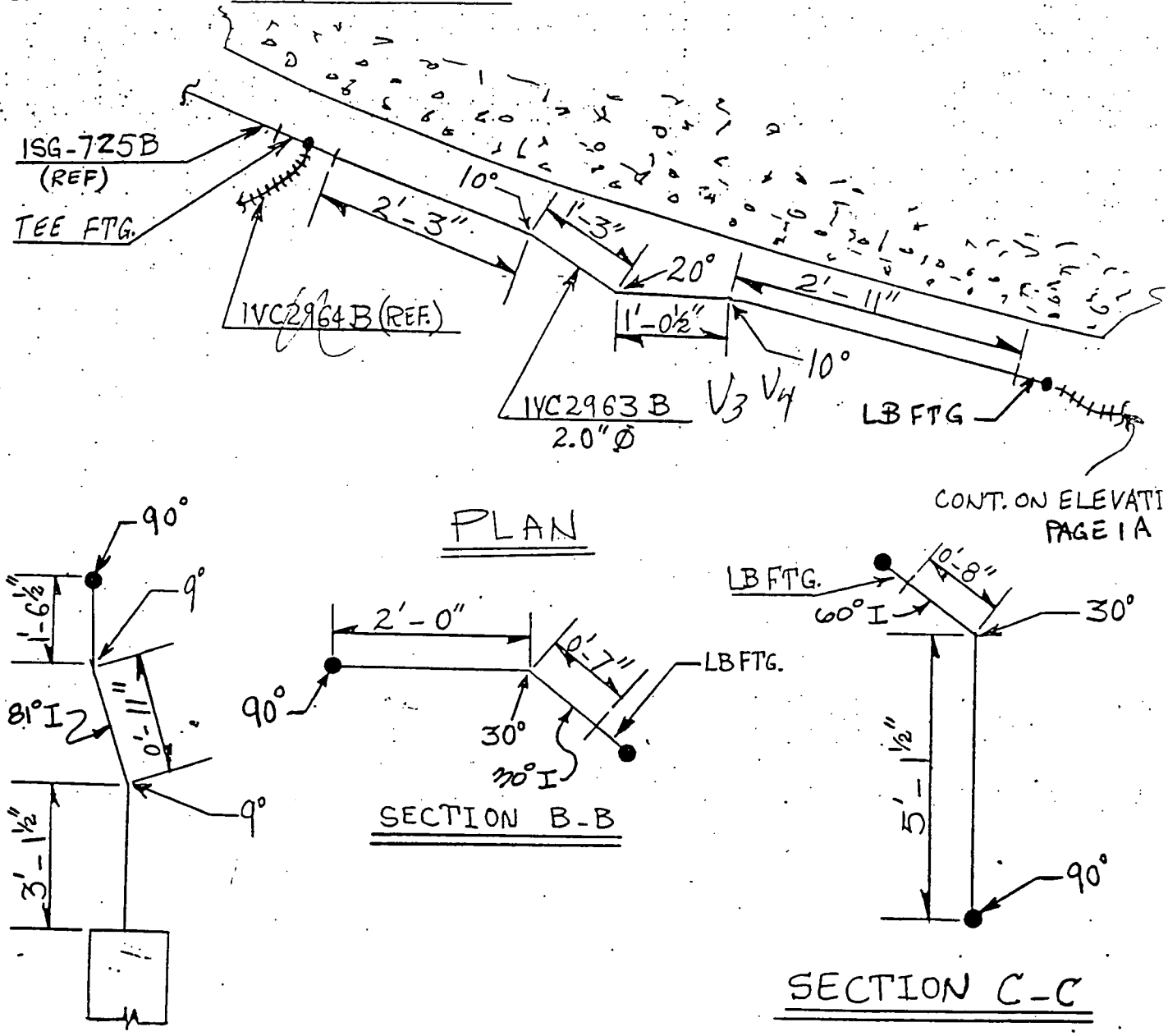
CONDUIT WALKDOWN SKETCH SHEET

SKETCH NUMBER _____ BUILDING LOCATION MSVR (A2U) (SOUTH)

FLOOR ELEVATION 729'-0"



I = ANGLE FROM HORIZ.

George F. Rowand, 6-20-90
First-Party Verifier Date

Michael Hutzen, 06-20-90
Second-Party Verifier Date

ATTACHMENT D
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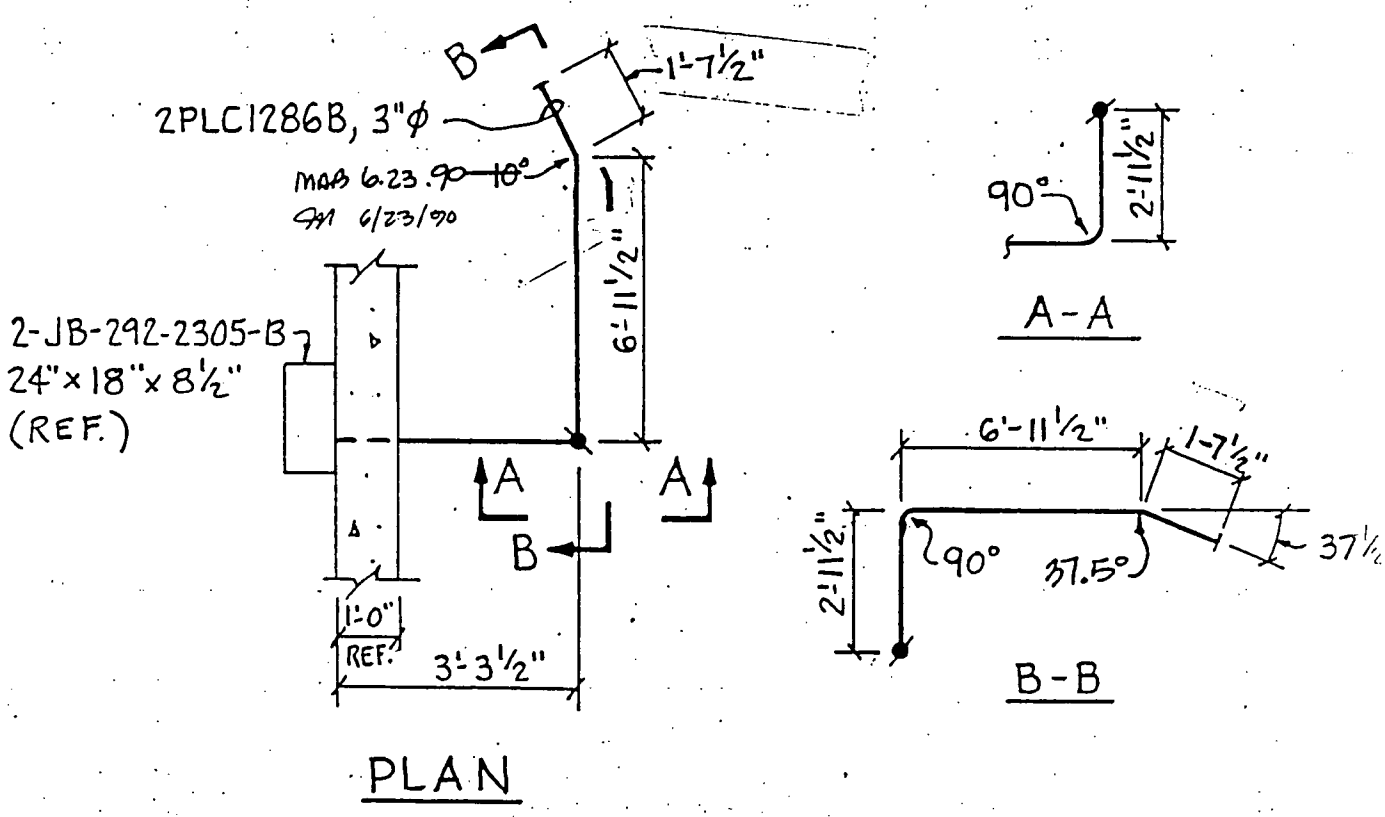
CONDUIT WALKDOWN SKETCH SHEET

SKETCH NUMBER _____ BUILDING LOCATION AUX. (A13T)

FLOOR ELEVATION 737.0'



V3, V4

Elyd D. Dodson, 06/23/90
First-Party Verifier Date

Warley C. Wallace, 6/23/90
Second-Party Verifier Date

WALKDOWN OF LOW RISK CONDUITS ASSOCIATED WITH THE WBN CABLE DAMAGE ISSUE FOR SELECTING TEST SAMPLES	WD013 Rev. 0

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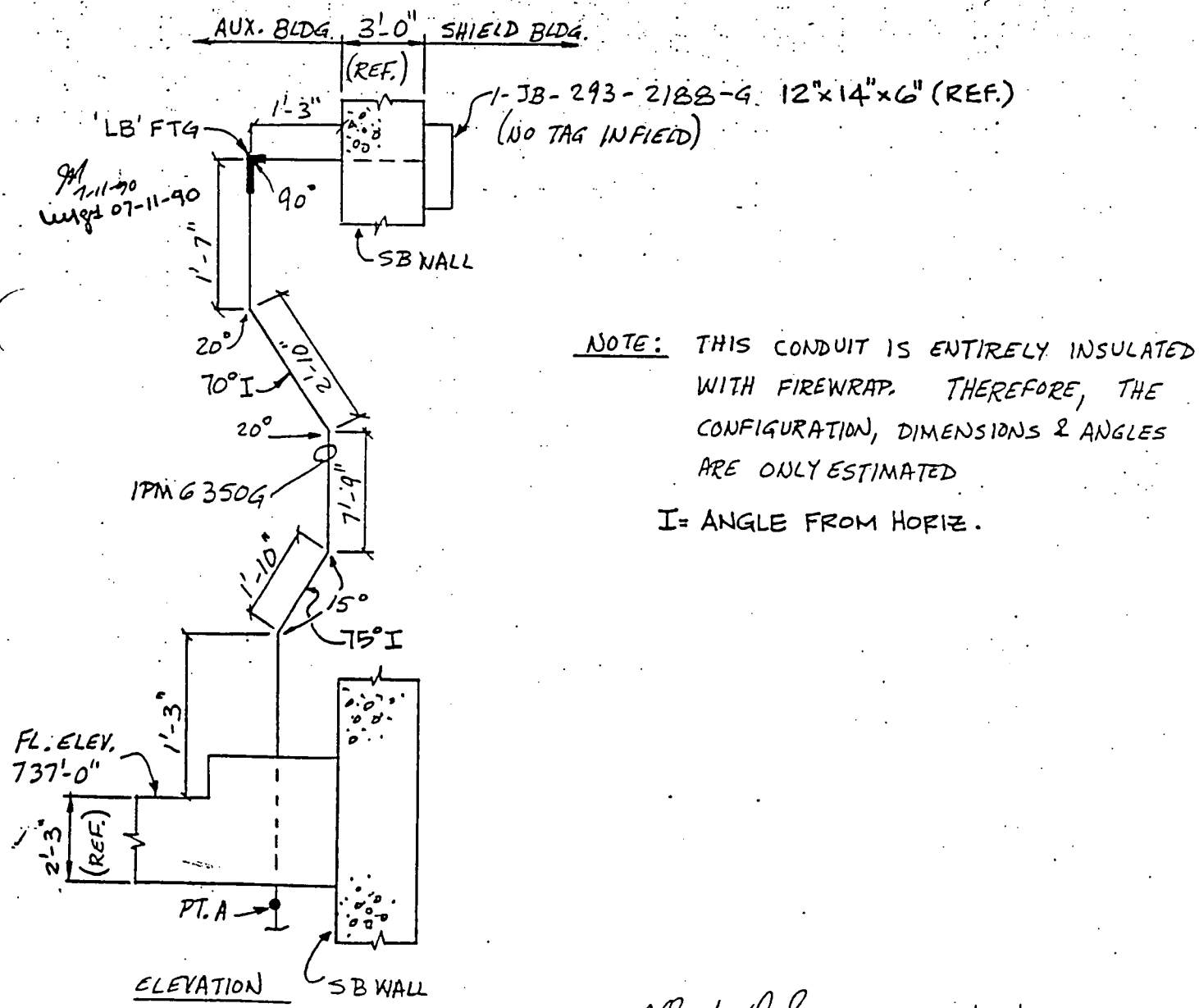
CONDUIT WALKDOWN SKETCH SHEET

SKETCH NUMBER _____ BUILDING LOCATION AUX (A5-W)

FLOOR ELEVATION 737'-0" & 744'-0"

REACTOR ANNULUS (R-Z 286°)



Alfred Dehange / 6/25/90
First-Party Verifier Date

Michael Hutzin / 06-25-90
Second-Party Verifier Date

WALKDOWN OF LOW RISK CONDUITS ASSOCIATED WITH THE WBN CABLE DAMAGE ISSUE FOR SELECTING TEST SAMPLES	WD013 Rev. 0

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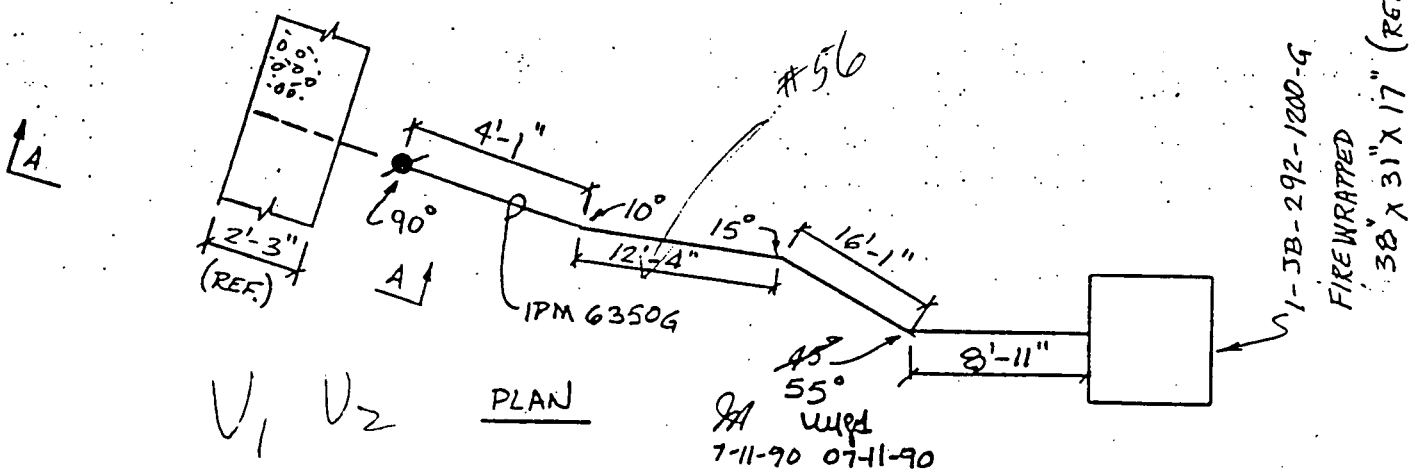
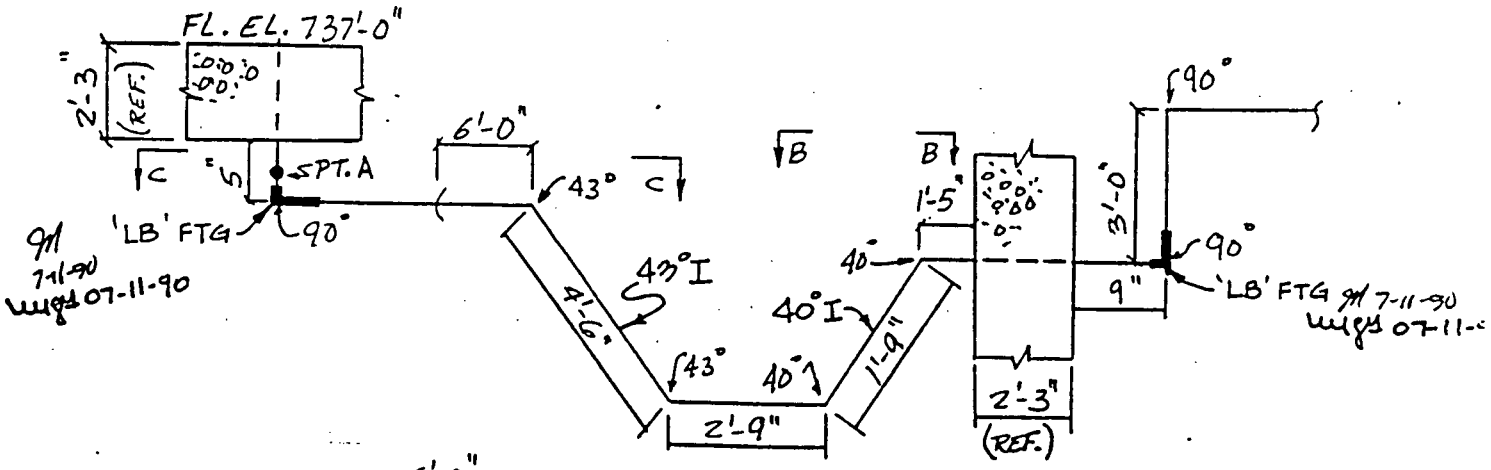
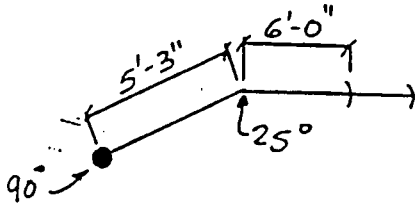
CONDUIT WALKDOWN SKETCH SHEET

SKETCH NUMBER _____ BUILDING LOCATION AUX (A5-W)

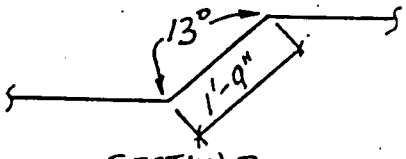
FLOOR ELEVATION 713'-0"







SECTION C-C



SECTION B-B

I = ANGLE FROM HORIZ.

Alfred Dahlonge : 6/25/90
First-Party Verifier Date

Michael Hutzen / 06-25-90
Second-Party Verifier Date

ATTACHMENT D
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ATTACHMENT B
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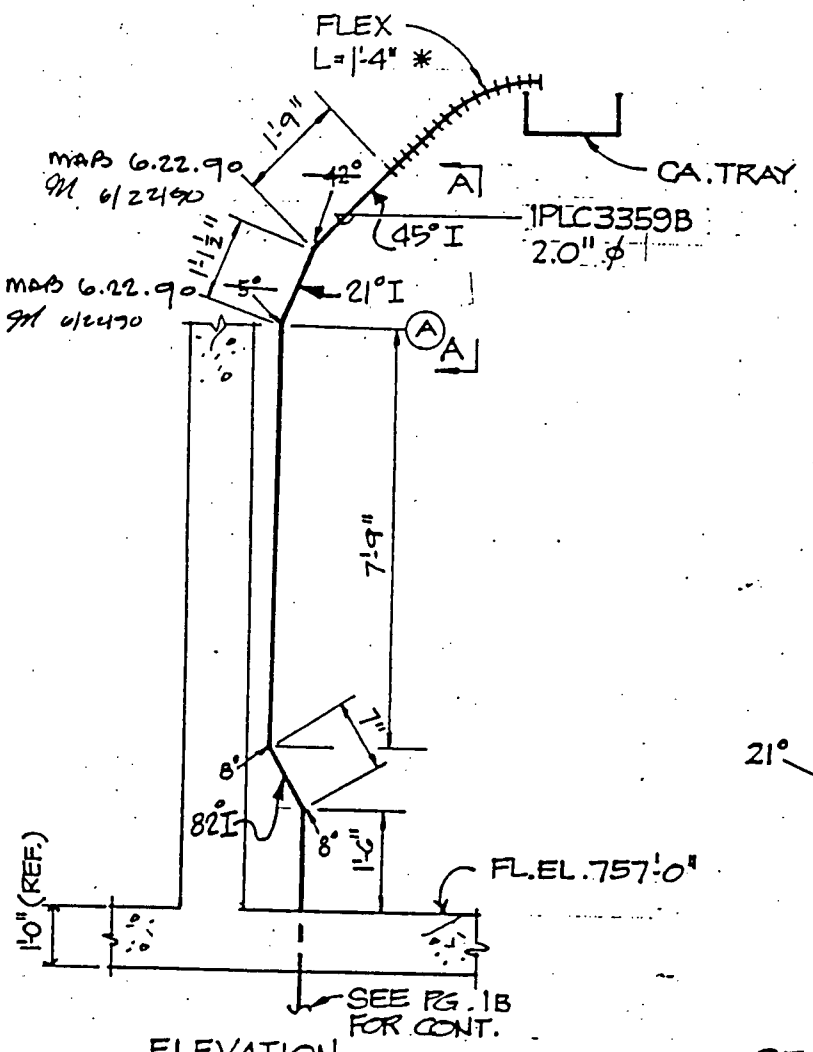
CONDUIT WALKDOWN SKETCH SHEET

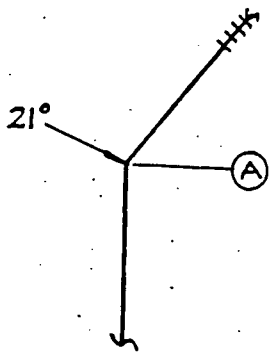
SKETCH NUMBER _____ BUILDING LOCATION AUXILIARY (AIR)

FLOOR ELEVATION 757'-0"

V1, V2



ELEVATION



SECTION A-A

* ESTIMATED
I = ANGLE FROM HORIZ.

F B Carrigan / 06-22-90
First-Party Verifier Date

Scott S. McClendon / 06-22-90
Second-Party Verifier Date

ATTACHMENT D
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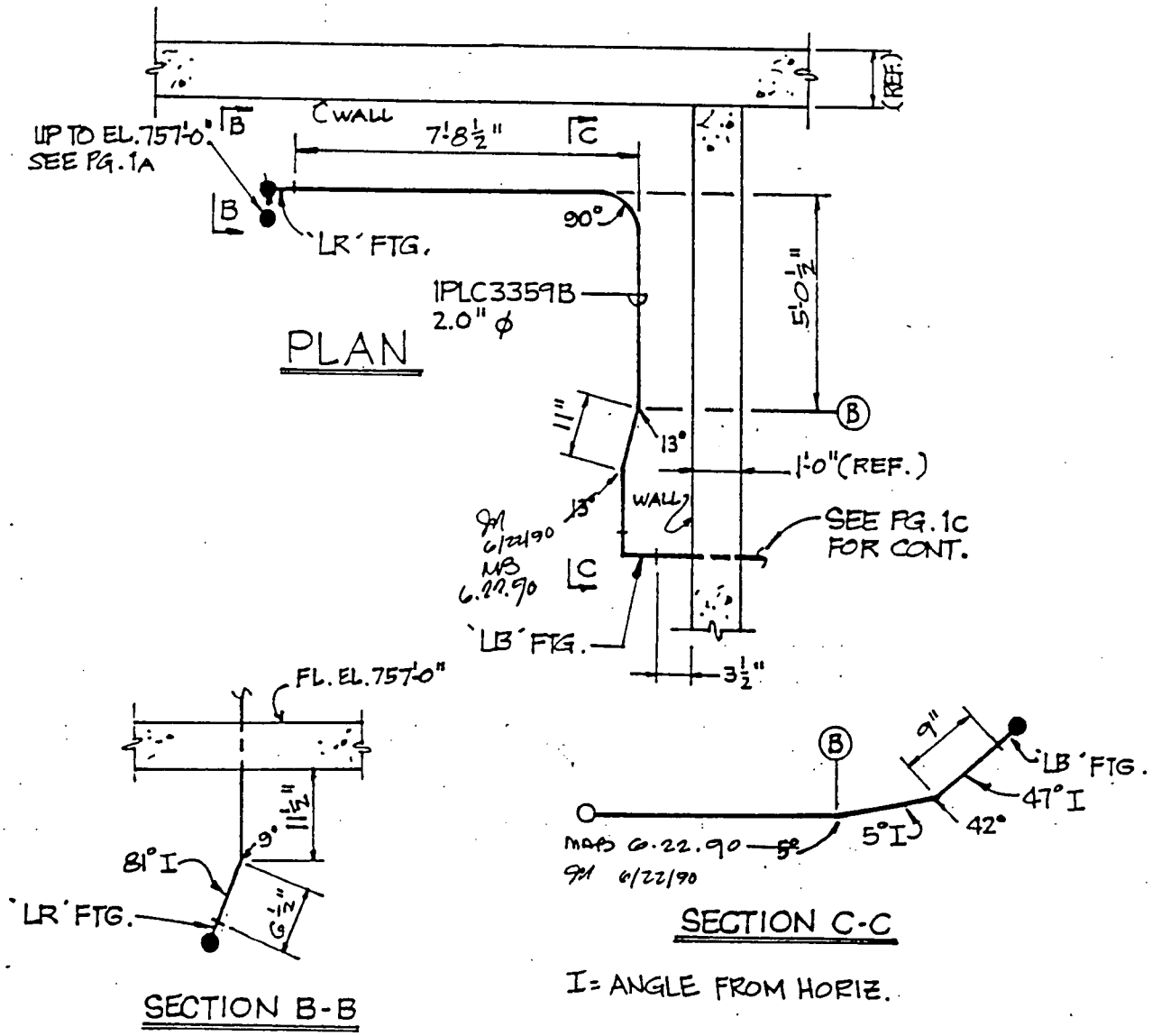
CONDUIT WALKDOWN SKETCH SHEET

SKETCH NUMBER _____ BUILDING LOCATION AUXILIARY (A2R)

FLOOR ELEVATION 737'-0"



F B Conlegan / 06-22-90
First-Party Verifier Date

Scott L McClendon / 06-22-90
Second-Party Verifier Date

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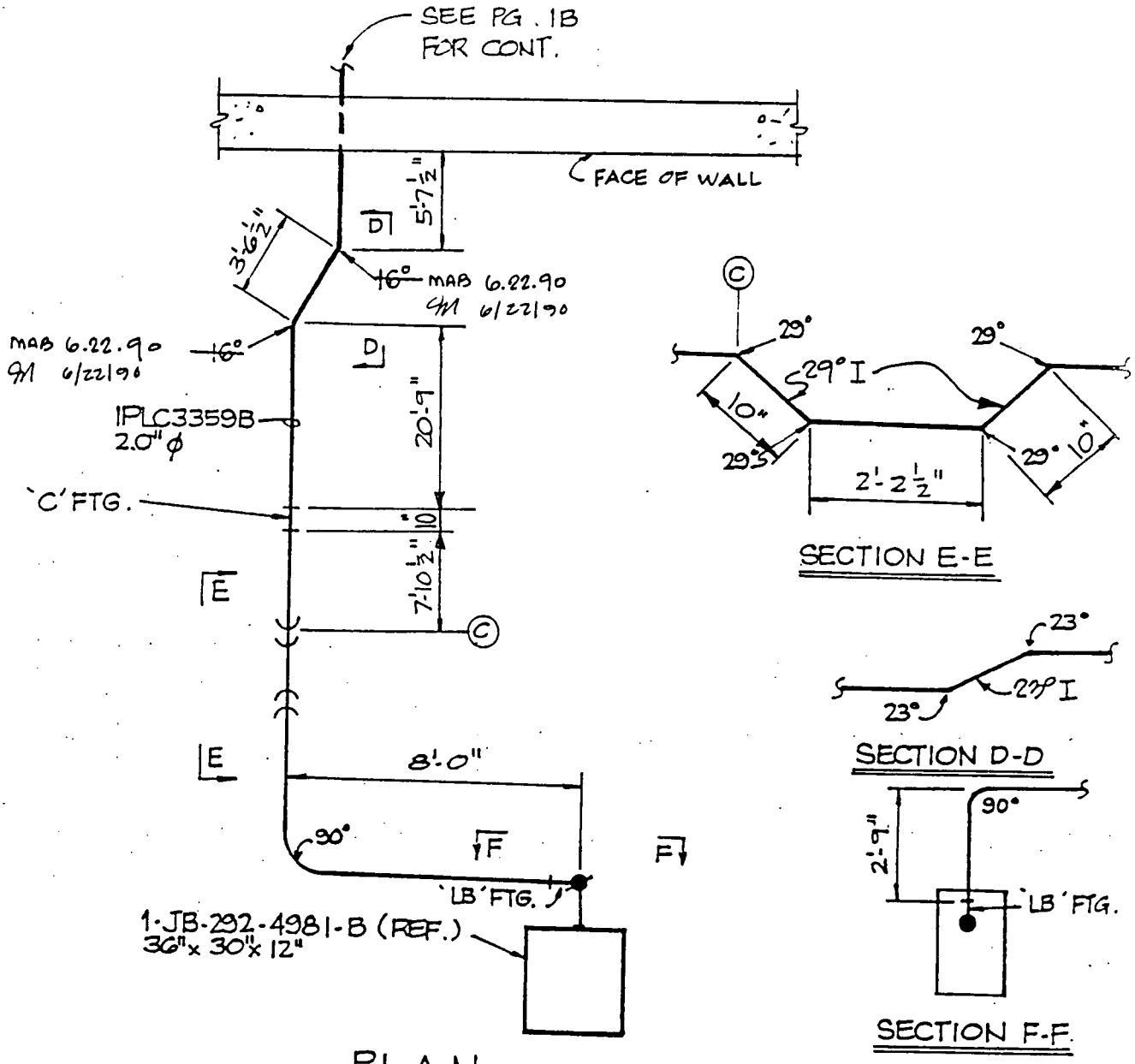
CONDUIT WALKDOWN SKETCH SHEET

SKETCH NUMBER _____ BUILDING LOCATION AUXILIARY (AIT)

FLOOR ELEVATION 737'-0"



I = ANGLE FROM HORIZ.

FD Ouegov / 06-22-90
First-Party Verifier Date

Scott J. McClendon / 06-22-90
Second-Party Verifier Date

ENCLOSURE 2

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UNITED STATES NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION

SPECIAL ASSESSMENT REPORT
EVALUATION OF WATTS BAR CABLE ISSUES
CABLE BEND RADIUS - VERTICAL DROP - CABLE JAMMING

JANUARY 7 - 11, 1991

J.B. Gardner

Daniel C. Ford 3/14/91

J.B. Gardner
Daniel C. Ford
Consulting Engineers
January 18, 1991

TO: Angelo Marinos
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission

FROM: J. B. Gardner
Daniel C. Ford

SUBJECT: Special Assessment Report
Evaluation of Watts Bar Cable Issues (Cable Bend Radius, Vertical Support, Cable Jamming)

OBJECTIVE

This NRC special assessment provides an evaluation of actions taken by TVA to resolve significant cable issues identified at the Watts Bar nuclear generating station. The assessment focused upon those actions taken to resolve cable issues in three areas; cable bend radius, cable jamming and vertical support. In each of these areas the objective of the assessment was to confirm that TVA programs and subsequent corrective actions have provided adequate assurance that Class 1E cable installations have not been degraded and will perform their intended function.

DISCUSSION

I. EVALUATION OF CABLE BEND RADIUS ISSUE

The implementation of the TVA program for resolution of Class 1E cable bend radius issues was examined in detail during the assessment. The program consisted of both testing which was performed by TVA at it's Central Laboratories Services Department in Chattanooga, and physical examination of class 1E cable installations at the Watts Bar facility. Test activities were conducted in order to evaluate the various fault mechanisms and to establish a "lower bound" for configuration of Watts Bar cable installations. Testing consisted of bending single conductor cables ranging in size from 16 AWG to 500 MCM to the point at which some significant deformation occurred or to the minimum practical bend. A "lower bound" was then established representing the radius at which cable deformation occurred plus one cable diameter. Test results were then utilized in the development of inspection and acceptance criteria for examination of Watts Bar cable installations. This criteria is detailed in Table I of the June 15, 1990 TVA response to the NRC.

The table also details those actions which must be taken for cables which exhibit a bend radius which is less than either the lower or upper bounds establish by testing. These limits, expressed in multiples of cable diameters, are uniquely applied based on cable type and the environment which the cable will experience. In general, cables which exhibit a bend radius less than the lower bound must be replaced. Cables which exhibit a bend radius between the lower and upper bounds will be retrained to at least the upper bound, and remaining cables will be used "as-is". Several specific exceptions to these general criteria have been established and are detailed in the subject table and clarified in the licensee's response of June 15, 1990. These include compliance with manufacturers requirements for Class 1E 10 CFR 50.49 cables located within primary containment and the application of high-potential withstand tests for certain cable configurations.

Having established inspection and acceptance criteria the licensee initiated a program of field verification designed to identify and correct those cables which did not meet minimum bend radius criteria. The effort involved both physical examination of cable installations and radiographic examination of cable segments which were otherwise inaccessible. The sections which follow detail the NRC evaluation of this effort.

a. Walkdown of Class 1E Cables

Discussions with licensee personnel indicate that approximately 4200 cables have been targeted for examination of cable bend radius criteria. Within this population multiple segments exist which may require cable examination. To accomplish this inspection activity TVA initiated work plan K-M10950-1. The work plan details general inspection methodology and prescribes remedial corrective actions when cable bend radius is determined to be within the upper and lower bounds established by the aforementioned test activities.

To date over 3,800 cable segments have been inspected by the licensee. Of this population approximately 200 segments were examined through use of radiographic techniques. (Details of this process are provided in section b. of this report.) Discussions with licensee personnel indicate that work completed to date (both walkdown and required radiographic examination) represents approximately 25% of the total inspection effort. As a result of this effort a total of 35 cables have been identified which will require replacement due to bend radius deficiencies. The inspections have also identified a number of cable segments exhibiting configurations which could be retrained to meet the established acceptance criteria.

In order to determine the effectiveness of licensee actions in this area the inspectors reviewed the subject work plan and selected a sample of conduit/cable segments for physical examination. Inspection methodology was then discussed with both engineering and quality control personnel to determine the adequacy of the licensee's walkdown effort. The discussions disclosed some confusion with regard to the method utilized to measure cable minimum bend radius. Additionally, the review of work plan K-M10950A-1 indicated that no procedural guidance had been given to personnel performing this activity. In general, measurements were taken using calibrated templates which were intended to be formed to the inside radius of the cable bend. However, discussions with inspection personnel indicated that placement of the templates was not always consistent with this approach. Additionally, the "As-Found" condition of the cables examined was not recorded during the walkdown.
To further evaluate the effectiveness of the licensee's program the NRC inspectors performed a walkdown of several cable segments and monitored TVA inspection and engineering personnel as they accomplished minimum bend radius measurements. Inspections were accomplished at conduit fittings, pull boxes, and at the transition point between conduit and cable tray. In general, the walkdowns indicated that those inspection personnel were knowledgeable and had properly implemented the requirements of the controlling work plan.

Based upon these observation the NRC has identified two concerns which must be addressed by the licensee prior to closure of this issue.

1. The lack of formal guidance with regard to methodology utilized in taking cable bend radius measurements challenges the integrity of walkdowns completed to date. Consequently, the inspectors believe that TVA should reinspect a sample of (59) previously examined cables which were retrained utilizing a methodology prescribed in formal work procedures. Additionally, since these cables had been accepted during the original bend radius walkdowns, any configuration which fails to meet the minimum bend radius criteria should be reported to the NRC.

2. Future CABLE BEND RADIUS walkdowns should incorporate provisions for recording the "As-Found" condition of the cables examined.

b. Radiographic Examination of Class 1E Cable Conduit Fittings

In order to determine the bend radius of class 1E cables located within conduits or conduit fittings that are sealed or otherwise impractical to measure visually, TVA initiated a program of radiographic examination. The methodology and technique utilized in this effort are described in temporary change 90-31 of TVA procedure NRC-2. A review of this procedure indicates that it provides sufficient detail and technical guidance to assure control of the radiographic process.

The NRC inspectors selected a sample of conduit segments for review of associated radiographic film. The review focused on the adequacy of the resultant image and the licensee's determination of the pass/fail mechanism described in the controlling procedure. The following radiographic packages were reviewed:

EEU-153	EEU-211	EEU-011A	EEU-15A
EEU-081	EEU-083	EEU-055	EEU-167
EEU-171	EEU-218	EEU-178	EEU-100
EEU-202	EEU-020	EEU-193	EEU-026
EEU-217	EEU-098		

The inspectors noted that for most of the packages reviewed image quality was very good. Conductor definition was clear and with few exceptions provided an adequate basis for evaluation of minimum bend radius. Approximately 200 cable segments had been examined using this technique. In fourteen of the segments examined cables exhibited a configuration which was less than the minimum bend radius and were dispositioned rejectable. Subsequent physical examination of these locations determined that in all but four locations the actual cable configuration was acceptable and no further actions were required. The four remaining cable segments will be retrained or replaced following further licensee evaluation.

Based upon this review the inspectors concluded that the methodology utilized in this effort had been effectively controlled and implemented. Additionally, since the impact of wet or harsh environments on these cables is of primary concern, cable segments encased in RTV sealant are effectively sheltered from the effects of moisture and high temperatures. Consequently, further radiographic examination of V1 & V2 circuits in RTV filled condulets should not be required.

CONCLUSION

In general, the audit indicates that TVA programs and actions taken to resolve cable bend radius concerns have successfully bounded the issue and provide adequate corrective action where required. However, of some concern was the lack of formal guidance with regard to methodology used in taking cable bend radius measurements. This concern could adversely impact the adequacy of physical CABLE BEND RADIUS inspection performed to date. As such, the licensee should initiate a program to reinspect (59) previously examined cables in order to demonstrate the integrity of completed walkdown activities.

Additionally, this issue will remain an open item pending NRC review of final test data from the TVA Central Laboratories Service Department's test program for cable minimum bend radius.

II. EVALUATION OF CABLE JAMMING ISSUE

The inspectors determined that insufficient TVA actions have occurred to properly evaluate this issue. Consequently, no status or conclusions will be provided in this report.

III. EVALUATION OF VERTICAL SUPPORT ISSUE

The assessment of the vertical support issue was separated into concerns for silicone rubber cable and those for cable with other than silicone rubber insulation. (See enclosure 2 of the June 15th, 1990 Supplemental Information on WBN Cable Issues letter). The assessment focused on the general issue of vertical support and then specifically addressed concerns with silicone rubber cable. The audit consisted of the following:

a. Review of the June 15, 1990 Supplemental Information on WBN Cable Issues letter, Enclosure 2, "Cable support in vertical Tray and Conduit", and Enclosure 6 "Commitments".

b. Review of the screening process including calculation WBPEVAR9005001.

c. Detailed check of the screening of 5 sample conduits previously identified to TVA by the NRC staff.

d. Review of TVA walkdown procedure WD006.

e. Walkdown of 3 sample conduits to verify the adequacy and accuracy of data.

f. Review of Construction Standard G-38, revision 10 for updated conduit vertical support policies and practices.

g. Review of silicone rubber cable screening and disposition.

A. TVA plans and commitments for resolution of vertical conduit/cable support issues as described in the June 15, 1990 letter included evaluation of the impact of the excess vertical drop on connected equipment , as well as walkdowns with analysis and required modifications for Class 1E cables, and revision of design and construction procedures. The NRC assessment of TVA actions indicates that the latter two subjects have been addressed in detail but the effect on connectec equipment is addressed only by reference to an "Equipment Seismic Qualification" CAP. (WBPEVAR9005001 Sec. 9.1.5) This CAP is being reviewed by the NRC under a separate program.

B. Review of the screening process to arrive at those conduits requiring modifications commenced with TVA calculation WBPEVAR8912010 revision 0 of 4/30/90. This, with the assistance of the TVA staff provided details of the initial screen of 3,260 conduits showing on the CCRS print out of Class 1E cables. The subsequent manual screening to 721 conduits was reviewed and considered acceptable on the basis of the assumptions given. The calculation then described the use of the 1990 edition of the NEC criteria whereby through further screening, analysis, and walkdowns, all vertical support requirements were met without additional rework for installations other than silicone rubber cables. Subsequently,, the TVA staff indicated that the use of the 1990 NEC was abandoned and calculation WBPEVAR90007011 and WBPEVAR9005001 would control the screening process.

The NRC review of these calculations resulted in the following concerns and observations.:

1. The analysis of side wall bearing pressure (SWBP) is conservative in some respects but ignores;

   (a) The dramatic physical effects on some cable materials when exposed to the high temperature of harsh environments.

   (b) The extreme bending radius condition or effect of local indenting of cables at tray sides or duct or condulet lips which create "hanging points", not simply the assumed cable passing over a round corner. (pp. 24-27)

Additionally, the assumption in the analysis of 1/8 inch radius bend at all conduit corners is questioned. Past observations of "LB" and "T" condulets has indicated that some have inside corners sharper than the 1/8" radius assumed. There is need to further review the walkdown procedure WP47 Rev. 0 to determine if proper observations were being made. 'The walkdown of silicone rubber cables inside of containment produced some 10 support corners sharper than 1/8 inch. Was this peculiar to these conduits, or tray edges? If so why? (p.37)

2. The review of WBPEVAR9005001 indicates that further NRC review of TVA calculation WBPEVAR8007011 which details actions taken to assure supports are added or other rework performed should be required. (Sec. 9.3.5 p. 45a)

3. The methodologies of the screening process, given the assumptions and analysis used by TVA, appears to be very adequate and properly carried out subject to any discrepancies found on the reviews called for in section B.1.

4. The definition of the term "near" for condulets near the top of vertical runs requires clarification. (Top of p. 4 of 19) Also see walkdown procedure WP-47

5. The term "Sharp edges" as indicated in TVA walkdowns are assumed to be a bend radius of 1/32". NRC should review this assumption to assure that cable can't be cut, under these conditions. The whole concept of SWBP is carried to extremes here, and apparently on the basis of one bounding case at SQN.

C. Review of the screening and disposition of 5 conduits selected by the NRC staff revealed one discrepancy in the records of the support action for conduit 1VC15B. Walkdown of this conduit indicated that the intended support (RTV foam) had been done despite the erroneous documentation.

D. Review of walkdown procedure WD006 indicated that it was thorough and clearly written. The procedure contains appropriate forms to be used to record walkdown observations and examples of their use. One question not answered by this procedure or other documents reviewed is at what time and point in the screening/walkdown process was the change made to not take credit for the horizontal runs of power cable for their vertical support. This remains an open item.

E. Walkdowns of three sample conduits (of the five originally selected by the NRC) were carried out to verify the accuracy of the data taken. No discrepancies were noted. The conduits examined were; 1VC15B, 1RM467A, and 1VC2924B.

F. Review of Construction Standard G-38 revision 10, was made in reference to the updating of vertical support policies and practices. Section 3.2.1.9 "Support of Cables Routed in Vertical Conduits" consists of three separate plant-specific sections. Section C is for Watts Bar and Bellefonte. Section C is entirely new in revision 10 of this standard and consists of four numbered subsections. Subsection 1 gives general instructions on when supports need to be used. Subsections 2 and 3 describe five alternate methods of supporting cable and subsection 4 describes other support options for use inside enclosures or at conduit/tray transitions.

The inspectors opinion is that subsection 1 is either poorly written and ambiguous or is in error depending upon the intent of the writers. It appears to be in direct conflict with 1987 NEC article 300-19 in giving credit for horizontal runs supporting vertical runs in all cases. The total of seven options for support given in subsection 2-4 include two accepted by many in the industry (Kellums grips, and OZ/Gedney wedge type fittings) and all others are of questionable acceptability in the inspectors opinion. One of the others (use of fire stop

material) was verbally accepted by the NRC staff during the January 11, 1990 audit visit to WBN but the others have never been discussed previously to the inspectors knowledge. A basic concern that derives from these vertical support policies is the precedent it sets for industry application.

1. Have any cable manufactures of concern agreed to the vertical support practices specified in G-38 either Rev. 8 or Rev. 10, specifically with regard to harsh environments?

2. Have all manufactures of support equipment or materials given endorsement or approval for their use as applied by TVA?

If the answer for 1 or 2 above is "no" then we must recognize that from any current NRC approval, general approval of the support practice of G-38 could be inferred even though suppliers do not endorse it. Even if further discussion and explanation results in present approval to use these support methods for WBN unit 1, it should be emphasized to both TVA and the industry that these methods may not be appropriate for any further construction. I believe that further discussion between NRC staff and consultants is required for before meeting with TVA.

6. Silicone Rubber Cables were reviewed as a separate issue following the audit. The following concerns were identified during the review.

   1. The basic concept of area of pressure (from Kerite) where used for conduit bends is very questionably applicable to sharp conduit bends. This issue will require further NRC review prior to resolution

   2. What has been done as a result of the September 89, recommendations in section 6.2* (p. 7 of 19) beyond that stated in the third June 15, 1990 Supplemental Information letter? Has NRC agreed that testing is an option for clearing assumed damaged cable? Under what conditions, dry, wet, at what voltage? What were the results of the visual inspections?

   3. Review of* Table 1 analysis appears OK but raises questions as to the geometry of some cable runs. This should remain an open item pending NRC review of isometrics for conduits indicated in walkdown packages #14, 26 and 29 as examples.

Conclusion

The inspectors believe that further discussion/clarification with TVA staff and NRC staff is appropriate before this issue can be closed.

* REFERENCE DOCUMENTATION - TVA CALCULATION - 17190.5001-EEB-007, "Silicone Rubber Insulated Cable Support in Vertical conduits - Critical Case Evaluation", Dated 9/20/89

LIST OF SIGNIFICANT DOCUMENTS
REVIEWED

Inspector: Daniel C. Ford Report No.: _____ Page 1

Number	Revision	Full Title	Date
WBPEVAR9007015	0	TVA calculation Electrical Cable Bend Radius Disposition of WBN Class 1E Cables	9/10/90
TC 90-31	0	Temporary Change to N-RT-2 Radiographic Examination of Electrical Cable Conduit Fittings	8/16/90
DS-E12.1.5	3	Minimum Radius for Field Installed Insulated Cables Rated 15,000 Volts and Less	4/26/88
G-38	10	General Engineering Specification, Installation, Modification and Maintenance of Insulated Cables Rated up to 15,000 volts	11/30/90
DS-E12.1.13	2	Class 1E Cable OD's and Weights	4/15/86
DCN G-12601-A	0	Evaluation of Cable Bend Radius Via Radiographic Film	
DCN M-10464-D	0	Inspection of System 70 Class 1E Cables for Violation of MBR	
DCN M-10823-C	0	Inspection of System 32 & 67 Class 1E Cables for Violation of MBR	
DCN M-10950-A	0	Inspection of System GR 2-6 Class 1E Cables for Violations of MBR	
DCN M-10951-A	0	Inspection of System GR 1-6 Class 1E Cables for Violations of MBR	
LETTER	0	TVA Responses to NRC Comments Resulting from August 1-3, 1990 Meeting	10/11/90

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ENCLOSURE 3

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March 21, 1991

Memorandum to: Mr. Hukam Garg, USNRC

From: J. B. Gardner

Subject: Resolution of WBN Pull Tension Calculation Discrepancy

The writer has resolved the prior observed discrepancy between his manual calculations for conduit ZPLCIZ286B and the computer calculations of TVA.

After receiving a copy of the manual calcs, TVA initially diagnosed the problem as being the writer's improper use of angle measurements in degrees or radians. However, in telcon with Mr. Ralph Skinner of TVA, we quickly agreed it was the writer's use of the shortened trigonometric form versus the long form programmed into the computer that was the source of difference. The very unusual geometry of the conduit segment gave rise to a significant tension error in the first bend which then multiplied through the run to end up with the large differences I reported.

Long form manual calculation confirms the TVA computer calculation so there is no outstanding issue with respect to the WBN pullby calculations for ranking.

J. B. Gardner, Consultant