

Docket No. 50-390

LICENSEE: TENNESSEE VALLEY AUTHORITY

FACILITIES: Watts Bar Nuclear Plant, Unit 1

SUBJECT: MINUTES OF NOVEMBER 17, 1989, MEETING ON CABLE DAMAGE RESOLUTION PLAN

On November 17, 1989, a meeting was held at the request of TVA in Rockville, Maryland between the NRC staff and the TVA's representatives. The purpose of the meeting was to discuss TVA's plans to resolve the issue of damaged electrical cable in conduits. A formal submittal on this subject will be provided for staff review. Attachment 1 is the list of individuals attending the meeting. Attachment 2 contains the handouts provided at the meeting.

While examining cables in conduit at Watts Bar in July, 1989 to determine if heat from welding or cutting had degraded the electrical conductors, damage to conductors caused by some other mechanism was discovered. Some cables had damaged insulation where the conductors were exposed. Pull cords, wire and foreign objects were also found in the conduits.

The applicant said that the conduits were field routed and the cables were damaged by excessive pulling tension during installation. TVA calculated pulling forces several times higher than those allowed by TVA specifications. TVA removed additional cables to determine the root cause of the damage.

TVA proposed to replace cables where relatively moderate or high pull tensions were applied when cables were pulled into conduits with cables already in place. For coaxial cables subjected to jacket damage from scuffs, nicks and scrapes, TVA proposed to replace all type WTK.

The methodology for determining cable potentially susceptible to damage was presented by TVA. The staff raised the concern that a similar problem may have occurred at Sequoyah or Browns Ferry. The staff needs documentation of the differences between the old and new criteria for selection of worst case cable pull-bys and the threshold for allowable installation forces. TVA needs to establish that the conduits used to validate the replacement criteria were a representative sample of the Class 1E conduits associated with Unit 1.

Original signed by

Paul Cortland, Project Engineer
TVA Projects Division
Office of Nuclear Reactor Regulation

Enclosures:

- 1. List of Attendees
- 2. TVA Presentation Handout

cc w/enclosures:
See next page

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PDR ADDCK 05000390
A FDC

OFC	:NRR:TVA/PM	:TVA:ROB/BC	:NRR:TVA/ST	:TVA:AD/P	:
NAME	:PCortland	:EMarinos	:RBlack	:SBlack	:
DATE	:11/29/89	:11/29/89	:11/29/89	:11/29/89	:

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ATTACHMENT 1

Attendees

MEETING ON WATTS BAR CABLE DAMAGE RESOLUTION PLAN

November 17, 1989

Name	Affiliation	Telephone
R. Auluck	NRC/NRR/TVAPD	(301) 492-0759
S. Black	NRC/NRR/TVAPD	(301) 492-0796
K. Barr	NRC/NRR/TVAPD	(404) 331-0342
P. Cortland	NRC/NRR/TVAPD	(301) 492-0754
H. Garg	NRC/NRR/TVAPD	(301) 492-0789
E. Goodwin	NRC/NRR/TVAPD	(301) 492-0794
B. Hayes	NRC/OI	(301) 492-0373
K. Jenison	NRC/NRR/TVAPD	(615) 842-8001
B. D. Liaw	NRC/NRR/TVAPD	(301) 492-3288
A. Marinos	NRC/NRR/TVAPD	(301) 492-0768
R. Pierson	NRC/NRR/TVAPD	(301) 492-0757
G. Walton	NRC/NRR/TVAPD	(615) 365-5487
M. Medford	TVA	(615) 751-4776
R. Stevens	TVA	(615) 365-8649
J. Rinne	TVA/Browns Ferry	(205) 729-5123
D. Skridulis	TVA/Licensing	(205) 729-2676
M. Brickley	TVA/NE	(615) 365-1416
K. Brown	TVA/NE	(615) 632-8690
J. Hutson	TVA/NE	(615) 632-2447
W. Raughley	TVA/NE	(615) 365-1390
R. Wilson	TVA/New Projects	(615) 751-8410
A. Gwal	TVA/Program Team	(615) 365-3729
H. Johnson	TVA/QA	(615) 365-8667
T. Ippilito	TVA/Rockville Office	(301) 770-6790
T. Horning	TVA/WBN Licensing	(615) 365-3381
S. Kaplan	Picket, Low & Garrett	(714) 650-8000
J. Stetkar	Picket, Low & Garrett	(714) 650-8000
J. Groeger	Univ. of Connecticut	(203) 486-5298
R. Luther	Consultant	(203) 223-3491

ATTACHMENT 2

TVA DOCUMENTS PRESENTED AT MEETING

1. Cable Damage Resolution Plan
2. Pullby Activity
3. Methodology Overview

WATTS BAR NUCLEAR PLANT

CABLE DAMAGE RESOLUTION PLAN

PRESENTED TO THE NRC NOVEMBER 17, 1989

AGENDA

- . Introduction - R.F. Wilson**
- . Purpose of Meeting - R.J. Stevens**
- . Discussion of Cable Damage - K.W. Brown / J.W. Stetkar**
- . Conclusions - K.W. Brown**
- . Closing Remarks - R.F. Wilson**

PURPOSE

- . To present actions taken to resolve an Employee Concern**
- . To discuss findings and additional actions required**
- . To obtain NRC endorsement of TVA's approach**

RESOLUTION OF EMPLOYEE CONCERN

- . Concern - Potential for heat damage to cable insulation due to welding or cutting operations near conduit**
- . Actions taken**
 - . Identified 9 conduit segments and 26 cables**
 - . Removed and inspected all 26 cables**
 - . Inspection results**
 - . No welding/heat damage**
 - . Installation damage noted**
 - . Pull rope found in conduit**
 - . Concrete anchor found in conduit**
- . Conclusions**
 - . Employee concern not substantiated**
 - . Additional actions required to address findings**

PRESENTATION OVERVIEW

- . Damage discovery and assessment**
- . Root cause determination**
- . Scope determination**
- . Present cable damage resolution plan**

BACKGROUND

- . Employee Concern (Unit 2)**
 - . Welding on or near conduit**
 - . Pullback to inspect for heat damage**

- . Inspection results**
 - . No welding / heat damage**
 - . Installation damage noted**
 - . Pull rope found in conduit**
 - . Concrete anchor found in conduit**
 - . Broken cable (abandoned)**
 - . ECP review notes suspect crew activity**

CABLE DAMAGE ASSESSMENT PROGRAM

UNIT 2

- . CAQR initiated and reported under 50.55(e)**
- . Conduit walkdown - Isometrics prepared**
- . Pull forces evaluated - Excessive Tension and SWP in pullby**
- . Correlation - Damage located in section with excessive forces**

- . UConn tests confirm pullby mechanism**

ROOT CAUSE DETERMINATION UCONN TESTS

- . Visual**
- . Jacket hardness**
- . Copper oxidation evaluation**
- . Optical microscopy**
 - Damaged cable**
 - Broken cable**
- . Micro-infrared analysis**
 - Wall anchor**
 - Damaged cable**
- . Flex conduit**
- . Pullby simulation**

- . Root cause mechanism - pullbys**

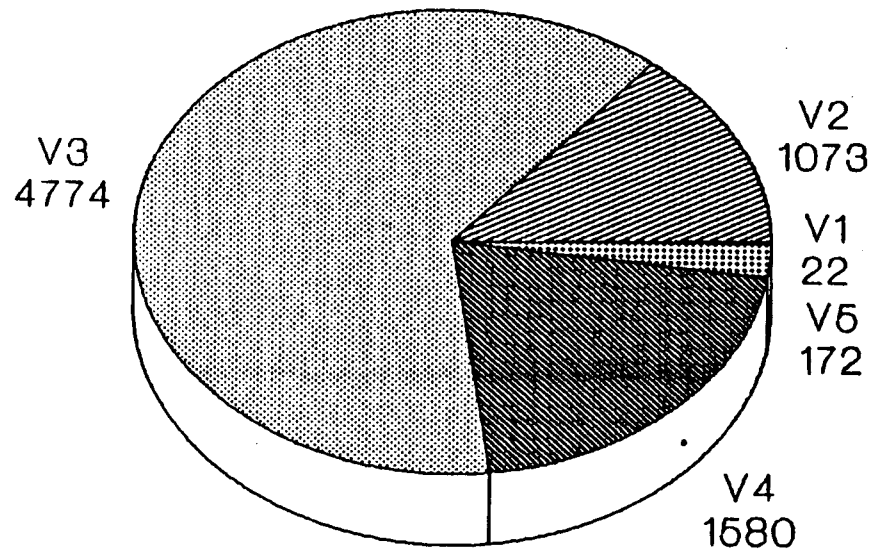
SCOPE ASSESSMENT

WBN VOLTAGE CLASSIFICATIONS

- . V5 - Shielded, medium voltage power**
- . V4 - Non-shielded, low-voltage power**
- . V3 - Non-shielded, control and control power**
- . V2 - Most are shielded, instrumentation**
- . V1 - Shielded, instrumentation**

WBN CLASS 1E CONDUITS

Common, Unit 1, & Unit 2 reqd for Unit 1



Data date = 10/31/89

TOTAL = 7621

V5 CABLE EVALUATION

- **Pullby damage mechanism does not exist**
- **Post installation hi-pot test required**
- **77 cables required for Unit 1**
- **Retest 7 cables**
- **Acceptable integrity demonstrated**

CONDUIT SELECTION FOR SCOPE ASSESSMENT

- . Unit 1 equivalent to Unit 2 conduit with damage**
- . Worst case pullby calculation**
- . Screen CCRS for high fill and length and confirm pullby activity**

SCOPE ASSESSMENT ACTIVITIES

- . Additional conduits removed (Unit 1 and 2)**
 - . Population V2, V3 and V4**
 - . V2 - 18**
 - . V3 - 8**
 - . V4 - 2**
- . On-site inspection**
 - . Installation damage noted**
- . Abandoned/spare cables not evaluated**
- . UConn analysis**
 - . Confirmed additional pullby damage**
 - . Identified coax jacket damage (non-pullby)**
 - . Identified other non-significant damage**

CABLE INSPECTION DAMAGE CATEGORIES

- . Conductor exposed**
- . Insulation damaged but conductor not exposed**
- . Shield or assembly wrap damage; no insulation damage**
- . Jacket penetrated; no damage to shield or assembly wrap**
- . Jacket scuff, nick, etc. but not penetrated**
- . Other (indentation, bend, bulge, etc.)**

CABLE INSPECTION SUMMARY
PULLBY DAMAGE

	<u>UNIT 2</u>	<u>UNIT 1 ASSESSMENT</u>
Conductor Exposed	5	1
Insulation Damage	0	1

NON-PULLBY RESULTS

<u>RESULTS</u>	<u>UNIT 2</u>	<u>UNIT 1 ASSESSMENT</u>
. Shield / assembly wrap	0/5	0/3
. Cut / scrape to jacket	0/30	2/17
. Bulge / kink etc	0/13	0/2

(A cable may appear in multiple categories)

CABLE / CONDUIT REMOVAL

	<u>UNIT 2</u>	<u>UNIT 1 ASSESSMENT</u>
Conduit segments	9	28
Conduit feet (approx)	550	1700
Cables	28	358
Cable footage (est)	12000	33500

RESOLUTION OVERVIEW

- . **Family of concern**
V1, V2, V3 and V4 Class 1E cables in conduit
U0, U1 and U2 required for U1
- . **Categorize conduits based on length and fill**
- . **Establish 'threshold' for allowable installation forces**

PULLCHART DEVELOPMENT

- . Separate charts for V1/V2, V3 and V4**
 - . Assume pullbys always occurred**
 - . Separate charts for various fills**
 - . Assume large pullbys**
 - . Coefficient of friction 0.75 (higher for overfills)**
 - . More than 360 degrees between pull points**
 - . Use maximum length in each range**
-
- . Results in conservative assessment of SWBP during pullbys**

WBN CABLE DAMAGE RESOLUTION

SIDEWALL BEARING PRESSURE DURING PULLBY

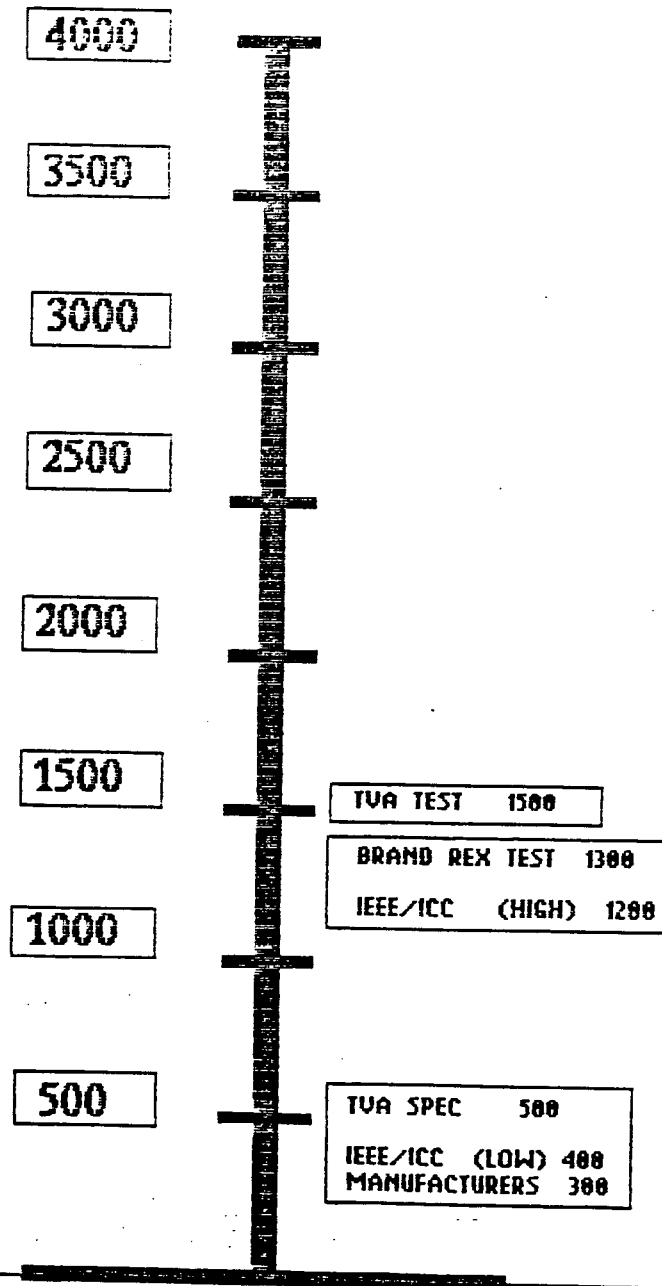
VOLTAGE LEVEL 3 40 PERCENT FILL

LENGTH

	0 - 10	11 - 25	26 - 50	51 - 75	76 - 100	> 100
0.75	88	221	442	664	885	1327
1.00	104	259	519	778	1038	1557
1.50	129	321	643	964	1286	1929
2.00	128	320	641	961	1282	1923
2.50	166	415	830	1244	1659	2489
3.00	213	532	1065	1597	2130	3194
4.00	238	595	1190	1785	2380	3570
5.00	243	606	1213	1819	2426	3639

WBN CABLE DAMAGE RESOLUTION

V1 and V2 Cable

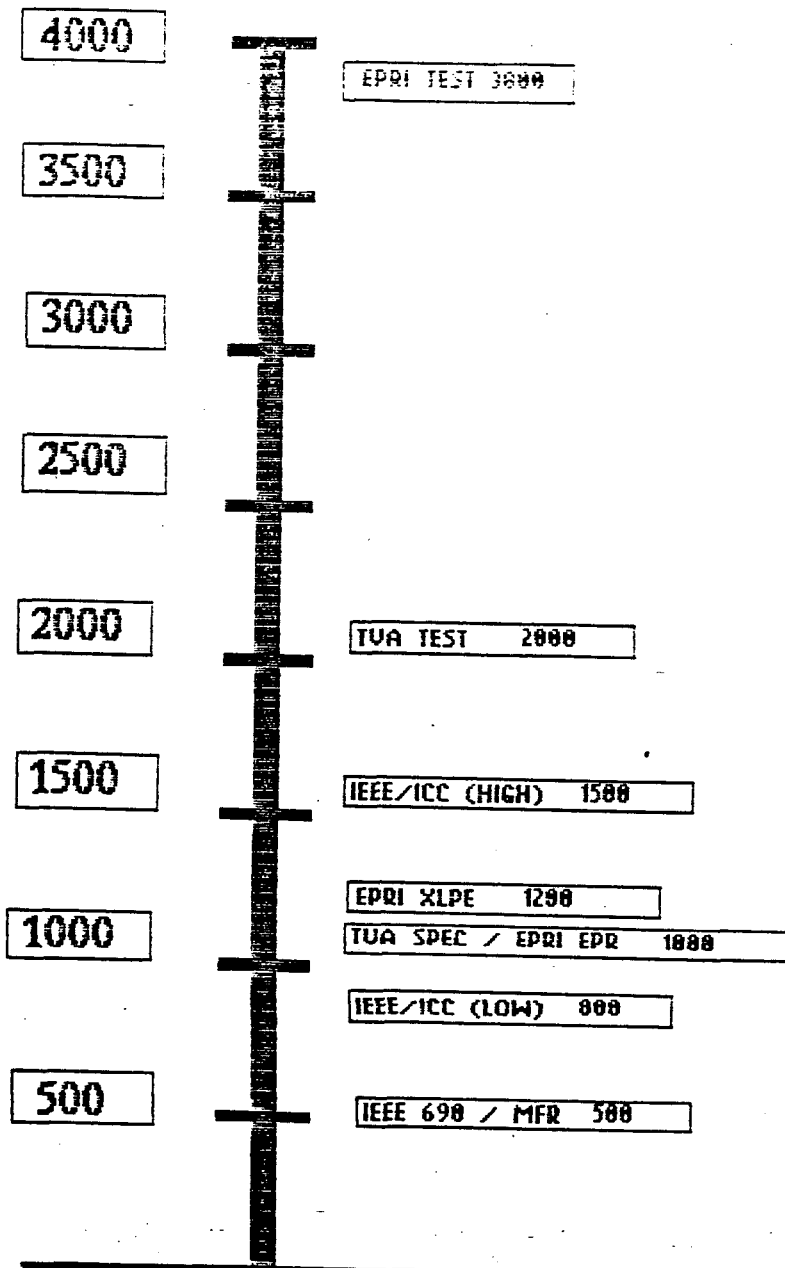


Sidewall Bearing Pressure

Test, G-Spec and Recommended Values

WBN CABLE DAMAGE RESOLUTION

V3 and V4 Cable



Sidewall Bearing Pressure

Test, G-Spec and Recommended Values

WBN CABLE DAMAGE RESOLUTION

PULLBY DAMAGE SUSCEPTIBILITY GROUPS

<u>VOLTAGE LEVEL</u>	<u>GROUP</u>	<u>SWBP</u>
V1/V2	A	< 300
	B	300 - 500
	C	500 - 1000
	D	1000 - 1500
	E	1500 - 2000
	F	> 2000

V3	G	< 500
	H	500 - 1000
	I	1000 - 1500
	J	1500 - 2000
	K	> 2000

V4	G	< 500
	H	500 - 1000
	I	1000 - 1500
	J	1500 - 2000
	K	> 2000

WBN CABLE DAMAGE RESOLUTION

SIDEWALL BEARING PRESSURE DURING PULLBY

VOLTAGE LEVEL 3

40 PERCENT FILL

LENGTH

CONDUIT SIZE	LENGTH					
	0 - 10	11 - 25	26 - 50	51 - 75	76 - 100	> 100
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	G	H	I	J		K

CONDUIT REMOVAL RESULTS

Unit 1, Common and Unit 2 Required for Unit 1

<u>Category</u>		<u>Removed</u>	<u>Failures</u>
Low	V1/V2 (A)	5	0
	(B)	2	0
	V3/V4 (G)	0	0
	(H)	1	0
	V4 (I)	1	0

Moderate	V1/V2 (C)	10	1
	(D)	7	1
	V3 (I)	2	0
	V4 (J)	0	0

High	V1/V2 (E)	1	0
	(F)	2	1
	V3 (J)	0	0
	(K)	6	1
	V4 (K)	0	0

LOW RISK CATEGORY DISPOSITION

- . Meets current SWBP limits on pullbys except Sub-category I-V4 (51 conduits)**
- . Accept cables as is; no replacement required**
- . Evaluate I-V4 with moderate risk category**

MODERATE RISK CATEGORY DISPOSITION

- . If no pullbys occurred then accept as is**
- . If pullby(s) occurred and conduit is overfilled then replace cables**
- . Confirm categorization of remaining conduits**
 - Verify assumed distance between pull points**
- . If still moderate then replace cables**
- . If new category is low**
 - Largest pullby meets SWBP limits; then accept as is**
 - Otherwise replace**

HIGH RISK CATEGORY DISPOSITION

- If no pullbys occurred then accept as is
- Replace remaining cables

COAX DAMAGE DISPOSITION

- . **Damage mechanism**
 - . **Not pullby related**
 - . **Scuffs, nicks and scrapes only**

- . **Applicability**
 - . **Two cable types (WTK/WWK)**
 - . **Radiation monitoring system (RMS)**
 - . **Nuclear instrumentation system (NIS)**

- . **Resolution**
 - . **Replace all WTK coax U1, U0 and U2 reqd for U1**

CONCLUSION

- . **Damage mechanisms - Pullbys**
 - **Cuts/scrapes (coax jackets)**

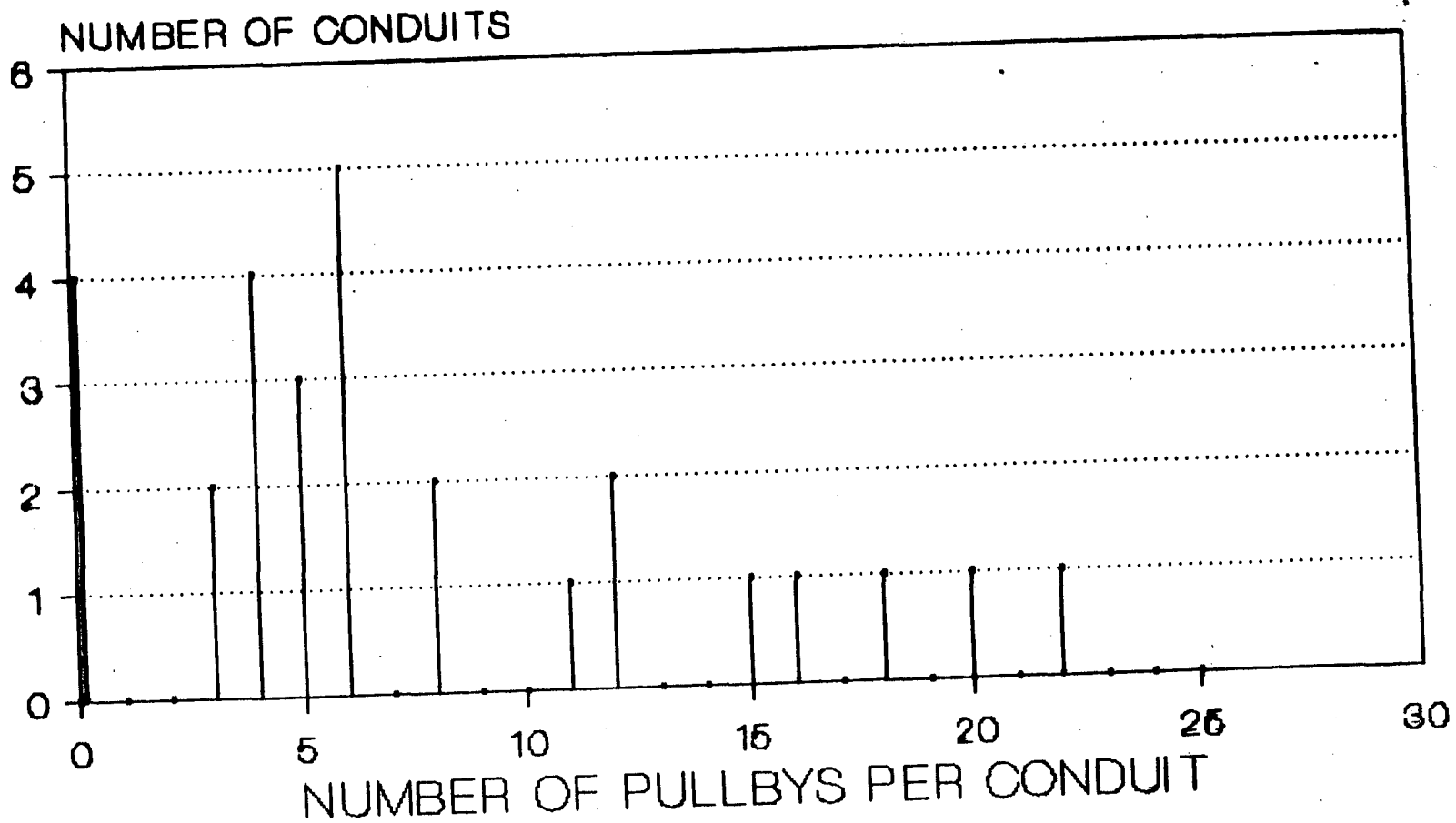
- . **Recovery actions:**
 - Low category (Benign configurations) - Use as is**
 - Moderate/High categories - Replace**
 - Coax - Replace all type WTK**

- . **Meets current criteria for SWBP during pullbys**

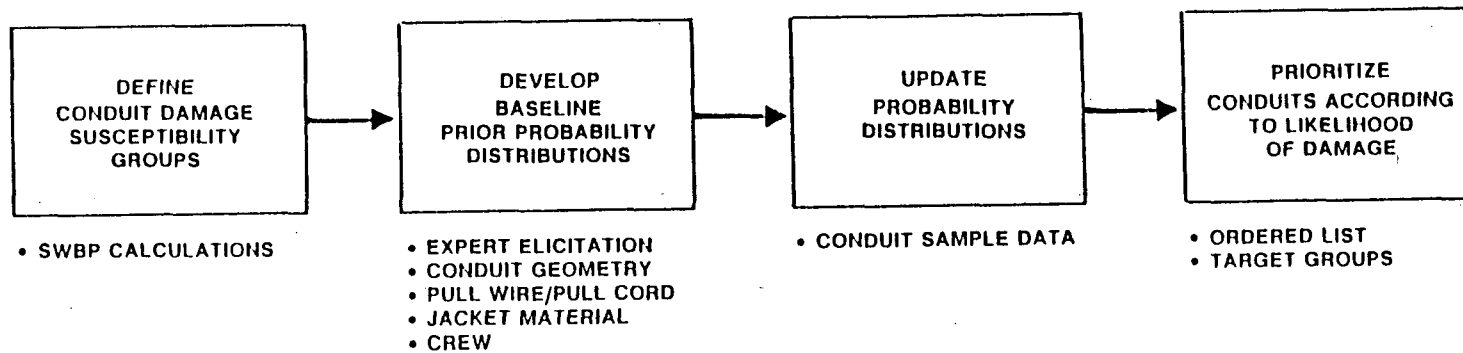
- . **Pullby and coax damage issues resolved**

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PULLBY ACTIVITY SCOPE ASSESSMENT CONDUITS

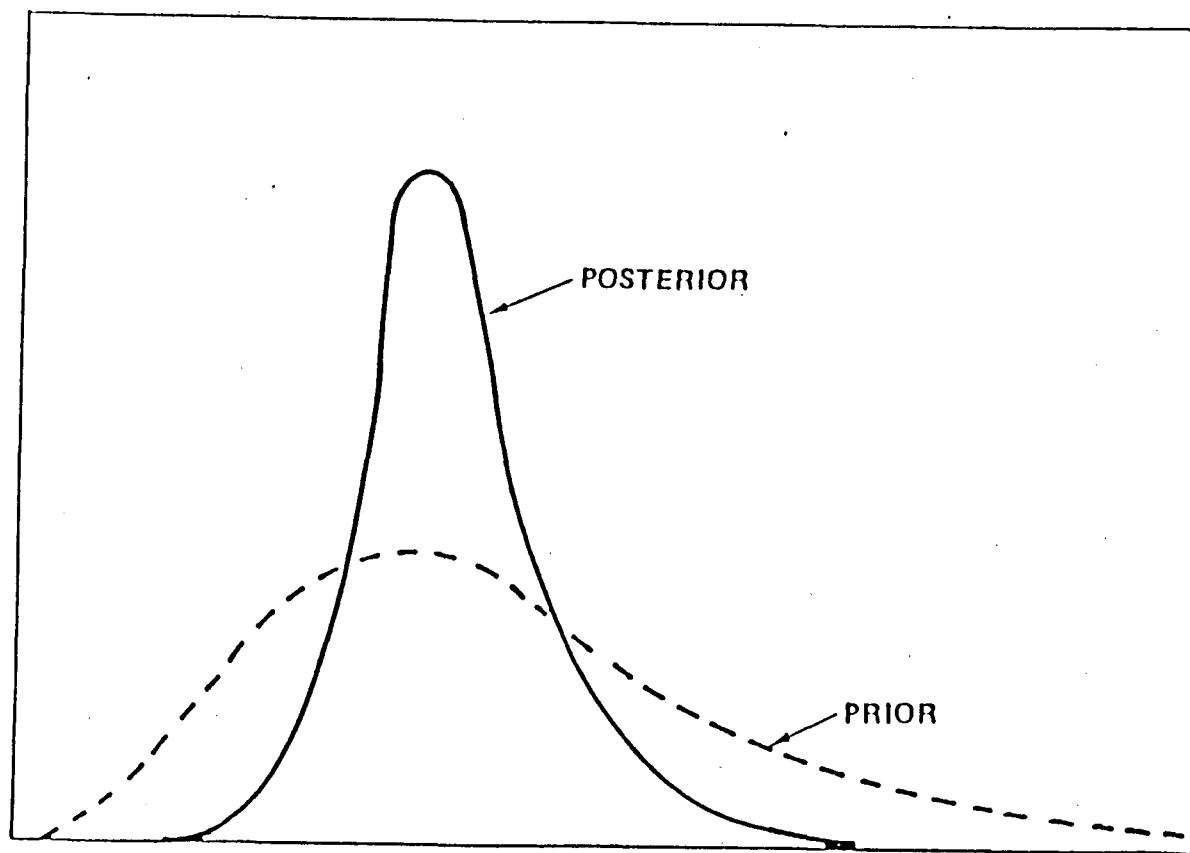


METHODOLOGY OVERVIEW



BAYESIAN SPECIALIZATION (UPDATE)

UPDATE GENERIC DISTRIBUTION OF INFORMATION ("PRIOR DISTRIBUTION") WITH MORE SPECIFIC OR MORE DETAILED DATA ("EVIDENCE") TO OBTAIN A WEIGHTED DISTRIBUTION WHICH GENERALLY CONTAINS LESS UNCERTAINTY THAN THE GENERIC INFORMATION ("SPECIALIZED POSTERIOR DISTRIBUTION")



WBN CABLE DAMAGE RESOLUTION

SIDEWALL BEARING PRESSURE DURING PULLBY

VOLTAGE LEVEL 3 40 PERCENT FILL

LENGTH

CONDUIT SIZE	LENGTH					
	0 - 10	11 - 25	26 - 50	51 - 75	76 - 100	> 100
0.75	88	221	442	664	885	1327
1.00	104	259	519	778	1038	1557
1.50	129	321	643	964	1286	1929
2.00	128	320	641	961	1282	1923
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3.00	213	532	1065	1597	2130	3194
4.00	238	595	1190	1785	2380	3570
5.00	243	606	1213	1819	2426	3639
	G	H	I	J		K

DEVELOP BASELINE PROBABILITY DISTRIBUTIONS

- . Expert elicitation process**
- . Conduit configuration**
 - Sidewall bearing pressure**
 - Clear path**
 - Pull wire in conduit**
 - Pull wire in conduit**
 - Pull cord in conduit**
- . Crew effect**
- . Jacket material effect**

DEVELOP BASELINE PROBABILITY DISTRIBUTIONS

EXPERT 1
VOLTAGE LEVEL V3
SUSCEPTIBILITY GROUP K

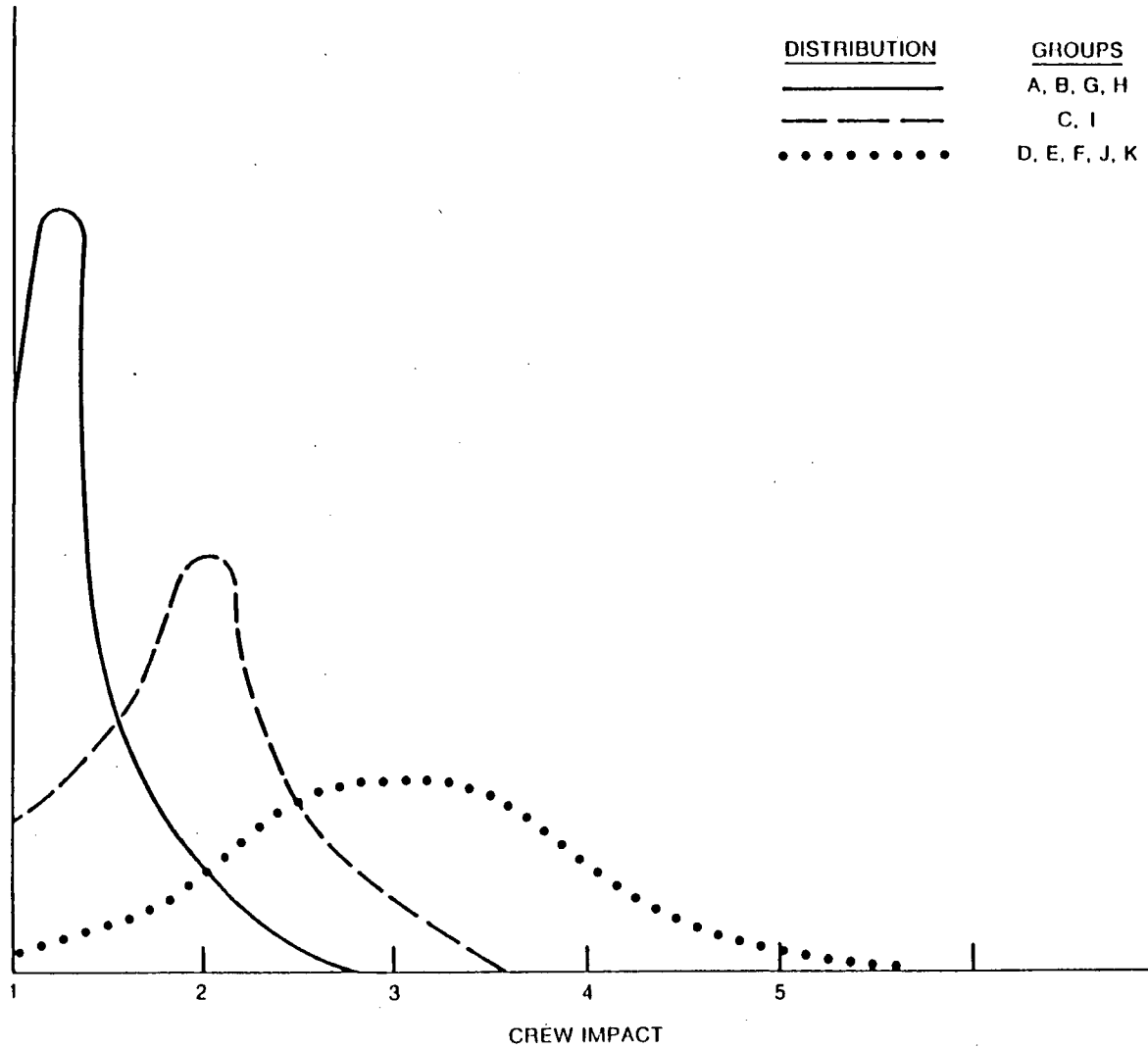
CONDITIONS	CONDITIONAL FREQUENCY OF PULLBY DAMAGE	CONDITIONAL PROBABILITY
NO PULL WIRE OR CORD IN CONDUIT	.20	.15
	.50	.50
	.75	.25
	1.00	.10
PULL WIRE IN CONDUIT	.30	.10
	.60	.35
	.80	.35
	1.00	.20
PULL CORD IN CONDUIT	.50	.10
	.80	.70
	1.00	.20

DEVELOP BASELINE PROBABILITY DISTRIBUTIONS

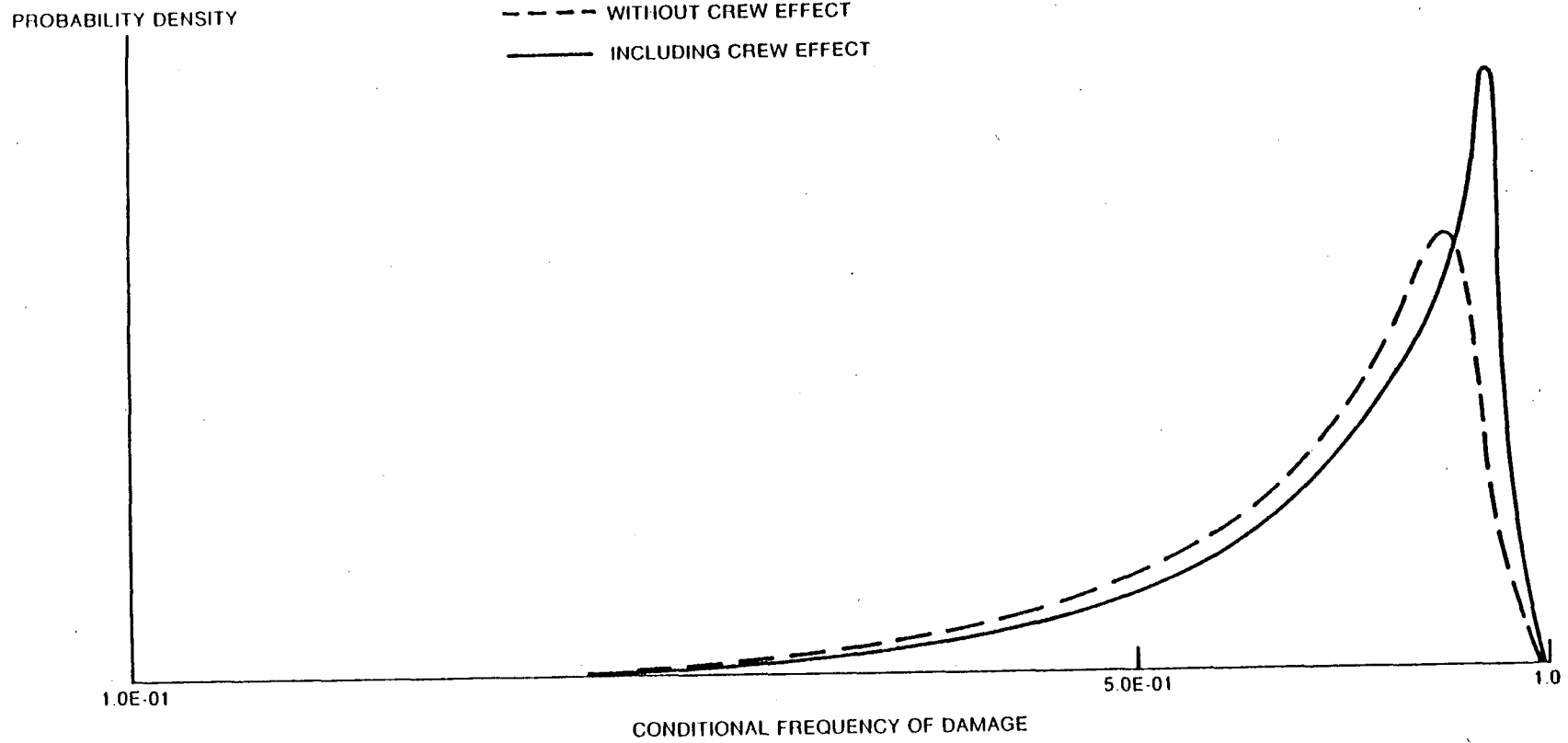
EXPERT 2 VOLTAGE LEVEL V3 SUSCEPTIBILITY GROUP K

CONDITIONS	CONDITIONAL FREQUENCY OF PULLBY DAMAGE	CONDITIONAL PROBABILITY
NO PULL WIRE OR CORD IN CONDUIT	.80	.02
	.85	.03
	.90	.05
	.95	.10
	.99	.40
	1.00	.40
PULL WIRE IN CONDUIT	.90	.02
	.93	.03
	.95	.05
	.99	.15
	1.00	.75
PULL CORD IN CONDUIT	1.00	1.00

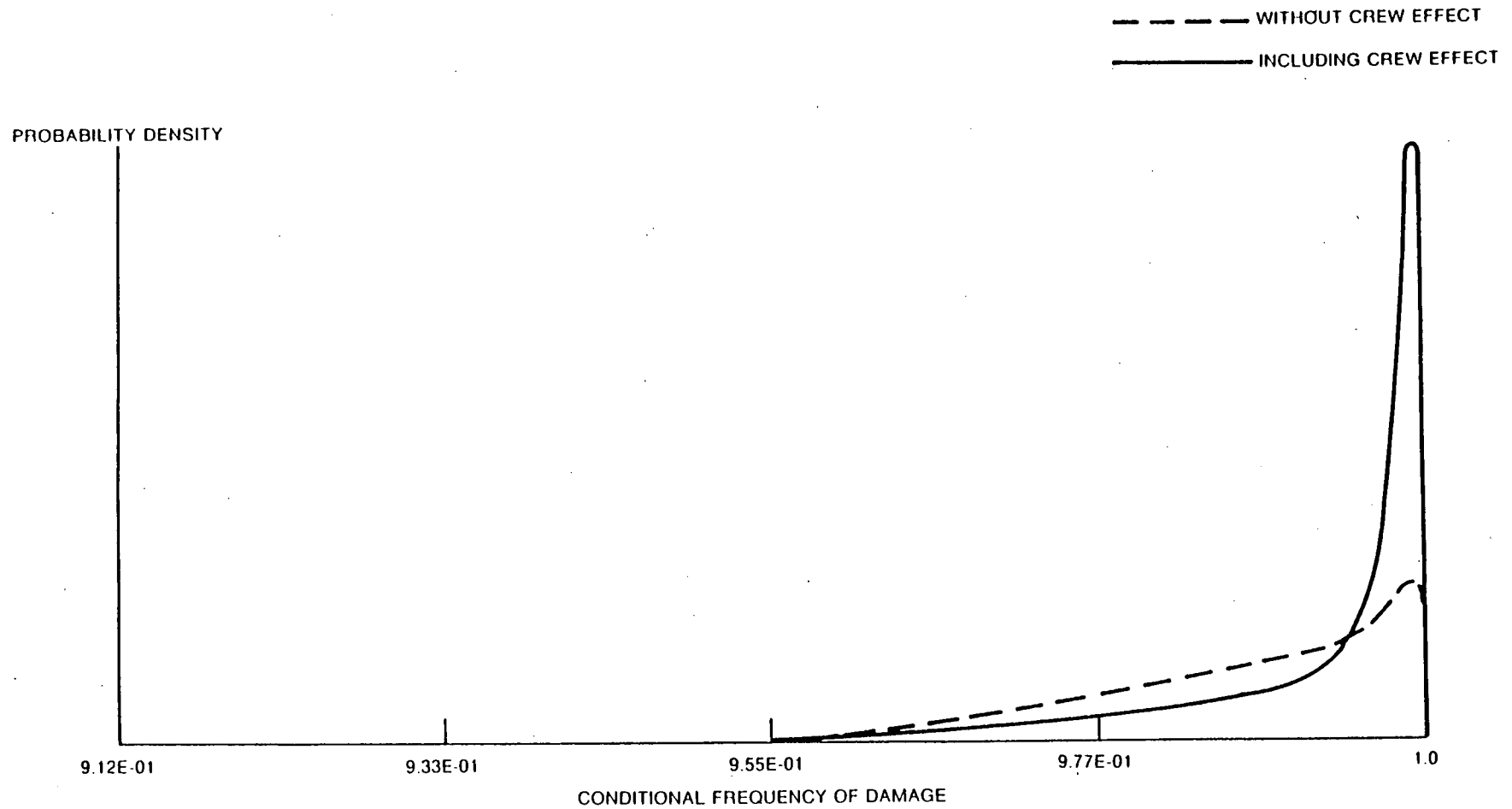
CREW EFFECT DISTRIBUTIONS
(SUSPECT CREWS WORK ON ~36% OF CONDUITS)



VOLTAGE LEVEL V3
SUSCEPTIBILITY GROUP K
EXPERT 1 PRIOR DISTRIBUTION



VOLTAGE LEVEL V3
SUSCEPTIBILITY GROUP K
EXPERT 2 PRIOR DISTRIBUTION



UPDATE PROBABILITY DISTRIBUTIONS USING EVIDENCE

COMPARISON OF EVIDENCE WITH PRIOR DISTRIBUTIONS

VOLT-AGE LEVEL	SUSCEPTIBILITY GROUP	PRIOR PROBABILITY DISTRIBUTION FOR CONDITIONAL FREQUENCY OF DAMAGE				EVIDENCE		
		5TH PERCENTILE	MEDIAN	95TH PERCENTILE	MEAN	UNIT 1	UNIT 2	COMBINED
V2	A	0	.0001	.014	.0039	0/3	0/2	0/5
	B	0	.0005	.078	.015	0/2	—	0/2
	C	0	.19	.58	.24	0/6	1/4	1/10
	D	.0032	.67	.97	.60	0/5	1/2	1/7
	E	.54	.87	.99	.87	0/1	—	0/1
	F	.91	.95	1.00	.99	0/1	1/1	1/2
V3	G	0	.0001	.013	.0035	—	—	—
	H	0	.0005	.11	.022	—	—	—
	I	0	.065	.88	.28	0/2	—	0/2
	J	.0033	.58	.98	.54	—	—	—
	K	.33	.89	.99	.85	1/6	—	1/6
V4	G	0	.0001	.0072	.0026	—	—	—
	H	0	.0001	.022	.0047	0/1	—	0/1
	I	0	.0008	.12	.023	0/1	—	0/1
	J	0	.011	.27	.060	—	—	—
	K	.25	.59	.91	.61	—	—	—

PROBABILITY DENSITY

--- --- --- PRIOR DISTRIBUTION
===== UPDATED DISTRIBUTION

VOLTAGE LEVEL V3
SUSCEPTIBILITY GROUP K

1.00E-02

2.51E-02

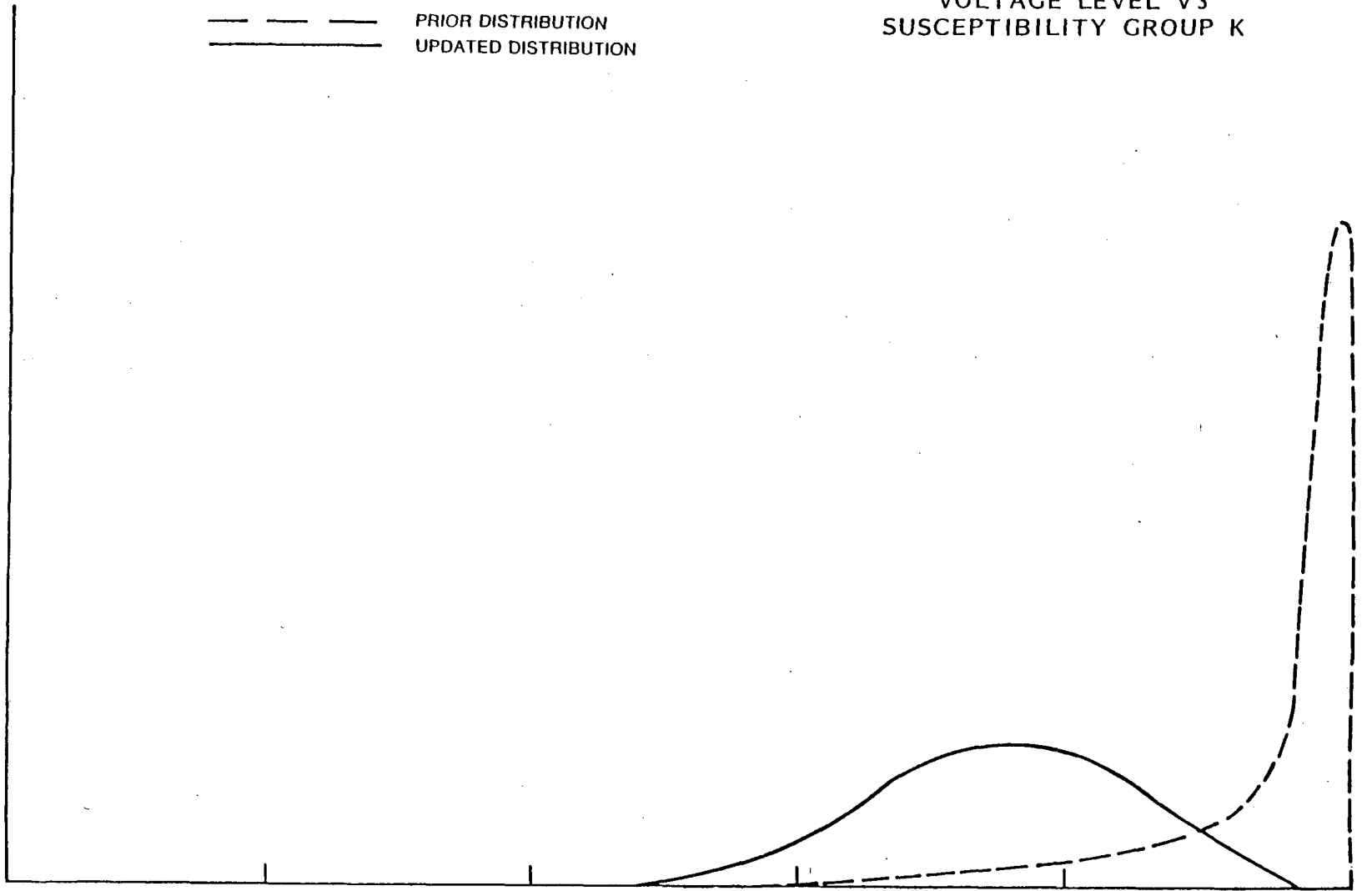
6.31E-02

1.58E-01

3.98E-01

1.0

CONDITIONAL FREQUENCY OF DAMAGE

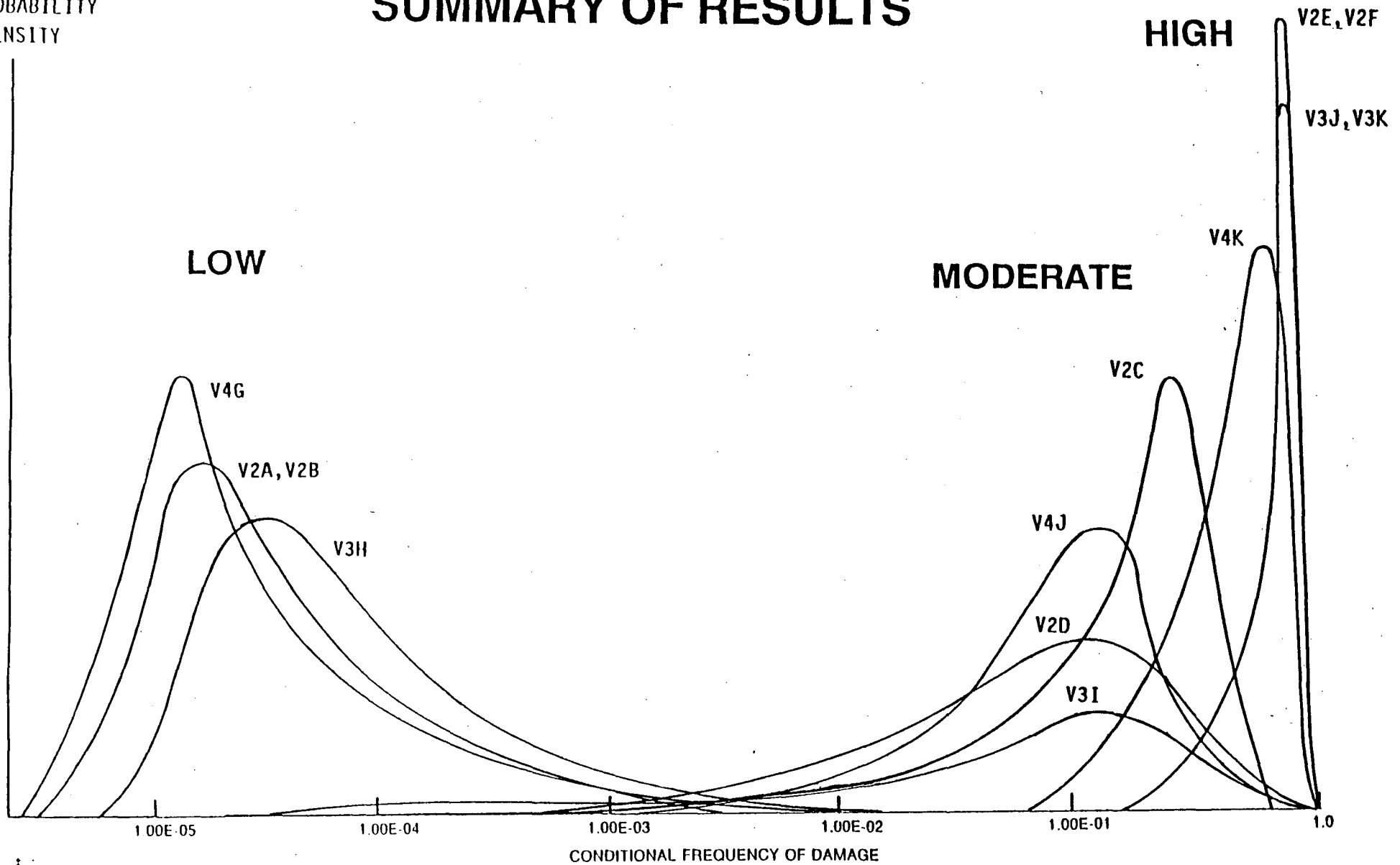


IDENTIFY TARGET GROUPS

LIKELIHOOD OF DAMAGE	VOLTAGE LEVEL	UPDATED PROBABILITY DISTRIBUTIONS FOR CONDITIONAL FREQUENCY OF DAMAGE				
		SUSCEPTIBILITY GROUP	10TH PERCENTILE	50TH PERCENTILE	90TH PERCENTILE	MEAN
LOW	V4	G	0	.0001	.0035	.0026
	V1 AND V2	A	0	.0001	.0035	.0026
	V3	G	0	.0001	.0047	.0035
	V4	H	0	.0001	.0074	.0044
	V1 AND V2	B	0	.0004	.028	.011
	V4	I	0	.0007	.047	.019
	V3	H	0	.0005	.050	.022
MODERATE	V4	J	.0001	.011	.17	.060
	V3	I	0	.0030	.25	.073
	V1 AND V2	D	.022	.11	.31	.16
	V1 AND V2	C	.015	.15	.30	.17
HIGH	V3	K	.17	.29	.49	.33
	V3	J	.0064	.58	.95	.54
	V4	K	.30	.59	.87	.61
	V1 AND V2	E	.48	.72	.88	.73
	V1 AND V2	F	.59	.84	.90	.82

SUMMARY OF RESULTS

PROBABILITY
DENSITY



Meeting Summary, Memoranda for Trip Reports or Site Visits*

Docket File
NRC PDR
Local PDR
Projects Reading
WB Reading
ADSP Reading
T. Murley/J. Sniezek
D. Crutchfield
B. D. Liaw
S. Black
R. Pierson
B. Wilson
R. Auluck
P. Cortland
K. Barr
H. Garg
E. Goodwin
A. Marinos
B. Hayes 3-E-4
K. Jenison
OGC 15-B-18
T. Quay
ACRS (10)
GPA/CA (M. Callahan) (3)
E. Jordan
B. Grimes
J. Scarborough 16-H-3
G. Marcus 16-H-3
L. Norrholm 16-H-3
C. Ader 16-H-3
J. Gray 16-H-3
R. Borchardt 17-G-21

*cc: Licensee/Applicant & Service List