SOLICITATION, OFFER AND AWARD	1. THIS CONTRACT IS A RATED ORDER UNDER DPAS (15 CFR 350) ▶	RATING DOC9	PAGE OF 1 / 14 PAGES

2. CONTRACT NO.	3. SOLICITATION NO.	4. TYPE OF SOLICITATION	5. DATE ISSUED	6. REQUISITION/PURCHASE NO.
	N00173-02-R-DL01	☐ SEALED BID (IFB) ☒ NEGOTIATED (RFP)	June 3, 2002	

7. ISSUED BY CODE N00173
CONTRACTING OFFICER
NAVAL RESEARCH LABORATORY
ATTN: CODE: 3220.DL
WASHINGTON DC 20375-5326

8. ADDRESS OFFER TO *(If other than Item 7)*

NOTE: In sealed bid solicitations "offer" and "offeror" mean "bid" and "bidder".

SOLICITATION

9. Sealed offers in original and 3 copies for furnishing the supplies or services in the Schedule will be received at the place specified in Item 8, or if handcarried, in the depository located in Naval Research LaboratoryBldg. 222, Rm 115 until 4:00 *(Hour)* local time July 3, 2002 *(Date)*

CAUTION - LATE Submissions, Modifications, and Withdrawals: See Section L, Provision No. 52.214-7 or 52.215-10. All offers are subject to all terms and conditions contained in this solicitation.

10. FOR INFORMATION CALL: ▶	A. NAME	B. TELEPHONE NO. *(Include area code) (NO COLLECT CALLS)*
	Dian Lockamy, Contract Specialist	202-767-3782

11. TABLE OF CONTENTS

(✓)	SEC.	DESCRIPTION	PAGE(S)	(✓)	SEC.	DESCRIPTION	PAGE(S)
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OFFER *(Must be fully completed by offeror)*

NOTE: Item 12 does not apply if the solicitation includes the provisions at 52.214-16, Minimum Bid Acceptance Period.

12. In compliance with the above, the undersigned agrees, if this offer is accepted within _____ calendar days *(60 calendar days unless a different period is inserted by the offeror)* from the date for receipt of offers specified above, to furnish any or all items upon which prices are offered at the price set opposite each item, delivered at the designated point(s), within the time specified in the schedule.

13. DISCOUNT FOR PROMPT PAYMENT *(See Section I, Clause No. 52-232-8)* ▶	10 CALENDAR DAYS %	20 CALENDAR DAYS %	30 CALENDAR DAYS %	CALENDAR DAYS %

14. ACKNOWLEDGMENT OF AMENDMENTS *(The offeror acknowledges receipt of amendments to the SOLICITATION for offerors and related documents numbered and dated:*	AMENDMENT NO.	DATE	AMENDMENT NO.	DATE

15A. NAME AND ADDRESS OF OFFEROR	CODE	FACILITY	16. NAME AND TITLE OF PERSON AUTHORIZED TO SIGN OFFER *(Type or print)*

15B. TELEPHONE NO. *(Include area code)*	15C. ☐ CHECK IF REMITTANCE ADDRESS IS DIFFERENT FROM ABOVE - ENTER SUCH ADDRESS IN SCHEDULE.	17. SIGNATURE	18. OFFER DATE

AWARD *(To be completed by Government)*

19. ACCEPTED AS TO ITEMS NUMBERED	20. AMOUNT	21. ACCOUNTING AND APPROPRIATION

22. AUTHORITY FOR USING OTHER THAN FULL AND OPEN COMPETITION:
☐ 10 U.S.C. 2304(c) ( ) ☐ 41 U.S.C. 253(c) ( )

23. SUBMIT INVOICES TO ADDRESS SHOWN IN ▶ *(4 copies unless otherwise specified)* ITEM

24. ADMINISTERED BY *(If other than Item 7)* CODE

25. PAYMENT WILL BE MADE BY CODE

26. NAME OF CONTRACTING OFFICER *(Type or print)*	27. UNITED STATES OF AMERICA *(Signature of Contracting Officer)*	28. AWARD DATE

IMPORTANT - Award will be made on this Form, or on Standard Form 26, or by other authorized official written notice.

PART I - THE SCHEDULE
SECTION B
SUPPLIES OR SERVICES AND PRICES/COSTS

B-1 SUPPLIES OR SERVICES AND PRICES/COSTS

ITEM NUMBER	SUPPLIES OR SERVICES	QTY	UNIT	UNIT PRICE	AMOUNT
0001	The contractor shall provide upgrades to an existing Anechoic Chamber Facility.	1	LOT	$	$
0002	Contract Data Requirements List (DD 1423)			**NSP	**NSP
TOTAL DOLLAR AMOUNT FOR CLINs*				$	$

*CONTRACT LINE ITEM NUMBER
**NOT SEPARATELY PRICED

SECTION C
DESCRIPTION/SPECIFICATIONS/STATEMENT OF WORK

C-1 The work under this contract shall be performed in accordance with Attachment (1), Specifications, with DD 1423, Contract Data Requirements List, Attachment (2) NRL Report 7793, Fire Retardant Properties, Attachment (3) NRL Report No. 8093, Modified Smoldering Test of Urethane Foams Used in Anechoic Chambers and all other Attachments cited in Section J, which are incorporated by reference into Section C.

C-2 REQUIREMENTS FOR ON-SITE CONTRACTORS

For those portions of the work under this contract performed at any NRL site, the contractor shall comply with the Requirements for On-Site Contractors dated 19 October 2001 which are hereby incorporated by reference. The full text is available at http://heron.nrl.navy.mil/contracts/home.htm.

SECTION D
PACKAGING AND MARKING

D-1 Preservation, packaging, packing and marking of all deliverable contract line items must conform to normal commercial packing standards to assure safe delivery at destination.

D-2 The Contractor shall mark all shipments under this contract in accordance with the edition of ASTM-D-3951-90 "Standard Practice for Commercial Packaging" in effect on the date of the contract.

SECTION E
INSPECTION AND ACCEPTANCE

E-1 INSPECTION AND ACCEPTANCE CLAUSES BY REFERENCE:

FAR CLAUSE		TITLE
52.246-4	-	Inspection of Services – Fixed Price (AUG 1996)
52.246-16	-	Responsibility For Supplies (APR 1984)

DFARS CLAUSE		TITLE
252.246-7000	-	Material Inspection And Receiving Report (DEC 1991)

E-2 INSPECTION AND ACCEPTANCE

Inspection and acceptance of the final delivery will be accomplished by the Technical Manager (TM) or Contracting Officer Representative (COR) designated in Section G of this contract . Inspection and acceptance will be performed at the Naval Research Laboratory, Washington DC 20375-5320.

Constructive acceptance, in accordance with FAR 32.904 (b) (1)(ii)(4), shall be deemed to have occurred on the 30 days after the final delivery.

SECTION F
DELIVERIES OR PERFORMANCE

F-1 DELIVERIES OR PERFORMANCE CLAUSES BY REFERENCE:

FAR CLAUSE		TITLE
52.242-17	-	Government Delay Of Work (APR 1984)
52.247-34	-	F.O.B. Destination (NOV 1991)

F-2 DELIVERIES OR PERFORMANCE

(a) The period of performance under this contract shall be from date of award through Ninety (90) days.

(b) The principle place of performance of this contract shall be the Naval Research Laboratory, Washington D. C. 20375.

F-3 PLACE OF DELIVERY - FOB DESTINATION

The contractor shall deliver supplies, all transportation charges paid, to destination in accordance with the clause in Section F of the Schedule titled FAR 52.247-34 FOB Destination (NOV 1991).

Receiving Officer
Naval Research Laboratory
Contract Number
ATTN: *
CODE: *
LOCATION: *
Bldg. 49
4555 Overlook Avenue, SW
Washington DC 20375-5320

(* To be filled in at time of award.)

SECTION G
CONTRACT ADMINISTRATION DATA

G-1 PROCURING OFFICE REPRESENTATIVE

In order to expedite administration of the contract, the Administrative Contracting Officer (ACO) will direct inquiries to the appropriate office listed below. Please do not direct routine inquiries to the person listed in Item 20A on Standard Form 26.

Contract Matters- *

Security Matters- *

Safety Matters- *

Patent Matters- *

Release of Data- *

The ACO will forward invention disclosures and reports directly to the Associate Counsel for Patents, Code 1008.2, Naval Research Laboratory, Washington DC 20375-5320. The Associate Counsel for Patents will return the reports along with a recommendation to the Administrative Contracting Officer. The Associate Counsel for Patents will represent the Contracting Officer with regard to invention reporting matters arising under this contract.

(* To be filled in at time of award)

G-2 CONTRACTING OFFICER'S REPRESENTATIVE (COR) - FUNCTIONS AND LIMITATIONS

* is hereby designated the cognizant COR who will represent the Contracting Officer in the administration of technical details within the scope of this contract and inspection and acceptance. The COR is not otherwise authorized to make any representations or commitments of any kind on behalf of the Contracting Officer or the Government. The COR does not have the authority to alter the Contractor's obligations or change the specifications in the contract. If, as a result of technical discussions, it is desirable to alter contract obligations or statements of work, a modification must be issued in writing and signed by the Contracting Officer. The COR is responsible for reviewing the bills and charges submitted by the Contractor and informing the ACO of areas where exceptions are to be taken.

(* To be filled in at time of award)

G-3 NAPS 5252.232-9000 - SUBMISSION OF INVOICES (FIXED PRICE) (JUL 1992)

(a) "Invoices" as used in this clause does not include contractor's requests for progress payments.

(b) The contractor shall submit original invoices with 4 copies to the address identified in the solicitation/contract award form (SF 26-Block 10; SF 33-Block 23; SF 1447-Block 14), unless delivery orders are applicable, in which case invoices will be segregated by individual order and submitted to the address specified in the order (DD 1155-Block 13 or SF 26-Block 10).

(c) The use of copies of the Material Inspection and Receiving Report (MIRR), DD Form 250, as an invoice is encouraged. DFARS Appendix F-306 provides instructions for such use. Copies of the MIRR used as an invoice are in addition to the standard distribution stated in DFARS F-401.

(d) In addition to the requirements of the Prompt Payment clause of this contract, the contractor shall cite on each invoice the contract line item number (CLIN); the contract subline item number (SLIN), if applicable; the accounting classification reference number (ACRN) as identified on the financial accounting data sheets, and the payment terms.

(e) The contractor shall prepare:

☐ a separate invoice for each activity designated to receive the supplies or services.
☒ a consolidated invoice covering all shipments delivered under an individual order.
☐ either of the above.

(f) If acceptance is at origin, the contractor shall submit the MIRR or other acceptance verification directly to the designated payment office. If acceptance is at destination, the consignee will forward acceptance verification to the designated payment office.

G-4 INVOICING ADDRESS

With reference to paragraph (b) of the above provision, "Submission of Invoices (Fixed Price)", the contractor shall submit invoices to the address in Block 12 of the contract award form (SF26).

SECTION H
SPECIAL CONTRACT REQUIREMENTS

H-1 TYPE OF CONTRACT

(To be filled in at time of award)

H-2 REPRESENTATIONS AND CERTIFICATIONS

The Contractor's completed Representations, Certifications, and Other Statements of Offerors or Respondents is incorporated herein by reference in any resultant award.

H-3 ELECTRONIC AND INFORMATION TECHNOLOGY (EIT)

In accordance with Section 508 of the Rehabilitation Act of 1973 (29 U.S.C. 794d), all EIT supplies and services provided under this contract must comply with the applicable accessibility standards issued by the Architectural and Transportation Barriers Compliance Board at 36 CFR part 1194 (see FAR Subpart 39.2). Electronic and information technology (EIT) is defined at FAR 2.101.

H-4 GOVERNMENT-FURNISHED PROPERTY

The following Government property will be furnished to the contractor on a rent-free basis for use in performing test operations. This includes Network Analyzer, signal sources, standard gain horns, and other microwave equipment necessary to carry out these tests.

PART II - CONTRACT CLAUSES
SECTION I
CONTRACT CLAUSES

I-1 52.252-2 - CLAUSES INCORPORATED BY REFERENCE (FEB 1998)

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es):

http://www.arnet.gov/far
http://heron.nrl.navy.mil/contracts/home.htm

a. FEDERAL ACQUISITION REGULATION CLAUSES

FAR CLAUSE		TITLE
52.202-1	-	Definitions (DEC 2001)
52.203-3	-	Gratuities (APR 1984)
52.203-5	-	Covenant Against Contingent Fees (APR 1984)
52.203-6	-	Restrictions On Subcontractor Sales To The Government (JUL 1995)
52.203-7	-	Anti-Kickback Procedures (JUL 1995)
52.203-8	-	Cancellation, Rescission, And Recovery Of Funds For Illegal Or Improper Activity (JAN 1997)
52.203-10	-	Price Or Fee Adjustment For Illegal Or Improper Activity (JAN 1997)
52.203-12	-	Limitation On Payments To Influence Certain Federal Transactions (JUN 1997)
52.204-4	-	Printed Or Copied Double-Sided On Recycled Paper (AUG 2000)
52.209-6	-	Protecting The Government's Interest When Subcontracting With Contractors Debarred, Suspended, Or Proposed For Debarment (JUL 1995)
52.211-5	-	Material Requirements (AUG 2000)
52.211-15	-	Defense Priority And Allocation Requirements (SEP 1990)
52.215-2	-	Audit And Records-Negotiation (JUN 1999)
52.215-8	-	Order Of Precedence - Uniform Contract Format (OCT 1997)
52.215-14	-	Integrity Of Unit Prices (OCT 1997)
52.215-17	-	Waiver Of Facilities Capital Cost Of Money (OCT 1997) (*will be included if the successful offeror does not propose facilities capital cost of money)*
52.215-21	-	Requirements For Cost And Pricing Data Or Information Other Than Cost Or Pricing Data - Modifications (OCT 1997) - Alternate IV (OCT 1997)
52.219-8	-	Utilization Of Small Business Concerns (OCT 2000)
52.222-3	-	Convict Labor (AUG 1996)
52.222-19	-	Child Labor – Cooperation With Authorities And Remedies (DEC 2001)
52.222-20	-	Walsh-Healey Public Contracts Act (DEC 1996)
52.222-21	-	Prohibition of Segregated Facilities (FEB 1999)
52.222-26	-	Equal Opportunity (FEB 1999)
52.222-35	-	Equal Opportunity For Special Disabled Veterans, Veterans Of The Vietnam Era, And Other Eligible Veterans (DEC 2001)
52.222-36	-	Affirmative Action For Workers With Disabilities (JUN 1998)
52.222-37	-	Employment Reports On Special Disabled Veterans, Veterans Of The Vietnam Era, And Other Eligible Veterans (DEC 2001)
52.222-44	-	Fair Labor Standards Act And Service Contract Act - Price Adjustment (FEB 2002)
52.223-3	-	Hazardous Material Identification And Material Safety Data (JAN 1997)
52.223-5	-	Pollution Prevention and Right-To-Know Information (APR 1998)
52.223-6	-	Drug-Free Workplace (MAY 2001)
52.223-14	-	Toxic Chemical Release Reporting (OCT 2000)
52.225-13	-	Restrictions On Certain Foreign Purchases (JUL 2000)
52.227-1	-	Authorization And Consent (JUL 1995)
52.227-2	-	Notice And Assistance Regarding Patent And Copyright Infringement (AUG 1996)
52.227-3	-	Patent Indemnity (APR 1984)
52.228-5	-	Insurance - Work on a Government Installation (JAN 1997)
52.229-3	-	Federal, State, And Local Taxes (JAN 1991)
52.229-5	-	Taxes - Contracts Performed In U.S. Possessions Or Puerto Rico (APR 1984)

52.230-2	-	Cost Accounting Standards (APR 1998)
52.230-6	-	Administration Of Cost Accounting Standards (NOV 1999)
52.232-1	-	Payments (APR 1984)
52.232-9	-	Limitation On Withholding Of Payments (APR 1984)
52.232-11	-	Extras (APR 1984)
52.232-17	-	Interest (JUN 1996)
52.232-23	-	Assignment Of Claims (JAN 1986)
52.232-33	-	Payment By Electronic Funds Transfer-Central Contractor Registration (MAY 1999)
52.233-1	-	Disputes (DEC 1998)
52.233-3	-	Protest After Award (AUG 1996)
52.237-2	-	Protection Of Government Buildings, Equipment, And Vegetation (APR 1984)
52.237-3	-	Continuity Of Services (JAN 1991)
52.242-13	-	Bankruptcy (JUL 1995)
52-245-2	-	Government Property (Fixed-Price Contracts) (DEC 1989) Alternate I (APR 1984) (DEVIATION)
52.243-1	-	Changes – Fixed Price (AUG 1987) Alternate II (APR 1984)
52.246-25	-	Limitation Of Liability - Services (FEB 1997)
52.248-1	-	Value Engineering (FEB 2000)
52.249-4	-	Termination For Convenience OF The Government (Services) (Short Form) (APR 1984)
52.249-14	-	Excusable Delays (APR 1984)
52.252-6	-	Authorized Deviations In Clauses (APR 1984) fill in Defense Federal Acquisition Regulation Supplement (48 CFR Chapter 2);
52.253-1	-	Computer Generated Forms (JAN 1991)

DFARS CLAUSE		**TITLE**
252.203-7001	-	Prohibition On Persons Convicted Of Fraud Or Other Defense Contract Related Felonies (MAR 1999)
252.204-7003	-	Control Of Government Personnel Work Product (APR 1992)
252.204-7004	-	Required Central Contractor Registration (NOV 2001)
252.209-7000	-	Acquisition From Subcontractors Subject To On-Site Inspection Under The Intermediate-Range Nuclear Forces (INF) Treaty (NOV 1995)
252.209-7004	-	Subcontracting With Firms That Are Owned Or Controlled By The Government Of A Terrorist Country (MAR 1998)
252.223-7006	-	Prohibition On Storage And Disposal Of Toxic And Hazardous Materials (APR 1993)
252.225-7001	-	Buy American Act And Balance Of Payments Program (MAR 1998)
252.225-7002	-	Qualifying Country Sources As Subcontractors (DEC 1991)
252.225-7009	-	Duty-Free Entry - Qualifying Country Supplies (End Products And Components) (AUG 2000)
252.225-7012	-	Preference For Certain Domestic Commodities (AUG 2000)
252.225-7031	-	Secondary Arab Boycott Of Israel (JUN 1992)
252.226-7001	-	Utilization of Indian Organizations and Indian-Owned Economic Enterprises-DoD Contracts (SEP 2001)
252.227-7034	-	Patents--Subcontracts (APR 1984)
252.231-7000	-	Supplemental Cost Principles (DEC 1991)

252.242-7000	-	Postaward Conference (DEC 1991)
252.243-7001	-	Pricing Of Contract Modifications (DEC 1991)
252.243-7002	-	Requests For Equitable Adjustment (MAR 1998)
252.244-7000	-	Subcontracts For Commercial Items And Commercial Components (DOD Contracts) (MAR 2000)
252.245-7001	-	Reports Of Government Property (MAY 1994)
252.247-7023	-	Transportation Of Supplies By Sea (MAR 2000)
252.247-7024	-	Notification Of Transportation Of Supplies By Sea (MAR 2000) *(will be included if the successful offeror made a negative response to the inquiry at DFARS 252.247-7022)*
252.251-7000	-	Ordering From Government Supply Sources (MAY 1995)

I-2 FAR 52.223-11 - OZONE-DEPLETING SUBSTANCES (MAY 2001)

(a) *Definitions.* "Ozone-depleting substance", as used in this clause, means any substance the Environmental Protection Agency designates in 40 CFR Part 82 as –

(1) Class I, including, but not limited to, chlorofluorocarbons, halons, carbon tetrachloride, and methyl chloroform; or

(2) Class II, including, but not limited to, hydrochlorofluorocarbons.

(b) The Contractor shall label products which contain or are manufactured with ozone-depleting substances in the manner and to the extent required by 42 U.S.C. 7671j (b), (c), and (d) and 40 CFR Part 82, Subpart E, as follows:

WARNING

Contains (or manufactured with, if applicable)_*_____, a substance(s) which harm(s) public health and environment by destroying ozone in the upper atmosphere.

*The Contractor shall insert the name of the substance(s).

PART III - LIST OF DOCUMENTS, EXHIBITS, AND OTHER ATTACHMENTS
SECTION J
LIST OF ATTACHMENTS

J-1 Attachment (1) - Specifications - 1 Page, with DD 1423, Contract Data Requirements List, 2 Page.

J-2 Attachment (2) NRL Report No. 8093, Modified Smoldering Test of Urethane Foams Used in Anechoic Chambers, 16 Pages.

J-3 Attachment (3) NRL Report No.7793, Fire Retardant Properties, 19 Pages

J-4 Attachment (3) - Accounting and Appropriation Data. 1 page. *

(To be included at time of award)*

PART IV - REPRESENTATIONS AND INSTRUCTIONS
SECTION K
REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF OFFERORS OR RESPONDENTS

K-1 Representations, Certifications, and Other Statements of Offerors or Respondents

Each Offeror must submit a completed Representations, Certifications, and Other Statements Of Offerors or Respondents with its proposal which is available electronically in full text at http://heron.nrl.navy.mil/contracts/reps&certs.htm

K-2 FILL IN FOR FAR 52.219-1 - SMALL BUSINESS PROGRAM REPRESENTATIONS (MAR 2001)

The fill in information is as follows:
The NAICS code for this acquisition is 334513.
The small business size standard is 500.

SECTION L
INSTRUCTIONS, CONDITIONS, AND NOTICES TO OFFERORS OR RESPONDENTS

L-1 52.252-1 SOLICITATION PROVISIONS INCORPORATED BY REFERENCE (FEB 1998)

This solicitation incorporates one or more solicitation provisions by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. The offeror is cautioned that the listed provisions may include blocks that must be completed by the offeror and submitted with its quotation or offer. In lieu of submitting the full text of those provisions, the offeror may identify the provision by paragraph identifier and provide the appropriate information with its quotation or offer. Also, the full text of a solicitation provision may be

accessed electronically at this/these address(es):

http://www.arnet.gov/far
http://heron.nrl.navy.mil/contracts/home.htm

FAR CLAUSE		TITLE
52.204-6	-	Data Universal Numbering System (DUNS) Number (JUNE 1999)
52.214-34	-	Submission Of Offers In The English Language (APR 1991)
52.214-35	-	Submission Of Offers In U.S. Currency (APR 1991)
52.215-1	-	Instructions To Offerors- Competitive Acquisition (MAY 2001)
52.215-1	-	Instructions To Offerors- Competitive Acquisition (MAY 2001) Alternate II (OCT 1997)
52.215-5	-	Facsimile Proposals (OCT 1997) Paragraph (c) is completed as follows: (202) 767- 3782 (primary) or (202) 767-0494 (alternate). In addition facsimile proposals may be transmitted by e-mail to lockamy@contracts.nrl.navy.mil (primary) or wallace@nrl.navy.mil (alternate) in either Microsoft Word (version 97 or earlier) or pdf format.
52.215-16	-	Facilities Capital Cost Of Money (OCT 1997)
52.219-24	-	Small Disadvantaged Business Participation Program - Targets (OCT 2000)
52.237-1	-	Site Visit (APR 1984)

L-2 SITE VISIT SCHEDULE

(a) A site visit will be conducted on June 14, 2002. Offerors must contact Dian Lockamy, 202-767-3782, on or before June 10, 2002 to be scheduled for the site visit. A limit of 2 representatives from each company is requested.

(b) During the site visit, Contractors must be prepared to:

(1) Evaluate the door area in order to provide a plan with their proposal that maximizes the open space when the door is open;

(2) Evaluate the existing heating, ventilation, and air conditioning for the shielded room and assess its adequacy for the safe use and preservation of the radar absorbing material they will propose. Remedies and/or solutions to inadequacies must be addressed in the proposal;

(3) Evaluate the existing lighting and recommend any improvements in the proposal.

L-3 FAR 52.211-14 - NOTICE OF PRIORITY RATING FOR NATIONAL DEFENSE USE (SEP 1990)

Any contract awarded as a result of this solicitation will be a ☐ DX rated order; ☒ DO rated order certified for national use under the Defense Priorities and Allocations system (DPAS) (15 CFR 700), and the Contractor will be required to follow all of the requirements of this regulation.

L-4 FAR 52.215-20 REQUIREMENTS FOR COST OR PRICING DATA OR INFORMATION OTHER THAN COST OR PRICING DATA (OCT 1997)ALTERNATE IV (OCT 1997)

(a) Submission of cost or pricing data is not required.

(b) Provide information described below :

Offerors should provide information to enable the Contracting Officer to determine that the proposed price is fair and reasonable. Such information could include published price lists, information on previous sales of the same of similar items, or the projected costs of fabricating and installing the item (material costs, labor costs, etc).

L-5 FAR 52.216-1 - TYPE OF CONTRACT (APR 1984)

The Government contemplates award of a Firm Fixed Price Servicecontract resulting from this solicitation.

L-6 FAR 52.222-18 - CERTIFICATION REGARDING KNOWLEDGE OF CHILD LABOR FOR LISTED END PRODUCTS (FEB 2001)

The fill-in information is as follows:

Listed End Product	Listed Countries of Origin

L-7 FAR 52.233-2 - SERVICE OF PROTEST (AUG 1996)

(a) Protests, as defined in Section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the General Accounting Office (GAO) shall be served on the Contracting Officer (addressed as follows) by obtaining written and dated acknowledgment of receipt from the Receptionist Desk, Code 3200, Bldg. 222, Rm. 115, Naval Research Laboratory, 4555 Overlook Ave., S.W., Washington DC 20375-5326.

(b) The copy of any protest shall be received in the office designated above within one day of filing a protest with the GAO.

L-8 INQUIRIES CONCERNING THE RFP

Any questions concerning the RFP must be submitted in writing to the Contracting Officer at the location noted in blocks 7 and 9 of the Standard Form 33, "Solicitation, Offer and Award," no less than fifteen (15) days before closing. The Government will not consider questions received after this date. Offerors are cautioned against directing any questions concerning this RFP to technical personnel at the Naval Research Laboratory.

L-9 CRITERIA FOR ALTERNATE PROPOSALS

Proposals submitted in response to this solicitation are not limited to the items listed in Section B. Offerors are encouraged to submit alternate proposals that offer significant beneficial improvements and meet the minimum needs of the Government. The alternate proposal will be evaluated in accordance with the evaluation criteria. The Government reserves the right to award a

contract based upon an alternate proposal which meets the Government's technical requirements and is otherwise awardable in accordance with the evaluation and award criteria.

L-10 INSTRUCTIONS FOR SUBMISSION AND INFORMATION REQUIRED TO EVALUATE PROPOSALS

PART A - PROPOSAL

(1) Required Copies: Original and 2 (Two)

(2) Proposal Identification/Mailing - The proposal should be packaged for delivery so as to permit safe and timely arrival at destination. The proposal package should be sent to the address shown in Block 7 of the RFP face page and marked:

RFP No. N00173-02-R- DL01
Closing Date:
(As specified in Block 9, RFP face page)
Attn: Code 3220

The technical portion must demonstrate in sufficient detail that the supplies or services proposed comply with the requirements of the RFP's Statement of Work or Specifications. General statements that the offeror can or will comply with the requirements, that standard procedures will be used, that well known techniques will be used, or paraphrases of the RFP's Statement of Work or Specification in whole or in part will not constitute compliance with these requirements concerning the content of the technical proposal. Failure to conform to any of the requirements of the RFP may form the basis for rejection of the proposal.

L-11 VOLUME I - TECHNICAL/MANAGEMENT PROPOSAL

REQUIRED COPIES: 1 ORIGINAL AND 2 (Two) COPIES.

(1) Include a matrix indicating proposed labor hours by skill category required to perform the statement of work.

(2) The following information is required for evaluation of your technical/management :

1. Past Performance

(a) Offerors shall submit the following information as part of their proposal. *(Offerors are encouraged to submit the information prior to other parts of the proposal to assist the government in reducing the length of the evaluation period.)* List the last two (2) contracts or subcontracts completed by the offeror or predecessor companies during the past two (2) years for services similar in nature to this requirement. Include in the two (2) contracts any current contracts or subcontracts for similar services that were awarded at least one year prior to the date of this solicitation. Offerors that have no similar previous or current contracts should provide the requested information for proposed subcontractors that will perform major or critical aspects of the requirement or for the proposed project manager or key personnel responsible for major or critical aspects of the requirement.

1. Name of contracting organization.
2. Contract number

3. Contract type
4. Total contract value
5. Description of the contract work
6. Contracting officer and telephone number
7. Contracting officer's representative, program manager, or similar official and telephone number

(b) Offerors shall contact the contracting organizations identified pursuant to paragraph (a) as soon as possible and request them to send past performance information on the identified contracts to the address in Block 7 of the face page of this solicitation. The past performance report which is available electronically in full text at http://heron.nrl.navy.mil/contracts/home.htm is to be provided to the contracting organization for this purpose. If the contracting organization has already collected past performance information on the contract pursuant to FAR Subpart 42.15, the format used to collect the information may be used instead of the past performance report.
(c) Offerors may include in their proposals specific information relating to problems encountered in performing the identified contracts and any corrective actions by the offeror. Offerors should not provide general information on their performance on the identified contracts as this will be obtained from the contracting organizations.

SECTION M
EVALUATION FACTORS FOR AWARD

M-1 EVALUATION

(a) Non cost factor(s):
(1) Technical Proposals will be evaluated on demonstrated compliance with the requirements of the RFP's Specifications.

(2) Past Performance will be evaluated on the basis of the quality of the work performed, or supplies delivered and the timeliness of performance or delivery. The evaluation will be based on the information provided pursuant to Section L and other sources if available. A determination will be made as to whether the offeror's past performance is acceptable or unacceptable. Offerors that have no relevant performance history or for which past performance information is not available will not be evaluated favorably or unfavorably on past performance.

(b) Award will be made to the responsible offeror proposing the lowest price that meets or exceeds the acceptability standards for non-cost factors.

M-2 EVALUATION

Award will be made to that offeror whose proposal is determined to be the best value to the Government, proposed price and other factors considered. The Government reserves the right to make award to other than the low offeror.

SPECIFICATIONS

1. Scope

This requirement is to upgrade for the Naval Research Laboratory an existing microwave Anechoic Chamber which is located in Building 210 and which shall operate over the range of frequencies of 600 MHz-100GHz. The Contractor shall remove and dispose of existing radar absorbing material (RAM), and provide and install all new radar absorbing material. In addition, the contractor shall provide and install an RF shielded door to provide RF isolation to the exterior laboratory area. After contractor installation, the contractor shall test the electromagnetic performance of the new installation and provide a test report containing the measured data.

2. Mechanical Requirements

2.1 The existing shielded room has dimensions of nominally 32ft (9.75M) x 15ft 9in (4.8M) x 15ft 5in (4.7M) (L x W x H). After all existing absorber has been removed; bulkhead connector access plate shall be cut in a sidewall of the shielded room for mounting bulkhead connectors for RF and electrical power access in and out of the room.

2.2 The contractor shall supply and install an RF shielded double door in the existing opening in the shielded room which measures 8ft x 8ft (2.44M x2.44M). The side of the doors facing the inside of the shielded room shall have RAM on them, the same material as used in the Anechoic chamber.

2.3 The contractor shall supply all required scaffolding and tools for the installation.

3.0 Radar Absorbing Material (RAM)

3.1 The back wall of the chamber shall have a maximum of –35 dB reflectivity over the frequency range of 600 MHz to 100 GHz. The other walls of the chamber shall have a maximum of –30 dB reflectivity over the same frequency range. All specular areas located on the sidewalls, floor and ceiling shall be treated to have a maximum of –35dB reflectivity from 600 MHz to 100 GHz.

3.2 A quiet volume in the center of the room shall be 6ft x 6ft x 6ft and measure –30 dB relative to an isotropic radiator.

3.3 The RAM shall be attached to the inside walls and ceiling with a plate and rail type system to provide for removal of absorbing panels if necessary. The RAM must be installed so that there are no gaps between the individual pieces of RAM and that they are aligned in a grid pattern.

3.4 RAM shall be installed so as not to obstruct airflow transfer in the shielded room while still providing absorber performance as specified.

3.5 The installed RAM shall be capable of safely withstanding without degradation in performance, physical damage, or fire, up to 150 mW/cm^2 of incident CW RF field intensity.

3.6 The contractor shall provide a walkway of absorber, a single path of walk-on absorber across the length of the room, which will support a minimum of 200 pounds per square foot.

3.7 The RAM shall meet the fire retardant properties as specified by NRL standard tests (NRL Report 7793) 1, 2, and 3; as well as NRL Report 8093 Tests 1, 2, and 3.

3.8 The RAM shall be light blue in color.

4.0 Fire Protection

4.1 The contractor shall comply with all codes and regulations set forth in NRL 5101.3B Fire Safety and Anechoic Chamber Operations Manual. The contractor shall provide the government with a manufacturers Material Safety Data Sheet (MSDS) for all materials used.

5.0 Performance verification

5.1 The contractor shall provide an acceptance plan to demonstrate the proper RF performance of the installed RAM. Detailed procedures for conducting the tests shall be provided to NRL for approval 30 days in advance of performing the test.

5.2 The contractor shall provide design and engineering drawings for government approval at least 30 days prior to initiating installation.

5.3 The contractor shall provide as built drawings to NRL within 30 days of the final acceptance tests along with the final copy of the acceptance test reports.

6.0 RF Performance tests

6.1 In accordance with the acceptance plan, the contractor shall perform the RF acceptance tests in order to evaluate the performance of the RAM material that is placed on the walls and on the design of the placement of the material.

6.2 All measurements shall be performed with NRL personnel on site. Final acceptance shall consider all performance measurements as compared to the government's specifications.

7.0 Safety Plan during Construction

7.1 The contractor shall submit a Safety Plan (29 CFR 1926) which shall cover the following elements:

- working surfaces
- emergency fire protection plan
- personal protective equipment
- confined space
- lockout/tagout
- signs and tags for physical hazards

- medical services and surveillance
- electrical
- welding/cutting
- Hazardous Communications
- Competent person in accordance with 29 CFR 1926.32F
- Inventory and Material Safety Data Sheets (MSDS) for all hazardous material and chemicals that will be brought on NRL property.

CONTRACT DATA REQUIREMENTS LIST

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A. CONTRACT LINE ITEM NO.	B. EXHIBIT	C. CATEGORY:
0002	A	TDP _____ TM- _____ OTHER _____

D. SYSTEM / ITEM	E. CONTRACT / PR NO.	F. CONTRACTOR
	57-4117-02	

1. DATA ITEM NO.	2. TITLE OF DATA ITEM	3. SUBTITLE	17. PRICE GROUP
A001	Acceptance Plan		18. ESTIMATED TOTAL PRICE

4. AUTHORITY (Data Acquisition Document No.)	5. CONTRACT REFERENCE	6. REQUIRING OFFICE
	Specificatios 5.1	NRL Code 6333

7. DD 250 REQ	9. DIST STATEMENT REQUIRED	10. FREQUENCY	12. DATE OF FIRST SUBMISSION
LT		ONCE	N/A
8. APP CODE		**11. AS OF DATE**	**13. DATE OF SUBSEQUENT SUBMISSION**
A	N/A	*See Blk 16	N/A

16. REMARKS
Detailed procedures for conducting the tests shall beprovided 30 days in advance of performing the test.

14. DISTRIBUTION	b. COPIES		
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1. DATA ITEM NO.	2. TITLE OF DATA ITEM	3. SUBTITLE	17. PRICE GROUP
A002	Design and Engineering Drawings		18. ESTIMATED TOTAL PRICE

4. AUTHORITY (Data Acquisition Document No.)	5. CONTRACT REFERENCE	6. REQUIRING OFFICE
	Specification 5.2	

7. DD 250 REQ	9. DIST STATEMENT REQUIRED	10. FREQUENCY	12. DATE OF FIRST SUBMISSION
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16. REMARKS
Delivery 30 days prior to initiating installation.

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A003	"As Built" Drawings		18. ESTIMATED TOTAL PRICE

4. AUTHORITY (Data Acquisition Document No.)	5. CONTRACT REFERENCE	6. REQUIRING OFFICE
	Specification 5.3	NRL Code 6333

7. DD 250 REQ	9. DIST STATEMENT REQUIRED	10. FREQUENCY	12. DATE OF FIRST SUBMISSION
LT		ONCE	N/A
8. APP CODE		**11. AS OF DATE**	**13. DATE OF SUBSEQUENT SUBMISSION**
N/A	N/A	*See Blk 16	N/A

16. REMARKS
*Provide "as built" drawings to NRL within 30 days of the final acceptance test

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1. DATA ITEM NO.	2. TITLE OF DATA ITEM	3. SUBTITLE	17. PRICE GROUP
A004	Safety Plan		18. ESTIMATED TOTAL PRICE

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	Specification 7.0	NRL Code 6333

7. DD 250 REQ	9. DIST STATEMENT REQUIRED	10. FREQUENCY	12. DATE OF FIRST SUBMISSION
LT		ONCE	N/A
8. APP CODE		**11. AS OF DATE**	**13. DATE OF SUBSEQUENT SUBMISSION**
N/A	N/A	*See Blk	N/A

16. REMARKS
*Provide Safety Plan within 30 days of the final acceptance test.

14. DISTRIBUTION	b. COPIES		
a. ADDRESSEE	Draft	Final Reg	Final Repro
15. TOTAL →			

G. PREPARED BY	H. DATE	I. APPROVED BY	J. DATE
NRL Code 6333	MAY 22, 2002		

Solicitation Number: N00173-02-R-DL01
Attachment No.: (2)

NRL Report 8093

Modified Smoldering Test of Urethane Foams Used in Anechoic Chambers

P. A. TATEM, P. D. MARSHALL, AND F. W. WILLIAMS

Combustion and Fuels Branch
Chemistry Division

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March 9, 1977

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Polyurethane foams
Scaling

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A program is under way at the Naval Research Laboratory to develop small-scale laboratory fire tests that will predict more accurately the behavior of Class A materials in fires. After development of five small-scale performance specifications for assessing the hazard of carbon-impregnated polyurethane foam, samples of the materials were installed in a large-scale fire test facility to determine the scaling parameters applicable to the foam. The knowledge gained from the large-scale tests under different experimental conditions and with several polyether and polyester foams has been used to scale down to a laboratory test that dynamically measures the expected behavior of the foam in a scaled situation.

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MODIFIED SMOLDERING TEST OF URETHANE FOAMS USED IN ANECHOIC CHAMBERS

INTRODUCTION

Since the 1973 fire in a Naval Research Laboratory anechoic chamber [1], several other fires involving carbon-impregnated polyurethane foam have occurred at various facilities [2,3]. The hazard of these chambers has been highlighted, and the public finally recognizes this long-existing problem.

The absorber material in these chambers presents several unique problems. First, the least expensive available material with the desired qualities, including required electrical characteristics, is polyurethane foam. The dangers of this base material are its self-smoldering properties and its toxic gas emission under thermal and fire stress [4]. Second, the types of fire retardants that can be used are limited because of restrictions placed on the end product. The end product is heavily loaded with carbon for specific electrical characteristics, and fire retardants used must not interfere with this function.

The Chemistry Division at NRL has been actively involved since 1973 in a research program to improve the fire behavior of the absorber materials on the market, and five fire performance tests have been conceived and developed [4,5]. These have been adopted as performance specifications in procurement contracts for chamber materials used by various governmental, institutional, and commercial agencies. Since the development of the small-scale fire performance tests, a large-scale testing program has been developed to determine scaling parameters applicable to the small-scale test results, for more accurate prediction of real-life performance.

One of the small-scale tests described in Ref. 4 evaluated the smoldering tendency of foams after ignition by a hot surface heater. This was the most severe test conceived, but it did not take into account the effects of heat transfer (heat feedback), fuel load, sample geometry, or other, more subtle scaling parameters encountered in full-scale fires involving this material. The large-scale testing program was to simulate a full-scale chamber so that these factors could be reevaluated. This program produced knowledge that has been used to reassess the small-scale smoldering test procedure and to evolve a redesign that better indicates the material's behavior under fire conditions in actual anechoic chambers.

EXPERIMENTAL SETUP AND PROCEDURE

The seven materials used in the first large-scale testing program were submitted by several of the companies that supplied foams for the program from which the test specifications were developed. The samples will be referred to by the letters A through G.

Manuscript submitted December 10, 1976

Each manufacturer has been deeply involved in improving its product since the performance specifications were developed. Although there may be several foams from the same company, each represents the state-of-the-art material for its company at the time of receipt.

Large-scale tests were carried out in the 1.8 m X 1.8 m X 2.4 m (6 ft X 6 ft X 8 ft) facility shown in Fig. 1. The walls, floor, and ceiling of this chamber were covered with absorber material in the configuration used in actual chambers. Although the entire interior of the chamber was covered with foam, the absorber under test at any time covered only a 0.6 m X 0.6 m (2 ft X 2 ft) area surrounding the location of the ignition source. The ignition source used was an 80-W hot-surface cartridge heater 1.27 cm (0.5 in.) in diameter and 16.5 cm (6 in.) long, as used in Test 3, Ref. 4. In the small-scale tests [4] we had found that the cartridge heater is a more severe form of ignition than the 1900°C methane-air flame required by Test 2 (Table 1). When a flame is played on a sample of the foam, the area in contact with the flame is burned away, creating a cavity, so that the only significant forms of heat transfer are radiative and convective. With the cartridge heater, heat is more efficiently transferred through conduction because of the constant contact between the heater and the foam. Conductive heat transfer is more effective in allowing heat to build up in the foam to the point at which combustion can sustain itself; heat buildup then depends on the ability of the foam to dissipate the energy rapidly.

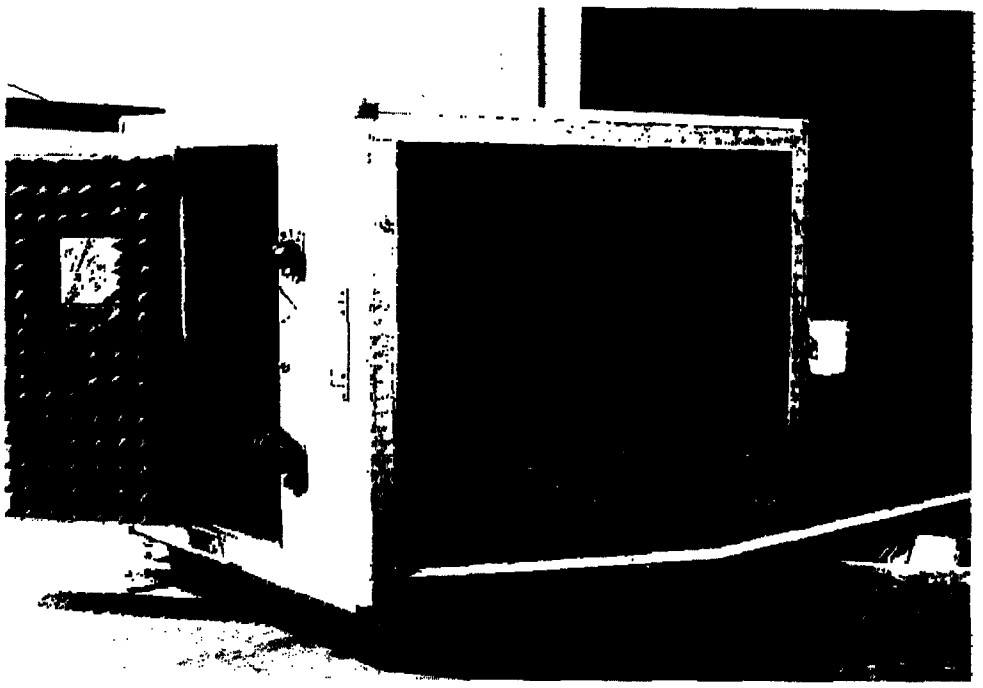

Fig. 1 — Interior view of model anechoic chamber used to conduct large-scale absorber fire tests

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Table 1 — Summary of Performance Specification Tests

Test	Equipment for Test	Property Tested	Experimental Conditions	Requirements Under Test Conditions
1. Resistance to electrical stress	Power supply (capable of 240 V ac, 8 A) Test leads located 2.5 cm apart	Ability to withstand electrical overload or short	Exposure to 240 V ac for 60 s	Self-extinguish within 60 s after removal of ignition source. Specimen damage <90%
2. Ease of ignition and flame Propagation	Bunsen burner Support for specimen Timing device	Ignitability and ability to self-extinquish flame (flaming ignition source)	Exposure to flame for 60 s	Self-extinguish within 60 s after removal of ignition source
3. Smoldering	Radiative cartridge heater (capable of 600°C)	Ability to self-extinguish smoldering (flameless ignition source)	Exposure to 600°C radiative heat source for 5 min	Specimen damage <90%
4. Toxic gas emission in a fire environment	Combustion boat H_2/air flame Closed chamber	Toxic gas production Under continuous exposure to flaming ignition source (T = 2400°C)	Exposure to flame for 15 min	HCN conc. <0.3 mg/g HC1 conc. <0.4 mg/g CO conc. <20 mg/g
5. Toxic gas emission due to a hot surface	Combustion boat Radiative cartridge heater Closed chamber	Toxic gas production under continuous exposure to flameless ignition source (T = 350°C)	Exposure to radiative heat source for 15 min	HCN conc. <0.6 mg/g HC1 conc. <0.9 mg/g CO conc. <5 mg/g

The fire spread within the absorber is monitored by a thermocouple array that covers one side of the chamber and extends to cover half of the back (Fig. 2). The thermocouples are spaced on a square grid 30.5 cm (12 in.) apart and extend 7.6 cm (3 in.) into the absorber attached to the wall. Two additional thermocouples are used, one attached to the cartridge heater and the other inserted 2.54 cm (1 in.) away from the cartridge heater. The thermocouples were inserted in the back of the foam through holes drilled through the chamber wall and the foam. The thermocouples were protected during insertion by 0.6 cm X 10.2 cm (0.25 in. X 4 in.) stainless steel tubing. This was removed after the thermocouple was in place, and the hole was repaired with General Electric RTV-112 potting compound.

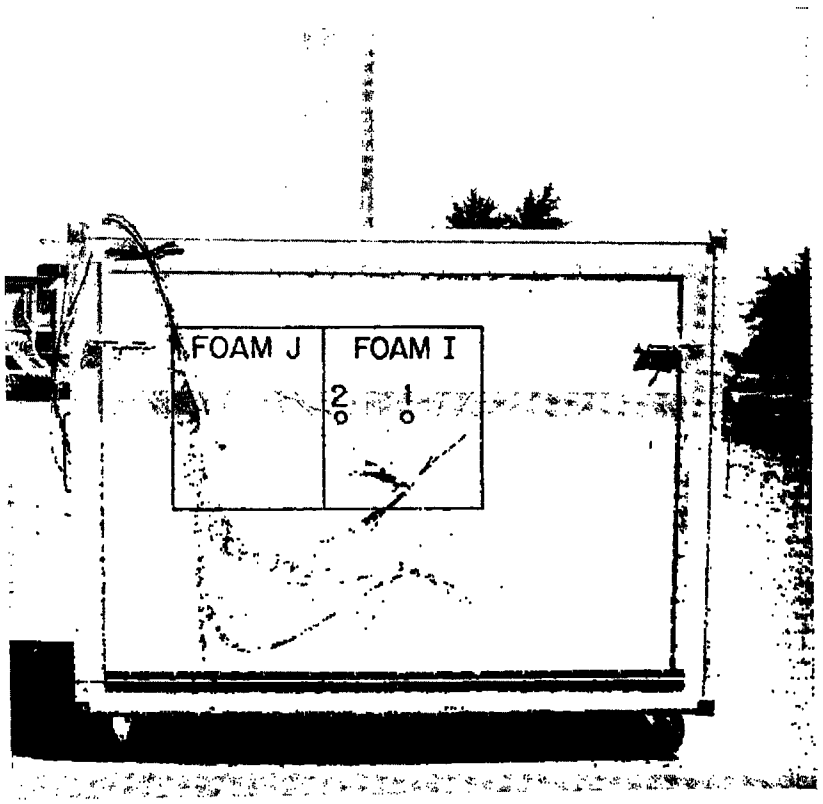

Fig. 2 — Side view of model chamber, showing thermocouple array

A stack located on top of the chamber houses the fire detectors (one photoelectric detector, two ionization detectors, and one toxic product monitor) used for sensing a fire (Fig. 2) and the gas sampling lines through which are continuously monitored, in some tests, oxygen (Beckman Instruments, Model 715) and carbon monoxide and dioxide on two analyzers (Beckman Instruments, Model 315A). Temperatures within the foam

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are recorded during fire tests by a Hewlett Packard Model 3480 Scanning Digital Voltmeter and output on paper tape at a rate of approximately one reading every 2 s. Subsequent computer plots of the data permit correlation of temperature profiles with the progress of the fire in the chamber.

The cartridge heater was imbedded in the base of the foam that was attached to the wall of the chamber. The heater temperature was then raised to the desired value, either stepwise in 100°C intervals or directly to maximum temperature, and then removed after all fire detectors were in the alarm mode. Monitoring of the temperatures was continued after removal of the ignition source to determine the extent of fire spread and time of extinguishment.

RESULTS AND DISCUSSION

The data from the large-scale fire tests are tabulated in Table 2. A typical computer plot generated during one of these fire tests is shown in Fig. 3. In the upper left-hand corner of the figure is the thermocouple (TC) configuration of the entire side wall on which the fire was initiated. In this particular test, the damper on the stack was 30% open but the blower to circulate air in the chamber was not activated. Thermocouple 39 monitors the temperature of the heater. From this figure we can follow the fire spread, which was negligible as indicated by the minimal responses of thermocouples 12, 13, 17, and 18 in the immediate vicinity of the fire.

Table 2 — Summary of Large-Scale Chamber Fire Tests

Sample	Maximum Temperature of Heater (°C)	Method of Reaching Temp.	Maximum Temperature of TC 2.5 cm Away (°C)	Max. Energy Input (kW)	Fire Test	Outcome
F	600	Stepped	—*	186	23	Smoldered
D	600	Stepped	460	176	11	Smoldered
E	600	Stepped	500	258	21	Smoldered
D	600	Stepped	410	172	16	Self-exting.
G	600	Stepped	550	160	22	Smoldered
C	600	Stepped	260	186	19	Self-exting.
C	600	Stepped	270	204	20	Self-exting.
B	600	Stepped	375	147	9	Self-exting.
D	560	Direct	460	157	13	Self-exting.
D	520	Direct	450	60	12	Self-exting.
C	600	Direct	400	—	18	Self-exting.
B	600	Direct	290	—	10	Self-exting.
B	600	Direct	220	—	14	Self-exting.
B	310	Direct	110	—	8	Self-exting.
A	300	Direct	—	—	3	Self-exting.
A	425	Direct	>550	—	4	Smoldered
A	440	Direct	—	—	1	Smoldered
A&D	600	Direct	630	47	17	Smoldered
A&B	600	Direct	520	—	15	Smoldered

* — Indicates data not available.

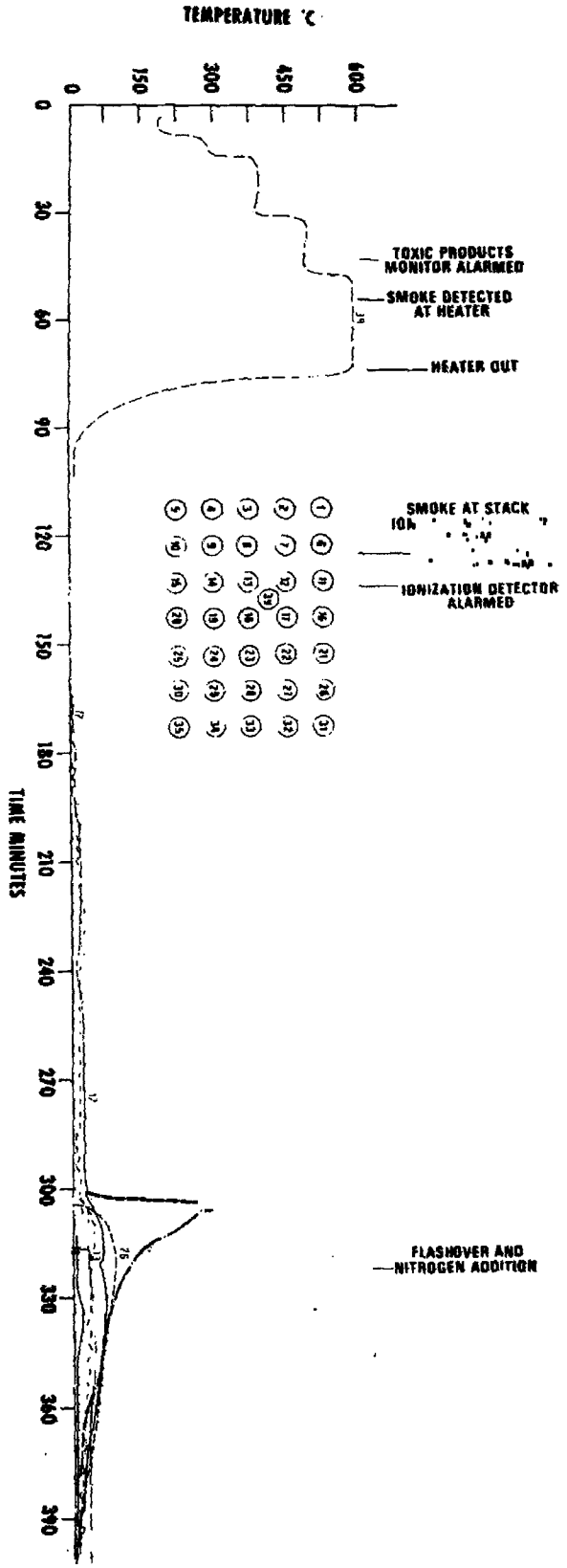

Fig. 3 — Fire scenario depicting the temperatures of several thermocouples during initiation and propagation of a fire that resulted in flashover in the large-scale facility

Under these minimal ventilation conditions, the fire was monitored for an additional 4 h after the heater was removed. At this time the combustible gases from the smoldering foam ignited, and rapid combustion spread throughout the chamber foam. This phenomenon is one form of "flashover" and is evident in the figure at 305 min into the test. This necessitated termination of the test, accomplished by flooding the chamber with nitrogen to suppress the fire. Following flashover, the fire was fought with nitrogen for approximately 1 h before being extinguished. More than 50% of the absorber material lining the chamber walls was destroyed during the later phase of the fire, post flashover (Fig. 4).

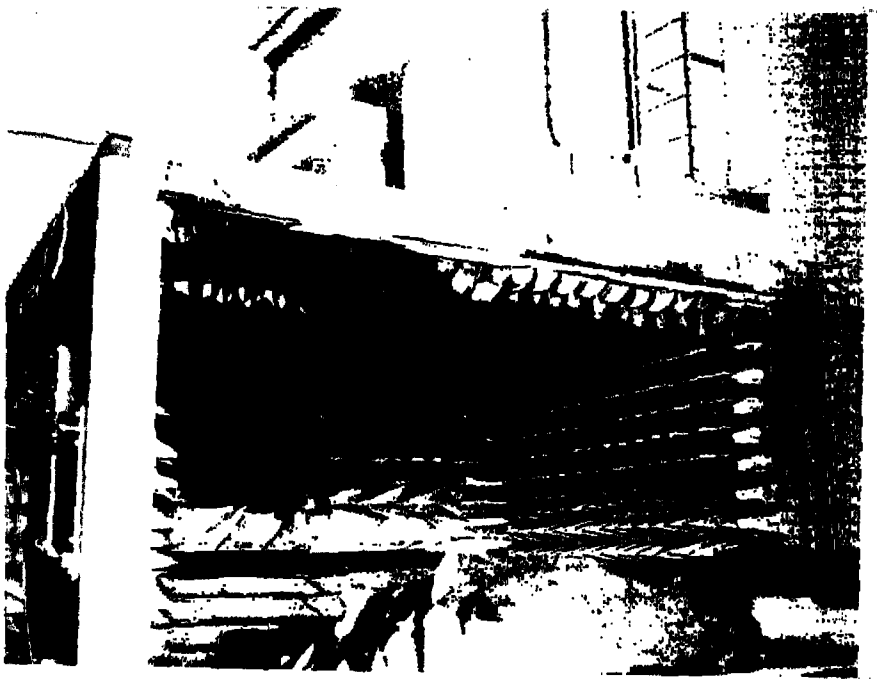

Fig. 4 — Appearance of large-scale facility after flashover fire

The fire was not halted before the 350 min point because the thermocouples indicated that the material was sustaining, rather than suppressing, smoldering. The fundamental characteristic being evaluated in the large-scale tests is the ability of the carbon-impregnated polyurethane foams to suppress smoldering when the heat source is removed. Correlations were attempted between smoldering and several other factors, such as the amount of heat or energy input (maximum temperature), time to reach maximum temperature (heating rate), and method of heat input (stepped or direct).

Attempts to predict the self-extinguishing ability of these foams based on maximum temperature reached or time and method of reaching maximum temperature individually were unsuccessful. The one factor common to each large-scale fire test was the maximum temperature reached by the thermocouple 2.54 cm (1 in.) away from the heat source. In these tests, if this thermocouple failed to exceed the temperature range of 450° ± 10°C, the material could self-extinguish once the heat source was removed. This ability is related to the insulating quality of the char produced by the decomposing foam. Since it is neither very realistic nor practical to run large-scale tests on all materials to determine their smoldering capability, this knowledge can be used in redesigning the small-scale smoldering test to give more reliable results. The essential ingredients of this modified test would be

1. Increased sample size, so that the fuel load represented will minimize heat loss to the exterior. The close packing arrangement of anechoic chambers minimizes heat dissipation in case of ignition.

2. Monitoring of the conductive heat transfer at some distance from the heat source to determine the heat being propagated through the char to the virgin foam. A critical temperature (450°C-460°C at a thermocouple 2.54 cm away) must not be exceeded if the char formed is to protect the remaining foam from being consumed.

This type of information will give specific information on the insulating qualities of the char and its effectiveness in controlling conductive energy transfer. These ideas have been incorporated in the modified Smoldering Test Procedure that appears in Appendix A.

Correlations of Modified Small-Scale and Large-Scale Test Results

Two additional urethane foams (I and J) were subjected to the modified small-scale test. This test uses 20.5 cm × 20.5 cm × 20.5 cm (8 in. × 8 in. × 8 in.) samples and monitors the temperature 2.54 cm (1 in.) from the hot-surface ignition source. The test procedure outlined in Ref. 4 (Test 3) was followed, and the ignition source was removed 5 min after reaching 600°C.

The results with these two samples are shown in Fig. 5. The thermocouple 2.54 cm (1 in.) from the cartridge heater did not exceed 280°C during the test on product I, and smoldering was suppressed within 10 min after the heater was removed. On the other hand, the thermocouple 2.54 cm (1 in.) from the heater exceeded 600°C during the test of foam J. This foam was reduced completely to char before smoldering was suppressed.

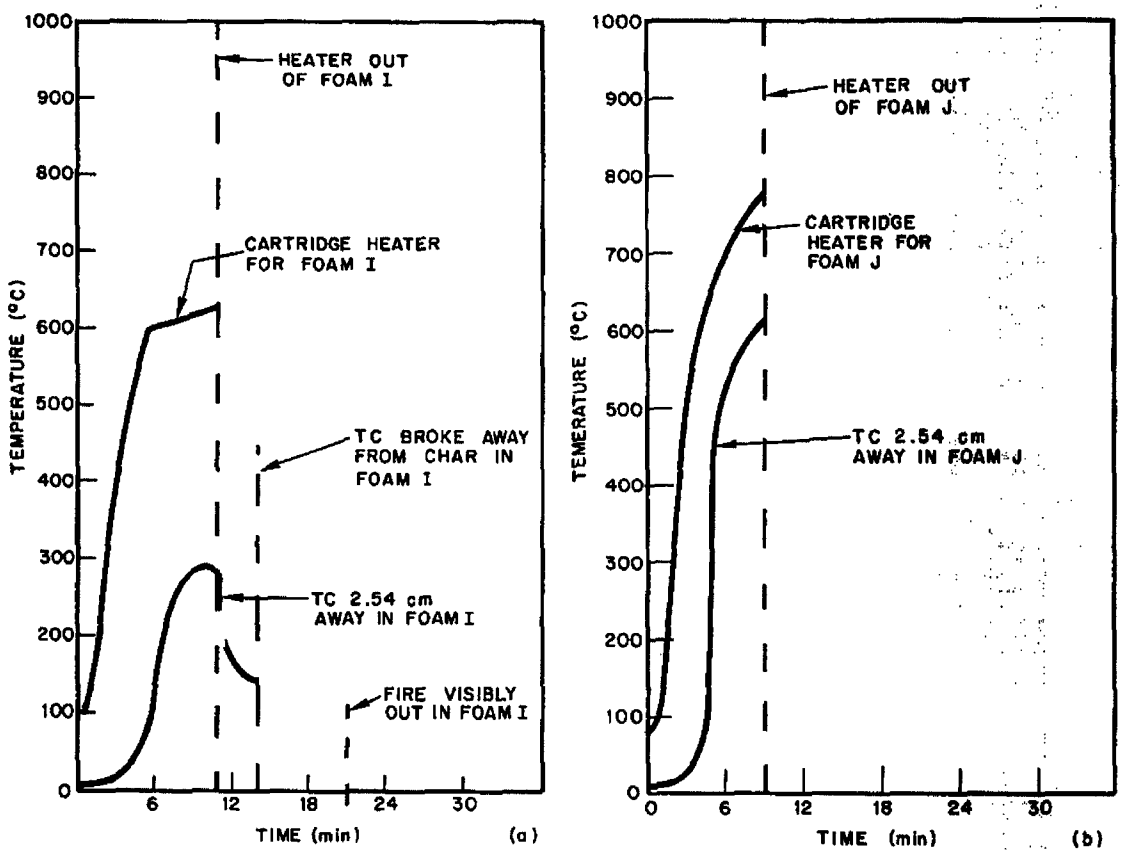

Fig. 5 — Thermocouple responses of Samples I and J during modified small-scale smoldering tests

Based on these measurements, foam I would not be expected to create the smoldering hazard that foam J would. To test this prediction, the same two foams were installed in the large-scale facility, as shown in Fig. 2, and examined under two modified large-scale test procedures. In the first test the hot-surface ignition source was inserted in foam I in position 1 (Fig. 2), and the temperature was increased to 900°C over a 20-min. span. The temperature of the thermocouple 2.54 cm (1 in.) away never exceeded 450°C during the test period, which spanned 25 min. The performance of this foam was satisfactory in that it self-extinguished the smoldering initiated by the heater and prevented additional material from being consumed after the heater was removed.

The hot-surface ignition source was again inserted in foam I in position 2 (Fig. 2), which is bordered by foam J. The temperature of the ignition source was raised to 600°C over 15 min. The ignition source temperature was not increased further, but as the combustion spread into foam J, the temperature of the thermocouple 2.54 cm (1 in.) away

began to rise and peaked at 800°C as the fire intensified. Foam J was incapable of suppressing the fire, and special additional measures had to be taken to extinguish the fire.

It is evident from these results that the modified small-scale test provides a qualitative basis for correlation to large-scale tests. It thus provides a simple, inexpensive way of predicting fire performance without engaging in an involved testing program. Many samples tested under both large- and small-scale test procedures have confirmed the usefulness of this modified test.

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Appendix A

PERFORMANCE SPECIFICATIONS FOR ANECHOIC-CHAMBER MATERIALS

TEST 1 — RESISTANCE TO ELECTRICAL STRESS

Specimens: — Three 5.2 cm X 15.1 cm X 15.1 cm (2-in. X 6-in. X 6-in.) samples. The surface area of the specimen in which the test leads are inserted shall not be covered with a surface fire retardant.

Equipment: — A 240-V a.c. power supply capable of 8-A output; test leads of AWG copper wire with 90° bends 1.9 cm (0.75 in.) from the ends.

Procedure: — The insulation is removed from the test leads to expose 1.3 cm (0.5 in.) of bare wire. The leads are inserted to a depth of 1.3 cm (0.5 in.) in the foam, 2.54 cm (1 in.) apart. They are horizontally supported so that they do not rest on the specimen. Power shall be applied to the specimen for 60 s. The specimen fails the test if it does not self-extinguish (no visible flame, smoke, or smoldering) within 60 s after the power has been turned off. If it does self-extinguish, the specimen is left undisturbed for 30 min and then reinspected; any specimen that is more than 90% (by weight) destroyed has failed the test. The specimen is then opened to expose its interior and is inspected for any evidence of remaining combustion (hot embers, smoke, or flame); any visible combustion rates the material as unsatisfactory.

TEST 2 — EASE OF IGNITION AND FLAME PROPAGATION

Specimens: — Five cubes, 5.2 cm (2 in.) or larger on each side. The bottom of each specimen shall not be covered with surface fire-retardant paint.

Equipment: — A laboratory ringstand with necessary clamps, suitable for supporting and positioning the specimen; a laboratory Bunsen burner adjusted to a height of 7.6 cm (3 in.) and producing a flame temperature of 1900°C; a time device permitting measurements of intervals of 1 s or less.

Procedure: — The test is conducted in a location free of drafts. The specimen is exposed so that the flame is directed at the bottom center of each specimen for 30 s. If the burning part of the specimen melts or shrinks away from the flame, the burner is moved to keep the specimen continuously in the flame. If the specimen self-extinguishes (no visible flame, smoke, or smoldering) within 60 s after the flame is withdrawn, it has passed the ignition test. For a material to be classified as self-extinguishing by this test, every specimen must self-extinguish within 60 s after flame withdrawal.

TEST 3 — MODIFIED SMOLDERING TEST (REVISED 1976)

Specimens: — Three cubes, 20.1 cm (8 in.) on each side.

Equipment: — A high-density electric cartridge heater 1.3 cm (0.5 in.) in diameter and 15.1 cm (6 in.) long, capable of being inserted snugly into a 7.6-cm (3 in.) deep hole in the specimen and of reaching a maximum temperature of 600°C; two thermocouples, capable of measuring temperatures to 1000°C.

Procedure: — The tests are conducted in a laboratory hood. One thermocouple is physically attached by temperature-resistant tape to the cartridge heater and inserted vertically into a hole in the specimen 7.6-cm (3 in.) deep. The second thermocouple is inserted into the specimen top 2.54 cm (1 in.) from the cartridge heater. Both the thermocouple and cartridge heater/thermocouple pair are supported so that they remain upright and imbedded in the specimen throughout the test. The heater is inserted in the specimen and the temperature is raised to 600°C. The heater is left in the specimen at 600°C for 5 min before being removed. The temperature of the thermocouple 2.54 cm (1 in.) from the heater is monitored throughout the test period. The test is considered over only when all visible smoldering has ceased (no smoke, flame, or hot embers). The specimen has failed if at any time during the test period the temperature of the thermocouple 2.54 cm (1 in.) from the heater exceeds 450°C ± 10°.

TEST 4 — TOXIC GAS EMISSION IN A FIRE ENVIRONMENT

Specimens: — Three 1-g quantities of 0.63-cm (0.25 in.) cubes.

Equipment: — A combustion boat capable of containing 1 g of the specimen; a 2400°C hydrogen-air torch adjusted to a height of 1.3-2.54 cm (0.5-1 in.) (Either the boat or the flame must be movable to allow exposure of the entire sample to the flame during the test — total involvement of the sample is required); a closed chamber capable of containing the boat with the specimen and the torch, equipped to ignite the torch remotely and sample the concentrations of CO, HC1, HCN, and O_2 and large enough that the O_2 concentration does not fall below 20% during the test; detector tubes or other instrumentation for measuring the concentrations of CO, HCN, and HC1 gases at the end of the test.

Procedure: — The combustion boat containing the specimen is placed in the closed system. The torch is remotely ignited and directed at an angle, from above the specimen for 15 min at a distance no greater than 0.63 cm (0.25 in.) from the specimen. During this time, the entire specimen must be exposed to the torch. At the end of the 15-min exposure, the concentrations of HCN, HC1, and CO are measured. Their productions are reported in terms of milligrams of combustion product per gram of specimen. If toxic gas production exceeds the following limits, the specimen has failed the test.

Combustion Product	Milligrams of Product per gram of Specimen
HCN	0.3
HC1	0.4
CO	20.0

Failure of any of the specimens rates the material as unsatisfactory.

TEST 5 — TOXIC GAS EMISSION DUE TO A HOT SURFACE

Specimens: — Three 1-g quantities of 0.63-cm (0.25-in.) cubes.

Equipment: — The combustion boat, closed chamber, and sampling devices used in Test 4; a radiative cartridge heater capable of generating a temperature up to 350°C.

Procedure: — The combustion boat containing the cubes is placed in the closed system with the heater lying on top of the cubes so that it heats all of the sample during the test. The heater is then remotely activated and allowed to heat to 350°C. The specimen is heated at this temperature for 15 min. During this time, the sample must be totally involved. At the end of the 15-min exposure, the concentration of CO, HCN, and HC1 gases are measured and reported in terms of milligrams of combustion product per gram of specimen. If toxic gas production exceeds the following limits, the specimen has failed the test.

Combustion Product	Milligrams of Product per gram of Specimen
HCN	0.6
HC1	0.9
CO	5.0

Failure of any specimen rates the material as unsatisfactory.

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Attachment (3)

NRL FR-7793

Flammability and Toxic-Gas Production of Urethane Foams Used in Anechoic Chambers

Patricia A. Tatem
Frederick W. Williams

September 13, 1974

Naval Research Laboratory
Washington D.C. 20362

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Four types of polyurethane foams for use in anechoic chaambers have been evaluated under burning and pyrolysis conditions to determine their flammabilityty and toxic-gas production characteristics. Toxic-gas productions of the foams under continuousis exposure to both conditions are comparable. However, there is variation in the ability of the fofoams to sustain combustion after removal of a heat source. Foams that propagate smoldering preresent greater heat and toxic-gas hazards than those that do not.

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FLAMMABILITY AND TOXIC-GAS PRODUCTION OF URETHANE FOAMS USED IN ANEECHOIC CHAMBERS

INTRODUCTION

In recent years, polymeric materials have been usesed more and more for structural components and for interior furnishings of buildings. Many of these materials contain halogen, cyanide, and/or other nitrogenous moieties, which can react during combustion or pyrolysis to form toxic products such as hydrogen chloride (HCl) and hydrogen cyanide (HCN). Because of the danger to life and property, the response of these materials to fire needs to be completely understood.

The interior walls and ceiling of many modern anechoic chambers are covered with a nitrogen-containing polymer-polyurethane foam. To serve as a good microwave absorber, the foam is impregnated with carbon and a latex binder to impart good electrical characteristics. The resulting material has low electrical resistance and is thus a good conductor. The foam is further treated with enough of a fire retardant, such as a chlorine-containing compound, to impart fire resistance without degrading electrical properties. When involved in fires, these treated foams may release toxic combustion products containing nitrogen [1, 2] and halogen, whose presence could significantly increase the toxicity of fire gases.

Although knowledge of the fire and toxicity hazards contributed by the treated polyurethane foam in anechoic chambers is limited, two recent fires involving these chambers have indicated the need for flammability and fire-retardance controls in manufacturing these materials. On November 15, 1973, the foam in an anechoic chamber at the Naval Research Laboratory, Washington, D.C., was ignited by an unknown source. The room, along with an associated support room, was severely damaged by the ensuing fire. The usual firefighting efforts were unsuccessful because of the ability of the foam to smolder after the ignition source was removed. High concentrations of HCN and HCl gases produced extremely hazardous conditions for the firefighters; six firemen wearing breathing apparatus were overcome by the toxic gases [3].

On February 5, 1974, an anechoic chamber at the Naval Air Rework Facility in Alameda, California, was completely destroyed by fire when hot slag from a welding torch ignited the chamber's foam. Investigation showed that the absorbent materials used in the chamber were manufactured from a self-extinguishing grade of polyurethane foam, coated with a fire-retardant material [4].

Experience has shown that one must be careful in interpreting the terminology used to describe varying degrees of fire resistance. *Self-extinguishing* materials burn as long as a source of external heat is present but are incapable of sustaining combustion after removal of the heat source. As demonstrated by the fire in Alameda, the fire characteristics of

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a self-extinguishing grade of polyurethane foam can be drastically changed by the processing it undergoes to produce a good microwave absorber. Treatment with *fire retardants* does not produce a nonflammable material; it only *reduces* flammability. A nonflammable material will not burn when exposed to a flame; however, foams that have been painted with a fire-retardant paint can lose their fire-retardant characteristics when the paint is destroyed, either mechanically or by fire. Unless these terms are well understood, the advertising and scientific literature about anechoic-chamber foams can be very misleading.

In an effort to eliminate the fire hazard associated with anechoic chambers, several foams submitted by contractors for use in a new anechoic chamber at NRL were tested for flammability and toxic-product formation under burning or pyrolysis. The two previous fires indicated a need to evaluate the ability of the foams to self-extinguish flame and smoldering after removal of an electrical ignition source, a flaming ignition source, or a flameless (hot-surface) heat source. Tests with these three sources of ignition will give an indication of the hazard once the material is ignited, if the ignition source is detected and eliminated without delay. High toxic-product concentrations during the fires suggested the need for evaluations of toxic-product formation when the material is continuously exposed to a source of ignition.

Four types of foams were tested extensively. As a result of these tests, several performance specifications were devised for fire-retardance and flammability requirements of foams to be considered for use in new chambers. The performance specifications are included as Appendix A; the test numbers in parentheses in the text correlate experimental procedures with these tests. The procedures outlined in the performance specifications do not necessarily duplicate the experimental procedures in the report. The sophisticated and detailed procedures followed for data collection were simplified to produce specification procedures that could be conducted with minimal difficulty and equipment.

EXPERIMENTAL

Materials and Apparatus

The names of the foams tested and their suppliers are given in Table 1.

Tests that required monitoring of combustion-product formation were carried out in the 9.5-ft^3 closed combustion chamber shown in Fig. 1 and described in detail in Ref. 5. The back and bottom of the chamber are equipped with assorted inlets for electrical connections, gas admissions, and product sampling. The chamber atmosphere is continuously sampled via the closed-loop manifold shown schematically in Fig. 2. The gas samples from the chamber flow, in order, through a 0.3-μm soot filter, a bleed valve, and a pressure regulator operated at a pressure differential of about 3.5 lb. The reference side of the regulator is maintained at about 10.7 psi, so that the sample loop is under a slight vacuum during the continuous sampling process. After the regulator the sample flow is divided along two pathways, one leading through a flowmeter into an oxygen analyzer (Beckman Instruments, Model F3) and the other through a flowmeter into CO_2 and CO analyzers (Beckman Instruments, Model 315AA). The flow is maintained at 250 cm^3/min into the O_2 analyzer and 900 cm^3/min into the CO_2 and CO analyzers by the individual needle valves ahead of the circulating pump.

Table 1
Anechoic Chamber Foams TTested

Manufacturer	Designation	Date Rec'd by NRL
Rantec, Division of Emerson Electric Co.	Rantec (EHP-5WG-FP)	October 1973
Plessy Environmental Systems	Plessy (Preproduction AF)	October 1973
Eastern Microwave	Eastern (FFP-3)	October 1973
Emerson-Cumming	E-C* (ECCOSORBHPY-12FFE)	December 1973

*Original sample received prior to December 1973 was :s not self-extinguishing. E-C represents newer formulation provided by the supplier and d was the Emerson-Cumming material that was eventually subjected to all tests.

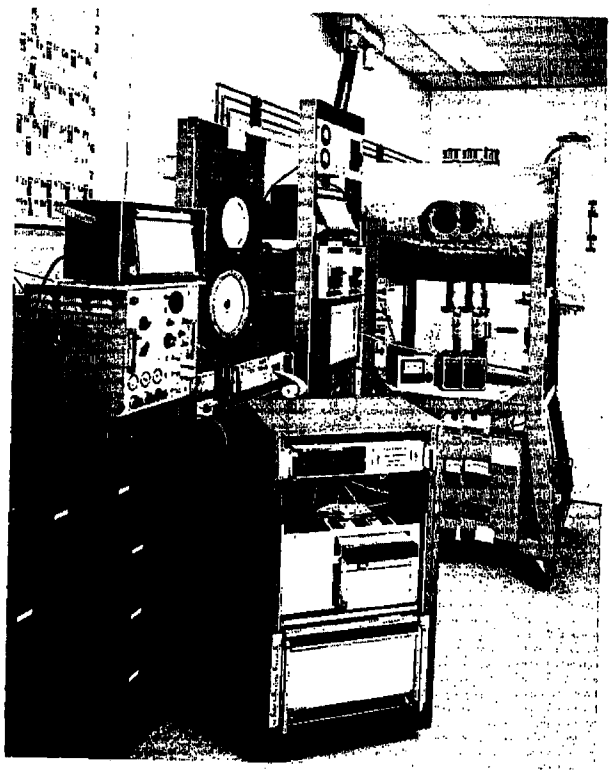

Fig. 1 — Experimental apparatutus

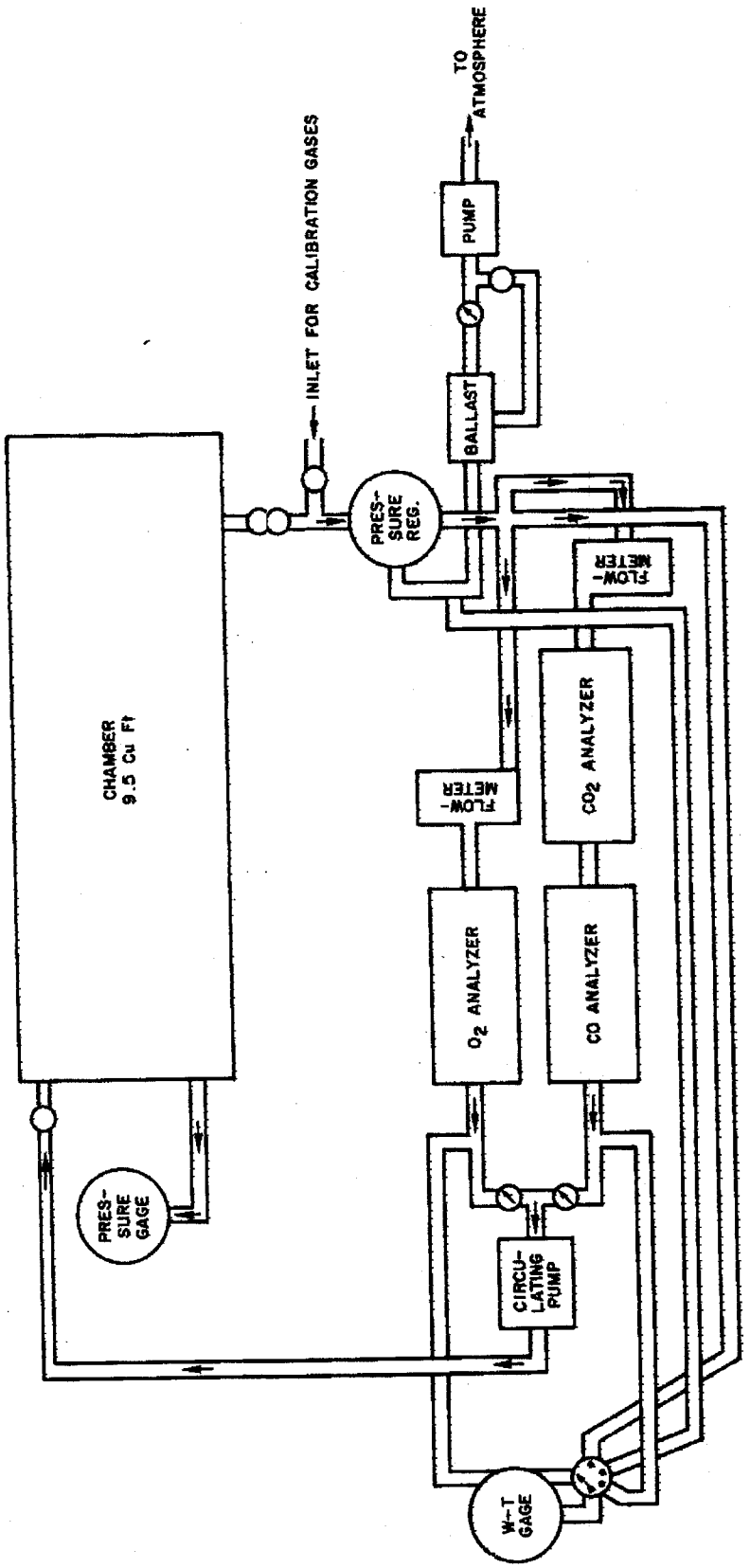

Fig. 2 — Schematic of closed-loop, continuous-sampling system

After leaving the analyzers, the gas flow is recombineed at the circulating pump and returned to the chamber. The pressure can be monitored d at four points along the sampling manifold—on the reference side of the regulator, in the saample loop immediately after leaving the regulator, after the O_2 analyzer, and after the e CO_2/CO analyzers. The closed-loop system operates under a slight vacuum during calibraation as well as during sampling, so that no corrections to the analyzer readings are necessasary. The CO_2 and CO analyzers have 0-10% and 0-4000 ppm scales, respectively. The $O_{2\ 2}$ analyzer range is 0-25%. An auxiliary valve in the rear of the chamber provides an outltlet for intermittent colorimetric tube sampling (Dräger tubes, Drägerwork Lübeck, 53/55 M Moislinger Allee, Lübeck 24, Germany) for HCl and HCN gases. Temperatures are meaasured with iron-constantan thermocouples referenced to ice water.

The ignition sources used were a power supply (capalable of 240 V ac), a hydrogen/air flame (T ≈ 2100°C), a methane flame (T ≈ 1950°C), a sosoldering iron (T ≈ 500°C), and a 6-in.-long radiative cartridge heater (capable of temperatureres up to 600°C). Test leads from the power supply were made of number 12 copper wire frfrom which 1 in. of insulation had been removed at each end. The hydrogen/air flame was pproduced on a microburner located in the chamber and had a flame height of about 0.5 in. TThe methane flame was produced on a laboratory Bunsen burner in the hood and had a flamme height of about 3 in.

The samples were contained in an alumina combustioion boat during the continuous-exposure tests. The boat was in the center of the chambeer and could be manipulated with a remote arm. Also in the center of the chamber was a ninichrome wire, connected to an external power supply, which served as the ignition sourceee for the hydrogen torch. The same power supply was used for heating the cartridge heatater.

Procedures

The samples were subjected to 240 V ac from the powwer supply under a laboratory hood (Test 1) by inserting the test leads 1 in. apart and 0.0.5 in. deep in each sample. Current was applied across the foam for 60 s. The foams s were inspected for damage at the end of this time and again 30 min later.

Supplementary timed voltage tests were carried out uunder the hood on specimens of Rantec foam. The same test leads from the power supply y were inserted 10 in. apart at opposite ends of the samples and voltages of 40 V, 120 V,V, and 240 V were applied in turn for 15 min each. Specimens were observed during thhis period for visible signs of combustion.

Additional tests performed in the laboratory hood (TTest 2) involved short exposures (about 30 s) of the foam to the methane flame and the sosoldering iron. During these exposures, care was taken to assure that the surface of theie foam subjected to the ignition source was not covered with a surface fire retardant. Spececimens were observed for 60 s after removal of the ignition source for evidence of any visisible signs of combustion.

The cartridge heater was insertrted snugly into a hole cut into a solid, 40- to 70-g cube of the foam. The specimen was plalaced in the chamber and the temperature of the heater was increased to a predetermined vavalue (Test 3). The interiors of the E-C samples were hollow, so for these materials the hheater was wedged into a corner between the 0.5-in.-thick walls. The power supply to the heaeater was disconnected after the desired temperature was reached, and the heater was remotelely removed from the sample. The temperature of the heater and the concentrations of CCO, CO_2, O_2 were monitored continuously.

A known quantity (about 1 g)!) of each foam was exposed to the hydrogen/air torch for 15-25 min in the chamber (Teststt 4). The foams were contained in the movable combustion boat, which allowed the enntire sample to be heated by the flame from above during the degradation period. The amounnts of toxic gases produced were determined at the end of the test period.

One-gram samples of the foamms were exposed to the cartridge heater in the combustion boat in the chamber (Test 5). The e heater was placed on top of the entire sample in the boat to allow maximum exposure o of the foam to the heater. During the course of an experiment, the heater temperatureee was raised as high as 350°C over a period of 25 min. At the end of the test period, measasurements were made of the toxic gases produced.

RESULTS AND DISCUSSION

When subjected to the electricical-resistance test (Test 1), samples of the Plessy and Eastern foams flamed and emitted l heavy yellow smoke during the entire test period, even after the power was discontinued. . These samples were completely destroyed by the end of the test period. Samples of E-CC foam were not availiable for electrical-resistance testing.

Samples of Rantec foam receiveived at different times gave varying responses to the electrical test (Test 1). One samplole of Rantec foam (Sample 1) showed no visible response (no smoke, flame, or smoldering) t to the electrical test. Sample 2 was completely consumed by flame during the test period, anand Sample 3 flamed only during the 60-s period that power was applied. Specimens froom Sample 3 showed no signs of smoldering within 60-s after the power was removed. Visisual observation of these specimens at the end of the test period indicated that the mateterial had confined the involved area and had not propagated smoldering, thus leaving an iiintact specimen.

To determine why different FRantec samples responded differently to the electrical tests, resistance measurements werere made on each of the Rantec samples. Sample 1 had an extremely high resistance, indicicating that the material had not been thoroughly impregnated with carbon and was essentitially a nonconductor. Although the resulting material was highly fire resistant, it would l not serve as a good microwave absorber. Comparison of Samples 2 and 3 indicated that t the latter was intermediate in resistance between Sample 2 and Sample 1. If these resistancce measurements are considered in conjunction with the fire retardance of Samples 1 and 2 2, as indicated by the electrical tests, it is evident that the important factor is that more enerrgy can be put into the foams with lower resistance, that is, the foams of higher carbonn impregnation. The amount of carbon also affects the fuel load of the sample; a nonflammmable foam becomes flammable with increased carbon

content. However, the resistance of the material cannot be made too high, or the electrical properties of the material will be destroyed, as illustrated by Sample 1.

In the timed voltage tests on Sample 3 flames did not emanate at any time during the 15-min intervals that the voltages were applied across the specimen. During the first 2 min at 240 V, visible smoldering was detected but immediately disappeared.

The flaming and smoldering characteristics determined from Test 2 are summarized in Table 2. Samples of Rantec foam were self-extinguishing and did not propagate smoldering after the ignition source was removed. The original sample of E-C foam was not self-extinguishing, but a newer formulation supplied for further testing proved to be self-extinguishing and did not propagate smoldering after removal of the heat source. Samples of Plessy and Eastern foam self-extinguished with respect to open flame and visible smoldering when the heat source was removed, but damage observed after these tests indicated that nonluminous reaction, and hence toxic-gas production, continued. More sophisticated testing was done to determine the extent of smoldering after a flameless heat source is removed (Test 3).

Table 2
Flaming Characteristics of Anechoic-Chamber Foams (Test 2)

Foam	Acceptable Self-Extinguishment Test	Acceptable Smoldering Test
Rantec	Yes	Yes
Plessy	Yes	No
Eastern	Yes	No
E-C	Yes	Yes

Typical examples of toxic-gas production in the smoldering test (Test 3) are given in Fig. 3. In these examples, the foams were exposed to similar temperatures (300-365°C), but the amounts of toxic products generated after the ignition source was removed differed widely. Toxic-gas production and sample damage varied according to the temperature to which the heater was raised before being removed. After removal of the ignition source, the rate of toxic-gas production depended on the extent of smoldering. If this rate was greater than zero, combustion products were still being formed as a result of propagating smoldering. As the rate approached zero, combustion-product formation was decreasing and smoldering diminishing. A rate of zero was evidence that smoldering had halted.

These tests can be correlated with the ability of the foam to propagate smoldering. For Rantec and E-C foams, the increase in combustion products ceased within 2 to 4 min after removal of the heater if pyrolysis had been initiated, as can be seen in Fig. 3. These foam samples incurred minor damage from smoldering. At temperatures below 225°C for Rantec foam and 300°C for E-C foam, no pyrolysis occurred, as indicated by the absence of gaseous products. In some cases the temperature of the heater was raised as high as 600°C for Rantec and 500°C for E-C before removal; smoldering stopped within the same time period.

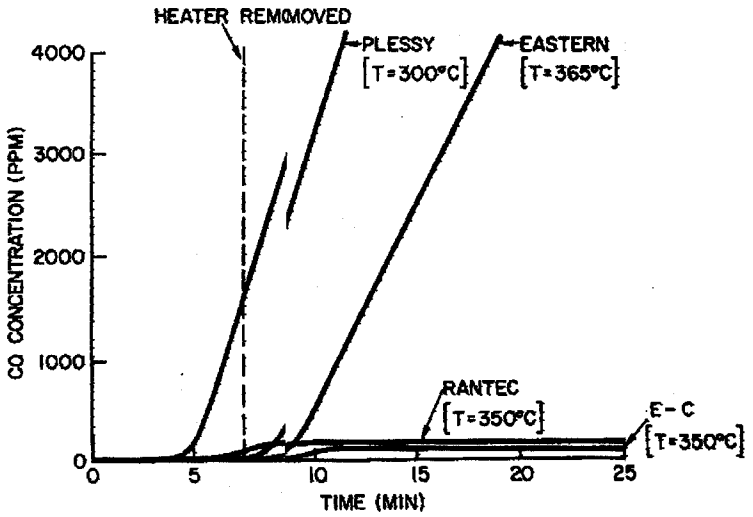

Fig. 3 — PrProduction of CO for foam samples in n smoldering test (Test 3)

The hollow interior of the E-C samples suggests that the data from its smoldering tests may not be as definitive as the data frcrom smoldering tests on the other foams. With the heater wedged into a corner between tlthe walls, the contact between the heater and E-C sample was not as effective as with thee other foams. For more comparable data, a solid sample of E-C foam should be subjecteted to the smoldering tests.

For Plessy and Eastern samples (F(Fig. 3), the concentration of toxic gases increased after removal of the heater (for heaterr temperatures above 200°C for Plessy or 250°C for Eastern) until CO, HCl, and HCN c concentrations were too high to be measured with available instrumentation (CO > 4000 p ppm; HCN > 150 ppm; HCl > 20 ppm). For these runs the data collection was terminateed 10 to 15 min after the heater was removed from the sample. At this time the CO_2 conncentration was still rising and the O_2 concentration falling. The samples were completely v destroyed. If the maximum heater temperatures were lower than the temperatures giveen above, the samples did not propagate smoldering, and damage was not detected.

Rapid deterioration of the atmosphere after the ignition source was removed is immediately evident for the Plessy and Eastern samples. The concentrations of CO and HCN gases produced by these foams w within 10 min after reaching 300° and 365°C, respectively, would be enough to causse death in less than an hour. The concentration of HCl gas produced would cause intensese discomfort and irritation [6,7].

When the samples were continuoously exposed to the hydrogen/air torch (Test 4), the concentrations of combustion prooducts listed in Table 3 were found. Similar results are given in Table 4 for the same samples exposed to the cartridge heater (Test 5). The data in Tables 3 and 4 show that for c exposures to intense fire stress (hydrogen torch) and lower temperature pyrolysis (cartrtridge heater), the yields of toxic products are comparable. Furthermore, as can be seenn by comparing the data in each table, each foam produced about the sample quantities s of toxic products, with the following exceptions:

1. HCl production was higher for the Plessy samples for both hydrogen/air-torch and cartridge-heater ignition sources.

2. HCN concentration was as high as 5 ppm in only two instances, one involving Plessy foam and the other Eastern foam.

3. CO production by the Eastern sample was the highest for both ignition sources.

Table 3
Atmospheric Analyses Following Exposure to Hydrogen/Air Torch (Test 4)

Foam	Combustion Product	Product Amount*	Weight of Combustion Product per gram of Sample* (mg)
Rantec	HCN	1 ppm	0.24
	HCl	N.D.†	—
	CO_2	0.1%	554
	CO	58 ppm	19
Plessy	HCN	4 ppm‡	0.9
	HCl	>12 ppm	>5.3
	CO_2	0.13%	670
	CO	63 ppm	21
Eastern	HCN	4 ppm‡	1
	HCl	<1 ppm	<0.4
	CO_2	0.11%	560
	CO	75 ppm	25
E-C	HCN	1 ppm	0.24
	HCl	2 ppm	0.7
	CO_2	0.06%	320
	CO	10 ppm	3

*Average values (for duplicate samples).
†Not detectable.
‡The individual values for the duplicate runs were 3 and 5 ppmm.

Although the concentrations of toxic gases produced by the 1-g samples of the four foams are well below the levels at which inhalation becomes unsafe [6,7], consideration

must be given to (a) the environmentnt in which these products would be encountered in a real fire situation and (b) the toxicic products formed when any of these foams is continuously exposed to fire conditions. FFirst, exposure to these concentrations of CO, HCN, and HCl under normal conditions coould be tolerated for several hours without any lasting adverse effects [6,7]. However, in ε a real fire situation, the environment created by the fire intensifies the hazards of these ggases. For example, work done by Stone, et al. supports the hypothesis that HCl may be carriried into the lungs by fire-generated soot and water particles [8]. Gas-phase HCl can nooormally be removed by the defenses of the upper respiratory tract, whereas HCl loosely bbound on water or soot particles can gain access to the lower lung. Here HCl may desorrb from these particles and invade the tissue of the lungs. The severity of exposure to HHCl in this form as opposed to gas-phase HCl is still to be defined by toxicologists.

Table 4
Atmospheric Analysis Followwing Exposure to Cartridge Heater* (Test 5)

Foam	Combustion Product	PProduct Amount †	Weight of Combustion Product per gram of Sample † (mg)
Rantec	HCN	3 ppm	0.6
	HCl	2 ppm	0.9
	CO_2	0.02%	110
	CO	15 ppm	5
Plessy	HCN	2 ppm	0.5
	HCl	20 ppm	9
	CO_2	0.04%	215
	CO	35 ppm	12
Eastern	HCN	2 ppm	0.5
	HCl	5 ppm	2
	CO_2	0.04%	215
	CO	130 ppm	44
E-C	HCN	1 ppm	0.24
	HCl	1 ppm	0.4
	CO_2	0%	—
	CO	10 ppm	3

*Smoldering not included.
†Average values (for duplicate samples).

Second, the concentrations given in Tables 3 and 4 are for 1-g samples only. Continuous exposure to any heat source would involve increasing amounts of the material and would generate toxic products from each foam to a concentration that can rapidly cause discomfort or even death in man. Since Rantec and E-C-C foams will not sustain combustion, removal of the heat source would immediately halt toxic-gas production. Plessy and Eastern foams are capable of propagating extensive smoldering; therefore, removal of the ignition source from these materials would not prevent the continued production of highly toxic gases and further deterioration of the atmosphere.

SUMMARY

This work demonstrates the variation in behavior of anechoic chamber foams under fire and thermal stress. The ability of a foam to self-extinguish external or visible flame does not necessarily indicate that the material is fire safe. The persistence of smoldering combustion can present additional hazards in the form of heat and continued production of toxic gases, even after the visible or flaming fire has subsided. This unseen glowing combustion can rapidly build up toxic gases, rendering an atmosphere unacceptable for prolonged human occupation.

RECOMMENDATIONS

1. The *finished* absorption material used in anechoic chambers should be self-extinguishing. It is not sufficient for a self-extinguishing grade of polyurethane foam to be used as the starting material.

2. Foams to be used in anechoic chambers should be homogeneously impregnated with a fire retardant. Exterior coating of a self-extinguishing polyurethane foam with a fire retardant does not impart the degree of fire retardance acquired by homogeneous impregnation.

3. For added fire protection, all foams considered for use in anechoic chambers should be subjected to and pass the performance specifications given in Appendix A.

4. Every batch of absorber foams produced should be subjected to these tests. Formulations of these absorber foams are changed frequently, and every batch produced must be qualified in order to be classified as safe for use in anechoic chambers.

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Appendix A
PERFORMANCE SPECIFICATIONS FOR ANECHOIC-CHAMBER MATERIALS

TEST 1—RESISTANCE TO ELECTRICAL STRESS

Specimens: Three 2- X 6- X 6-in. samples.

Equipment: A 240-V ac power supply capable of 8-A output; test leads of 10 AWG copper wire with a 90° bend 0.75 from the ends.

Procedure: The insulation is removed from the test leads to expose 0.5 in. of bare wire. The leads are inserted to a depth of 0.5. in the foam, 1 in. apart. The surface area of the specimen in which the test leads are inserted shall not be covered with a surface fire retardant. Power shall be applied to the specimen for 60 s. The specimen fails the test if it does not self-extinguish (no visible flame, smoke, or smoldering) within 60 s after the power has been turned off. The specimen is then left undisturbed for 30 min. At the end of this period, the specimen is inspected and damage to the specimen is rated visually: 1—no damage; 2—Minor damage; 3—extensive damage; 4—total destruction (only char remaining). The specimen is then opened to expose its interior and is inspected for any evidence of remaining combustion (hot embers, smoke, or flame); any visible combustion is reported. Any specimen that is totally destroyed has failed the test. Failure of any specimen rates the material as unsatisfactory.

TEST 2—EASE OF IGNITION AND FLAME PROPAGATION

Specimens: Five cubes, 2 in. or larger on each side.

Equipment: A laboratory ringstand with necessary clamps suitable for supporting and positioning the specimen; a laboratory Bunsen burner adjusted to a height of 3 in. and producing a flame temperature of 2000°C; a timing device permitting measurements of intervals of 1 s or less.

Procedure: The test shall be conducted in a location free of drafts. The specimen is exposed so that the flame is directed at the bottom center of each specimen for 30 s. The bottom of the specimen shall not be covered with surface fire-retardant paint. If the burning part of the specimen melts or shrinks away from the flame, the burner should be moved so that the specimen is continuously in the flame. If the specimen self-extinguishes (no visible flame, smoke, or smoldering) within 60 s after the flame is withdrawn, it has passed the ignition test. For a material to be classified as self-extinguishing by this test, every specimen must self-extinguish within 60 s after flame withdrawal.

TEST 3—SMOLDERING

Specimens: Three 4-in. cubes

Equipment: A radiative cartridge heaeater, capable of being inserted snugly into a 3-in.-deep hole in the side of the specimen and i of reaching a maximum temperature of 600°C.

Procedure: The tests are conducted i in a laboratory hood. The temperature of the heater is raised to 600°C before inserting it t into the specimen. The heater is left in the specimen for 10 min, then removed. The specicimen is left undisturbed for 30 min. At the end of this time, the specimen is inspected a and damage to the specimen is rated visually: 1—no damage; 2—minor damage; 3—extensisive damage; 4—total destruction (only char remaining). The specimen is then opened to expoose its interior and is inspected for any evidence of remaining combustion (hot embers, s smoke, or flame); any visible combustion is reported. Any specimen that is totally destroyed has failed the test. Failure of any specimen rates the material as unsatisfactory.

TEST 4—TOXIC-GAS EMISSION INN A FIRE ENVIRONMENT

Specimens: Three 1-g quantities of C 0.25-in. cubes.

Equipment: A combustion boat capapable of containing 1g of the specimen; a 2000°C hydrogen/air torch adjusted to a heigight of 0.5 to 1 in. (Either the boat or the flame must be movable to allow exposure of the e entire sample to the flame during the test; total involvement of the sample is requireed.); a closed chamber capable of containing the boat with the specimen and the torch, equipped to remotely ignite the torch and sample the concentrations of CO, HCl, HCN, and O_2 and large enough that the O_2 does not fall below 20 percent during the test; detector r tubes or other instrumentation for measuring the concentrations of CO, HCN, and HCl gases at the end of the test.

Procedure: The combustion boat coontaining the specimen is placed in the closed system. The torch is remotely ignited and diirected from an angle above the specimen for 15 min; The flame should be within 0.25 in. of the specimen. During this time, the entire specimen must be exposed to the torch. At the end of the 15-min exposure, the concentrations of HCN, HCl, and CO are measured. Their productions are reported in terms of milligrams of combustion product per gram of specimen. If toxic-gas production exceeds the following limits, the specimen has failed the test.

Combustion Product	Amount of Product per gram Specimen (mg)
HCN	0.3
HCl	0.4
CO	20.0

Failure of any of the specimens rates the material as unsatisfactory.

TEST 5—TOXIC-GAS EMISSION DUE TO A HOT SURRFACE

Specimens: Three 1-g quantities of 0.25-in. cubes.

Equipment: The combustion boat, closed chamber (largrge enough that the O_2 concentration dose not fall below 20 percent during the test) and sampmpling devices used in Test 4; a radiative cartridge heater capable of generating a temperrature up to 350°C. The heater shall be placed on top of the cubes in the boat so that i it heats all of the sample during the test.

Procedure: The combustion boat containing the 0.25-inn. cubes is placed in the closed system with the heater lying on top of the cubes, so that it heatats all of the specimen. The heater is then remotely activated and allowed to heat to 350°CC. The specimen is heated at this temperature for 15 min. At the end of the 15-min expoosure, the concentrationof CO, HCN, and HCl gases are measured and reported in termsis of milligrams of combustion product per gram of specimen. If toxic-gas production exceeeds the following limits, the specimen has failed the test.

Combustion Product	Product per gramn of Specimen (mg)
HCN	00.6
HCl	00.9
CO	55.0

Failure of any of the specimens rates the material as unsatisfactory.

A summary of the performance tests described aboove is given in Table A1.

Table A1
Summary of Performance Specification Tests

Test	Equipment for Test	Property Tested	Experimental Conditions	Requirements Under Test Conditions
1. Resistance to electrical stress	Power supply (capable of 240 V ac Test leads	Ability to withstand electrical overload or short	Exposure to 240 V ac for 60 s	Self-extinguish within 60 s after removal of ignition source and intact specimen at end of 30 min
2. Ease of ignition and flame propagation	Bunsen burner Support for specimen Timing device	Ignitability and ability to self-extinguish flame (flaming ignition source)	Exposure to flame for 60 s	Self-extinguish within 60 s after removal of ignition source
3. Smoldering	Radiative cartridge heater (capable of 600°C)	Ability to self-extinguish smoldering (flameless ignition source)	Exposure to 600°C radiative heat source for 10 min	Intact specimen following test
4. Toxic-gas emission in a fire environment	Combustion boat H_2/air flame Closed chamber	Toxic gas production under continuous exposure to flaming ignition source (T = 2000°C)	Exposure to flame for 15 min	HCN concentration <0.3 mg/g HCl concentration <0.4 mg/g CO concentration <20 mg/g
5. Toxic-gas emission due to a hot surface	Combustion boat Radiative cartridge heater Closed chamber	Toxic gas production under continuous exposure to flameless ignition source (T = 350°C)	Exposure to radiative heat source for 15 min	HCN concentration <0.6 mg/g HCl concentration <0.9 mg/g CO concentration <5 mg/g

NAVAL RESEARCH LABORATORY
Washington, D.C.

NRLINST 5101.3C
Code 1240

JUL 13 1998

NRL INSTRUCTION 5101.3C

From: Commanding Officer
To: Distribution Lists A and B

Subj: FIRE SAFETY IN ANECHOIC CHAMBER OPERATIONS

1. Purpose. To update guidance regarding fire prevention and procedures to be followed in case of fire during use of anechoic chambers at NRL.

2. Cancellation. This instruction cancels and supersedes NRLINST 5101.3B.

3. Scope. This instruction applies to NRL-DC only.

4. Information

a. Anechoic chambers pose unique fire hazards. They are lined with various polymers, most of which produce dense smoke if ignited. Fires in such materials are very difficult to extinguish. Their smoke contains highly toxic gases such as hydrogen chloride (HCl), carbon monoxide (CO), toluene diisocyanate, and hydrogen cyanide (HCN) (the latter being absorbable through the skin as well as through inhalation). Besides the immediate danger of these gases, there is the possibility of death from pulmonary edema (chemical pneumonia) 24 to 48 hours after exposure to HCl.

b. Following an anechoic chamber fire in 1973 in NRL-DC Building 56, a research project was started in the Navy Technology Center for Safety and Survivability (Code 6180) to determine fire prevention, fire fighting, and hazard control procedures. The measures developed by Code 6180 are contained in this instruction.

5. Policy. All anechoic chambers at NRL shall meet the design requirements and have the safety features and precautions described in this instruction. A fire inspector shall be assigned to each anechoic chamber to carry out fire safety responsibilities. Design specifications for all new anechoic chambers shall be submitted to the Safety Branch (Code 1240), the NDW Fire Department (Code 1250), and the Research and Development Services Division (Code 3500) for review prior to construction.

6. Definitions. For purposes of this instruction, an anechoic chamber is any device or installation in which quantities of polymers (e.g., polyurethane foam, polystyrene, polyvinylchloride, and

nitrile rubber) are used to reduce electromagnetic wave echoes. An anechoic chamber is generally located within a parent room.

7. Responsibilities

a. Code 1240 shall:

(1) Review designs for new anechoic chambers, and for modifications or renovations of existing anechoic chambers.

(2) Review anechoic chamber safety procedures submitted by chamber safety engineers.

(3) Review work requests and service calls involving maintenance or repair work in anechoic chambers and prescribe appropriate precautionary measures.

(4) Conduct evaluations of anechoic chambers during regularly scheduled workplace safety inspections.

(5) Inspect storage areas where bulk quantities of polymer materials are stored to ensure that material is stored properly and that protective measures are in place.

(6) Conduct, on request, evaluations of unusual odors associated with anechoic chambers.

(7) Conduct evaluations of conditions following an anechoic chamber fire before permitting personnel to reenter the area.

b. Division superintendents shall:

(1) Appoint an anechoic chamber safety representative for each anechoic chamber, including the parent room. One safety representative may be appointed for all anechoic chambers in each branch or division. The person(s) appointed must be thoroughly familiar with all anechoic chambers and with the operations conducted under their areas of responsibility.

(2) Review and approve written procedures prepared by the anechoic chamber safety engineers.

(3) Ensure compliance with this instruction and with the specific procedures developed by the anechoic chamber safety engineers.

c. Anechoic Chamber Safety Representatives shall:

(1) Review, within 90 days of assignment, fire safety procedures for all anechoic chambers under their responsibility to ensure compliance with the safety precautions provided in paragraph 8 of this instruction. Include in this review the procedures for handling classified materials in the event of a fire. If any

deviations from paragraph 8 are noted, such as lack of mechanical ventilation, provide the rationale for the deviation. Prepare appropriate amendments to the safety procedures where necessary. Send copies of the proposed amendments via the division superintendent to Codes 1240, 1250, and 6180.

(2) Ensure that all personnel working in their assigned anechoic chamber have been informed of the potential hazards of chamber fires and have received instructions on safe operating procedures and emergency evacuation procedures for the particular chamber.

(3) Monitor the operations in the chamber to ensure compliance with safety procedures and regulations. Report violations to the division superintendent.

(4) Ensure that all visitors are indoctrinated about the hazards associated with anechoic chamber fires prior to entry. This may be accomplished through an oral briefing, furnishing a briefing paper, or posting signs at each entrance.

(5) Review and approve plans for new chamber operations that may pose unusual fire hazards. Develop additional fire safety measures, as necessary, that are consistent with the precautions provided in this instruction.

(6) Correct any hazardous conditions noted by Code 1250 during periodic inspections.

(7) Coordinate with Code 3500 in planning and developing fire safety for new anechoic chambers, and modification/renovation of existing chambers.

(8) Route all work requests and service calls involving maintenance or repair work in anechoic chambers via Code 1240. Code 1240 shall review the type of work to be performed and prescribe appropriate precautionary measures to supervisory personnel.

d. <u>Code 3500 shall</u>:

(1) Review designs for new anechoic chambers, and for modifications or renovations of existing anechoic chambers.

(2) Provide guidance and recommendations for improving the fire safety of new and existing anechoic chambers.

(3) Provide instructions on the hazards of anechoic chamber fires to Code 3500 personnel when maintenance or repair work is to be conducted inside anechoic chambers. Code 1240 shall provide technical guidance on request.

e. Code 1250 shall:

(1) Review safety procedures submitted by anechoic chamber safety engineers and make recommendations for changes or improvements.

(2) Review designs for new anechoic chambers, and for modifications or renovations of existing anechoic chambers, and make recommendations for changes or improvements.

(3) Assign a fire inspector to each anechoic chamber and conduct inspections of anechoic chambers during regularly scheduled building inspections. Provide the chamber safety representative with a written report of any identified discrepancies.

(4) Conduct an annual fire prevention training class and evacuation drill for each anechoic chamber.

8. Safety Precautions. It is essential in preventing anechoic chamber fires to eliminate sources of ignition such as overheating cables or motors, welding, soldering, smoking, or anything that could produce the heat necessary for ignition of anechoic chamber material or of materials used inside the chamber; and to educate anechoic chamber personnel about fire hazards.

a. The following signs shall be posted:

(1) At all entrances to buildings containing anechoic chambers, a Building Fire Bill (NAVFAC-11320/9) and a sign stating:

> "This building contains an anechoic chamber facility that shall produce lethal gases when exposed to fire. In the event of fire, evacuate the entire building."

(2) At all entrances to a chamber, signs stating:

> "No person shall work alone in this anechoic chamber if the operation poses an unusual fire hazard, or if the person is required to work at elevated heights or to perform some other type of work that exposes him/her to unusual safety hazards. In such situations, other personnel shall remain within voice and/or visual contact in order to summon help in the event of an emergency."

> "Warning! This chamber is not designed for high-power density application."

> "This anechoic chamber facility shall produce lethal gases when exposed to fire. In the event of fire, evacuate the entire building."

b. The following safety features and precautions shall apply:

(1) The annunciator panels for the fire protection system and the controls for the ventilation system (see paragraph 8b(3) below) shall be located outside the parent room so that Code 1250 personnel must not pass through heavy smoke to reach the panels or ventilation controls.

(2) All fire locator controls and evacuation pull stations shall be located outside the hazardous area and as close as possible to the emergency exits.

(3) Mechanical ventilation shall be provided to remove smoke in case of fire. The ventilation system should have the capability of removing smoke from the anechoic chamber or the parent room separately or at the same time. The objectives of providing ventilation are to remove smoke so that firefighters can see and to reduce smoke damage to the rest of the building.

(4) If an unusual odor is noticed in the vicinity of the chamber, call Code 1240 on 767-2232 for an evaluation. If smoke or fire is detected, call Code 1250 immediately on 767-3333; do not wait for an evaluation by Code 1240.

(5) Electrically operated doors to chambers should have a remote control switch located outside the parent room.

c. The following safety precautions shall be incorporated into the "Safety Procedures" developed by the anechoic chamber safety representative for each chamber:

(1) Equipment shall not be left operating in the chamber while the chamber is unattended unless required for operational needs. If equipment is required to be left operating, it must be kept at least 3 inches away from the polymer lining, it must be positioned so that air can circulate freely around it, and it must not generate enough heat to feel hot to the touch.

(2) Flammable or combustible liquids shall not be handled or stored inside the chamber unless absolutely required. Before starting repair operations using volatiles or solvents, or tests that involve the use of fuels, the chamber safety representative's approval must be obtained and Code 1250 must be notified. Alcohol, commonly used to clean electrical components, should be replaced by nonflammable, non-ozone-depleting materials such as Genesolv 2004 or Inonox MC. If the use of flammable liquids is approved, personnel shall wear electrically conductive shoes or grounding straps to bleed off static electricity.

(3) Sources of ignition shall not be permitted inside of or in the vicinity of the chamber except by special approval of the anechoic chamber safety representative. Extreme caution should be used when using soldering guns and high-intensity lights in the

chamber. Portable fluorescent lights are cooler and should be used when portable lights are required. Oxyacetylene and arc welding are prohibited inside anechoic chambers.

(4) All polymer materials (as defined in paragraph 6) that are not installed in anechoic chambers shall be protected from becoming ignited. Such materials shall be stored away from electrical equipment, flammable liquids, welding and soldering operations, and other such conditions that may promote ignition. Preferably, loose polymer materials should be stored in metal cabinets with signs posted reading: "WARNING. This cabinet contains polymer materials that produce lethal gases when ignited or exposed to flames. Keep all ignition sources and flammable liquids away. In the event of a fire involving this material, call the NDW Fire Department on 767-3333 and evacuate entire building." Storage of quantities of bulk polymer materials exceeding two cubic yards, such as new material in cartons awaiting installation, shall be approved by Code 1250.

(5) Polymer materials for new chambers shall be of the highest flame-retardant material available unless operational requirements call for a lower-rated material. Deviations from the design requirements specified in paragraph 8b may be authorized to meet operational requirements; requests for such deviations shall be reviewed carefully by all parties concerned.

(6) Before using electrical equipment in the chamber (including temporary flexible wiring or exposed power supply terminals), the voltage between the chamber ground and equipment chassis shall be measured across a 10 ohm resistor. The voltage shall not exceed 0.5 volts.

(7) If a current interruption device activates, all activity shall cease and the area shall be inspected before power is restored.

(8) In the event that fire or smoke is detected, the first concern is for personnel safety. If possible, steps should be taken to contain a fire within the chamber to prevent involvement of the entire building. However, <u>personnel should take no actions that would seriously endanger their personal safety</u>. All personnel arriving at the scene of the fire should be advised of the hazard of breathing toxic gases and of the dangers of absorption of smoke through the skin. In case of fire, the procedures below shall be followed, in the order listed, by the personnel near the fire who presumably set off the fire alarm:

(a) Notify Code 1250. Use automatic fire alarm if possible.

(b) Shut off all electrical power to the chamber, including lighting.

(c) Secure all ordinary doors to the chamber. (Any electrically operated door should be closed by the remote switch outside the hazardous area after determining that no one remains inside the chamber.)

(d) Evacuate all personnel from the building to a specified location to facilitate accounting for personnel and for providing information to Code 1250. Chamber procedures should specify the meeting area.

(e) Actuate CO_2 suppression system if available. Water deluge systems should be actuated only by order of the anechoic chamber safety representative or Code 1250.

(f) Evacuate all personnel from the building.

(g) Chamber ceiling vents should be opened only by Code 1250.

(9) After a fire, the chamber should not be entered until permission has been granted by Codes 1240 and 1250.

(10) Special precautions should be taken for some time after a fire since gases generated by the fire are readily absorbed on surfaces of the chamber. If the chamber has been closed for a period of time, toxic gas concentrations can build up inside. Chambers should therefore be ventilated continuously, and toxic gas levels should be measured before entering.

9. Forms Availability. Building Fire Bill (NAVFAC 11320/9 (4-67)) is available from the Occupational Safety and Health Section (Code 1241).

B.W. BUCKLEY