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From: Commanding Officer, Naval Research Laboratory
To: Distribution

Subj: DOD AFFF ENVIRONMENTAL MEETING

Encl: (1) Minutes of subject meeting

1. The Navy Technology Center for Safety and Survivability of the Naval Research Laboratory hosted the DOD AFFF Environmental Meeting on 2-3 August 2000. The meeting was held to exchange information on environmental issues surrounding AFFF. The meeting was sponsored jointly by The Naval Facilities Engineering Command and the Naval Air Systems Command.

2. Enclosure (1) is a copy of the minutes of the meeting.

3. The NRL point of contact for this program is Dr. Frederick W. Williams, Code 6180, (202) 767-2476, email: fwilliam@ccs.nrl.navy.mil.

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6180/0394A:FWW
September 12, 2000

Minutes
Of the
DOD AFFF Environmental Meeting

Held at the Naval Research Laboratory
Navy Technology Center for Safety and Survivability
Washington, D.C.
On
2-3 August 2000

Encl (1) to NRL Ltr
9555
6180/0394:FWW

Minutes of
DOD AFFF Environmental Meeting
Naval Research Laboratory
2-3 August 2000

Summary

A meeting to discuss AFFF environmental issues within the Department of Defense (DoD) was held at the Naval Research Laboratory (NRL), Washington, D.C., on 2-3 August 2000. The meeting was hosted by Dr. Fred Williams, NRL, Director, Navy Technology Center for Safety and Survivability. The meeting was jointly sponsored by the Naval Facilities Engineering Command (NAVFAC) and the Naval Air Systems Command (NAVAIR). The agenda for the meeting is shown in Appendix (1). A list of attendees is provided in Appendix (2), along with a photo of attendees present at the opening general session on 2 August 2000. To facilitate future exchanges of information on this subject, Appendix (2) includes mailing addresses, phone numbers and E-Mail addresses for each attendee.

Objective

The overall objective of the meeting was to provide a forum for open discussion on AFFF environmental issues within DoD. Additionally, the meeting was called to address three specific objectives:

(1) Assist NAVFAC in the development of a DoD design policy for AFFF systems in aircraft hangars and other shore facilities to minimize adverse environmental impact.

(2) Obtain information to assist NAVAIR in finalizing their AFFF Environmental Safety and Health Need Assessment Summary (ESH NAS) and in preparing the follow-on Development Plan.

(3) Provide information for attendees on the relevant issues surrounding the decision by the 3M Company to phase-out production of AFFF and other products containing perfluorooctyl sulfonate (PFOS).

Background

There has been growing concern in the past few years about the potential adverse environmental impact of AFFF. This concern has been spawned by a number of factors:

- The establishment by EPA in 1994 of threshold quantities for reporting spills of AFFF due to the butyl carbitol commonly used as a solvent in AFFF
- Inadvertent activations of AFFF systems in hangars and the resultant clean-up and disposal
- Reports of problems created by the discharge of AFFF to waste water treatment facilities

- Limitations on overboard discharges of AFFF by ships under the Uniform National Discharge Standards (UNDS) of the Clean Water Act
- Anecdotal reports of damage to aquatic life by discharge of AFFF to streams and waterways
- Various designations of AFFF waste, necessitating expensive disposal by specialty contractors
- Recognition of the persistence and limited biodegradability of the fluorocarbon surfactants in AFFF
- Publicity surrounding 3M's decision to phase-out production of AFFF and other chemicals containing perfluorooctyl sulfonate (PFOS)
- Claims by vendors of so-called "environmentally-friendly" AFFF alternatives

As a result of these concerns, the affected Navy Systems Commands have undertaken various actions:

- NAVFAC, under the auspices of the DoD Fire Protection Coordinating Committee, has started the development of design policy for shore facility AFFF systems to minimize discharges and to address environmental issues.
- NAVAIR has funded Concurrent Technologies Corporation to draft an ESH Need Assessment Study on AFFF, to be followed by a Development Plan that will recommend future action to alleviate identified problems.
- NAVSEA has reduced the frequency of testing of shipboard AFFF systems to minimize overboard AFFF discharge in compliance with the UNDS regulations.

The meeting was called to share recent information and discuss issues relevant to the above concerns and on-going actions.

Meeting Scope/Presentations

The meeting consisted of general session discussions and presentations as well as two specifically focused breakout sessions. Copies of the general session presentations are provided as Appendices (3) – (10). Presentations given at the Hangar Facility breakout session are contained in Appendices (11) and (12). Overall summaries of each breakout session are provided in Appendices (13) and (14).

Significant Discussion and Presentation Points

There were many important points raised during discussion sessions or contained in formal presentations. Those considered to be the most significant are summarized below (additional details are contained in the appendices):

- AFFF is a vital fire fighting agent for controlling and extinguishing flammable liquid fires. Within DoD, it is especially critical for fire scenarios where life safety is paramount, where ordnance is exposed or high value assets are threatened.

- The AFFF military specification (Mil Spec) is considerably more demanding than the applicable UL standard relative to speed of extinguishment of a flammable liquid pool fire.
- The AFFF Mil Spec is widely cited in procurement specifications in the civil sector, especially at municipal airports.
- There are currently 5 manufacturers that have AFFFs on the Mil Spec Qualified Products List.
- There are many fire fighting foams that are commercially available. However, no non-AFFFs have been able to match the rapid fire extinguishment performance of AFFF.
- At present there is no regulation or directive to modify the AFFF Mil Spec.
- There is no recognized or universally accepted definition of "environmentally friendly" fire fighting foam.
- NAVSEA is the designated DoD technical custodian of the existing AFFF Mil Spec. Only NAVSEA can formally change the Mil Spec, though it may be possible to develop a separate specification just for shore-based applications.
- Inconsistent policy and guidance have led to expensive and questionable secondary containment designs in recent shore facility projects.
- 3M is voluntarily phasing-out production of AFFF because the fluorocarbon surfactant in their AFFF biodegrades to perfluorooctyl sulfonate (PFOS). PFOS has been identified by EPA as environmentally persistent, bio-accumulative in blood, and toxic to aquatic life and laboratory animals (the degree varies by species).
- Levels of PFOS measured in humans and found in blood banks is not considered to present a heath hazard at present levels. Concern is the potential for build-up over time.
- Other AFFF manufacturers do not produce AFFF that is currently believed to biodegrade to PFOS.
- It is not known if other AFFFs have a similar problem. EPA is currently in a fact-finding mode relative to other AFFFs.
- At present the EPA does not prohibit or limit specifically the manufacturing of AFFF.
- A comprehensive review of federal and local environmental regulations applicable to AFFF (and other foam agents) has just been completed (see Appendix (8)).
- All fire fighting foams have environmental properties and/or constituents that are regulated.
- Adverse impact on waste water treatment facilities is a major concern, primarily due to foaming.
- A "risk based" approach, using the Frequency Vs Severity concepts in Military Standard 882C, has been shown to be feasible for managing AFFF environmental issues in shore facilities. Such an approach may be applicable to other AFFF applications as well.
- The NAVFAC Facility AFFF Management Working Group will continue development of policy, with a completion goal of approximately 6 months.

The next meeting of the NAVFAC Working Group is scheduled for October 12, 2000.

- NAVAIR will complete the AFFF Need Assessment Study and prepare the Development Plan to recommend a future course of action.
- There was a general consensus that a second follow-on DoD meeting should be held (host, location, dates – TBD). Depending on developments between now and the next meeting, a decision could be made to establish a governing charter for a DoD AFFF Environmental Steering Group and perhaps to designate a formal DoD "advocate" for the effort.

List of Appendices

(1) Meeting Agenda

(2) List of attendees and photo

(3) Presentation: "AFFF Performance Perspective," R. Darwin, Hughes Associates

(4) Presentation: "NAVSEA Comments on the AFFF Mil Spec", R. Williams, NAVSEA

(5) Presentation: "Hangar Facility AFFF Management Breakout Session Introduction", J. Gott, NAVFAC

(6) Presentation: "AFFF Environmental Impact Breakout Session Introduction", J. Hoover, NAWCWD China Lake

(7) Presentation: "Issues With 3M's Withdrawal from the Market", C. Hanauska, Hughes Associates

(8) Presentation: "AFFF Environmental Impact Review", W. Ruppert, Hughes Associates

(9) Presentation: "AFFF Management – Risk Based Approach", D. Verdonik, Hughes Associates

(10) Presentation: "Phasing out a Problem: Perfluorooctyl Sulfonate", M. Dominiak, EPA

(11) Presentation: Facilities Background and AFFF Issues", J. Simone, NAVFAC

(12) Presentation: "AFFF Risk Assessment", A. Wakelin, Hughes Associates

(13) Presentation: "Summary of Shore Facility AFFF Management Breakout Session", D. Verdonik, Hughes Associates

(14) Presentation: "Summary of AFFF Environmental Breakout Session", J. Hoover NAWCWD China Lake and R. Darwin, Hughes Associates

APPENDIX (1)

Meeting Agenda

DOD AFFF Environmental Meeting

Location:

Building 207 (Chemistry Building)
Naval Research Laboratory,
4555 Overlook Ave,
Washington DC, 20735

Agenda:

Wednesday August 2nd

0830 – 0845	Welcome and Introduction – Dr Fredrick Williams, NRL, Director, Navy Technology Center for Safety and Survivability.
0845 – 0915	AFFF Performance Perspective – Robert Darwin, Senior Engineer, Hughes Associates, Inc.
0915 – 0925	NAVSEA Comments on the AFFF Military Specification - Robert Williams, NAVSEA Fire Protection and Damage Control Division
0925 – 0935	Hangar Facility AFFF Management Breakout Session Introduction – Joseph Gott, NAVFAC, Director, Navy Facilities Safety and Health Office
0935 – 0945	AFFF Environmental Impact Breakout Session Introduction – Dr. Jim Hoover, NAWCWD, Head, Combustion Research Branch
0945 – 1000	Break
1000 – 1015	Issues Surrounding 3M Withdrawal from the Market – Chris Hanauska, Senior Engineer, Hughes Associates, Inc.
1015 – 1100	Presentation of AFFF Environmental Regulatory Aspects – Bill Ruppert, Senior Environmental Engineer, Hughes Associates, Inc.
1100 – 1130	Summary Presentation on Risk Assessment for Hangar Facilities – Dr. Dan Verdonik, Hughes Associates, Inc.
1130 – 1230	Lunch
1230 – 1600	Breakout sessions

Thursday August 3rd

0830 – 0930	3M Withdrawal from Market – Mary Dominiak, EPA, Chemical Control Division, Office of Prevention, Pesticides & Toxic Substances.
0930 – 1230	Presentation of Breakout Session Conclusions. Discussion of any further requirements to complete breakout session action items.

Hangar Facility AFFF Management Breakout Session

Session Objectives and Details:

The objectives of the Naval Facility Engineering Command (NAVFAC) hangar facility AFFF Management breakout session are:

- To begin efforts toward developing a policy that details requirements for hangar facilities that will provide "adequate measures" to:
  (a) prevent an accidental AFFF discharge,
  (b) limit any adverse environmental impacts from a release.

- To achieve an agreement on the definition of "adequate measures" and to begin to establish design criteria to meet them.

Initial draft design criteria and costs of specific engineering solutions will be presented and discussed as a starting point.

Agenda

1230 – 1315	Facility Background and Issues – Joe Simone, Head Fire Protection Engineer, Naval Facilities Engineering Command
1315 – 1430	Risk Assessment for Hangar Facilities – Alison Wakelin, Fire Protection Engineer, Hughes Associates, Inc.
1430 – 1600	Design Criteria Discussion and Development

List of Breakout Session Attendees:

D. Verdonik (Chair)	L. Wolf
J. Gott	K. Ellis
W. Ruppert	M. Doherty
A. Wakelin	K. Kochar
J. Simone	B. Scott
V. Donnally	R. Talbot
T. Ruffini	R. Hansen
D. Roderique	J. Shah
G. Sadler	F. Williams

AFFF Environmental Impact Breakout Session

Session Objectives and Details:

The objective of this meeting is to share the technical data related to the environmental impact, status and the planned future use of AFFF. NAVAIR will use output from this session to ensure their Environmental Safety and Health (ESH) Need Assessment Summary (the where we are today) is accurate and complete, and to ensure their Development Plan (the where we go from here) is consistent with the need to provide sound fire protection in an environmentally responsible manner.

The AFFF Environmental Impact working group will address the following questions:

- What current and future environmental regulations impact AFFF use and why (data and politics)?
- What data do we have (or lack) on the environmental impact of AFFF?
- What technology or products exist that could help reduce AFFF releases into our environment or mitigate the impact of those releases?
- What technology or products could be applied to recycle or reuse AFFF?
- What alternatives to AFFF currently exist and how do they compare in effectiveness, cost, environmental impact, availability, etc?

List of Breakout Session Attendees:

J. Hoover (Chair)
R. Darwin
J. Scheffey
C. Hanauska
W. Leach
D. McCrory
R. Williams
S. Wade
M. Wade
K. Bagot
R. Morris
B. Parks
S. Johnson
P. Bungcayo
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R. DiAngelo
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APPENDIX (2)

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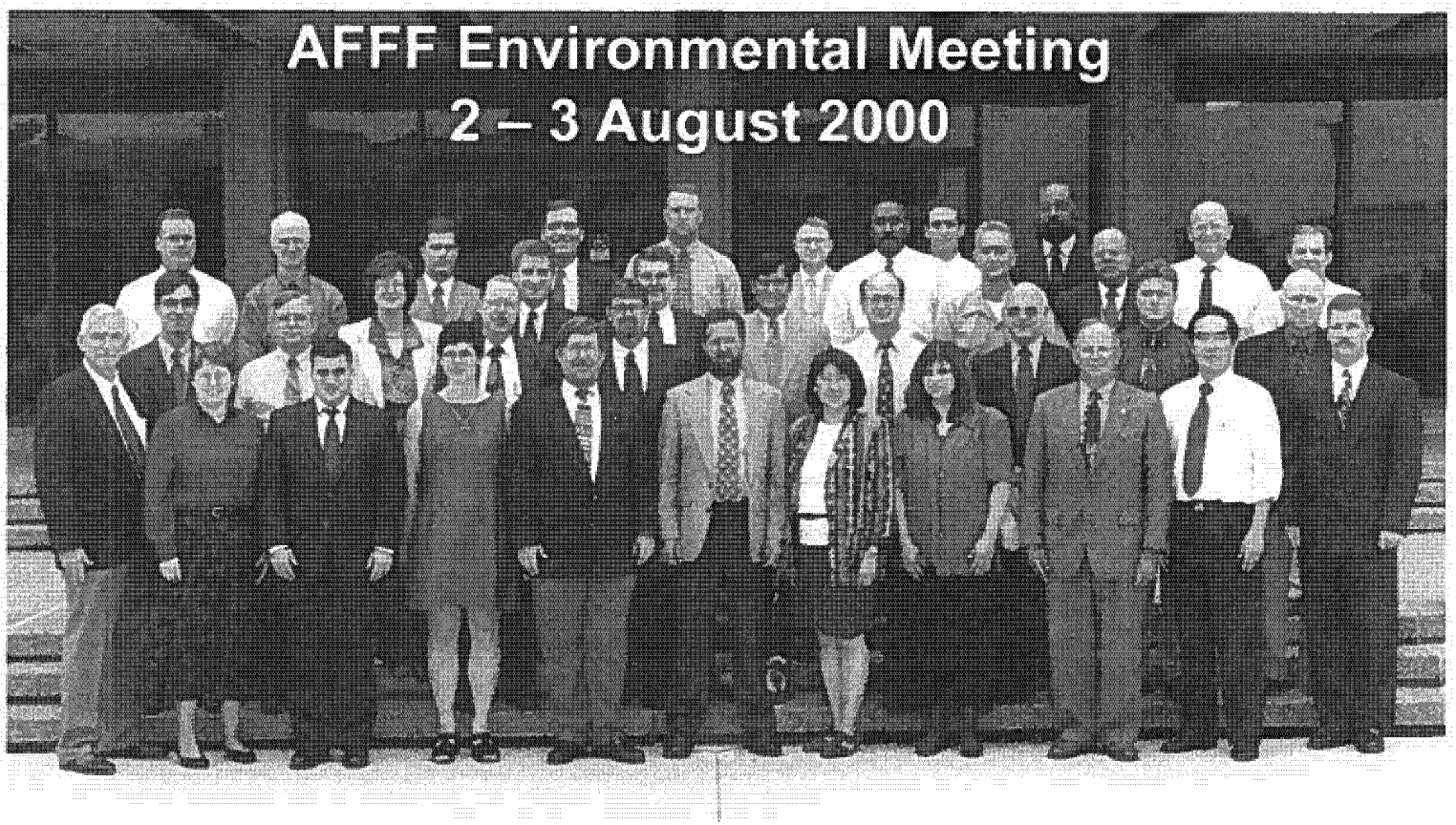

Top Row: C. Hanauska, D. McCrory, J. Simone, L. Wolf, K. Bagot, M. Doherty, B. Parks, J. LaPoint, S. Johnson, R. Hansen, R. DiAngelo

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APPENDIX (3)

Presentation: "AFFF Performance Perspective"

R. Darwin,
Hughes Associates, Inc.
Baltimore MD

AFFF

Performance Perspective

Robert L. Darwin, PE

Senior Engineer

Hughes Associates, Inc.

2 August 2000

History of Foam

1920-40 Chemical Foam

1940-70 Protein Foam (Air Foam)

1970- 2000 AFFF

<u>AFFF Key Events:</u>

1961 First experiments with fluorocarbon surfactants at NRL

1962 First Mil-Spec (Mil-F-23905, 1 Nov 63)
25 % concentration (fresh water only)
Emphasis on twin agent application

1963 Large scale tests at NAS pensacola
Led to procurement of 100 twin agent units

1964 Helo air borne TAU tests at NAS Miramar

1965 6 % concentration developed by 3M (FC-194)

1966 Testing of FC-194 in airfield crash trucks
Selective conversion of some crash trucks

1967 Flight deck conflagration on USS Forrestal
TAUs to aircraft carriers
Push to develop seawater-compatible AFFF

1967 Seawater –compatible AFFF developed by 3M/NRL

1968 Additional crash truck tests at NAS Miramar

1968 Shipboard equipment tests w/ seawater at NAS Jacksonville
First edition of seawater/AFFF mil spec (Mill-F-24385)

1969 Flight deck conflagration on USS Enterprise
Push to convert ships to AFFF

1970 Navy starts comprehensive conversion of ship systems and crash trucks

1973 USAF starts converting all USAF crash trucks

UL Listed Foams

(Per UL 162-"Foam Equipment & Liquid Concentrates")

AFFF – Aqueous Film Forming Foam
FFFP – Film Forming Fluoroprotein
FP – Fluoroprotein
PF – Protein Foam

	Manufacturers	Concentrates
AFFF	24	110
FFFP	5	16
FP	12	26
PF	5	6

Mil Spec Qualified Product List (QPL)

Ansul		
	Ansulite 3 (AFC-5A) *	Type 3
	Ansulite 6 (AFC-5) *	Type 6
3M		
	FC-203C	Type 3
	FC-203CE *	
	FC-203CF *	
	FC-206C	Type 6
	FC-206CE	
	FC-206CF *	
Chemguard		
	C-301MS *	Type 3
National Foam		
	Aer-O-Water 3-EM *	Type 3
	Aer-O-Water 6-EM *	Type 6
Angus		
	Tridol M	Type 3

* Also UL Listed

"Application Density" (Defined as the Gallons of Agent Per Unit Area of Pool Fire Size) is the best measure of effectiveness for a flammable liquid pool fire

Application Rate = GPM/Sq Ft of fire area

Application Rate x Ext Time = Application Density

GPM/Sq Ft x Minutes = Gals/Sq Ft

Example

Fire Area = 1000 Sq Ft
Appl Rate of Agent = 200 GPM
Ext Time = 0.5 minutes

Appl Rate = 200 GPM/1000 Sq Ft = 0.2 GPM/Sq Ft

Appl Density = Appl Rate x Time
= 0.2 GPM/SqFt x 0.5 minutes
= 0.1 Gals/SqFt

AFFF Performance Requirements

Mil Spec (Mil-F-24385):

Max Appl Density

2 gpm/28 sq ft x 30/60 minutes = .036 gal/sq ft

2 gpm/50 sq ft x 50/60 minutes = .033 gal/sq ft

Underwriters Laboratory:

2 gpm/50 sq ft x 3 minutes = .12 gal/sq ft

(Maximum extinguishment time is 5 minutes for fluoroprotein and protein foam)

Rapid Extinguishment of Pool Fires is Critical When:

- Pool fire threatens high value assets (such as an aircraft hangar)
- Pool fire under an occupied aircraft (must maintain fuselage integrity and rescue occupants)
- Pool fire exposes weapons to potential "cook off"

Relative Performance of Foam Agents on Pool Fires

(Best)	AFFF (Mil-Spec)
	AFFF (UL listed, non Mil-Spec)
	AFFF (non UL, non Mil-Spec)
	FFFP
	FP
	PF
(Worse)	Wetting Agents

UL Listed Wetting Agents
(Based on NFPA 18)

" A liquid concentrate for addition to water to produce a solution having a greater fire extinguishing efficiency than plain water"

Manufacturers: 11

Agents: 13

If Use Non-Film Formers:

- Extinguishment time will be slower, unless application rate is increased

- Higher application rate causes

  Greater system cost

  Greater quantity of agent emitted

- Must consider possible need for "air aspiration"

  Replace nozzles

  Less reach than "non air aspirated"

AFFF Environmental Issue - 1994

Glycol Ethers (Butyl Carbitol), solvent in most AFFFs, placed on EPA list of hazardous air pollutants.

Since no reporting threshold had been established, a default quantity of one pound per day was established for required reporting under CERCLA.

Because Diethylene Glycol Butyl Ether (DGBE) typically comprises about 20 % of AFFF, spills of just a few gallons of AFFF had to be reported to the National Response Center and to State and local officials.

One pound per day reporting requirement dropped in 1996.

Some manufacturers substituted Propylene Glycol for Ethylene Glycol and declared their foam to be "environmentally friendly".

DOD Uses of AFFF

- Shipboard Foam Systems
- CFR Vehicles at Airfields
- Aircraft Hangar Foam Systems
- Misc Shore Facilities
  - Hush Houses
  - Jet Engine Test Facilities
  - Hardened Aircraft Shelters
  - Aircraft Fueling Stations
  - Fuel Farms
- Foam Sytems on Structural Pumpers

DOD AFFF Discharges

- Fires
- Training Evolutions
- System Tests and Maintenance
- Accidental/Malicious Discharges
- Research and Development

There is a Need to Quantify and Characterize:

- All DOD AFFF applications (What precisely do we use it for ?)
- Precise quantities in service and in reserve stocks (How much do we have ?)
- Annual emmisions (type and quantity) (How much do we discharge ?)

APPENDIX (4)

Presentation: 'NAVSEA Comments on the AFFF Mil Spec"

R. Williams,
Naval Sea Systems Command

NAVSEA Comments
On the
AFFF Military Specification
Mil-F-24385F
(Amendment 1 of 8/94)

(Talking Points)

Presentation to DOD AFFF Environmental Meeting
2 August 2000

Robert B. Williams
Fire Protection & Damage Control Division
Naval Sea Systems Command
(Technical Custodian of the AFFF Mil-Spec)

1. I would like to express appreciation to NAVFAC and NAVAIR for sponsorship of this Conference. Also, I appreciate the opportunity to establish the NAVSEA perspective up front.

2. This conference is important and timely:

Recently there has been a proliferation of Navy groups active in AFFF; usually with no focus, some scattered and uncoordinated EPA contacts.

Recently there has been aggressive commercial marketing of so-called "environmentally friendly foams"; yet there is no established definition of "environmentally friendly foam".

AFFF is subject of considerable hype: effect on sewage plants, danger to aquatic life, exposure results in mutant first born, etc.

AFFF spills are media friendly- very visible, makes for good "films at 11", photos provide permanent record, helps stir up environmental activists

Real issues from my perspective:

3M withdrawal and fall out relative to other QPL AFFFs

Restrictions by AHJs; technical basis or not

Unknown forthcoming EPA activity

All are on agenda to be addressed

3. The product I personally desire of this conference is to specifically identify what the problems are regarding MILSPEC AFFF, and problems that are inherent to any foam alternative (visible, wastewater treatment plants).

Appears money is & will be directed at AFFF.

My concern is that funding needs to be attached to a focus on specifics that are documented as requiring resolution.

Navy labs and contractors see a golden egg out there on this topic; I personally don't want to see them going off into the sunset with a generic task to find an environmentally friendly firefighting agent. (whatever friendly means).
The specific problems to be resolved require documentation before charging onto a search for solutions; doesn't always happen in correct order.

The agenda appears to support what I hope is the conference objective.

4. A few quick comments about the MILSPEC and shipboard applications:

NAVSEA is custodian; only NAVSEA can revise. Self appointed cannot.

However, an alternate extinguishing agent specification under someone else's cognizance could be created.

For example, it might be feasible to develop a separate specification just for shore facility use (fresh water only, one percent, universal foam, no refractive index requirement, etc).

NAVSEA goal regarding the spec: Satisfy environmental requirements without degradation of firefighting effectiveness. If maintaining performance requirements is not possible, then where do we draw the trade-off line in the sand? (fish vs. sailors; national defense vs. environment)

MILSPEC contents - shipboard oriented, even though it is essentially the national standard ashore and afloat:

AFFF is for two dimensional shallow spill fires, rapid control and extinguishment are essential. No "foam-of-the-month" has matched the performance of mil-spec AFFF.

Environmental provisions in spec; fish kill, BOD/COD limits, chemical restrictions.

Compatibility: seawater effectiveness, intermixing of products from different manufacturers on QPL.

It is an integrated match with our capital investment in hardware: viscosity, corrosion, pipe & tank materials, effect on seals/gaskets, a refractive index, container size & strength.

5. Our primary environmental involvement has been with the Uniform National Discharge Standards (UNDS) program which is relative to overboard discharge of liquids; basically a Clean Water Act action item.

Our imput to EPA, which has been accepted thus far, is discharge management:

New construction/alterations - no repeat testing, at sea

Preventative Maintenance - reliable hardware, reduced testing periodicity

Fewer ships

Geographic restrictions: no discharges within 3 miles of coast, must be making at least 10 knots for discharges within 3-12 miles, preference for only discharging when greater than 12 miles out

6. In closing, I pass along that as custodian of the MILSPEC, I have no direction, pressure, or formal or informal tasking to conduct an environmental review of MILSPEC AFFF aside from the UNS. At NFPA aviation committee meetings I have queried major airport fire chiefs, all of whom stated no direction to pursue an alternative to MILSPEC AFFF. However, we at NAVSEA know whether politically, technically, or regulatory driven, environmental restrictions on AFFF may be coming. We fully support this conference, identification of problems & potential problems, and initiation of remedial research/actions.

APPENDIX (5)

Presentation: "Hangar Facility AFFF Management Breakout Session Introduction"

J. Gott,
Naval Facilities Engineering Command

Hangar Facility AFFF Management Breakout Session Introduction

(Talking Points)

Presentation to AFFF Environmental Meeting
2 August 2000

Joseph Gott
Director, Navy Facilities Safety and Health Office
Naval Facilities Engineering Command

AFFF DOD Meeting Talking Points

- Need a consistent DOD position on AFFF management
- If we are not proactive, AFFF will become our next halon 1301
- AFFF is only product on market right now that meets our needs
- Time for the design engineers, and environmental engineers to come together
- The services have already done this with the Unified Design Guidance Group
- As past chair of DOD FPE committee, we wrote the first tri-service design criteria
- Fixed containment systems are affecting our mission because they have already caused the omission of AFFF from some hangars resulting in the air wings inability to perform their mission
- This is the beginning of a working group to address this important issue
- Need to get all the right players
- Need to address AFFF management from a risk assessment approach
- Need to dismiss all the myths and fears and address the facts
- Need to give the local regulators something to reference as adequate protection
- Need to determine if additional research is needed to produce a different AFFF
- Discuss changes to NFPA 409 - mandatory drains, reduced AFFF, various protection options
- NAVFAC has long history in fixed AFFF systems, their behavior, problems, and design characteristics

APPENDIX (6)

Presentation: "AFFF Environmental Impact Breakout Session Introduction"

J. Hoover,
Naval Air Warfare Center
China Lake CA

AFFF Environmental Impact Breakout Session Introduction

(Talking Points)

Presentation to DOD AFFF Environmental Meeting
2 August 2000

Dr. Jim Hoover
Head, Combustion Research Branch
NAWCWD China Lake

The purpose of the AFFF Environmental Impact Breakout Session will be to share technical information within the DoD on AFFF use and environmental impact. This information will be used to assist the completion of two environmental planning documents used by the Naval Air Systems Command (NAVAIR) - an Environmental Safety and Health Needs Assessment Summary (NAS) and a Development Plan. The NAS will provide a "snap-shot" of technical issues surrounding AFFF use and environmental impact, and the Development Plan will recommend a strategy for future efforts within NAVAIR.

Background: The importance of AFFF in protecting Navy personnel and assets must not be understated. Likewise, public safety and commercial assets are highly dependent on AFFF for fire protection. Its firefighting performance remains unmatched and much remains unknown about its human health and environmental effects.

Other services and agencies have data and experiences with AFFF that could assist the Navy in future decision making, so a forum for technical information exchange is needed. In planning for the future, all aspects of technical knowledge about AFFF (and all of its formulated components) should be considered. These should include costs, performance/function, human health and environmental effects, availability, inventory, alternatives, etc.

Break-out Session Format:

The following questions will be asked of the participants to promote discussion and information exchange. Participants will be invited to provide other questions.

1. What current and future environmental regulations impact AFFF use and why (data and politics)?

2. What data do we have (or lack) on the environmental impact of AFFF?

3. What technology or products exist that could help reduce AFFF releases into our environment or mitigate the impact of those releases?

4. What technology or products could be applied to recycle or reuse AFFF?

5. What alternatives to AFFF currently exist and how do they compare in effectiveness, cost, environmental impact, availability, etc?

6. What related planning documents exist with other services or agencies?

7. What follow-on strategies should be considered?

APPENDIX (7)

"Issues With 3M's Withdrawal From the Market"

C. Hanauska
Hughes Associates, Inc.
Baltimore MD

Issues with 3M's Withdrawal from the Market

AFFF DoD Meeting

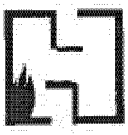
Christopher Hanauska

HUGHES ASSOCIATES, INC.
FIRE SCIENCE & ENGINEERING

August 2, 2000

Purpose of this Presentation

- Mary Dominiak of EPA will provide more detailed information tomorrow
- Provide some background for her presentation
- Frame the issue relative to the subjects of this meeting
- *This presentation is only an executive summary*



Fluorochemical Surfactants (FC's)

- FC's are a component of AFFF
  - One of several components in AFFF
  - FC's are difficult and expensive to make
  - Formulators have minimized (and attempted to eliminate) the FC content for 30 years
  - Necessary for performance (especially for CFR)
    - rapid fire knockdown
    - relatively low application rates

What is an FC?

- C8F17-functional group
- Length of carbon chain varies
- Fluoronated carbon chain is very stable
- Functional group gives different properties

FC's for AFFF Do Not Fully Biodegrade

- 3M's FC's => PFOS (Perfluorooctyl Sulfonate)
- Other FC's => ?
- Functional group may biodegrade, but something is always left
- Ultimate fate unknown
- "Persistent"

3M Performed Testing
(Last 2 Years)

- Found PFOS
  - in blood banks around the US
  - in fish and birds
- Discovered toxicity issues
  - reproductive sub-chronic studies
- "Bioaccumulative" and "Toxic"

3M Voluntarily Phasing Out PFOS Related Chemicals

- Scotchguard, Scotchban, industrial uses, AFFF
- About 2 years for complete halt of production
- Decision made at highest level of 3M
  - were in discussion with EPA at the time
- An unexpected and extreme action

If Only 3M PFOS FC's are a Problem

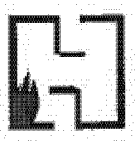
- Other non-PFOS FC based AFFF's are on the QPL
- Possibly a short term supply issue
- Should not be a major fire protection/environmental concern

Do Non-PFOS FC's Have a Problem?

- EPA has asked manufacturers to examine and test
- What constitutes a "problem" uncertain
  - "Bioaccumulative" "Toxic"
- EPA will do risk/benefit and risk/risk analysis
  - Understanding of importance of AFFF to fire protection

Conclusions

- No FC specific regulations exist
- No apparent short term (1 year) problems
- Mid-term (2-3 years) problems related to supply only
  - as 3M withdraws from market
- Potentially no long term problems (3+ years)
- *Unless other FC's have significant problems*



APPENDIX (8)

Presentation: "AFFF Environmental Impact Review"

W. Ruppert
Hughes Associates, Inc.
Baltimore MD

Aqueous Film Forming Foam (AFFF) ENVIRONMENTAL IMPACT REVIEW

Bill Ruppert

HUGHES ASSOCIATES, INC.
FIRE SCIENCE & ENGINEERING

Background:
AFFF Constituents

- MILSPEC based on Performance, not Constituents
- Must be on Qualified Products List - QPL
- Main Ingredients in Firefighting Strength Foam:
  - WATER = 98%-99%
  - Butyl Carbitol (Glycol Ether) = 0.5%–1.1%
  - Fluorosurfactants & Hydrocarbon Surfactants = 0.03%–0.45%
  - Ethylene Glycol (Not in all formulations) = 0.34%–0.60%
  - Urea (Not in all formulations) = 0.2–0.4%

Background:
AFFF 'Environmental' Properties

- MIL-F-24385F Requirements
  - Chemical Oxygen Demand
    - 3% Concentrate - 1,000,000 mg/L Max
    - 6% Concentrate - 500,000 mg/L Max
    - Calculated Firefighting Strength ~ 30,000 mg/L Max
  - Biochemical Oxygen Demand (20 Day)
    - =(0.65 X COD) or greater
  - Aquatic Toxicity (LC50, Killiefish)
    - 3% Concentrate - 500 mg/L Min
    - 6% Concentrate - 1000 mg/L Min
    - Calculated Firefighting Strength ~ 16,667 mg/L Min
- Persistence and Bioaccumulation
  - Only Fluorosurfactants - Not in other constituents
  - example: Butyl Carbitol log BCF = 0.46
- Foams

Background: AFFF Properties
MILSPEC vs. Typical QPL Product

Property	MIL-F-24385F Requirements			Typical QPL Product		
	3%	6%	FF	3%	6%	FF
Chemical Oxygen Demand (mg/L)	1,000,000 Max	500,000 Max	30,000 Max	750,000	341,000	22,500
Biochemical Oxygen Demand (mg/L)	BOD_{20} > 0.65 x COD			720,000 (0.96*COD)	274,000 (0.80*COD)	21,600
Aquatic Toxicity (Killiefish) (mg/L)	500 Min	1000 Min	16,667	>1000	>1000	>16,777 or >33,333

Codes and Standards Survey
Approach

- Electronic Review
- Federal Environmental Regulations
  - "AFFF"
  - MILSPEC AFFF Constituents (19)
    - Surfactants
    - Fluorosurfactants
    - Glycol Ethers
    - Urea, etc.
  - AFFF "Environmental" Properties
    - Biochemical And Chemical Oxygen Demands
    - Aquatic Toxicity
    - Foaming
- DOD, State And Local Regulations
  - "AFFF"
  - MILSPEC AFFF Constituents

Codes and Standards Survey
Federal Environmental Regulations

- Clean Air Act (CAA)
  - Air Emissions
  - Air Discharge Permits
- Emergency Planning and Community Right-to-Know Act (EPCRA)
  - Toxics Release Inventory (TRI)
  - Chemical Storage and Use
- Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA)
  - Superfund Amendments and Re-authorization Act (SARA)
  - Spills and Clean-up Of Spills
- Resource Conservation and Recovery Act (RCRA)
  - Hazardous Waste
- Safe Drinking Water Act (SDWA)
  - Regulates Contaminants in Treated Drinking Water
- Clean Water Act (CWA)
  - Water Discharges
  - Water Discharge Permits

Federal Environmental Regulations
Results

- Clean Air Act (CAA)
  - Glycol Ethers In AFFF Are Hazardous Air Pollutants (HAPs)
  - HAP Releases Are Regulated by the Installation Air Permit
    - Major Sources for HAPs Might Have Potential Permit Issue
- EPCRA and TRI
  - Glycol Ethers are Covered Because CAA Defines them as HAPs
  - Chemicals Released Above a Reportable Quantity (RQ) Must Be Reported
    - Default RQ was One (1) Pound
    - EPA Established a No RQ
  - AFFF Discharges Do Not Currently Need to Be Reported Under EPCRA and TRI
  - Ethylene Glycol Specifically Listed
  - No Other Constituent is Currently Regulated by EPCRA and TRI

Federal Environmental Regulations
Results

- CERCLA and SARA
  - Glycol Ethers are Covered Because CAA Defines them as HAPs
  - Glycol Ethers May Need to Be "Cleaned Up" After a Spill
    - Air Pollutants So Expected to be Volatile
      - Are not volatile when mixed with water
    - Biodegradable So Might Be "Cleaned Up" Naturally
- Resource Conservation And Recovery Act (RCRA)
  - AFFF and Its Constituents are Not Classified as Hazardous Waste
  - RCRA Does Not Apply
- Safe Drinking Water Act:
  - Primary Drinking Water Regulations (Health Properties)
    - Does not regulate AFFF or its constituents
  - Secondary Drinking Water Regulations (Aesthetic Properties):
    - Foaming Agents <0.5 mg/L in drinking water
    - Do not regulate foaming agents in source water
    - Guideline for State Regulations Only (Not Federally Enforceable)

Federal Environmental Regulations
Results (Continued)

- Clean Water Act (CWA)
  - Installations Require Discharge Permits
    - Storm Water
    - Treated Sewage from Installation Wastewater Treatment Plant
    - Raw Sewage to Public Wastewater Treatment Plant (Locale Specific)
  - Regulates Wastewater that:
    - Foam
    - Remove Oxygen From Water
    - Disrupt Wastewater Treatment Plants, etc.
  - AFFF
    - Persistent Foam
    - Removes High Amounts of Oxygen From Water (High BOD and/or COD)
    - Untreated, Undiluted AFFF Will Disrupt Wastewater Treatment Plant
    - (Even Diluted AFFF Can Disrupt Wastewater Treatment Plant) SDWA

Codes and Standards Survey

State/Local Environmental Regulations

- State Regulations Can be More Strict Than Federal
  - No Specific Instances Found for AFFF
  - Storm Sewer Regulations Emphasized
- Nothing Additional in County and City Regulations
- Representative Jurisdictions
  - Telephone Surveys
  - Focused on Jurisdictions In:
    - Virginia
    - Hawaii
    - Florida
    - California
- Local Anecdotal AFFF 'Problems'
  - Sewage Treatment Plants Becoming 'Bubble Baths'
  - Pump Stations 'Burned-up'
  - Storm Sewer Overflowing With Foam

State/Local Environmental Regulations
(Continued)

- Foaming the Greatest Concern
- Perception:
  - Foam Is Highly Toxic to Everything
  - No Concentration is Okay for a WWTP
- Results
  - Local Jurisdictions **CAN** and **DO** Regulate AFFF by Name
  - Have Water Discharge Permit Authority
  - Local Waste Water Treatment Plants Often Ban AFFF
    - Based on Direct Experience with a Disruption
    - High Oxygen Demand
    - Foaming

Environmental Consequences

- Media Considered
  - Air
  - Groundwater
  - Soil
  - Surface Water
    - Via storm water
    - Via wastewater treatment plant
- Both Constituent Characteristics and AFFF Solution Properties

Environmental Consequences
Media: Air

- HAPS: Butyl Carbitol, Ethylene Glycol
- Low Migration Potential (All Constituents)
  - Highly Soluble in Water
    - Tends to stay with liquid water
    - Not very volatile
  - If Volatilized, Half-lives in Air 4 Hr - 3.5 Days

Environmental Consequences
Media: Groundwater

- Consequence Varies Depending on Subsurface Conditions
- Fluorosurfactants: Not Mobile
- All Other Constituents:
  - Highly Soluble, Highly Mobile
  - Degrades Rapidly in Soil
    - 30% Degradation Over 24 Hour Period
- Drinking Water Wells 'Under the Influence of Surface Water' Could Receive Undegraded AFFF Constituents

Environmental Consequences
Media: Soil

- Consequence varies depending on soil type
- Fluorosurfactants and break-down products
  - Persistent in soil
  - No quantified environmental impact
  - EPA will discuss further tomorrow
- Other constituents highly mobile in water, will not adsorb to soil

Environmental Consequences

Media: Surface Water Via Storm Water

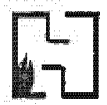
- Foaming:
  - Aesthetic Concern
- Oxygen Demand
  - Robs Oxygen from Water
  - Usually near water's surface
- Aquatic Toxicity
  - Considered 'Practically Nontoxic' by the US Fish and Wildlife Service.
  - Lowest toxicity value in 40 CFR 300
    - LC50 > 1000 mg/L in concentrate
    - ~160 mg/L in most sensitive species
    - Much Lower Toxicity in Firefighting Strength
  - Anecdotal Reports of Higher Toxicity
- Surface Water May influence Groundwater
- 'Environmental' Threat
  - Depends on Sensitivity of Receiving Water: Worst Cases
    - Kaneohe Bay, HI Risk Analysis - "Potential for significant ecological damage … relatively small"
    - Wetlands
      - Waterfowl-Fluorosurfactant Interaction being studied in St. Johns River Basin in Florida.

Environmental Consequences

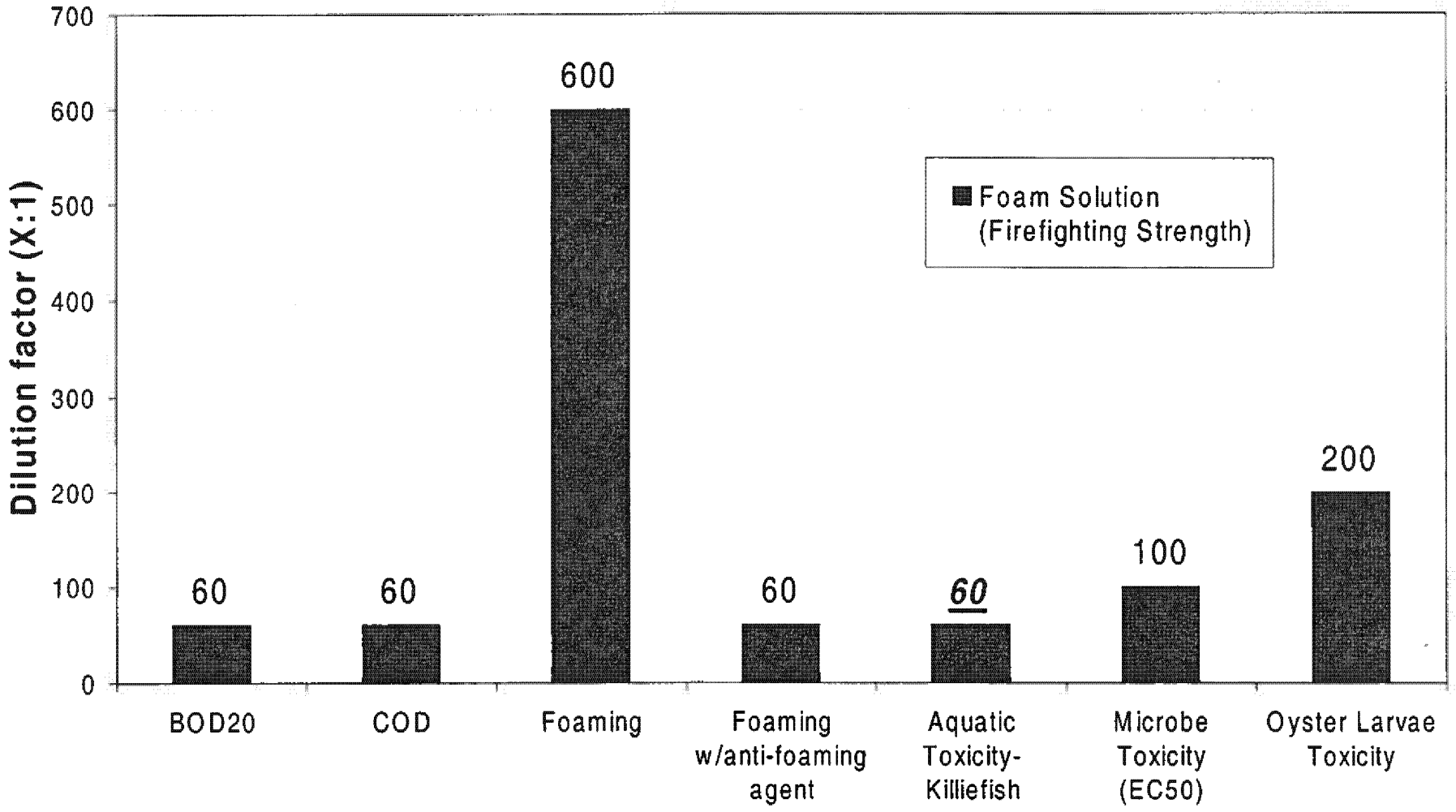
Media: Surface Water Via Direct Discharge to WWTP

- Disrupts plant through:
  - Foaming
    - Disrupts mechanical devices
    - Causes 'sludge bulking'
    - Causes Froth
  - High Oxygen Demand
    - Removes all oxygen - killing microorganisms used to treat sewage
    - Causes 'sludge bulking'.
  - Aquatic Toxicity
    - Of lower concern than Foaming and Oxygen Demand
    - May cause 'sloughing' of organisms from certain processes

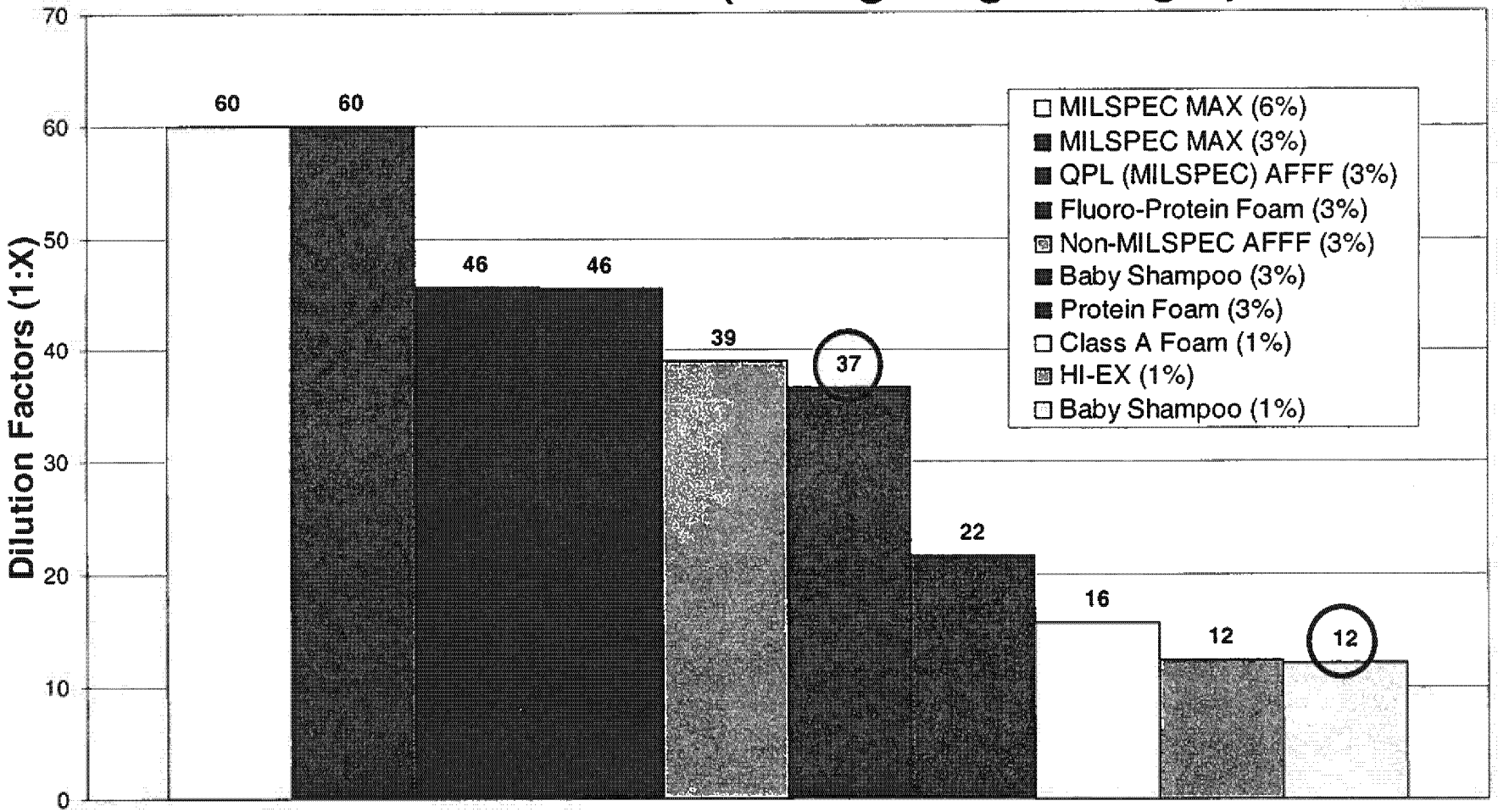
- Disrupted plant:
  - Contaminates receiving water
  - Could cause fish kill
  - Makes water unfit for:
    - Drinking
    - Recreation, etc.



Representative Dilution Factors for Treatment of MAX MILSPEC AFFF at a WWTP



Representative Dilution Factors for COD of Foam Solution (Firefighting Strength)



Summary

- Under Context of Current Laws/Regulations, AFFF and all other Foams Regulated Based On:
  - Properties
    - BOD, COD, Foaming and Aquatic Toxicity
  - "Listed" Chemical Constituents
    - Butyl Carbitol, Surfactants, Ethylene Glycol, Urea, etc.
  - Water Issues are Most Prevalent
  - Foaming is Major Issue for WWTP
- Potential Environmental Impacts Generally Low
  - Impacts Consequence of
    - Foaming
    - O_2 Demand
    - Aquatic Toxicity
  - Upset of WWTP Creates Greatest Impact

APPENDIX (9)

Presentation: AFFF Management – Risk Based Approach"

D. Verdonik
Hughes Associates, Inc.
Baltimore MD

AFFF Management
Risk Based Approach

Dr. Dan Verdonik

HUGHES ASSOCIATES, INC.
FIRE SCIENCE & ENGINEERING

Why a Risk Based Approach?

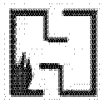
- From Environmental Review
  - AFFF / Foams have Similar Environmental Impacts
    - Based on the Properties of Foams in General
    - Worst Impact for WWTP
  - Hazard Exists
  - Cannot Alter What Would Happen IF Released
- Can Reduce the If or Likelihood of Release
  - Example - Double Hulled Oil Tankers
    - Hazard Exists from Potential Oil Spill
    - Double Hull Reduces Probability of Having the Oil Spill
    - Double Hull Does Not Reduce Environmental Impact IF Have Oil Spill
    - Reducing Probability Reduces the Risk to the Environment
- Need to Evaluate Probability of Foam Release
- Probability + Severity = Risk

Risk and Risk Assessments

- Military Standard 882C: System Safety Program Requirements
  - Define Terms
    - Risk - Combination of hazard severity AND hazard probability
    - Hazard Probability: Aggregate probability of the individual events
    - Hazard Severity: Consequences of worst credible mishap
    - Control: Action to Eliminate Hazard or Reduce Risk
  - Applicable to All DOD Systems and Facilities
  - Identify the Hazards and Impose Design Requirements and Management Controls to Prevent Mishaps
  - Tailor to Application
    - AFFF/Foam Discharge from Facility Fixed Fire Suppression System
    - Accidental Discharge
    - Pre-planned testing
- Have Hazard Severity, Need Hazard Probability
  - Determine Risk
  - Risk Decision

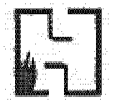
MIL-STD-882C
4.5.2 Hazard Probability

- Potential occurrences per unit of time, events, population, items, or activity
  - Quantitative probability for potential design generally not possible
  - Qualitative probability
    - Derived from research, analysis, and evaluation of historical data
- Given for Specific Individual Item or Fleet / Inventory
- Assign Probability of Having Environmental Consequence



Qualitative Probability Levels
Specific Individual Item

FREQUENT	(A)	Likely to occur frequently
PROBABLE	(B)	Will occur several times in the life of an item
OCCASIONAL	(C)	Likely to occur some time in the life of an item
REMOTE	(D)	Unlikely but possible to occur in the life of an item
IMPROBABLE	(E)	So unlikely, it can be assumed occurrence may not be experienced



MIL-STD-882C
4.5.1 Hazard Severity

- Hazard Severity Category Definition
  - Provide Qualitative Measure of Worst Credible Mishap
  - Result of:
    - Personnel Error
    - Environmental Conditions
    - Design Inadequacies
    - Procedural Deficiencies
    - System, Subsystem or Component Failure or Malfunction

Qualitative Hazard Severity Categories

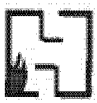
CATASTROPHIC	(1)	Death, System Loss, or Severe Environmental Damage
CRITICAL	(2)	Severe Injury, Severe Occupational Illness, Major System or Environmental Damage
MARGINAL	(3)	Minor Injury, Minor Occupational Illness, Minor System or Environmental Damage
NEGLIGIBLE	(4)	Less Than Minor Injury, Occupational Illness, Less Than Minor System or Environmental Damage

Risk Assessment and Acceptance

CATEGORY / FREQUENCY	1 CATASTROPHIC	2 CRITICAL	3 MARGINAL	4 NEGLIGIBLE
A – FREQUENT	1A	2A	3A	4A
B – PROBABLE	1B	2B	3B	4B
C – OCCASIONAL	1C	2C	3C	4C
D – REMOTE	1D	2D	3D	4D
E - IMPROBABLE	1E	2E	3E	4E

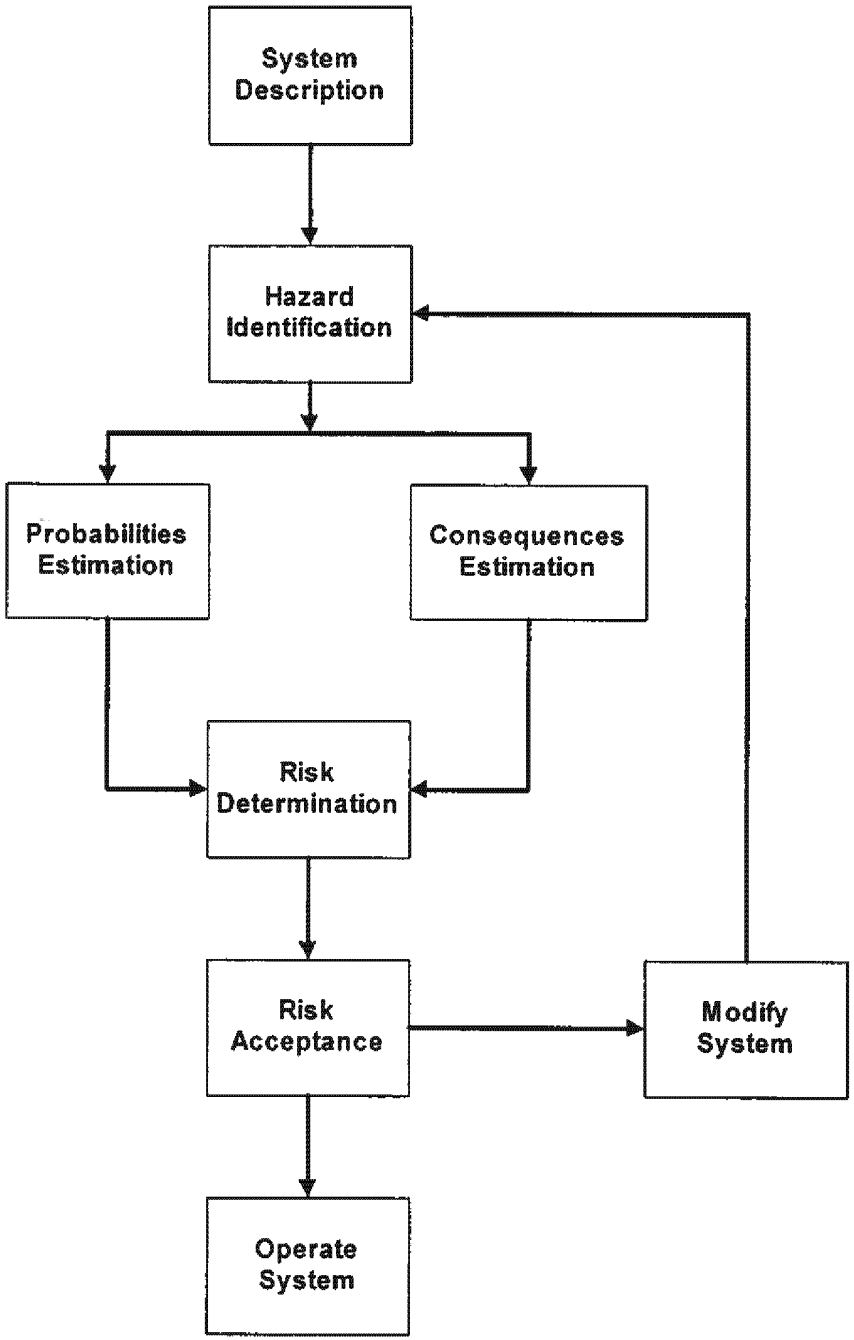
- Risk Index - Suggested Acceptance Criteria in MIL-STD-882C

Unacceptable:	1A, 1B, 1C, 2A, 2B, 3A
Undesirable:	1D, 2C, 2D, 3B, 3C
Acceptable w/ Review by Managing Activity:	1E, 2E, 3D, 3E, 4A, 4B
Acceptable w/out Review:	4C, 4D, 4E



Design Criteria

- Design for minimum risk
  - Review design criteria for inadequate or overly restrictive requirements
  - Design to eliminate hazards
  - If hazard cannot be eliminated
    - Reduce risk to an acceptable level through design selection
    - Interlocks, redundancy, fail safe design, system protection, fire suppression, and protective clothing, equipment, devices, and procedures
- Recommend new design criteria supported by study, analyses, or test data


System Description
Hazard Identification
Probabilities Estimation
Consequences Estimation
Risk Determination
Risk Acceptance
Modify System
Operate System

Probability Estimation

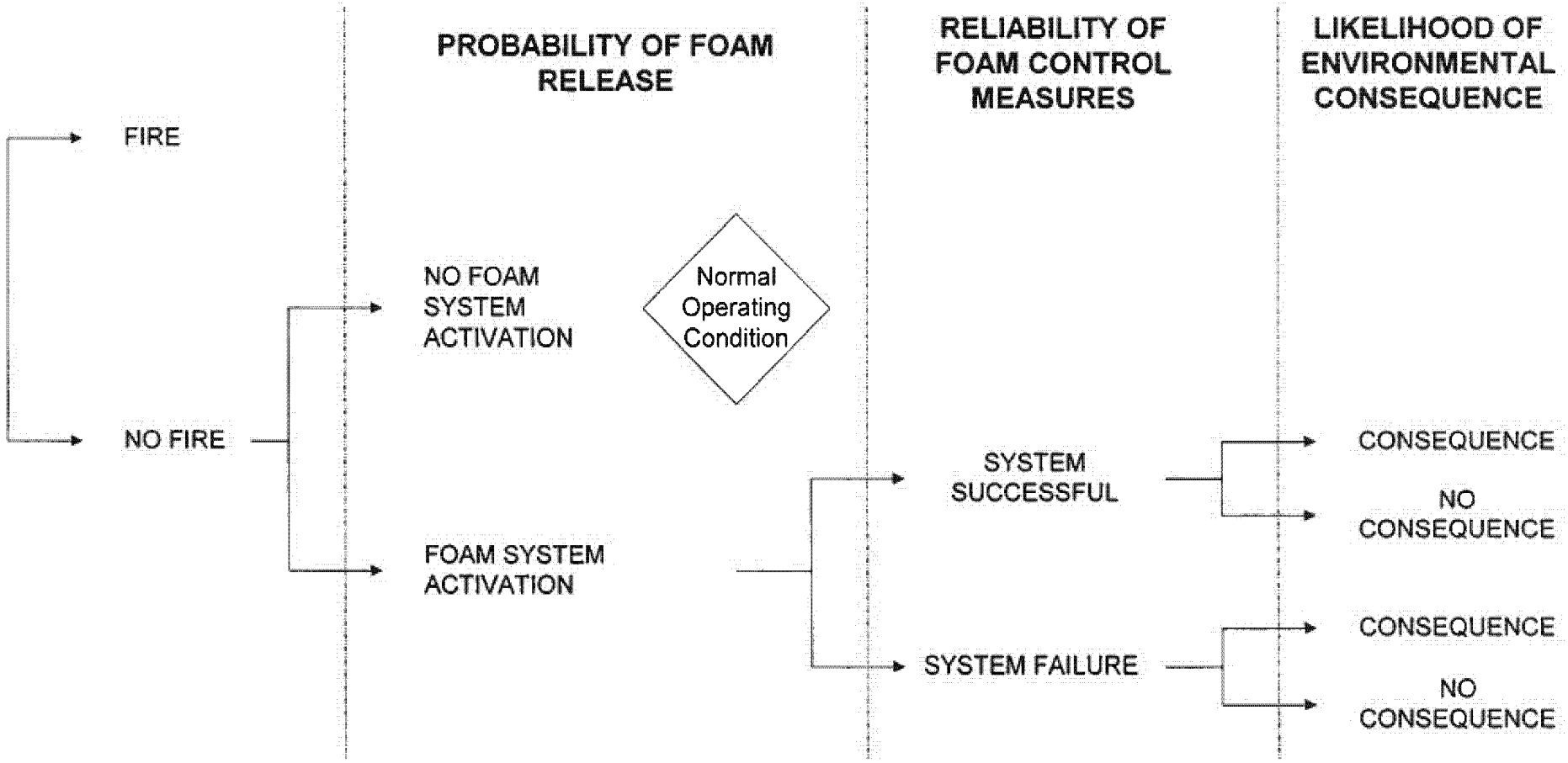
3 Parts to Probability Estimation

Probability of foam release

Reliability of system controlling foam movement

Likelihood of environmental consequence

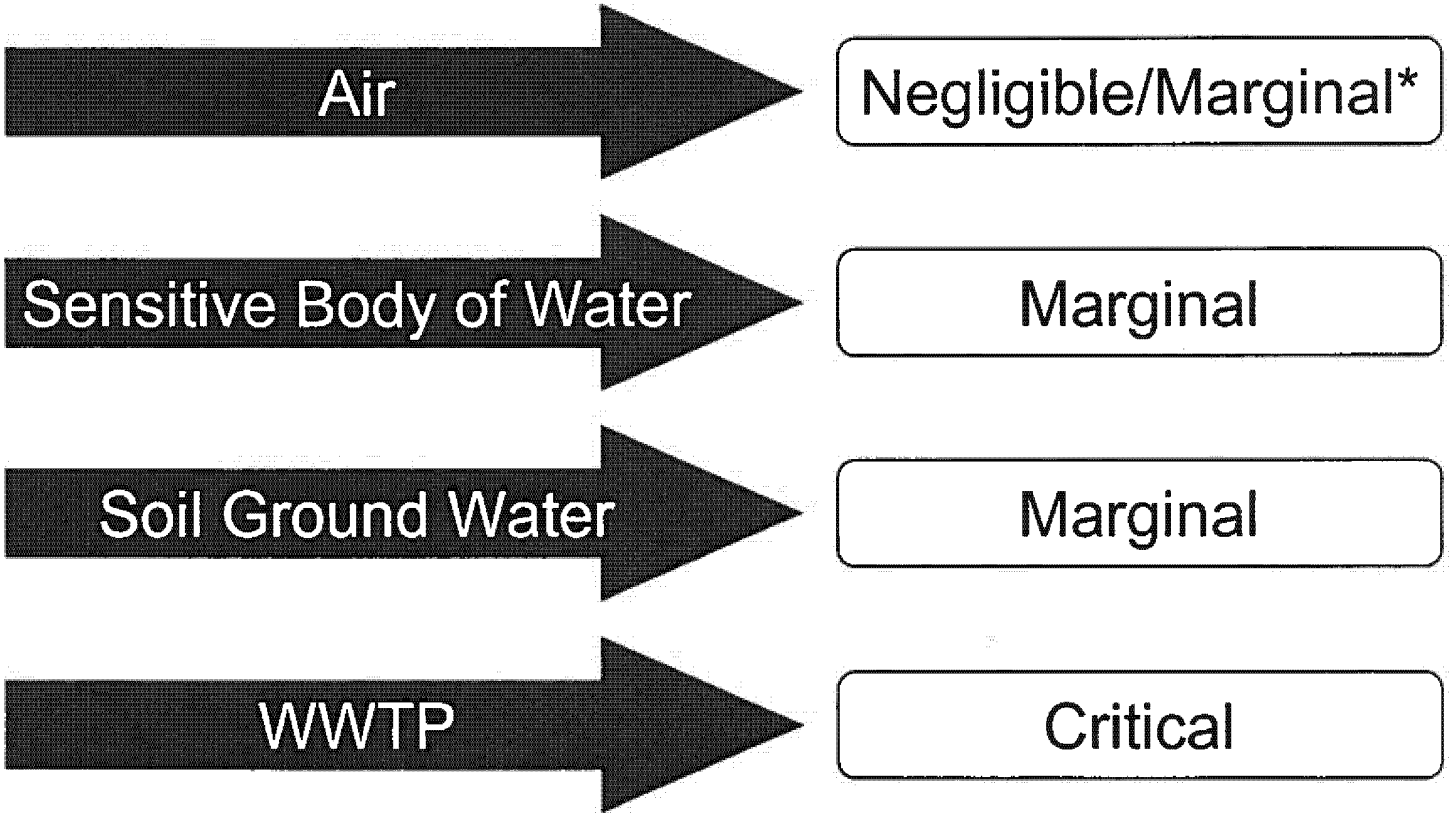
Probability Estimation



Accident Probability Estimation Of Environmental Consequence

	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP	E	C	E	C
2. Segregated Storm Sewer	E	C	E	E
3. Plugged, Storm Sewer	E	D	E	D
4. Pavement, Plugged Storm Sewer/drains	E	D	E	E
5. Pavement, Plugged Combined Sewer/drains	E	D	E	D
6. Pavement, Combined Sewer WWTP	E	C	E	C
7. Pavement, Storm Sewer	E	C	E	E
8. Unlined Pond, Percolates	E	E	E	E
9. Lined Pond, Pump Off-Site	E	E	E	E
10 Lined Pond, evaporate	E	E	E	E
11. Lined Pond, Meter WWTP	E	D	E	D
12. Lined Pond, Meter Storm Sewer	E	C	E	D
13. Lined Pond, Degrade WWTP	E	D	E	D
14. Lined Pond, Degrade Storm Sewer	E	D	E	D
15. Tank, Pump Off-Site	E	E	E	E
16. Tank, Meter WWTP	E	D	E	D
17. Tank Meter Storm Sewer	E	C	E	D
18. Tank, Degrade WWTP	E	D	E	D
19. Tank, Degrade Storm Sewer	E	D	E	D

Consequence Estimation
Severity of Environmental Impact



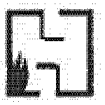
*Air becomes marginal if foam in WWTP

Risk Assessment and Acceptance

	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP	3E	3C	3E	2C
2. Segregated Storm Sewer	4E	3C	3E	2E
3. Plugged, Storm Sewer	4E	3D	3E	2D
4. Pavement, Plugged Storm Sewer/drains	4E	3D	3E	2E
5. Pavement, Plugged Combined Sewer/drains	4E	3D	3E	2D
6. Pavement, Combined Sewer WWTP	3E	3C	3E	2C
7. Pavement, Storm Sewer	4E	3C	3E	2E
8. Unlined Pond, Percolates	4E	3E	3E	2E
9. Lined Pond, Pump Off-Site	4E	3E	3E	2E
10 Lined Pond, evaporate	4E	3E	3E	2E
11. Lined Pond, Meter WWTP	3E	3D	3E	2D
12. Lined Pond, Meter Storm Sewer	4E	3C	3E	2D
13. Lined Pond, Degrade WWTP	3E	3D	3E	2D
14. Lined Pond, Degrade Storm Sewer	4E	3D	3E	2D
15. Tank, Pump Off-Site	4E	3E	3E	2E
16. Tank, Meter WWTP	3E	3D	3E	2D
17. Tank Meter Storm Sewer	4E	3C	3E	2D
18. Tank, Degrade WWTP	3E	3D	3E	2D
19. Tank, Degrade Storm Sewer	4E	3D	3E	2D

Summary

- Control and Management of AFFF Solutions
  - Based on Risk of Environmental Consequence
    - Risk Decision
    - Probability AND Severity
  - No "Unacceptable" Risks from Accidental Discharge
  - "Undesirable" Risks Avoidable through Design
  - Remaining Options All have Equivocal Residual Risk
- Basis for Design Criteria
  - Ensure Risk is "Acceptable w/ Review by Managing Activity" Category
  - Minimizes Risk to the Environment
  - Does Not Increase Risk to Life-Safety/ Fire Loss



APPENDIX (10)

Presentation: "Phasing Out a Problem: Perfluorooctyl Sulfonate"

M. Dominiak
Environmental Protection Agency

Phasing Out a Problem: Perfluorooctyl Sulfonate (PFOS)

Mary F. Dominiak
U.S. Environmental Protection Agency
Naval Research Laboratory
3 August 2000

What is PFOS?

- Perfluorooctyl sulfonates; *acids, salts, halides, etc.*
- Man-made: do not occur in nature
- Produced since 1950's for use in surface treatment, paper protection, and performance chemical (surfactant and insecticide) products
- Also produced by breakdown/degradation of other sulfonyl-based fluorochemicals
- Made mostly by 3M Company

What is PFOS used for?

- Soil and stain resistant coatings on textiles, carpets, leather (2.3 million lbs/year)
- Oil, grease, and water resistance on paper products, including paperboard and food contact papers (2.6 million lbs/year)
- Performance chemicals: fire fighting foams, industrial surfactants, acid mist suppression, etc. (1.5 million lbs/year)

Why is PFOS a problem?

- PFOS is a PBT chemical:

  Persistent

  Bioaccumulative

  Toxic

- PFOS has been found in the blood of the general US population, in wildlife, and in people overseas

Why is PFOS a problem?

- Persistent:
  - PFOS is a very stable chemical that does not break down or degrade in the environment; *once it's there, it stays*
- Bioaccumulative:
  - PFOS can build up over time; *its half-life in human blood is about 4 years*
  - Higher-ups in the food chain are exposed to the full dose of what has built up in their food

Why is PFOS a problem?

- Toxicity:
  - PFOS is only moderately toxic via acute oral exposure; *rat LD_{50} of 251 mg/kg*
  - In repeat oral dose subchronic and reproductive toxicity studies, however, serious effects seen
    - *Post-natal deaths in rats at 3.2 and 1.6 mg/kg/day*
    - *In repeat-dose treated Rhesus monkeys, death within 3 weeks at 10 mg/kg/day; within 7 weeks at 4.5 mg/kg/day. Adverse effects in cynomolgus monkeys at 0.75 mg/kg/day*

Why is PFOS a problem?

- Detected in blood not only in workers handling the chemical, but in the general US population and in wildlife
  - *High as 12.83 ppm in manufacturing workers*
  - *In pooled serum from general population, 30-40 ppb; small sample of children, mean 54 ppb*
  - *In eagles, wild birds, and fish, in ppb range*

How did PFOS get in people?

- We don't know the precise exposure route, but studies are underway
- Possibilities include:
  - Dietary intake from food wrapped in papers treated with PFOS derivatives
  - Inhalation from aerosol applications
  - Inhalation, dietary, or dermal exposures during manufacturing, use, or disposal of chemicals and treated products

Why haven't PFOS problems been addressed before?

- PFOS was always known to be persistent, but much information on bioaccumulation and toxicity is recent
  - Improved detection technologies find PFOS at much lower levels in humans, wildlife
  - PFOS doesn't fit normal bioaccumulation model; *partitions to blood, not fat*
  - Newest toxicity tests raise greatest concerns

How big a risk is PFOS?

- EPA does not believe that the current situation presents an imminent health risk to the general US population; *blood levels low, concentration in surface-treated products (carpets/textiles) low*
- However, serious concern for potential future risk to humans and wildlife if PFOS continues to be produced, released, built up in the environment
- Studies underway to determine relationship of current blood levels to potential for adverse effects
- Questions/concerns on occupational exposures

What is being done about PFOS?

- 3M conducted studies, shared results with EPA, and discussed concerns
- On 5/16/2000, 3M publicly announced voluntary phase-out of perfluorooctanyl chemistries, most by end of 2000
- 3M submitted phase-out plan to EPA on 6/16/2000, amended on 7/7/2000
- 3M continues aggressive research program

What does the 3M PFOS phaseout plan involve?

- 3M will stop manufacture of PFOS for surface treatment products by 12/31/2000; *includes fabric/carpet/leather soil and stain resistance and paper coating products, including food contact*
- 3M will phase out manufacture of PFOS for performance products by 12/31/2002
- *Caveat:* May request permission for extended production for specific performance uses for which adequate substitutes do not exist or can't be qualified in time; *risk/risk tradeoffs, national security, technical performance issues*

What does EPA think of 3M's PFOS phaseout plan?

- EPA agrees that continued manufacture and use of PFOS represents an unacceptable technology that should be eliminated to protect human health and the environment from long term consequences
- 3M's voluntary phaseout will accomplish this goal more quickly than regulation could
- EPA may use regulation to "close the door" on PFOS after 3M's exit; *concerned parties will be able to comment and to dialogue with EPA*

What does this mean for fire fighters using PFOS foams?

- Fire fighting foams are in the performance category of products; continue through 2002
- 3M and EPA will be assessing health, safety and environmental implications of possible substitutes; *will welcome dialogue!*
- If qualified substitutes not available by end of 2002, 3M may request continued PFOS production for specific uses

What about using chemicals other than PFOS?

- Initial actions and phaseout apply to PFOS chemicals only
- EPA will be expanding review to assess other perfluorinated chemicals and related chemistries; *PFOA, telomers*
- Assessment activities will be international
- Industry group already proposing voluntary two-year research effort on some major telomers to begin 9/2000
- Too early to anticipate outcomes

How will EPA make decisions on PFOS issues?

- Toxic Substances Control Act (TSCA)
- Risk/benefit balancing requirements allow flexibility; *TSCA lets EPA take risk/risk tradeoffs, economic issues into account*
- Possible actions include:
  - Bans
  - Restrictions on uses
  - Production volume limits
  - Data collection and new testing requirements
  - Labeling, hazard communication

Where can I find information on PFOS and EPA actions?

- All documents on PFOS in public EPA Administrative Record, File AR-226
  - Includes all health studies submitted on PFOS
  - Available in hard copy or on CD-ROM
  - 401 M St, SW, Room NE B-607, Wash., DC, noon to 4 PM Eastern, Monday-Friday; telephone 202-260-7099
- Working on website; *not up yet, stay tuned*
- Interim EPA "Voice of PFOS:" Mary Dominiak, phone 202-260-7768; *dominiak.mary@epa.gov*

APPENDIX (11)

Presentation: "Facilities Background and AFFF Issues"

J. Simone
Naval Facilities Engineering Command

Facilities Background
And
AFFF Issues

Presentation to Hangar Facilities Breakout Session
DOD AFFF Environmental Meeting
2 August 2000

Joe Simone
Naval Facilities Engineering Command

FACILITIES BACKROUND

- Facilities that use AFFF - Aircraft Hangars, HAZ/FLAM Buildings, Fire Fighters Test Facilities, Hush Houses, and others
- Variety of Fire Protection Criteria in the Last 10 Years
- Variety of Containment Requirements
- No Risk Analysis with respect to Environmental
- Budget Proposals Guess or Don't Address Funding

1

NAVAIR/NAVFAC HANGAR PROJECTS

- Evaluated Detector & Sprinkler Response Time in Hangars
- Evaluated Removing AFFF from Overhead Sprinkler Systems
  - Evaluated Using Lower AFFF Application Rate
- Evaluated New Low Level AFFF Distribution Systems
- Evaluated Variety of Optical Flame Detectors
- Developed New Fire Protection Criteria

2

DESIGN

PREVIOUS DESIGNS	CURRENT DESIGNS
• Deluge AFFF Sprinklers	• Closed Head, Water only Sprinklers
• High Volume AFFF System (20,000 sq.ft. => 5,000 gpm AFFF)	• Low Volume AFFF System (20,000 sq.ft. => 2,000 gpm AFFF & 3,000 gpm water)
• AFFF is used in the Ceiling and Low Level Systems	• AFFF is used in the Low Level System only
• Full Discharge Testing	• Test Ports for Discharge Testing
• May or May not have Drainage System	• Drainage
	• Detection Technology
	• Can Include Abort Switches

3

AFFF MANAGEMENT ISSUES

- Environmental Hazard is Not Quantified
  - Toxicity?, Air?, Water?
- No Uniform Criteria for AFFF Management (site specific)
- Current Containment Requirements are Based on Worst Case
- Cost of Containment Exceeds Project Funding
- Exceeding Project Funding Results in Removal of Fire Protection Systems from Hangars - Impaired Mission

4

CONTAINMENT ISSUES

If Containment is Required:

- Manual Intervention or Fixed Containment?
- How Do You Size Containment (10 minutes of AFFF supply)?
- Disposal - Is it necessary?

5

APPENDIX (12)

Presentation: "AFFF Risk Assessment"

A. Wakelin
Hughes Associates, Inc.
Baltimore MD

Aqueous Film Forming Foam (AFFF) Risk Assessment

For discharges of AFFF from fixed fire protection systems in shore facilities

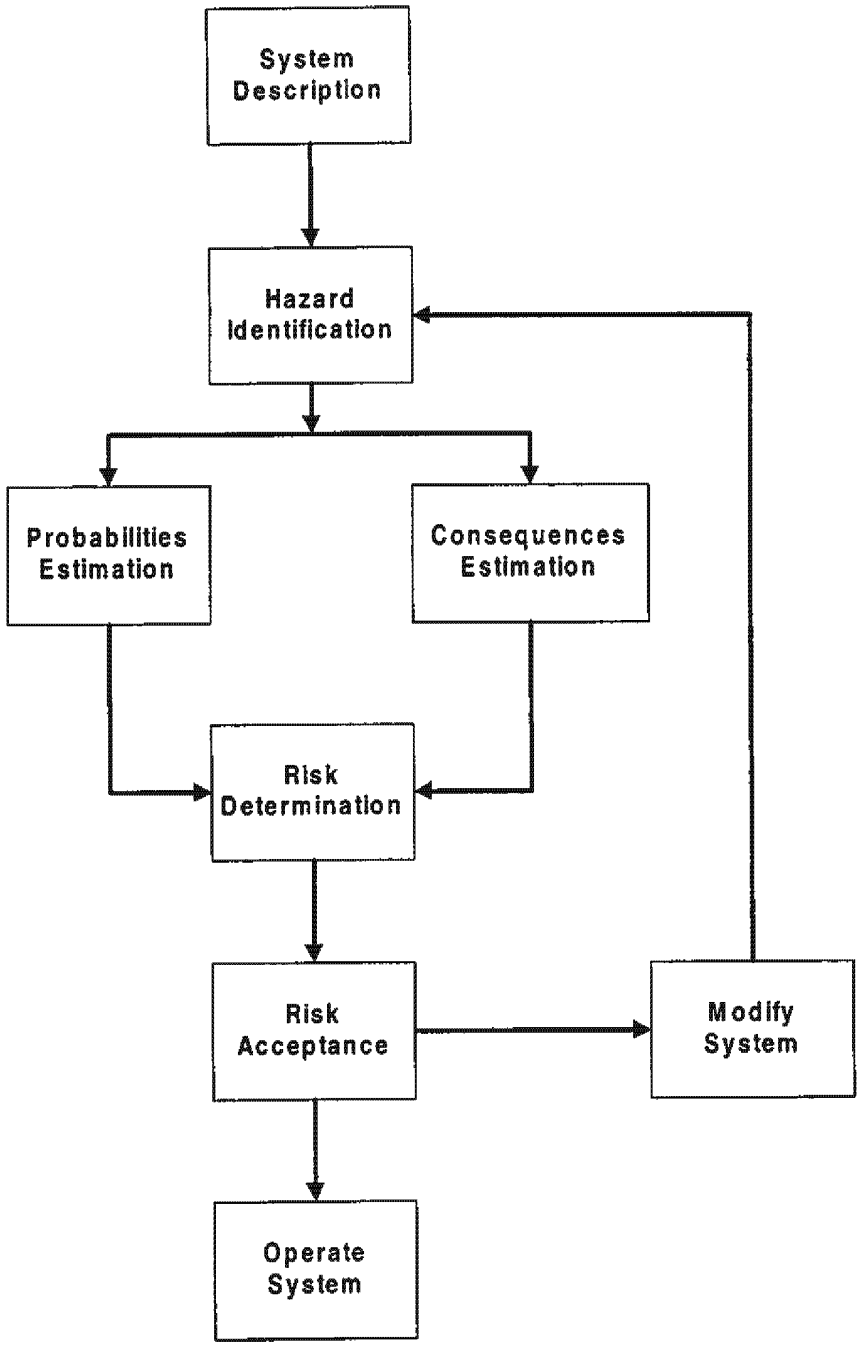
Alison Wakelin

HUGHES ASSOCIATES, INC.
FIRE SCIENCE & ENGINEERING

August 2, 2000

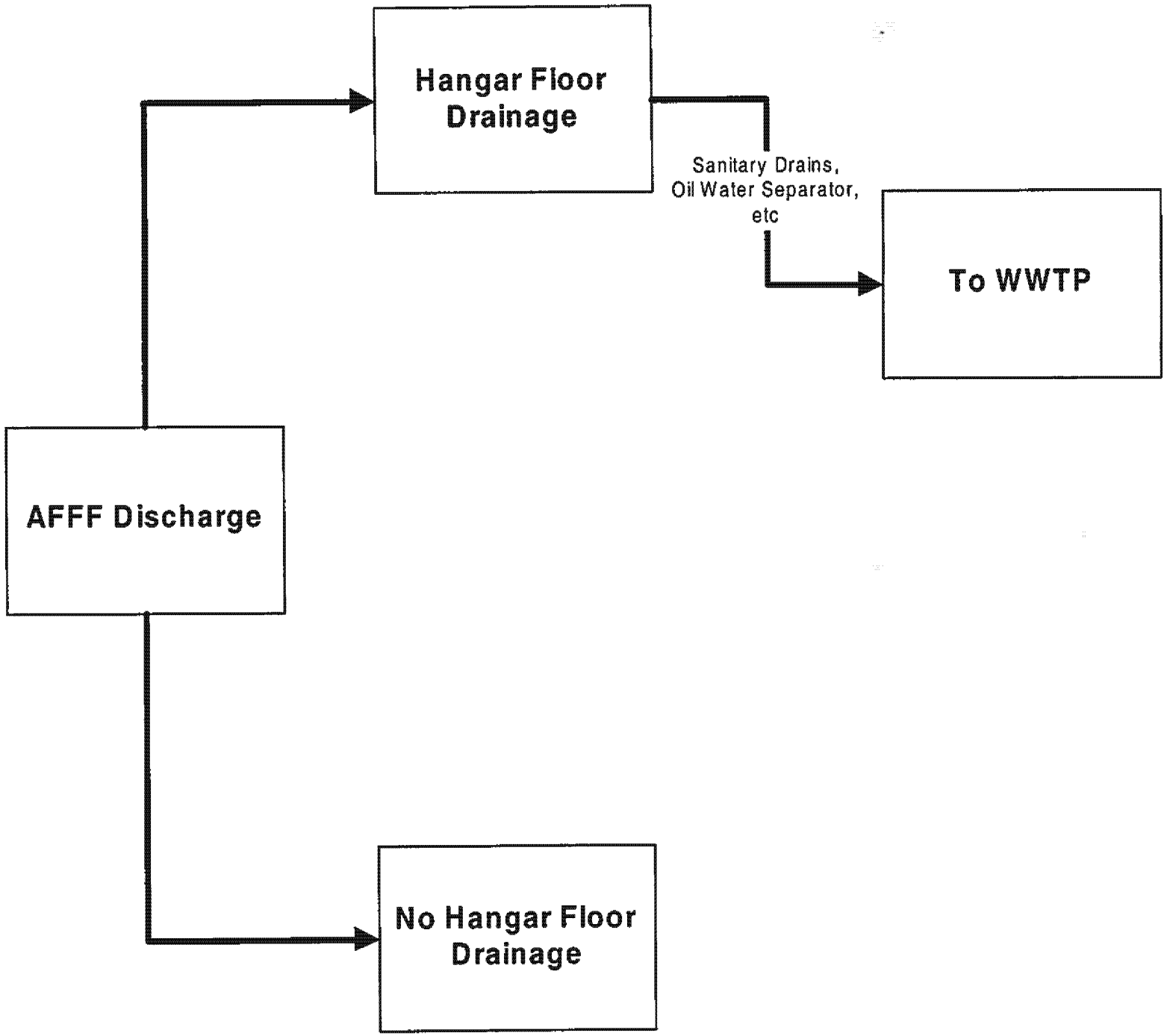
Overview

- Develop physical control options
  - Performance Criteria
- Probability Estimation
- Consequence Estimation
- Risk Assessment

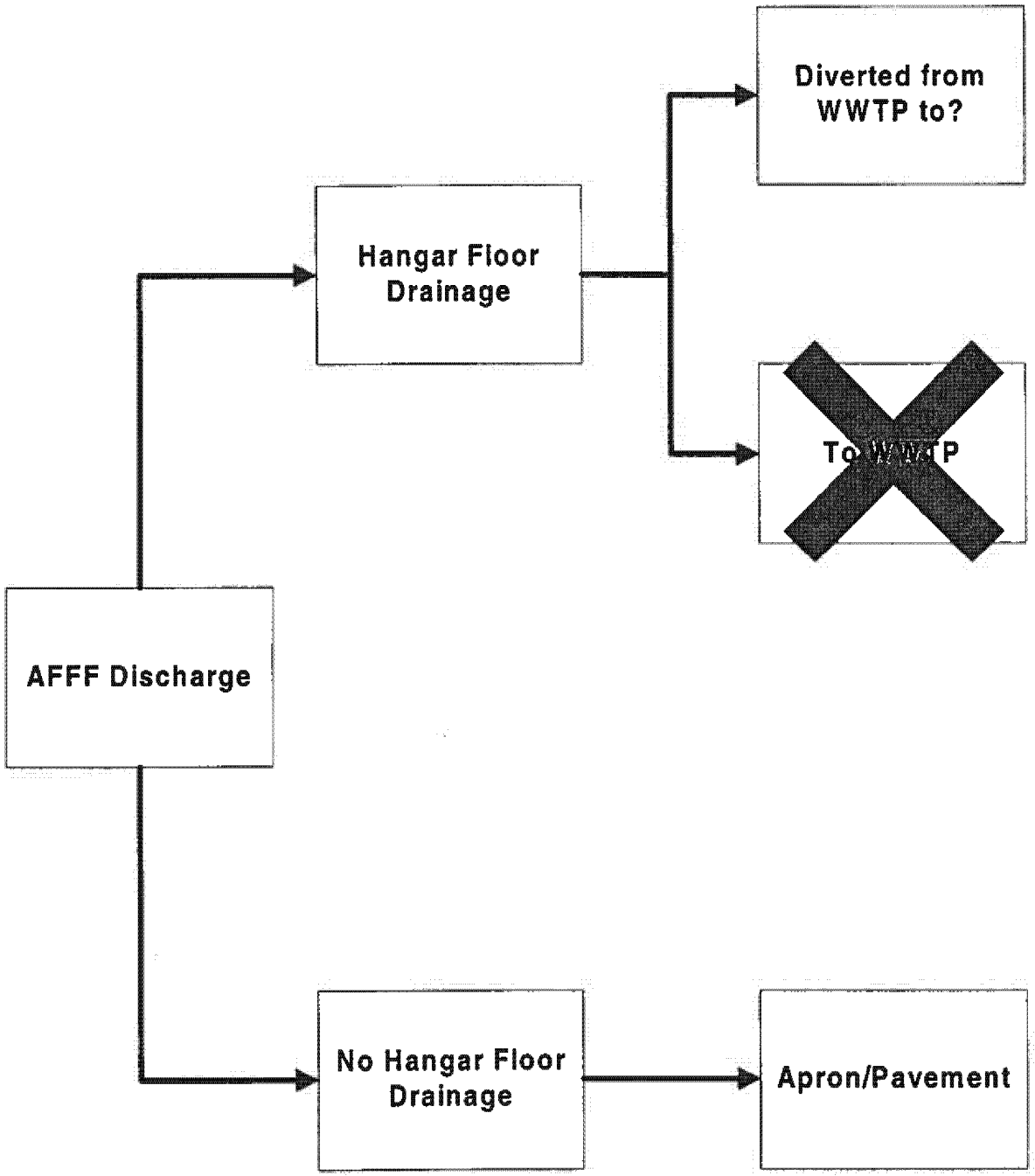

System Description
Hazard Identification
Probabilities Estimation
Consequences Estimation
Risk Determination
Risk Acceptance
Modify System
Operate System

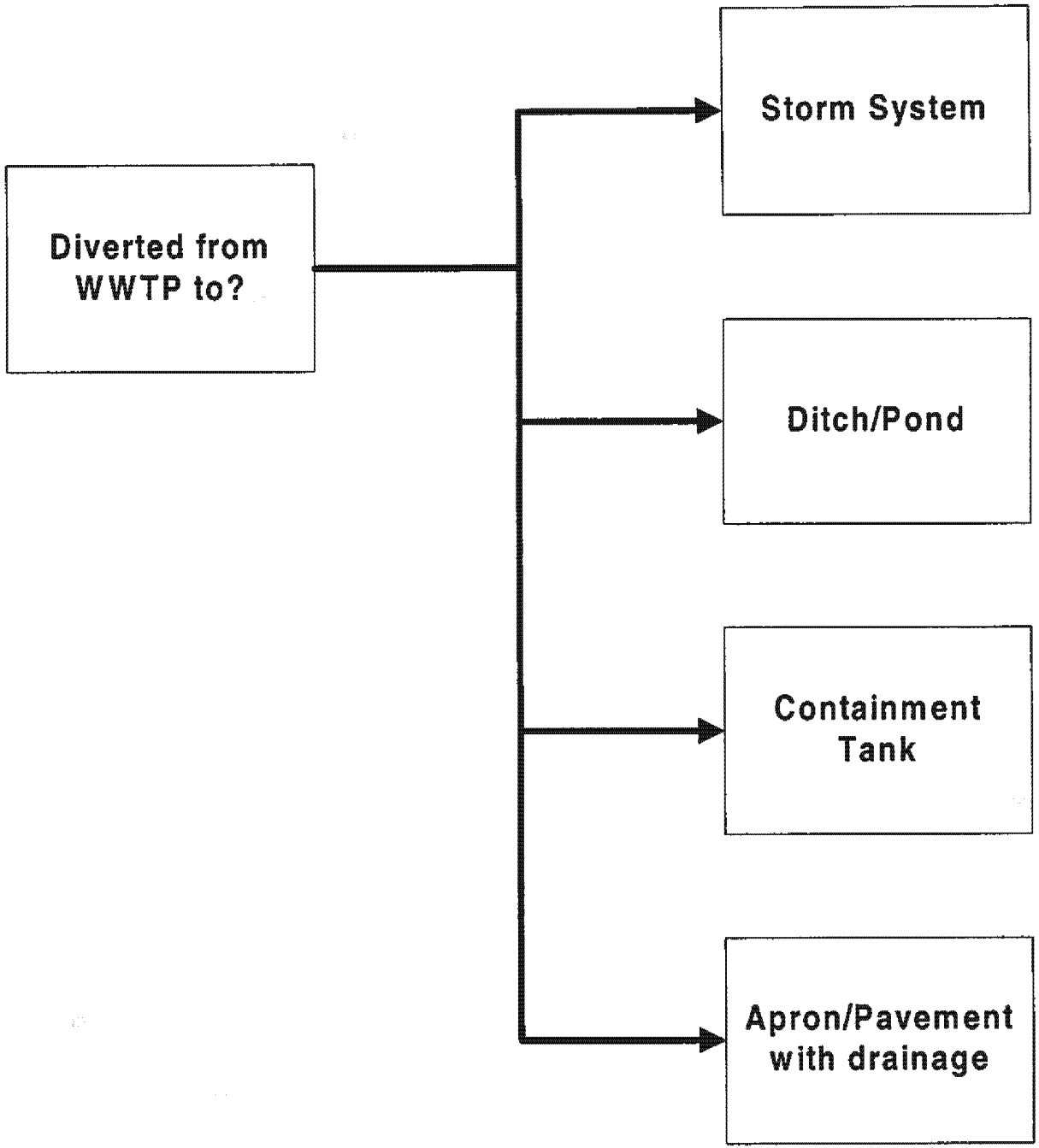
Develop Physical Control Options

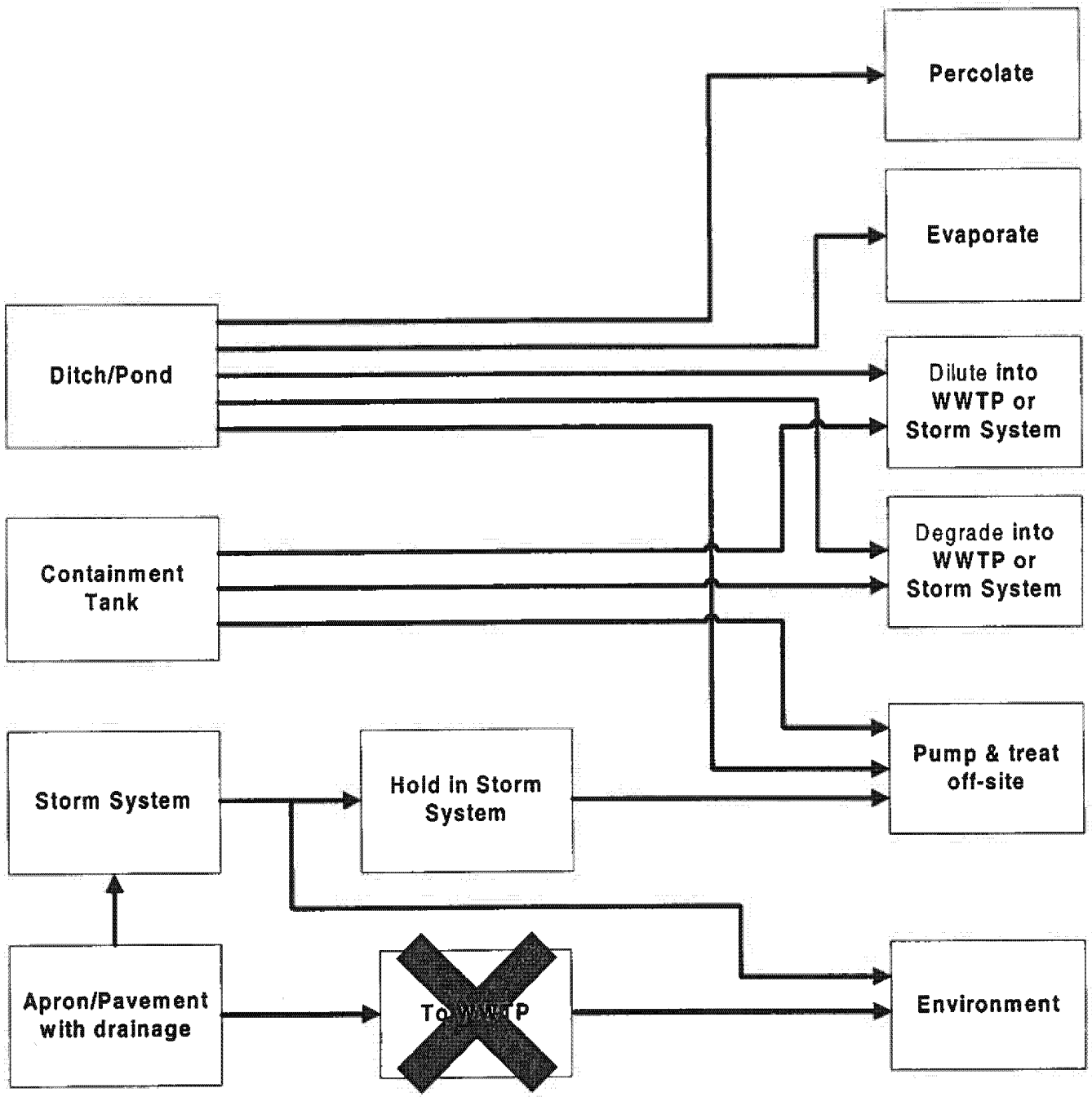
- Hangar drainage requirements (NFPA 409)
- Foam to the WWTP?
- Other options for maintaining positive control of foam


Hangar Floor Drainage
Sanitary Drains, Oil Water Separator, etc
To WWTP
AFFF Discharge
No Hangar Floor Drainage

US00000727


Diverted from WWTP to?
Hangar Floor Drainage
To WWTP
AFFF Discharge
No Hangar Floor Drainage
Apron/Pavement


Diverted from WWTP to?
Storm System
Ditch/Pond
Containment Tank
Apron/Pavement with drainage


Percolate
Evaporate
Ditch/Pond
Dilute into WWTP or Storm System
Containment Tank
Degrade into WWTP or Storm System
Pump & treat off-site
Storm System
Hold in Storm System
Apron/Pavement with drainage
To WWTP
Environment

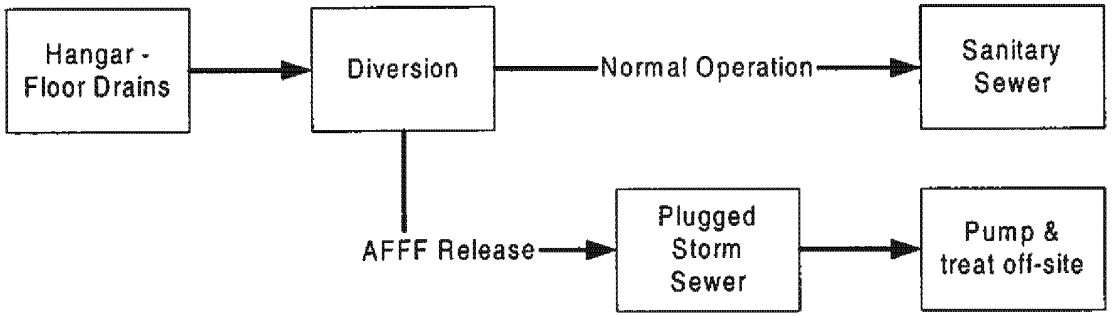
Physical Control Options

- 19 different control options
- Sufficient number to show range of risks
- Three options will be presented
  - data from all available on request

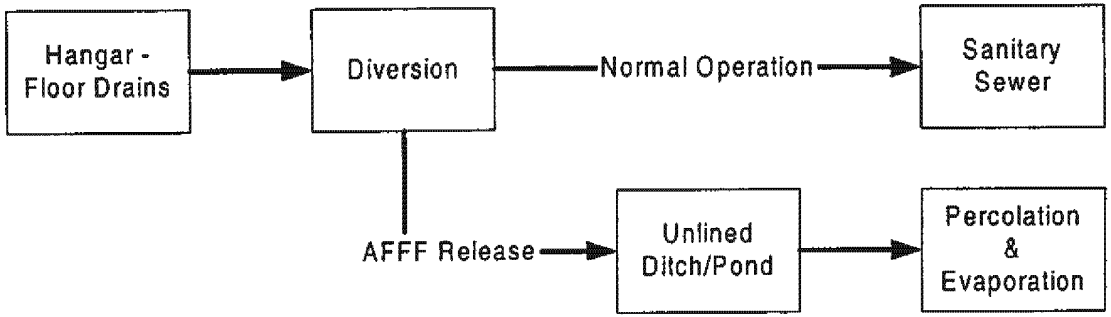
Example Physical Control Options

1. Sanitary sewer with direct access to WWTP

2. Plugged, totally segregated storm sewer



3. Pond, Percolate (drains into soil)



Performance Criteria

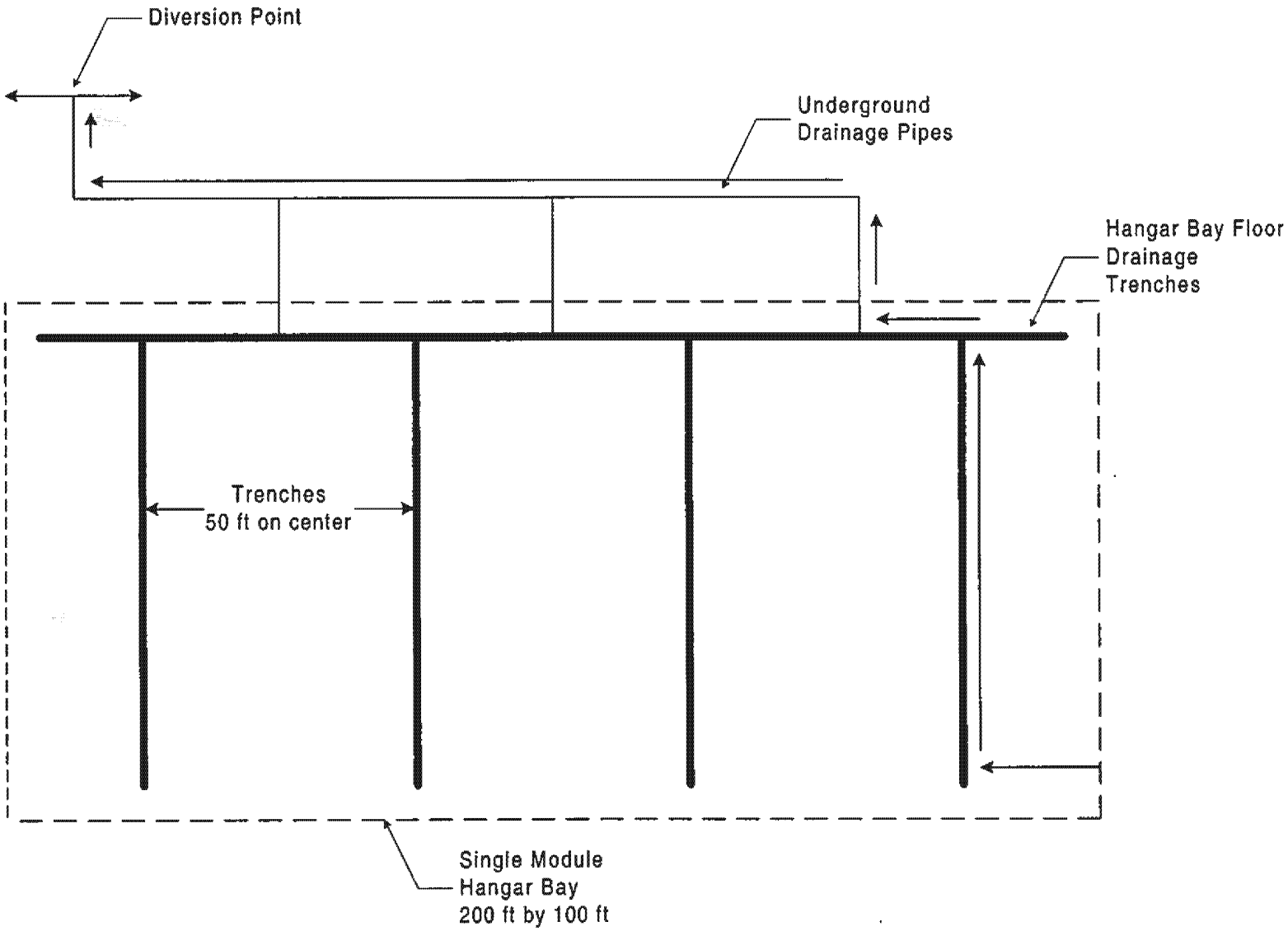
- Detailed investigation of control options
- What are performance goals of control options?
  - How much of a discharge needs to be controlled?
- Accidental discharge shut-off in 3 mins?
- Accidental discharge of all foam?

Proposed Foam Control Criteria

- Conservative approach all foam has drained to beyond diversion point
- No emergency shut-off
- 6 min drainage time
- Single "module" hangar 100 ft by 200 ft
- Total flow
  - 16 min @ 2000 gpm = 32,000 gal

Proposed Foam Control Criteria

Drainage



Probability Estimation

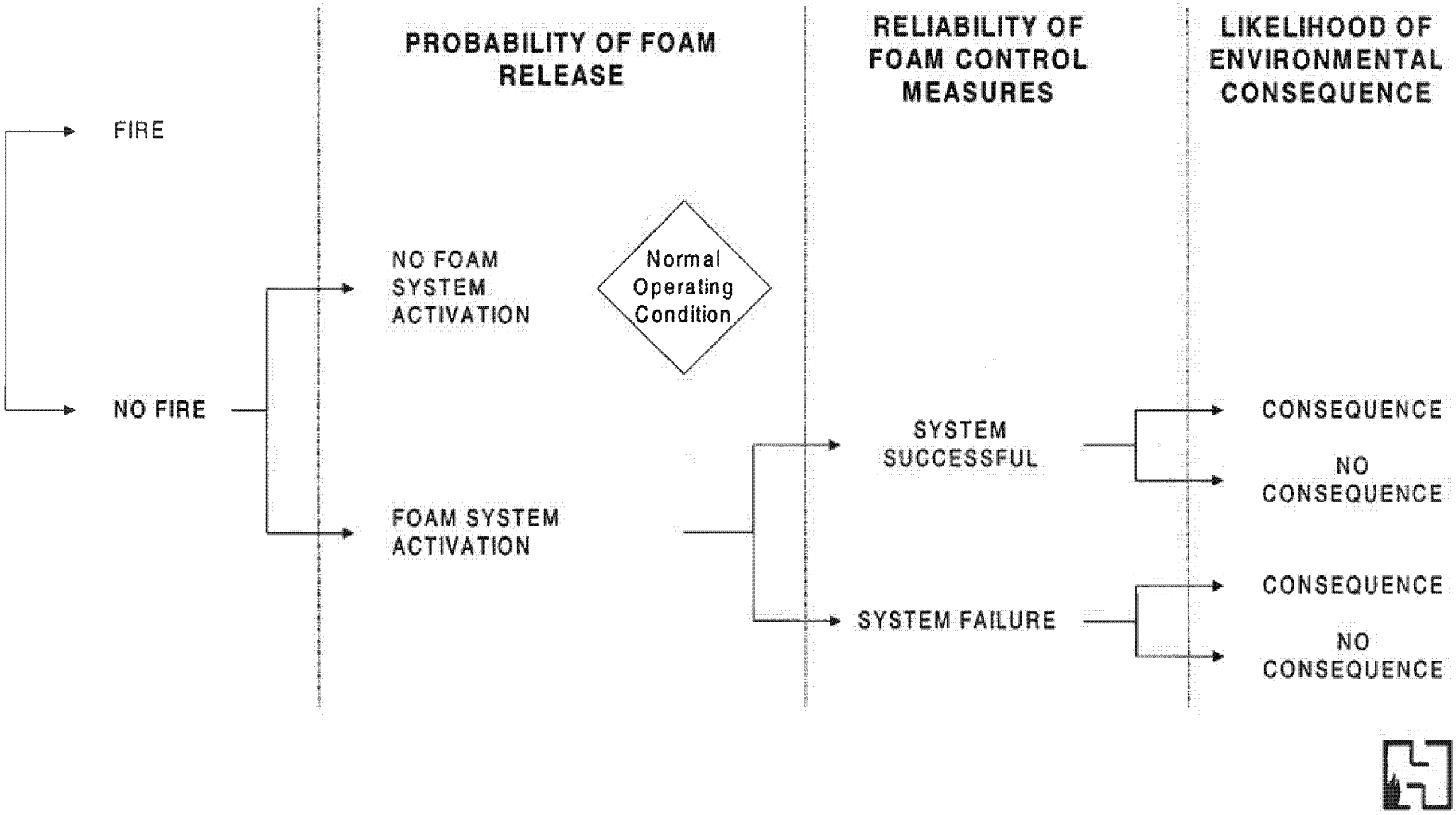
3 Parts to Probability Estimation

Probability of foam release

Reliability of system controlling foam movement

Likelihood of environmental consequence

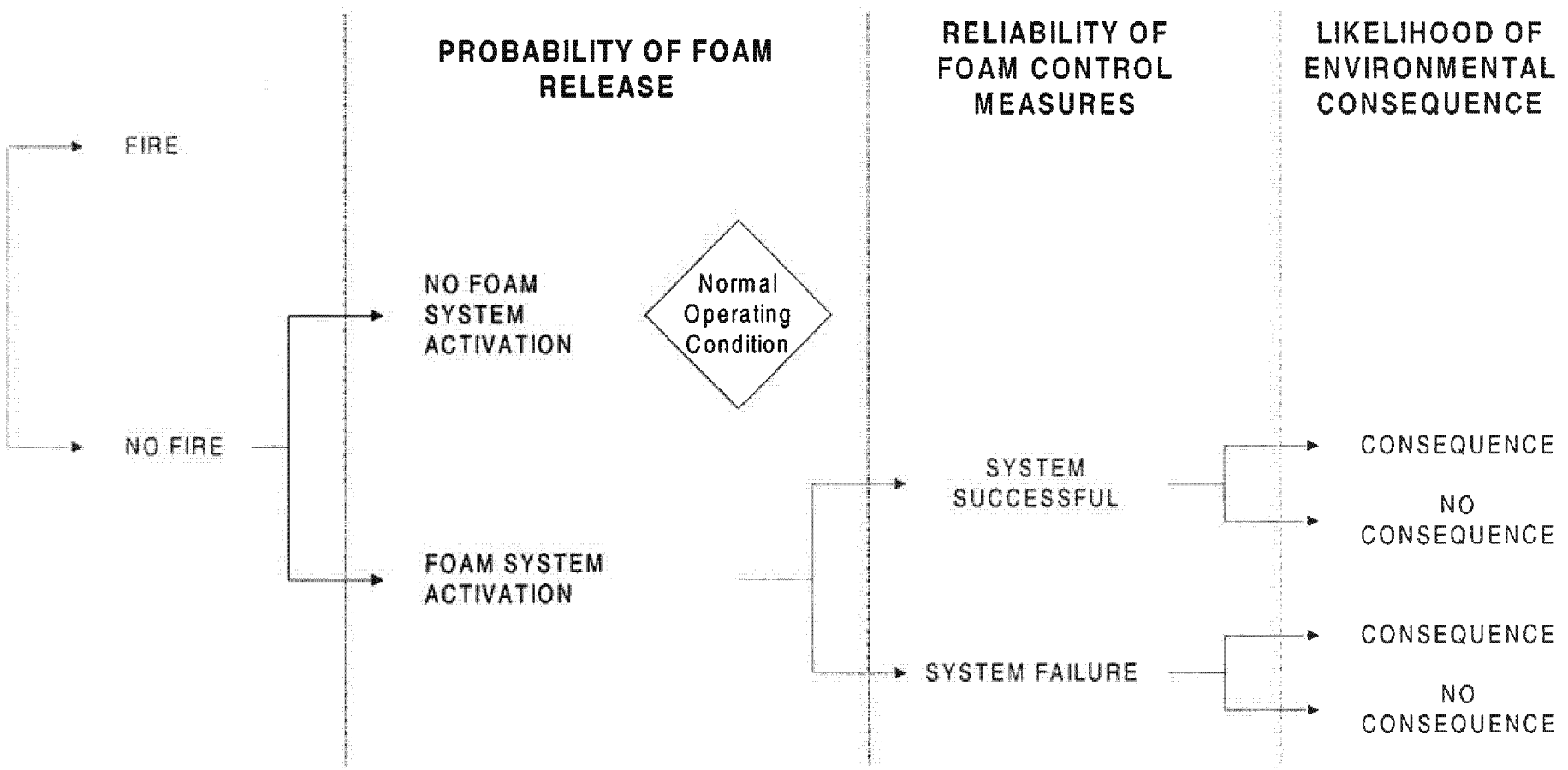
Probability Estimation



Probability Estimation

A	FREQUENT	Likely to occur frequently
B	PROBABLE	Will occur several times in the life of an item
C	OCCASIONAL	Likely to occur some time in the life of an item
D	REMOTE	Unlikely but possible to occur in the life of an item
E	IMPROBABLE	So unlikely, it can be assumed occurrence may not be experienced

Probability Estimation
Foam System Activation



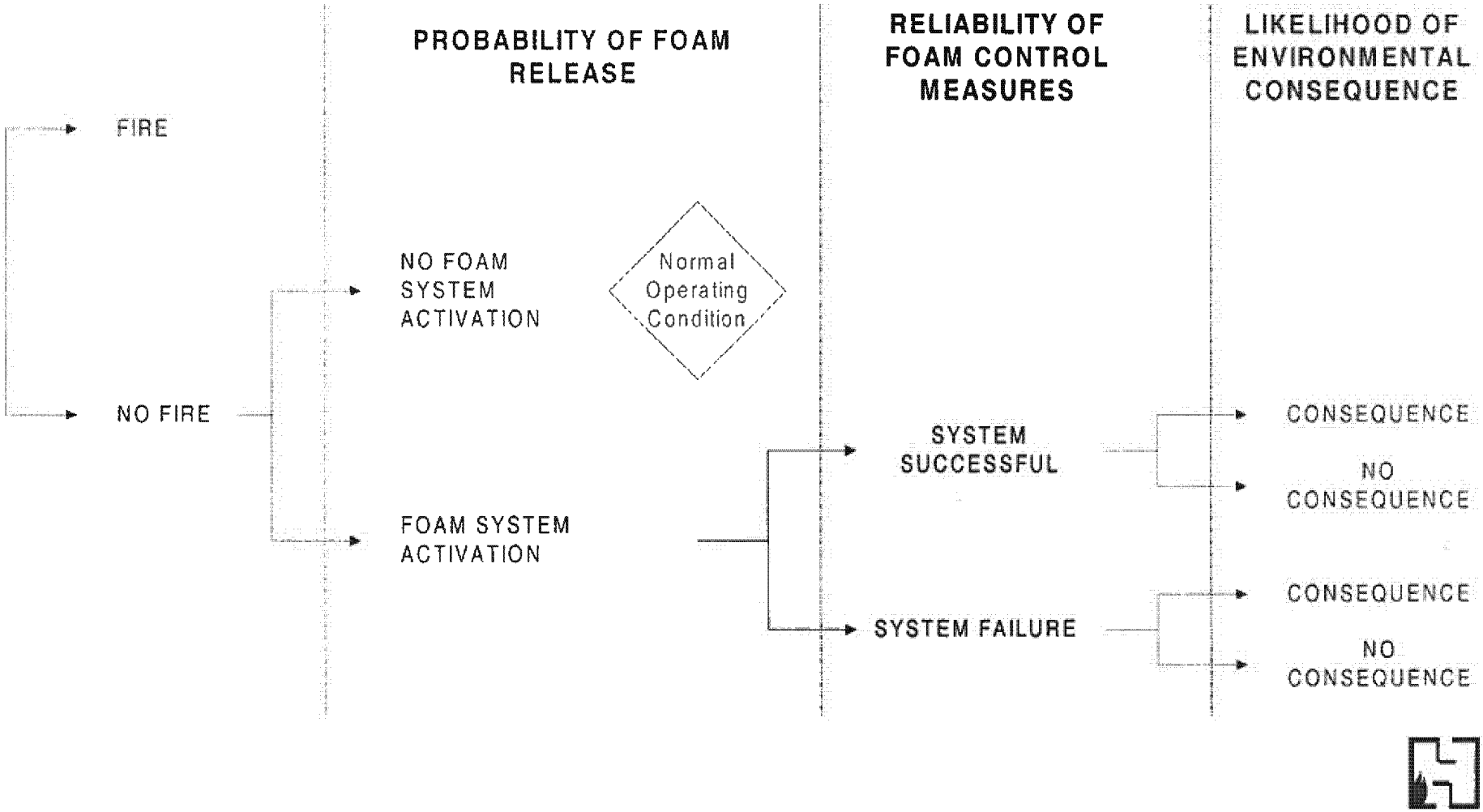
US00000739

Probability Estimation
Foam System Activation

- Accidental activation of a low level foam system
- Likely to occur some time in the life of an item

$\Rightarrow$ Occasional C

Probability Estimation
Foam Control Measures



Probability Estimation
Foam Control Measures

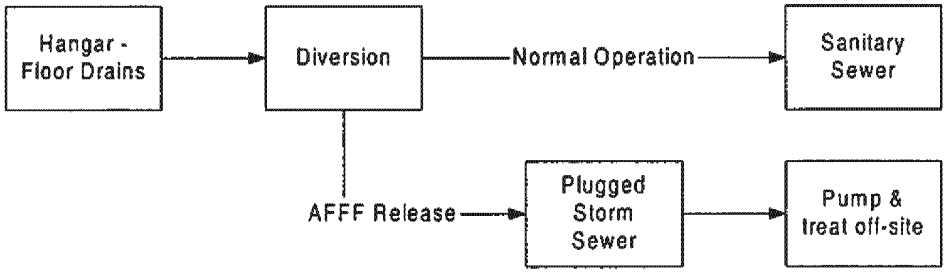
- An engineered design of each control measure is evaluated for:
  - Reliability
    - Likelihood of Control System Failure is Established
    - Failure based on complexity of system

Probability Estimation
Likelihood of system failure

1. Sanitary sewer with direct access to WWTP

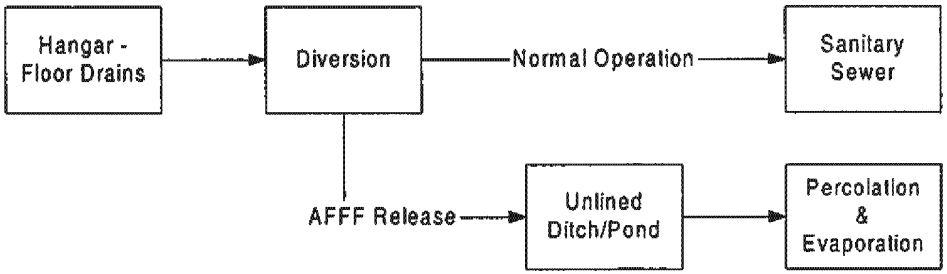
Improbable E

2. Plugged, totally segregated storm sewer



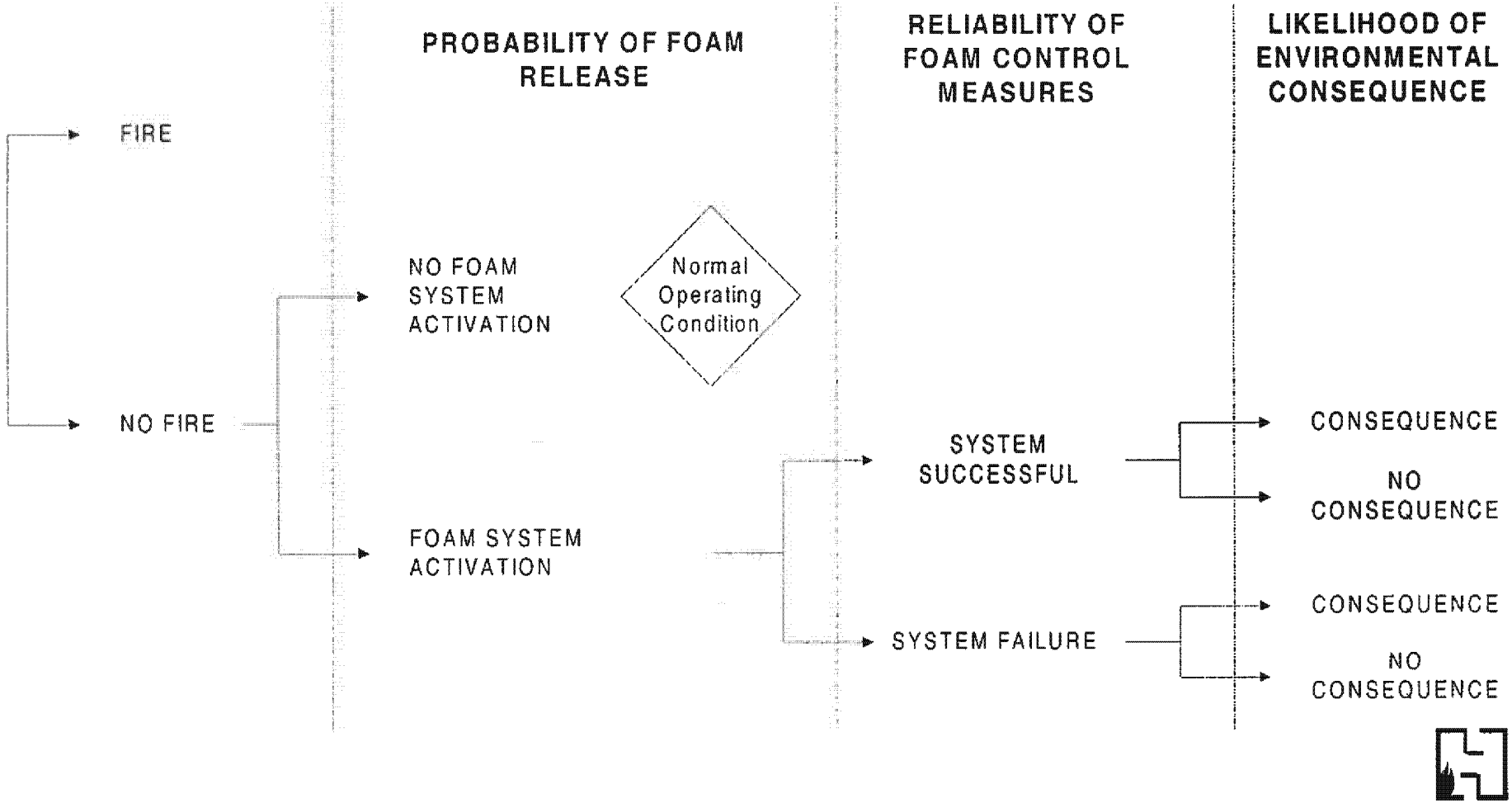
Probable B

3. Pond, Percolate (drains into soil)



Occasional C

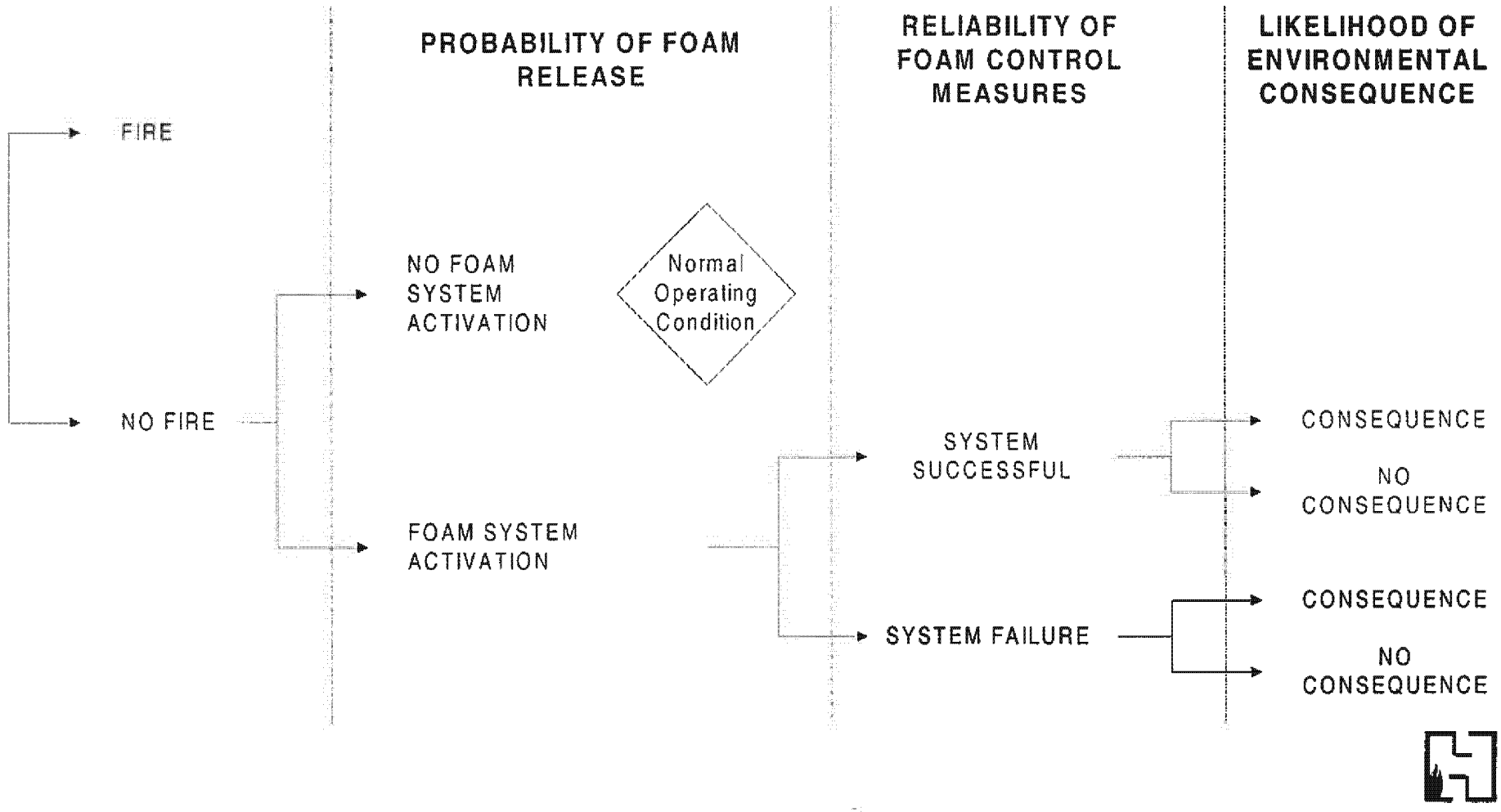
Probability Estimation
Environmental Consequence



Probability Estimation
Environmental Consequence

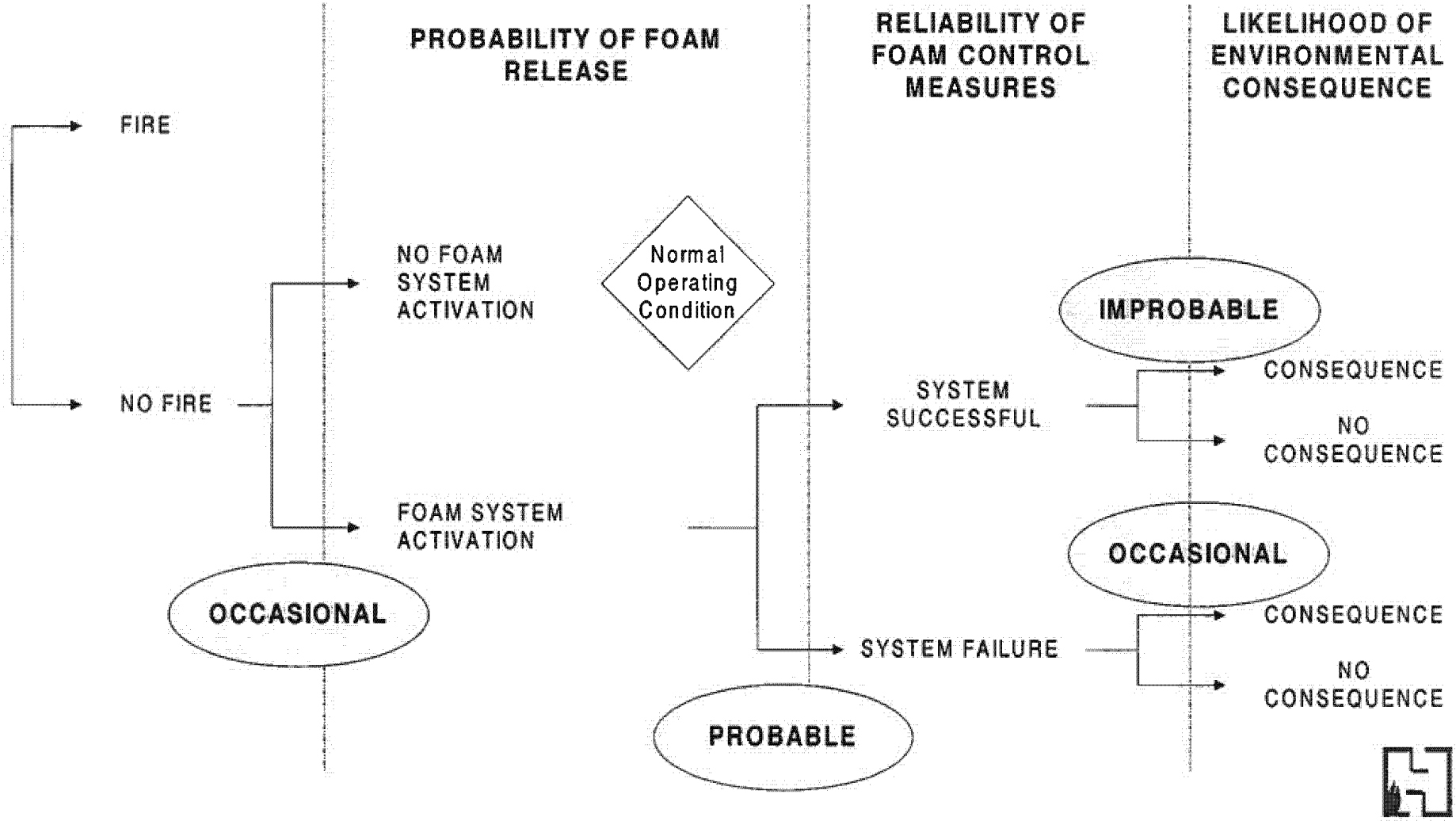
Successful Foam Control (Risk By Media)				
	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP	Remote	Frequent	Improbable	Frequent
2. Plugged, Storm Sewer	Remote	Improbable	Improbable	Improbable
3. Unlined Pond, Percolates	Remote	Remote	Remote	Improbable
Unsuccessful Foam Control (Risk By Media)				
	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP	Remote	Frequent	Remote	Frequent
2. Plugged, Storm Sewer	Remote	Occasional	Remote	Occasional
3. Unlined Pond, Percolates	Remote	Occasional	Occasional	Occasional

Probability Estimation
Environmental Consequence



Probability Estimation
Environmental Consequences

Option 2: Plugged storm sewer Sensitive body of water



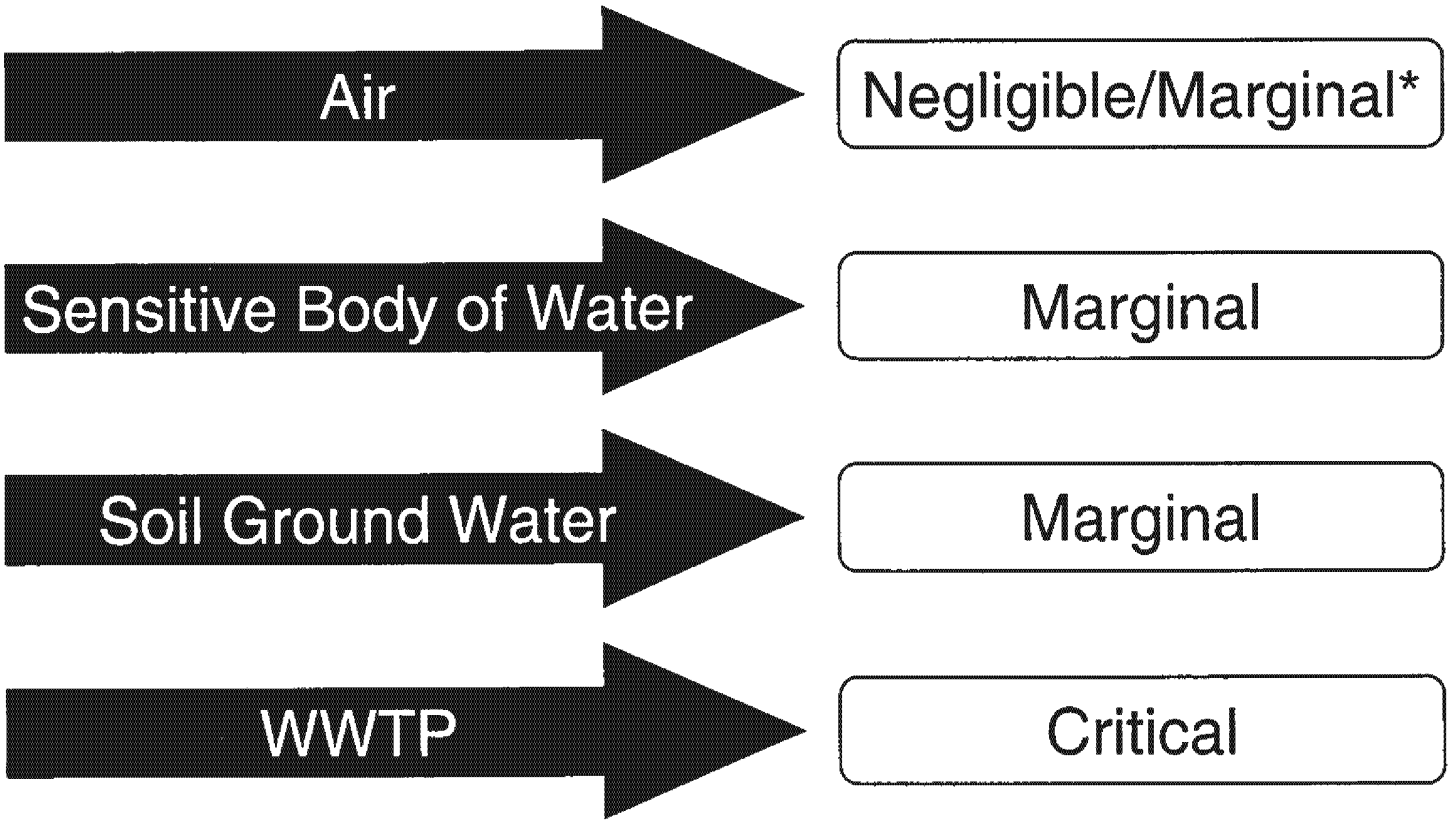
Probability Estimation

Frequency Estimation		Suggested Range
A	FREQUENT	$X > 10^{-1}$
B	PROBABLE	$10^{-1} > X > 10^{-2}$
C	OCCASIONAL	$10^{-2} > X > 10^{-3}$
D	REMOTE	$10^{-3} > X > 10^{-6}$
E	IMPROBABLE	$10^{-6} > X$

Probability Estimation
Environmental Consequence

	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP	E	C	E	C
2. Plugged, Storm Sewer	E	D	E	D
3. Unlined Pond, Percolates	E	E	E	E

Consequence Estimation
Severity of Environmental Impact



*Air becomes marginal if foam in WWTP

Risk Assessment & Acceptance

CATEGORY / FREQUENCY	1 CATASTROPHIC	2 CRITICAL	3 MARGINAL	4 NEGLIGIBLE
A – FREQUENT	1A	2A	3A	
B – PROBABLE	1B	2B	3B	
C – OCCASIONAL	1C	2C	3C	4C
D – REMOTE	1D	2D		4D
E - IMPROBABLE				4E

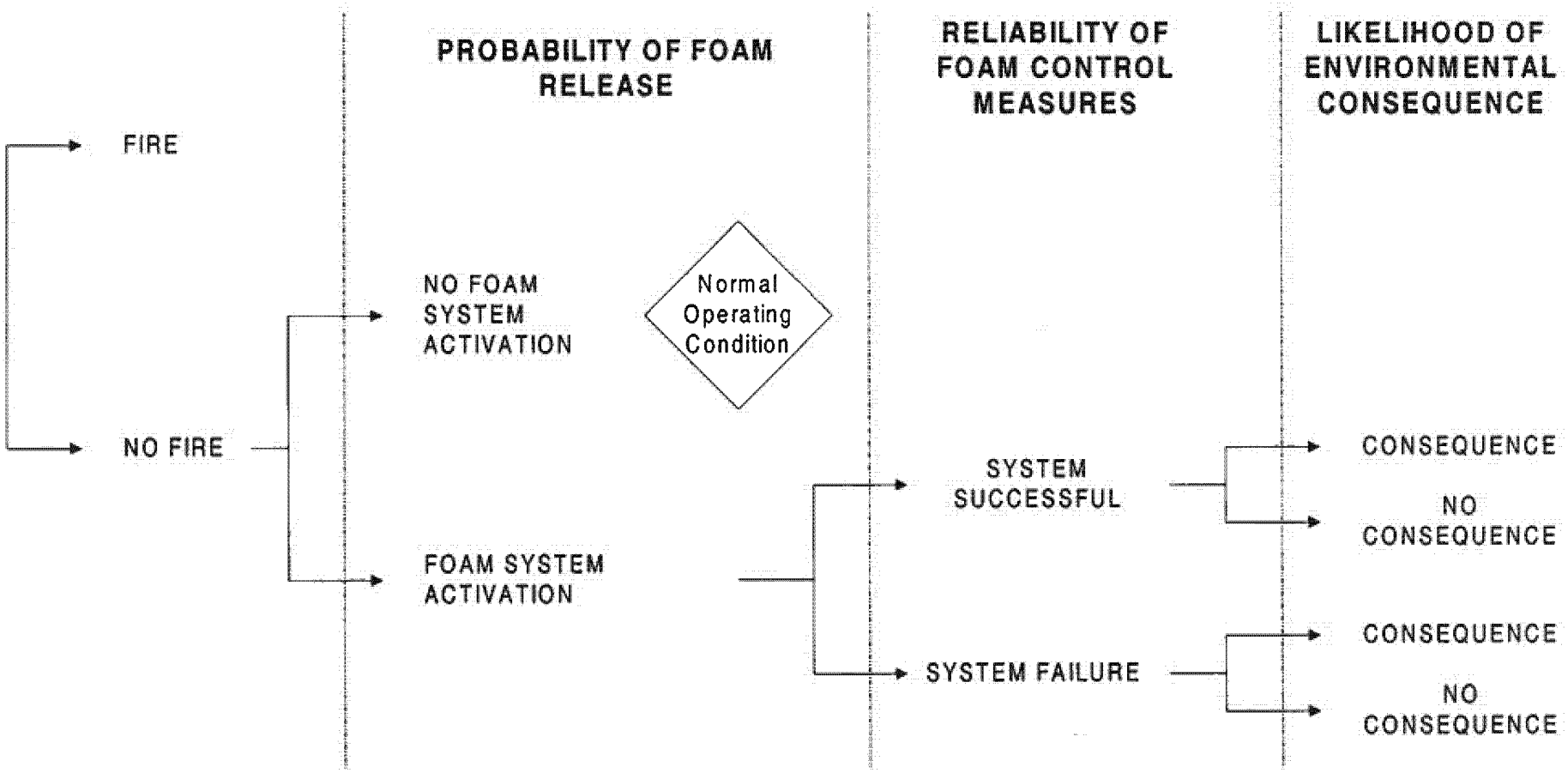
UNACCEPTABLE:	1A, 1B, 1C, 2A, 2B, 3A
UNDESIRABLE:	1D, 2C, 2D, 3B, 3C
ACCEPTABLE WITH REVIEW:	
ACCEPTABLE WITHOUT REVIEW:	4C, 4D, 4E

Risk Assessment
Environmental Consequence

	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP		3C		2C
2. Plugged, Storm Sewer	4E			2D
3. Unlined Pond, Percolates	4E			

Probability Estimation

Foam System Activation



Probability Estimation
Foam System Testing

- Should foam control systems be used for testing?
- Foam system activation becomes probable
- Reliability improved as testing supervised

Risk Assessment
Environmental Consequence

For Foam Testing				
	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP		3B		2B
2. Plugged, Storm Sewer	4D			2D
3. Unlined Pond, Percolates	4D			
For Accidental Release				
	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP		3C		2C
2. Plugged, Storm Sewer	4E			2D
3. Unlined Pond, Percolates	4E			

Risk Assessment
Environmental Consequence

	AIR	Sensitive Body of Water	Soil Ground Water	Wastewater Treatment Plant
1. Sanitary sewer, WWTP		3C		2C
2. Segregated Storm Sewer	4E	3C		
3. Plugged, Storm Sewer	4E			2D
4. Pavement, Plugged Storm Sewer/drains	4E			
5. Pavement, Plugged Combined Sewer/drains	4E			2D
6. Pavement, Combined Sewer WWTP		3C		2C
7. Pavement, Storm Sewer	4E	3C		
8. Unlined Pond, Percolates	4E			
9. Lined Pond, Pump Off-Site	4E			
10 Lined Pond, evaporate	4E			
11. Lined Pond, Meter WWTP				2D
12. Lined Pond, Meter Storm Sewer	4E	3C		2D
13. Lined Pond, Degrade WWTP				2D
14. Lined Pond, Degrade Storm Sewer	4E			2D
15. Tank, Pump Off-Site	4E			
16. Tank, Meter WWTP				2D
17. Tank Meter Storm Sewer	4E	3C		2D
18. Tank, Degrade WWTP				2D
19. Tank, Degrade Storm Sewer	4E			2D

Costs

- Single module, 16 minutes of foam discharge
- Costs options we have identified are in the $0–200K range
- More stringent control criteria can lead to much greater costs
- However risk of an environmental consequence is not reduced

APPENDIX (13)

Presentation: "Summary of Shore Facility AFFF Management Breakout Session"

D. Verdonik
Hughes Associates, Inc.
Baltimore MD

Summary of Shore Facility AFFF Management Break-Out Session

Dan Verdonik

3 August 2000

Facility AFFF Management Working Group

- Decision to 'formalize' a Working Group
  - Develop Facility Policy for AFFF Management
    - Changed name from "Hangar" to "Facility" to reflect broader scope
    - Target for Completion: Approximately 6 months
  - Develop a draft DoDI
    - Staff Through Environmental Side of Services
    - Present to OSD
  - Next Meeting Scheduled for October 12
- Accepted-in-Principle the Risk Based Approach
  - Use as the Basis for the Policy
  - Need to Review Details and Back-up Information
  - Report will be Provided Prior to Next Meeting

Facility AFFF Management Working Group - Membership

Service	Office	Name
Navy	HQ NAVFAC	Joe Gott
Navy	HQ NAVFAC	Joe Simone
Navy	NAVFAC	Vincent Donnally
Navy	CNO N457C	Ms. Kathy Ellis
Navy	NAVAIR	Larry Wolf
Navy	HQ NAVFAC (Contractor Representative)	Kim DePaul Dawn Roderique
Army	USACE	Bob DiAngelo
Army	USACE	K.C. Kochhar
Army	ACSIM F&H	Bruce Park
Army	USACE/ACE	Billy Ray Scott
USAF	AFCESA	Fred Walker
USAF	HQ USAF ILEV	Jayant Shah
USMC	HQUSMC DCS/I&LFL	Michael Doherty
USMC	HQUSMC DCS/I&LFF	Kevin King

- Additional Members To Be Identified Prior to Next Meeting

APPENDIX (14)

Presentation: Summary of AFFF Environmental Breakout Session"

J. Hoover
Naval Air Warfare Center
China Lake CA

R. Darwin
Hughes Associates, Inc.
Baltimore MD

Summary
Of
AFFF Environmental Impact
Breakout Session

Naval Research Laboratory
3 August 2000

Dr. Jim Hoover
Head, Combustion Research Branch
NAWCWD China Lake

Robert Darwin
Senior Engineer
Hughes Associates, Inc.

Purpose of Breakout Session

Share Information on AFFF

History, performance, chemical composition

Environmental and human health impacts

Regulations – current and future

Replacement activity and status

Future management strategy

(1) What current and future environmental regulations impact AFFF and why (data and policies)?

Current:

Different regulations affect different components of AFFF

Presentation by Bill Ruppert yesterday provided good summary

Except for UNDS, there are no definitive restrictions at present and no identified directives for change

Future:

Depends on future EPA assessment of AFFF as data is reviewed

(2) What data do we have (or lack) on the environmental impact of AFFF?

Lacking:

Component toxicity/BOD/Persistence (Fate)/Bio-accumulation

Accurate and appropriate dilution factors when AFFF discharged in open bodies of water

Predictive capability/data regarding releases for estimating potential environmental damage. Must consider where the release occurs (shore hangars, runways, unpaved ground, ship bilges, at sea, etc)

(3) What technology or products exist that could help reduce AFFF releases into our environment or mitigate the impact of those releases?

Depends on the type and location of the release

Reducing releases:

- Reduction in system tests, efficiency improvements
- Spill response/advance planning/preparedness

Mitigation:

- ASH (Air-sparged hydrocyclone)
- RO (Reverse osmosis)
- Biological/microbial systems

Education and Planning:

- DOD guidance/standards on prevention, clean-up and disposal, training, intentional discharges

(4) What technology or products could be applied to recycle or reuse AFFF?

Not considered to be feasible or cost effective (reformulation, losses, contamination)

(5) What alternatives to AFFF currently exist and how do they compare in effectiveness, cost, environmental impact, availability, etc ?

None meet performance specification (mil spec)

Development of an AFFF alternative was proposed as project under ONR Future Naval Capability Platform Protection Program

Potential SERDP statement of need

Some UK effort on environmentally friendly foam

(6) What related planning documents exist with other services or agencies?

UK is reportedly working on a standard definition of "biodegradability"

EPA presentation mentioned international dialog on AFFF PFOS issue

USAF needs included in draft NAVAIR ESH-Needs Assessment

(7) What follow-on strategies should be considered ?

Need accurate quantitative definition of the problem

- DOD inventory status
  - How much AFFF in DOD/where used/in-service and reserve stocks/concentrate types
- DOD AFFF discharges
  - How much released/consumed annually (training, system testing and maintenance, accidental discharges, research, fires)
- Review current DOD regs and policy

Need a definition of "environmentally friendly" (need "green" definition—what are acceptable thresholds from an environmental standpoint)

- Biodegradability
- BOD/COD
- Toxicity
- Persistence
- Bio-accumulation

Follow-On Strategies (con't)

Need for future research
- SBIR
- Goals for Universities
- ONR

Need to develop small scale screening tests

Develop "SNAP-equivalent" guidance

Need for "worst case" transition plan (short/mid/long term)

Information distribution to all levels (users, requirers, trainers, regulators, etc)

Develop AFFF detection capability (learn method used by 3M)

Define hazard protocols and appropriateness of AFFF (use and response)

Follow-On strategies (con't)

Assess commercial state-of-the-art
- CBD announcement
- "Turkey shoot" of all available AFFF alternatives
- Quantify performance, chemical and physical properties
- Obtain EPA endorsement of screening tests

Consider future mods to AFFF mil spec
- Prioritze requirements
- Consider trade-offs

Establish formal AFFF working group
- Info sharing
- Formal charter
- DOD primary advocate?
- Future meetings/host/agenda topics

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AFFF Environmental Impact
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Naval Research Laboratory
3 August 2000

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