NASA TECHNICAL MEMORANDUM

NASA TM X-73408

NASA TM X-73408

(NASA-TM-X-73408) BIBLIOGRAPHY ON LIQUEFIED NATURAL GAS (LNG) SAFETY (NASA) 654 p HC A99 CSCL 21D

N77-15208

Unclas
00/28 11794

BIBLIOGRAPHY ON LIQUEFIED NATURAL GAS (LNG) SAFETY

by Paul M. Ordin
Lewis Research Center
Cleveland, Ohio 44135
April 1976

1. Report No. NASA TM X-73408	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle BIBLIOGRAPHY ON LIQUEFIED NATURAL GAS (LNG) SAFETY		5. Report Date April 1976
		6. Performing Organization Code E-8715
7. Author(s) Paul M. Ordin		8. Performing Organization Report No.
9. Performing Organization Name and Address Aerospace Safety Research and Data Institute Lewis Research Center Cleveland, Ohio 44135		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		13. Type of Report and Period Covered Technical Memorandum
		14. Sponsoring Agency Code

15. Supplementary Notes

This information is being published in preliminary form in order to expedite its early release.

16. Abstract

This Bibliography contains citations concerned with the safety of liquefied natural gas (LNG) and liquid methane. Each citation includes the title, author, abstract, source, description of figures, key references, and major descriptors by which the document can be retrieved. The raw data for this report was a computer printout based on a keyword search strategy of descriptors in the cryogenic safety data bank dealing with LNG. This work was supported by the NASA Technology Utilization Office.

17. Key Words (Suggested by Author(s)) Bibliographies; Liquefied natural gas; LNG; Liquid methane; Safety; Fire; Fire protection; Storage; Handling		18. Distribution Statement Unclassified - unlimited STAR Category 28	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price*

* For sale by the National Technical Information Service, Springfield, Virginia 22161

Page
Intentionally
Left Blank

CONTENTS

Preceding page blank

Page
Intentionally
Left Blank

BIBLIOGRAPHY ON LIQUEFIED NATURAL GAS (LNG) SAFETY

by Paul M. Ordin
Lewis Research Center

INTRODUCTION

The Aerospace Safety Research and Data Institute (ASRDI) at the Lewis Research Center provides NASA and its contractors with technical information on safety problems. To accomplish this objective, ASRDI has been collecting, organizing, and evaluating safety related information in various areas related to aerospace activities. One of these problem areas has been cryogenic systems. The information, which includes bibliographic citations on properties, hazards, and safety, has been compiled and stored in a computerized retrieval system for easy and direct access.

Our information program includes over 8000 documents in the cryogenic safety area which, until recently, were primarily concerned with oxygen and hydrogen. Citations containing safety information on LNG (Liquefied Natural Gas) and liquid methane have recently been added to the data bank. This work has been supported by the NASA Technology Utilization Office. The utilization of the NASA technical experience with cryogenic fluids and industrial gases was derived from the nation's aerospace programs. This considerable experience was invaluable in compiling and evaluating the LNG safety information.

Each citation contains many items of information about the document. These items include the title, author, abstract, source, description of figures, key references, and major descriptors (key words or subject terms) by which the document can be retrieved.

This report is a compilation of LNG and methane safety information reviewed as of December 1975. This report includes an index of key terms or descriptors which identify the subject information in the citations on LNG, methane, and/or natural gas. Abstracts of the reports containing information related to these specific terms are identified by page number.

Preceding page blank

Although the majority of the citations were obtained from the Cryogenics Fluid Safety collection, other safety collections which were compiled by ASRDI provided information pertinent to the safety of LNG and methane. These included the Fire and Explosion file and Mechanics of Structural Materials file. Citations from these files are listed in the Index of Descriptors under the key terms of Aircraft Fuel Fires, Fire Detection, and Aircraft. The material in these reports are related to the detection of fuel leaks, fighting of aircraft fuel fires with various extinguishing agents, explosions of fuel systems, and fragmentation hazards. These identified reports contain data helpful with problems associated with LNG and/or methane fires and explosions.

An Index of Authors is also included in this report.

The raw data for this report was a computer printout based on a keyword search strategy of descriptors dealing with LNG (liquefied natural gas) safety. The raw data was screened, reviewed, and evaluated to assure the reader that all the citations included in this report were relevant items that would be useful to design engineers and safety specialists.

keys 20957 through 20962

MARITIME LNG MANUAL

by

GEREMIA,J.O.

07/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS REPORT DISCUSSES MANY OF THE PROBLEMS AND PROCEDURES INVOLVED IN TRANSPORTING LIQUEFIED NATURAL GAS BY SEA. IT BEGINS WITH A BRIEF HISTORICAL BACKGROUND AND GOES ON WITH A DISCUSSION OF THE THEORETICAL AND PRACTICAL PROCESSES BY WHICH NATURAL GAS IS LIQUEFIED. THE TEXT THEN PROCEEDS TO GIVE A DESCRIPTION OF CARGO CONSTRUCTION, TYPICAL SHIPS EQUIPMENT, OPERATING, SAFETY AND MAINTENANCE PROCEDURES. IT ENDS WITH A DISCUSSION OF THE ECONOMICS AND FUTURE GROWTH POTENTIAL OF LIQUEFIED NATURAL GAS AS A NATURAL RESOURCE. THE INFORMATION PRESENTED WAS OBTAINED EITHER FROM A VARIETY OF PUBLICATIONS OR FROM CONVERSATIONS WITH PERSONS ACTIVE IN THE FIELD.

-PERTINENT FIGURES-

FIG.3-13 HEAT TRANSFER RATES TO A CYLINDRICAL TANK, PAGE 58//FIG.3-14 LIQUID LEVEL/TANK HEIGHT, PAGE 59//FIG.3-16 EFFECTS OF DROP IN TANK PRESSURE ON BOIL-OFF RATE, PAGE 63//FIG.4-14 TYPICAL LOADING/UNLOADING ARRANGEMENT, PAGE 99

-BIBLIOGRAPHY-

THOMAS,W.D. AND SCHVENDTNER,A.H., LNG CARRIERS, THE CURRENT STATE OF THE ART, J.J. HENRY COMPANY, 1971, SNAME (NOV 1971)//SLIEPEVICH,C.M., RADIATION, HEAT FLUX, AND OVERPRESSURE IN LNG TANKS, CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY, NATIONAL ACADEMY OF SCIENCES, BOSTON, MASS. (JUN 1972)//GEIST,J.M. AND CHATTEJEE,N., THE EFFECTS OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS, CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY, NATIONAL ACADEMY OF SCIENCES, BOSTON, MASS. (JUN 1972)//MCCONNAUGHEY,W.E. AND LAKEY,R.J., SAFETY ASPECTS OF LNG IN TRANSPORTATION, OFFICE OF MARINE SAFETY HAZARDOUS MATERIALS DIVISION (MAY 1973)//HAZARDS OF SPILLAGE OF LNG INTO WATER, BUREAU OF MINES FINAL REPORT TO U.S. COAST GUARD (SEP 1972) (NTIS ACCESSION NO. AD754498)//SAFETY CONSIDERATION IN THE DESIGN AND CONSTRUCTION OF TANKERS FOR CRYOGENIC GARGOES, NATIONAL SAFETY COUNCIL, GREATER LOS ANGELES CHAPTER (MAY 1971)

-SOURCE INFORMATION-

CORPORATE SOURCE -
TRIDENT ENGINEERING ASSOCIATES, ANNAPOLIS, MD.
REPORT NUMBER -
NMRC-KP-126//COM-75-10136
SPONSOR -
NATIONAL MARITIME RESEARCH CENTER, KINGS POINT, N.Y
CONTRACT NUMBER -
PURCHASE ORDER 30556
OTHER INFORMATION -
0332 PAGES, 0112 FIGURES, 0019 TABLES, 0059 REFERENCES

A REVIEW OF SOME RECENT ACCIDENTS IN THE MARITIME TRANSPORTATION MODE

by

HALVORSEN, F. H.

03/19/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

WITHIN LESS THAN ONE YEAR, TWO CRUDE OIL TANKERS (ELIAS AND CORINTHOS) CATASTROPHICALLY EXPLODED, BURNED, AND SANK IN A MAJOR U. S. PORT AREA. THIS PAPER DISCUSSES THESE ACCIDENTS AND OUTLINES A WELL KNOWN AND PROVEN METHOD WHICH COULD HAVE PREVENTED OR MITIGATED THE INITIAL EXPLOSIONS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
COAST GUARD, WASHINGTON, D. C.
PUBLISHER -
COAST GUARD, WASHINGTON, D. C.
SPONSOR -
COAST GUARD, WASHINGTON, D. C.

keys 20930 through 20932

ACCIDENT SIMULATION TESTS ON A WET-WALL LNG DESIGN

by

METZ,P.O.
LAUTENSLEGER,R.W.
SARNO,D.A.

07/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL
U/Unrestricted	Unlimited	Summary	Good/Excel

-ABSTRACT-

AN ACCIDENT SITUATION HAS BEEN EVALUATED FOR AN LNG WET WAL DESIGN SHIP WHERE THE PRIMARY LIQUID BARRIER AND THE SECONDAR INSULATION BARRIER HAVE FAILED LOCALLY. UNDER THESE CONDITIONS THE INNER HULL (TERTIARY BARRIER) IS SUBJECTED TO NORMAL WORKIN STRESSES AND TO THERMAL STRESSES GENERATED BY A LOCALIZED EXPOSUR TO THE LNG CARGO. COLD SPOT AND CRACK SUSCEPTIBILITY TEST INDICATE THAT CARBON STEEL HULL PLATE, STIFFENERS AND WEBS MAY B A POTENTIAL HAZARD. THE USE OF CRYOGENIC NICKEL STEEL HULL PLATE STIFFENERS AND A COMPOSITE NICKEL STEEL/CARBON STEEL WEB I SUGGESTED. A SPECIAL SURFACE FLAWED T-SECTION WAS FABRICATED WI' 16 MM (5/8 INCH) ASTM A645 (5 PERCENT NI STEEL) AND THERMAL SHO TESTED. NEITHER OF TWO 11.5 MM (0.45 INCH) DEEP SURFACE FLA PROPAGATED WHEN LOADED TO APPROXIMATELY 85 PERCENT OF THE BA PLATE YIELD STRENGTH.

-PERTINENT FIGURES-

TAB.1 A SUMMARY OF THE STRESSES EXPECTED IN A REPRESENTATIVE I HULL SECTION UNDER THREE POSSIBLE CONDITIONS

-BIBLIOGRAPHY-

THOMAS,W.D. AND SCHWENDTNER,A.H., LNG CARRIERS. THE CURRENT OF THE ART, 1971 ANNUAL NEW YORK MEETING, THE SOCIETY OF ARCHITECTS AND MARINE ENGINEERS//SARNO,D.A., HAVENS,F.E BOWLEY,D.L., TRANSFORMATIONS INVOLVED IN DEVELOPING TOUGHNESS IN A NEW 5 PERCENT NICKEL STEEL FOR CRY APPLICATIONS, ASM MATERIALS ENGINEERING CONGRESS, CLEVELA TECH. REPORT NO. C70-39.2 (1970)//SARNO,D.A., BRUNER,J. KAMPSCHAEFER,G.E., FRACTURE TOUGHNESS OF ARMCO CRYONIC 5 WELDMENTS, WELDING LOW TEMPERATURE CONTAINMENT PLANT CONF THE WELDING INST., LONDON (NOV 1973)

-SOURCE INFORMATION-

CORPORATE SOURCE -
ARMCO STEEL CO., MIDDLETOWN, OHIO
JOURNAL PROCEEDINGS -
CRYOGENIC MATERIALS INTERNATIONAL CONF., (PRES. AT) KINGSTON, ONTARIO, JUL 22-5, 1975. PAPER Y-1
OTHER INFORMATION -
0022 PAGES, 0005 FIGURES, 0001 TABLES, 0009 REFERENCES

DETONATION OF A FLAMMABLE CLOUD FOLLOWING A PROPANE PIPELINE BREAK. THE DECEMBER 9, 1970 EXPLOSION IN PORT HUDSON, MO.

by

BURGESS, D. S.
ZABETAKIS, M. G.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Acceptable

-ABSTRACT-

THIS REPORT SUMMARIZES THE INCIDENTS THAT PRECEDED THE DECEMBER 9, 1970, PROPANE-AIR EXPLOSION IN PORT HUDSON, MO., AND THEN ATTEMPTS ~~TO ESTABLISH THE NATURE OF THE EXPLOSION FROM THE ENSUING EVENTS.~~ SPECIAL EMPHASIS IS GIVEN TO POSSIBLE IGNITION SOURCES, THE DISTRIBUTION OF FLAMMABLE VAPORS, AND THE ANALYSIS OF BLAST DAMAGE. BOTH NEAR- AND FAR-FIELD DAMAGE INDICATED THAT THIS EXPLOSION MAY BE ATTRIBUTED TO THE DETONATION OF PROPANE IN AIR WITH AN ENERGY RELEASE EQUIVALENT TO THAT FROM ABOUT 50 TONS OF DETONATING TNT.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, WASHINGTON, D. C.
PUBLISHER -
INTERIOR DEPT.
SPONSOR -
INTERIOR DEPT., WASHINGTON, D. C.
CONTRACT NUMBER -
REPORT OF INVESTIGATIONS 7752

key 21308

TECHNICAL ASPECTS OF AMBIENT VAPORIZERS AND SUPERHEATERS

by

BERNERT, R. E.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER PRESENTS DESIGN CRITERIA AND OPERATIONAL PROBLEMS AND PRACTICES ASSOCIATED WITH AMBIENT AIR AND WATER HEATED VAPORIZERS FOR CRYOGENIC SERVICE. PRECAUTIONARY ADVICE IS GIVEN CONCERNING THE USE OF SUCH HEAT EXCHANGERS - PARTICULARLY REGARDING ICE-UP, FROST FORMATION AND LOSS OF HEAT TRANSFER EFFICIENCY DUE TO AMBIENT CONDITIONS. A COST COMPARISON IS MADE BETWEEN FIRED AND AMBIENT HEATED VAPORIZERS FOR ONE LONG TERM CONTINUOUS DUTY APPLICATION CONSIDERING BOTH CAPITAL AND OPERATING EXPENSES.

-PERTINENT FIGURES-

FIG.1 THERMAL GRADIENT-FLUID TO FLUID THROUGH A FOULING ICE/FROST LAYER// FIG.2 HEAT FLUX VALUES FOR WATER AND ICE//FIG.3 OPERATING LIMITS - TYPICAL THERMEX TVN(PW) SERIES VAPORIZER//FIG.5 VERTICALLY FINNED ALUMINUM EXTRUSION//FIG.6 FROST LAYER BUILDUP ON 2 DIFFERENT FINNED EXTRUSION CONFIGURATIONS

-SOURCE INFORMATION-

CORPORATE SOURCE -
    THERMEX, INC., DARTMOUTH, MASS.
OTHER INFORMATION -
    0011 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21309

FACTORS AFFECTING LNG STORAGE TANK SIZING FOR MARINE IMPORTATION/BASE LOAD TERMINALS

by

AARTS, J. J.
BENVEGNU, J. A.

10/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THERE ARE MANY FACTORS WHICH CONTROL THE ULTIMATE LNG STORAGE TANK CAPACITY, ITS DESIGN AND CONSTRUCTION REQUIREMENTS AND, CONSEQUENTLY, THE UNIT STORAGE PRICE. EACH OF THESE FACTORS MUST BE EVALUATED CORRECTLY AT THE START OF EACH PROJECT. THIS PAPER PRESENTS A GENERAL DISCUSSION OF THE MAJOR ITEMS WHICH PLAY A BIG PART IN DETERMINING THE ULTIMATE STORAGE TANK SIZE.

-PERTINENT FIGURES-

FIG.2 DOUBLE-WALL LNG STORAGE TANK WITH OPEN TOP INNER SHELL AND SUSPENDED DECK, PAGE 2//FIG.3 LNG STORAGE TANK ROOF-TO-SHELL JUNCTURES, PAGE 9//FIG.4 LOW PROFILE LNG STORAGE TANK CONCEPTS, PAGE 15//FIG.5 LNG STORAGE TANK OVER-THE-TOP FILL LINE DETAIL, PAGE 17//FIG.6 LNG STORAGE TANK UNDERBOTTOM LINE DETAIL, PAGE 18

-BIBLIOGRAPHY-

HANKE, C. C., CHICAGO BRIDGE AND IRON COMPANY. NEW DEVELOPMENTS IN ABOVE GROUND METAL LNG CONTAINERS, THE AMERICAN GAS ASSOCIATION DISTRIBUTION CONFERENCE, MAY 6-9, 1968//SHAH, J. M. AND AARTS, J. J., CHICAGO BRIDGE AND IRON COMPANY. WEATHERING EFFECTS OF LNG IN STORAGE TANKS, CRYOGENIC ENGINEERING CONFERENCE - ATLANTA, GEORGIA, AUGUST 8-10, 1973//LUSK, D. T. AND DORNEY, D. C., CHICAGO BRIDGE AND IRON COMPANY. LNG STORAGE TANK SYSTEMS, LNG III, WASHINGTON, D. C., SEPTEMBER 24-28, 1972//CLAPP, M. B. AND LITZINGER, L. F., CHICAGO BRIDGE AND IRON COMPANY. MARINE TERMINALS FOR LPG, ETHYLENE AND LNG. 68TH NATIONAL MEETING AND 6TH PETROCHEMICAL AND REFINING EXPOSITION - HOUSTON, TEXAS, FEBRUARY 28-MARCH 4, 1971

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.

JOURNAL PROCEEDINGS -
CRYO/73 NATIONAL SYMP., (PRES. AT) LOS ANGELES, CALIF., OCT 2-4, 1973
OTHER INFORMATION -
0027 PAGES, 0006 FIGURES, 0000 TABLES, 0004 REFERENCES

LP GAS FIRES AND EXPLOSIONS

-ABSTRACT-

SUMMARIES OF THE MORE SERIOUS CASES AND REPRESENTATIVE EXAMPLES OF "RUN-OF-THE-MILL" LP GAS INCIDENTS ARE PRESENTED IN THIS PAPER TO MAKE AVAILABLE IN CONVENIENT FORM EVIDENCE OF THE TYPES AND SEVERITY OF ACCIDENTS THAT CAN OCCUR IF THE PROPERTIES OF LIQUEFIED PETROLEUM GASES ARE NOT UNDERSTOOD AND IF SAFE PRACTICES IN THEIR HANDLING AND STORAGE ARE NOT FOLLOWED. THIS STUDY COVERS ONLY CASES WHERE LIQUEFIED PETROLEUM GAS WAS INVOLVED, INCLUDING SO CALLED BOTTLE GAS, VARIOUS TYPES OF LP GAS CONTAINERS, PIPED SYSTEMS, AND OTHER LP GAS APPLICATIONS. ONLY INCIDENTS FROM 1930 TO 1952 ARE DISCUSSED.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
JOURNAL PROCEEDINGS -
QNFPAX, QUART. NAT. FIRE PROT. ASS., 46-82 (JULY 1952)
PUBLISHER -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
SPONSOR -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
OTHER INFORMATION -
0037 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21310

A NEW LNG TANKER DESIGN

by

WHITEHEAD, S.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER DESCRIBES THE BOTTOM-SUPPORTED, FREE-STANDING LNG CARGO CONTAINMENT SYSTEM JOINTLY DEVELOPED BY THE FRENCH FIRM, GAZ TRANSPORT, IN PARTNERSHIP WITH THE AMERICAN PITTSBURGH-DES MOINES STEEL COMPANY. THE CONCEPT IS SIMILAR TO THAT USED SUCCESSFULLY IN THE LNG CARGO SHIP JULES VERNE, SUBSTITUTING ALUMINUM FOR NINE PERCENT NICKEL STEEL AS THE PRIMARY MATERIAL OF CONSTRUCTION. THE TANK DESIGN CONSISTS OF A CONICAL BOTTOM RESTING ON A CONE OF LOAD-BEARING INSULATION, A CYLINDRICAL SHELL, AND A HEMISPHERICAL ROOF.

-PERTINENT FIGURES-

FIG.3 MID-SECTION VIEW OF PDM/GT LNG CARGO TANK, PAGE 22//FIG.4 PDM/GT 125,000 CUBIC METER LNG CARGO SHIP - GENERAL ARRANGEMENT, PAGE 24//FIG.5 TRANSVERSE SHIP SECTION OF PDM/GT LNG CARGO SHIP, PAGE 25//FIG.6 PLATE LAYOUT OF PDM/GT LNG CARGO TANK, PAGE 26//FIG.7 INSULATION SYSTEM FOR PDM/GT LNG CARGO TANK, PAGE 27//FIG.8 WEATHER COVER FOR PDM/GT LNG CARGO TANK, PAGE 28

-SOURCE INFORMATION-

CORPORATE SOURCE -
PITTSBURGH-DES MOINES STEEL CO., PITTSBURGH, PA.
JOURNAL PROCEEDINGS -
APPLICATIONS OF CRYOGENIC TECHNOLOGY VOL 6, 19-34 (1974), S. H. BOOTH AND R. W. VANCE, EDITORS. (PROC. OF CRYO/73 CONF., 6TH, LOS ANGELES, CALIF., OCT 2-4, 1973)
PUBLISHER -
SCHOLIUM INTERNATIONAL INC.
OTHER INFORMATION -
0016 PAGES, 0010 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21311 through 21312

LNG - WATER EXPLOSIONS

by

KATZ, D. L.

03/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

A BREAKTHROUGH IN UNDERSTANDING OF LNG-WATER REACTION TOOK PLACE IN 1971 AMONG SEVERAL PEOPLE. THE EXPLOSIVE FLASHING OF A LIQUID WHICH REACHES ITS LIMIT OF SUPERHEAT APPEARED TO BE A SATISFYING EXPLANATION FOR LNG-WATER EXPLOSIONS. SUPERHEAT-LIMIT EXPLOSIONS WERE REPORTED PREVIOUSLY IN THE LITERATURE AND THEY HAVE A THEORETICAL UNDERGIRDING. EARLY STUDIES OF LNG-WATER REACTIONS INCLUDED CONCEPTS OF DEGREE OF SUPERHEAT, BUT THE UNIQUE TRIGGERING OF EXPLOSIONS BY REACHING THE LIMIT OF SUPERHEAT IS CONSIDERED A MAJOR BREAKTHROUGH IN UNDERSTANDING LIQUID-LIQUID VAPOR EXPLOSIONS. THIS LITTLE-KNOWN SUPERHEAT-LIMIT EXPLOSION DOES NOT INVOLVE THE HEAT OF A CHEMICAL REACTION BECAUSE IT IS FLAMELESS. THE ENERGY SUPPORTING THIS HIGH VELOCITY VAPORIZATION IS ONLY THE SUPERHEAT ENERGY ABOVE THAT OF A SATURATED LIQUID. ONE CAN CONCLUDE THAT THE PHYSICAL VIOLENCE RESULTING FROM A SUPERHEAT-LIMIT EXPLOSION IS MINOR COMPARED TO ONE SUPPORTED BY COMBUSTION OR CHEMICAL DECOMPOSITION. SUGGESTED MECHANISMS BY WHICH VOLATILE HYDROCARBONS CAN BE SUPERHEATED IN MILLISECONDS INCLUDE LIQUID-LIQUID HEAT TRANSFER WITH THE ABSENCE OF NUCLEATION SITE. A TEMPERATURE DIFFERENCE JUST BELOW THAT AT WHICH FILM BOILING TAKES PLACE IS THE CONDITION FOR SUPERHEATING ONE LIQUID FLOATING ON OR IMMERSED IN ANOTHER LIQUID. HIGH METHANE LNG WILL FILM BOIL WHEN PLACED ON WATER AND WILL NOT EXPLODE. ONLY ENRICHED LNG WITH NO MORE THAN SOME 50 MOLE PERCENT METHANE WILL HAVE THE APPROPRIATE BOILING POINT TO GIVE THE TEMPERATURE DIFFERENCE WHICH WILL WET WATER, SUPERHEAT TO ITS LIMIT, AND EXPLODE. THE REPORT GIVES RECOMMENDATIONS FOR FURTHER STUDY AND OFFERS INFORMAL COMMENTS ON THE SLOWNESS OF INFORMATION TRANSFER RELATIVE TO SUPERHEAT-LIMIT PHENOMENA.

-PERTINENT FIGURES-

FIG.1 BOILING HEAT TRANSFER MECHANISMS, PAGE 4//FIG.6 MODEL FOR SUPERHEATING LAYER OF HYDROCARBON ON WATER, PAGE 43//FIG.7 PRESSURE-TEMPERATURE RELATIONSHIP AND LOCATION OF SUPERHEAT-LIMIT TRANSFORMATION FROM METASTABLE LIQUID (K) TO VAPOR-LIQUID MIXTURE, PAGE 43//TAB.1 MEASURED AND CALCULATED LIMITS OF SUPERHEAT, PAGE 8//FIG.3 SCHEMATIC OF PRESSURE-VOLUME CURVES METASTABLE AND UNSTABLE BEHAVIOR, PAGE 10

-BIBLIOGRAPHY-

BURGESS, D. S., MURPHY, J. N. AND ZABETAKIS, M. G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, U. S. BUREAU OF MINES, REPORT TO U. S. COAST GUARD (FEB 1970)//HIGUCHI, S., STUDY OF LNG SAFETY (1) (2), CENTRAL LABORATORY, TOKYO GAS COMPANY LTD. (FEB 1971)//SCIANCE, C. T., COLVER, C. P. AND SLIEPCEVICH, C. M., POOL BOILING OF METHANE BETWEEN ATMOSPHERIC PRESSURE AND THE CRITICAL PRESSURE, ADVANCES IN CRYOGENIC ENGINEERING VOL 12, 395 (1967)//BROWN, L. C. AND COLVER, C. P., NUCLEATE AND FILM BOILING HEAT TRANSFER IN LIQUEFIED NATURAL GAS, ADVANCES IN CRYOGENIC ENGINEERING VOL 13, 647 (1968)//KATZ, D. L. AND SLIEPCEVICH, C. M., LNG-WATER EXPLOSIONS. CAUSE AND EFFECT, HYDROCARBON PROCESSING VOL 50, NO. 11, 240 (NOV 1971)//WITTE, L. C. AND COX, J. E., NON-CHEMICAL EXPLOSIVE INTERACTION OF LNG AND WATER, ASME PREPRINT 71-WA/AT-31 (DEC 1971)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL ACADEMY OF SCIENCES, WASHINGTON, D.C.
REPORT NUMBER -
CG-D-60-74//AD-775005
SPONSOR -
COAST GUARD, WASHINGTON, D.C.
CONTRACT NUMBER -
CONTRACT DOT-CG-11,775-A
OTHER INFORMATION -
0063 PAGES, 0007 FIGURES, 0002 TABLES, 0044 REFERENCES

keys 21362 through 21366

RISK MANAGEMENT TECHNIQUE FOR DESIGN AND OPERATION OF LIQUEFIED NATURAL GAS FACILITIES AND EQUIPMENT - FINAL REPORT, JUN-DEC 1974

by

MEDKIEF, JR., C. A.
NIERGARTH, A. W.
PARSONS, W. N.

12/31/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PROJECT, SPONSORED UNDER THE NASA TECHNOLOGY PROGRAM, IS TO DEVELOP A RISK MANAGEMENT AND FACILITIES CERTIFICATION METHODOLOGY APPLICABLE TO LIQUID NATURAL GAS FACILITIES AT THE NATIONS PORT CITIES. NASA AND THE BOEING AEROSPACE COMPANY AT THE KENNEDY SPACE CENTER ARE WORKING WITH THE NEW YORK FIRE DEPARTMENT TO APPLY TECHNIQUES DERIVED FROM THEIR EXPERIENCE IN MANAGEMENT OF SPACE PROGRAM HAZARDOUS MATERIALS FACILITIES. THIS REPORT COVERS WORK ACCOMPLISHED DURING THE PERIOD JUNE 1, 1974 - DECEMBER 31, 1974 AND IS PRESENTED IN FOUR SECTIONS. (1) REGULATION FOR MANUFACTURE, STORAGE, TRANSPORTATION, DELIVERY AND PROCESSING OF LNG, (2) PROPOSED RISK MANAGEMENT PROVISIONS FOR THE DESIGN, FABRICATION AND OPERATION OF LNG FACILITIES, (3) PRELIMINARY OPERATING INSTRUCTIONS - RISK MANAGEMENT SYSTEM FOR LNG, (4) PRELIMINARY ADP REQUIREMENTS FOR RMS.

-PERTINENT FIGURES-

FIG.2-1 RISK MANAGEMENT SYSTEM LOGIC, PAGE 3-3//FIG.2-2 RMS PHASE AND PROJECT REVIEW IDENTIFICATION, PAGE 3-4//FIG.2-3 RISK MANAGEMENT SYSTEM OPERATION ELEMENTS, PAGE 3-8//FIG.3-2 SAMPLE CHECKLIST, PAGE 3-13//FIG.4-1 HAZARD REDUCTION PRECEDENCE SEQUENCE LOGIC, PAGE 3-16//FIG.D-4 SAFETY ANALYSIS, PAGE 3-D-12

-BIBLIOGRAPHY-

ANSI B31.3 - PETROLEUM REFINERY PIPING//ANSI B31.5 - REFRIGERATION PIPING SYSTEMS//API 620 - RECOMMENDED RULES FOR DESIGN AND CONSTRUCTION OF LARGE WELDED LOW PRESSURE STORAGE TANKS//ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII - UNFIRED PRESSURE VESSELS//NFPA 59A - PRODUCTION, STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS

-SOURCE INFORMATION-

CORPORATE SOURCE -
BOEING AEROSPACE CO., KENNEDY SPACE CENTER, FLA.
REPORT NUMBER -
NASA-CR-139183
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. JOHN F. KENNEDY SPACE CENTER, COCOA BEACH, FLA.
CONTRACT NUMBER -
CONTRACT NAS-10-7200 S. A. NO. 63
OTHER INFORMATION -
0224 PAGES, 0023 FIGURES, 0000 TABLES, 0023 REFERENCES

STUDY OF GAS EXPLOSIONS AND FIRES

-ABSTRACT-

EXPLOSIONS FROM 1950 TO 1957 INVOLVING FUEL GAS IN CENTRAL PIPING DISTRIBUTION SYSTEMS AND IN CONSUMER PROPERTIES AND GAS WORKS SERVED BY OR SUPPLYING SUCH SYSTEMS ARE BRIEFLY REVIEWED IN THIS ARTICLE. IN ADDITION TO THE 140 EXPLOSIONS REPORTED, 23 CASES ARE INCLUDED IN WHICH IGNITION OF ESCAPING GAS WAS THE CAUSE OF A FIRE OR CONTRIBUTED TO THE SPREAD OF A FIRE. THE PRINCIPAL CONCLUSION THAT SHOULD BE DRAWN FROM THE CASE HISTORIES IS THE EVER PRESENT NEED FOR VIGILANCE IN THE PROPER INSTALLATION, MAINTENANCE, REPAIR AND OPERATION OF GAS PIPING AND EQUIPMENT.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
PUBLISHER -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
SPONSOR -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
OTHER INFORMATION -
0037 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

RISK MANAGEMENT TECHNIQUE FOR DESIGN AND OPERATION OF LIQUEFIED NATURAL GAS FACILITIES AND EQUIPMENT (PIPING, FITTINGS, VALVES, AND CONTROLS) - FINAL REPORT, JUN-DEC 1974

by

MEDKIEF, JR., C. A.
NIERGARTH, A. W.
PARSONS, W. N.

12/31/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PROJECT, SPONSORED UNDER THE NASA TECHNOLOGY PROGRAM, IS TO DEVELOP A RISK MANAGEMENT AND FACILITIES CERTICATION METHODOLOGY APPLICABLE TO LIQUID NATURAL GAS FACILITIES AT THE NATIONS PORT CITIES, NASA AND THE BOEING AEROSPACE COMPANY AT THE KENNEDY SPACE CENTER ARE WORKING WITH THE NEW YORK FIRE DEPARTMENT TO APPLY TECHNIQUES DERIVED FROM THEIR EXPERIENCE IN MANAGEMENT OF SPACE PROGRAM HAZARDOUS MATERIALS FACILITIES. THIS REPORT COVERS WORK ACCOMPLISHED DURING THE PERIOD JUNE 1, 1974 - DECEMBER 31, 1974 AND IS PRESENTED IN FOUR SECTIONS. (1) REGULATION FOR MANUFACTURE, STORAGE, TRANSPORTATION, DELIVERY AND PROCESSING OF LNG, (2) PROPOSED RISK MANAGEMENT PROVISIONS FOR THE DESIGN, FABRICATION AND OPERATION OF LNG FACILITIES, (3) PRELIMINARY OPERATING INSTRUCTIONS-RISK MANAGEMENT SYSTEM FOR LNG, (4) PRELIMINARY ADP REQUIREMENTS FOR RMS.

-BIBLIOGRAPHY-

ANSI B31.3 - PETROLEUM REFINERY PIPING//ANSI B31.5 - REFRIGERATION PIPING SYSTEMS

-SOURCE INFORMATION-

CORPORATE SOURCE -
BOEING AEROSPACE CO., KENNEDY SPACE CENTER, FLA.
REPORT NUMBER -
NASA-CR-139183
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. JOHN F. KENNEDY SPACE CENTER, COCOA BEACH, FLA.
CONTRACT NUMBER -
CONTRACT NAS-10-7200 S. A. NO. 63
OTHER INFORMATICN -
0224 PAGES, 0023 FIGURES, 0000 TABLES, 0023 REFERENCES

RISK MANAGEMENT TECHNIQUE FOR DESIGN AND OPERATION OF LIQUEFIED NATURAL GAS FACILITIES AND EQUIPMENT (STORAGE TANKS) - FINAL REPORT, JUN-DEC 1974

by

MEDKIEF, JR., C. A.
NIERGARTH, A. W.
PARSONS, W. N.

12/31/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PROJECT, SPONSORED UNDER THE NASA TECHNOLOGY PROGRAM, IS TO DEVELOP A RISK MANAGEMENT AND FACILITIES CERTIFICATION METHODOLOGY APPLICABLE TO LIQUID NATURAL GAS FACILITIES AT THE NATIONS PORT CITIES. NASA AND THE BOEING AEROSPACE COMPANY AT THE KENNEDY SPACE CENTER ARE WORKING WITH THE NEW YORK FIRE DEPARTMENT TO APPLY TECHNIQUES DERIVED FROM THEIR EXPERIENCE IN MANAGEMENT OF SPACE PROGRAM HAZARDOUS MATERIALS FACILITIES. THIS REPORT COVERS WORK ACCOMPLISHED DURING THE PERIOD JUNE 1, 1974 - DECEMBER 31, 1974 AND IS PRESENTED IN FOUR SECTIONS. (1) REGULATION FOR MANUFACTURE, STORAGE, TRANSPORTATION, DELIVERY AND PROCESSING OF LNG, (2) PROPOSED RISK MANAGEMENT PROVISIONS FOR THE DESIGN, FABRICATION AND OPERATION OF LNG FACILITIES, (3) PRELIMINARY OPERATING INSTRUCTIONS - RISK MANAGEMENT SYSTEM FOR LNG, (4) PRELIMINARY ADP REQUIREMENTS FOR RMS.

-PERTINENT FIGURES-

FIG.1 SEPARATION DISTANCES, PAGE 1-4-2//FIG.2 RATIO OF DIKE HEIGHT TO LIQUID LEVEL, PAGE 1-6-2

-BIBLIOGRAPHY-

API 620 - RECOMMENDED RULES FOR DESIGN AND CONSTRUCTION OF LARGE WELDED LOW PRESSURE STORAGE TANKS//ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII - UNFIRED PRESSURE VESSELS//NFPA 59A - PRODUCTION, STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS

-SOURCE INFORMATION-

CORPORATE SOURCE -
BOEING AEROSPACE CO., KENNEDY SPACE CENTER, FLA.
REPORT NUMBER -

NASA-CR-139183
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. JOHN F. KENNEDY SPACE CENTER, COCOA BEACH, FLA.
CONTRACT NUMBER -
CONTRACT NAS-10-7200 S. A. NO. 63
OTHER INFORMATION -
0224 PAGES, 0023 FIGURES, 0000 TABLES, 0023 REFERENCES

PIPELINE ACCIDENT REPORT - PHILLIPS PIPE LINE COMPANY, NATIONAL GAS LIQUIDS FIRE, AUSTIN, TEXAS, FEBRUARY 22, 1973

-ABSTRACT-

THIS REPORT DESCRIBES AND ANALYZES A FIRE INVOLVING NATURAL GAS LIQUIDS WHICH LEAKED FROM A RUPTURED LO-INCH PIPELINE AT A PUMP STATION IN AUSTIN, TEXAS, FLOWED INTO DITCHES ALONGSIDE A ROAD ADJACENT TO THE STATION, AND VAPORIZED. A DODGE VAN DROVE INTO THE VAPOR-RICH ZONE AND STALLED. WHEN THE DRIVER ATTEMPTED TO RESTART THE ENGINE, THE VAPOR IGNITED, AND THE DRIVER AND SEVEN PASSENGERS WERE ENGULFED IN FLAMES. SIX OF THESE PERSONS DIED AND TWO WERE CRITICALLY BURNED. THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINES THAT THE PROBABLE CAUSE OF THE ACCIDENT WAS THE FAILURE OF THE 10-INCH PIPE IN AN AREA OF STRESS CONCENTRATION, WHICH WAS DUE TO IMPROPER PIPELINE REPAIR WELDING PROCEDURES. THE FAILURE WAS CAUSED BY THE REPEATED SWELLING OF THE SOIL AT THE LEAK SITE WHICH BROKE THE PIPE IN THE AREA OF THE STRESS CONCENTRATION. THE IGNITION OF THE NGL VAPOR WHICH HAD LEAKED FROM THE BREAK WAS CAUSED BY THE RESTARTING OF THE ENGINE OF THE VAN WHICH HAD STALLED IN THE VAPOR-RICH ZONE. THE REPORT CONTAINS RECOMMENDATIONS TO THE OFFICE OF PIPELINE SAFETY CONCERNING (1) REGULATORY CONTROL OF TRANSPORTATION BY PIPELINE OF LIQUEFIED PETROLEUM GASES, (2) METHODS OF HANDLING, CONTAINING, AND DISPOSING OF LPG INVOLVED IN PIPELINE ACCIDENTS, (3) THE NEED FOR PUBLIC RECOGNITION AND REPORTING OF LPG LEAKS, AND (4) A POSSIBLE STUDY OF THE EFFECTS OF PIPE STRESS CONCENTRATION DUE TO IMPROPER WELDING PROCEDURES. RECOMMENDATIONS ARE ALSO MADE TO THE PHILLIPS PIPE LINE COMPANY REGARDING OPERATION OF THE PIPELINE SYSTEM INVOLVED IN THE ACCIDENT AND OTHER SIMILAR SYSTEMS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, D.C.
REPORT NUMBER -
NTSB-PAR-73-4
PUBLISHER -
NATIONAL TRANSPORTATION SAFETY BOARD

keys 21377 through 21379

RISK MANAGEMENT TECHNIQUE FOR DESIGN AND OPERATION OF LIQUEFIED NATURAL GAS FACILITIES AND EQUIPMENT (VAPORIZERS) - FINAL REPORT, JUN-DEC 1974

by

MEDKIEF, JR., C. A.
NIERGARTH, A. W.
PARSONS, W. N.

12/31/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PROJECT, SPONSORED UNDER THE NASA TECHNOLOGY PROGRAM, IS TO DEVELOP A RISK MANAGEMENT AND FACILITIES CERTIFICATION METHODOLOGY APPLICABLE TO LIQUID NATURAL GAS FACILITIES AT THE NATIONS PORT CITIES. NASA AND THE BOEING AEROSPACE COMPANY AT THE KENNEDY SPACE CENTER ARE WORKING WITH THE NEW YORK FIRE DEPARTMENT TO APPLY TECHNIQUES DERIVED FROM THEIR EXPERIENCE IN MANAGEMENT OF SPACE PROGRAM HAZARDOUS MATERIALS FACILITIES. THIS REPORT COVERS WORK ACCOMPLISHED DURING THE PERIOD JUNE 1, 1974 - DECEMBER 31, 1974 AND IS PRESENTED IN FOUR SECTIONS. (1) REGULATION FOR MANUFACTURE, STORAGE, TRANSPORTATION, DELIVERY AND PROCESSING OF LNG, (2) PROPOSED RISK MANAGEMENT PROVISIONS FOR THE DESIGN, FABRICATION AND OPERATION OF LNG FACILITIES, (3) PRELIMINARY OPERATING INSTRUCTIONS-RISK MANAGEMENT SYSTEM FOR LNG, (4) PRELIMINARY ADP REQUIREMENTS FOR RMS.

-BIBLIOGRAPHY-

ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII - UNFIRED PRESSURE VESSELS

-SOURCE INFORMATION-

CORPORATE SOURCE -
BOEING AEROSPACE CO., KENNEDY SPACE CENTER, FLA.
REPORT NUMBER -
NASA-CR-139183
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. JOHN F. KENNEDY SPACE CENTER, COCOA BEACH, FLA.
CONTRACT NUMBER -
CONTRACT NAS-10-7200 S. A. NO. 63
OTHER INFORMATION -
0224 PAGES, 0023 FIGURES, 0000 TABLES, 0023 REFERENCES

keys 21380 through 21384

RISK MANAGEMENT TECHNIQUE FOR DESIGN AND OPERATION OF LIQUEFIED NATURAL GAS FACILITIES AND EQUIPMENT (FIRE PROTECTION) - FINAL REPORT, JUNE-DEC 1974

by

MEDKIEF, JR., C. A.
NIERGARTH, A. W.
PARSONS, W. N.

12/31/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PROJECT, SPONSORED UNDER THE NASA TECHNOLOGY PROGRAM, IS TO DEVELOP A RISK MANAGEMENT AND FACILITIES CERTIFICATION METHODOLOGY APPLICABLE TO LIQUID NATURAL GAS FACILITIES AT THE NATIONS PORT CITIES. NASA AND THE BOEING AEROSPACE COMPANY AT THE KENNEDY SPACE CENTER ARE WORKING WITH THE NEW YORK FIRE DEPARTMENT TO APPLY TECHNIQUES DERIVED FROM THEIR EXPERIENCE IN MANAGEMENT OF SPACE PROGRAM HAZARDOUS MATERIALS FACILITIES. THIS REPORT COVERS WORK ACCOMPLISHED DURING THE PERIOD JUNE 1, 1974 - DECEMBER 31, 1974 AND IS PRESENTED IN FOUR SECTIONS. (1) REGULATION FOR MANUFACTURE, STORAGE, TRANSPORTATION, DELIVERY AND PROCESSING OF LNG, (2) PROPOSED RISK MANAGEMENT PROVISIONS FOR THE DESIGN, FABRICATION AND OPERATION OF LNG FACILITIES, (3) PRELIMINARY OPERATING INSTRUCTIONS-RISK MANAGEMENT SYSTEM FOR LNG, (4) PRELIMINARY ADP REQUIREMENTS FOR RMS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
    BOEING AEROSPACE CO., KENNEDY SPACE CENTER, FLA.
REPORT NUMBER -
    NASA-CR-139183
SPONSOR -
    NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. JOHN F. KENNEDY SPACE CENTER, COCOA BEACH, FLA.
CONTRACT NUMBER -
    CONTRACT NAS-10-7200 S. A. NO. 63
OTHER INFORMATION -
    0224 PAGES, 0023 FIGURES, 0000 TABLES, 0023 REFERENCES

STATEN ISLAND EXPLOSION - SAFETY ISSUES CONCERNING LNG STORAGE FACILITIES

-ABSTRACT-

THIS 795 PAGE DOCUMENT IS A TRANSCRIPT OF THE HEARINGS BEFORE THE SPECIAL SUBCOMMITTEE ON INVESTIGATIONS OF THE COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE, HOUSE OF REPRESENTATIVES, WHICH TOOK PLACE JULY 10-12, 1973. TESTIMONY AND EXHIBITS CONCERN THE FIRE AND EXPLOSION THAT OCCURRED IN THE EMPTY TEXAS EASTERN TRANSMISSION CORPORATION 600,000 BARREL LNG STORAGE TANK ON STATEN ISLAND, N. Y. - CLAIMING THE LIVES OF 40 WORKMEN WHO HAD BEEN PERFORMING REPAIRS ON THE INSIDE OF THE TANK. PROBABLE CAUSE OF THE ACCIDENT IS DISCUSSED AS WELL AS IMPLICATIONS OF SAFETY HAZARDS POSED BY OTHER LNG STORAGE FACILITIES PLANNED, UNDER CONSTRUCTION, OR ALREADY OPERATING - PARTICULARLY THE DISTRIGAS FACILITY (ALSO ON STATEN ISLAND).

-SOURCE INFORMATION-

CORPORATE SOURCE -
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE (U. S. HOUSE)
JOURNAL PROCEEDINGS -
HEARINGS BEFORE THE SPECIAL SUBCOMMITTEE ON INVESTIGATIONS OF THE COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE, HOUSE OF REPRESENTATIVES, WASHINGTON, D. C., 93RD CONGRESS, FIRST SESSION ON LEGISLATIVE ISSUES RELATING TO THE SAFETY OF STORING LIQUEFIED NATURAL GAS, SERIAL NO. 93-42 (JUL 10-12, 1973)
OTHER INFORMATION -
0795 PAGES, 0058 FIGURES, 0026 TABLES, 0037 REFERENCES

keys 21399 through 21401

NATURAL GAS LIQUEFACTION PLANTS

-ABSTRACT-

THE GENERAL DISCUSSION PROVIDED IN THIS CHAPTER IS INTENDED TO INTRODUCE THE READER TO THE FUNCTION OF EACH SECTION OF A NATURAL GAS LIQUEFACTION PLANT - GAS TREATMENT AND PURIFICATION, LIQUEFACTION, STORAGE, VAPORIZATION - AND DESCRIBE COMMON PROCESSES AND EQUIPMENT.

-PERTINENT FIGURES-

FIG.2.2A SIMPLIFIED CASCADE SYSTEM, SHOWING PRINCIPLES OF THE METHOD, PAGE 7//FIG.2.2B SIMPLIFIED MODIFIED CASCADE CYCLE, PAGE 7//FIG.2.2C AUTO-REFRIGERATION PRINCIPLE SIMPLIFIED, PAGE 8//FIG.2.5 TYPICAL ABOVEGROUND DOUBLE-WALL TANK WITH ARTISTS CUTAWAY SECTION, PAGE 9//FIG.2.6 VARIOUS DESIGN CONFIGURATIONS FOR PRESTRESSED CONCRETE LNG TANKS, PAGE 10 //FIG.2.7 DIAGRAMMATIC CROSS-SECTION OF DIRECT-FIRED CONVECTIVE HEAT EXCHANGER, PAGE 10//FIG.2.8 SUBMERGED COMBUSTION LNG VAPORIZER, PAGE 11// FIG.2.9 REMOTE HEATED LNG VAPORIZER, PAGE 11

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
JOURNAL PROCEEDINGS -
INTRODUCTION TO LNG FOR PERSONNEL SAFETY, CHAP. 2, AMERICAN GAS ASSOC., ARLINGTON, VA., 5-12 (1973)
OTHER INFORMATION -
0007 PAGES, 0009 FIGURES, 0000 TABLES, 0000 REFERENCES

DESIGN, CONSTRUCTION, AND OPERATION OF LNG FACILITIES FOR SAFETY

-ABSTRACT-

THIS CHAPTER OUTLINES SOME GENERAL GUIDES AND RECOGNIZED REQUIREMENTS FOR SAFETY IN THE DESIGN, CONSTRUCTION AND OPERATION OF AN LNG PLANT. A PLANT OPERATOR TRAINING PROGRAM IS ALSO DESCRIBED.

-PERTINENT FIGURES-

TAB.3.1 GUIDE FOR CRYOGENIC METALS, PAGE 14//TAB.3.2 APPLICATIONS OF SOME MATERIALS IN LNG PLANT DESIGN, PAGE 14//TAB.3.3 PARTIAL LIST OF STANDARDS APPLICABLE TO DESIGN, CONSTRUCTION AND OPERATION OF LNG FACILITIES, PAGE 15

-BIBLIOGRAPHY-

AMERICAN GAS ASSOCIATION, GAS ENGINEERS HANDBOOK, NEW YORK. INDUSTRIAL PRESS (1965)//AMERICAN PETROLEUM INST., RECOMMENDED PRACTICE FOR CLEANING PETROLEUM STORAGE TANKS, RP 2015, WASHINGTCN, D.C. (1968)

-SOURCE INFORMATION-

CORPORATE SOURCE -
    AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
JOURNAL PROCEEDINGS -
    INTRODUCTION TC LNG FOR PERSONNEL SAFETY, CHAP. 3, AMERICAN GAS ASSOC., ARLINGTON, VA., 13-20 (1973)
OTHER INFORMATION -
    0007 PAGES, 0000 FIGURES, 0003 TABLES, 0002 REFERENCES

HAZARD IDENTIFICATION AT LNG FACILITIES

-ABSTRACT-

THE PURPOSE OF THIS CHAPTER IS TO INDICATE TO OPERATORS, PLANT SUPERVISORS, AND SAFETY MANAGERS HAZARDS TO WHICH PERSONNEL MIGHT BE EXPOSED, WHERE THE HAZARDS ARE LOCATED, HOW THE HAZARDS MAY COME ABOUT AND SOME SUGGESTIONS FOR DEALING WITH THEM.

-PERTINENT FIGURES-

TAB.5.1 FOUR STAGES OF ASPHYXIA WITH PHYSIOLOGICAL SYMPTOMS, PAGE 29// TAB.5.2 EXPOSURE AND RADIATION LEVELS LEADING TO EXTREME PAIN, PAGE 29// TAB.5.3 EXPOSURE AND RADIATION LEVELS LEADING TO BLISTERING, PAGE 30

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
JOURNAL PROCEEDINGS -
INTRODUCTION TO LNG FOR PERSONNEL SAFETY, CHAP. 4, AMERICAN GAS ASSOC., ARLINGTON, VA., 21-6 (1973)
OTHER INFORMATION -
0005 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

HAZARDS TO PERSONNEL RESULTING FROM A SPILL

-ABSTRACT-

IN THIS CHAPTER, THE EXTENT OF PERSONNEL HAZARDS FROM SPILLED LNG IS COVERED. VAPORIZATION AND DISPERSION OF SPILLED LNG IS DISCUSSED ALONG WITH THE RESULTANT LOW TEMPERATURE AND FIRE HAZARDS.

-PERTINENT FIGURES-

TAB.5.1 FOUR STAGES OF ASPHYXIA WITH PHYSIOLOGICAL SYMPTOMS, PAGE 29// TAB.5.2 EXPOSURE AND RADIATION LEVELS LEADING TO EXTREME PAIN, PAGE 29// TAB.5.3 EXPOSURE AND RADIATION LEVELS LEADING TO BLISTERING, PAGE 30

-BIBLIOGRAPHY-

AMERICAN GAS ASSOCIATION, REPORT ON LNG SAFETY RESEARCH, VOL 2, ARLINGTON, VA., 1971//BRITISH CRYOGENICS COUNCIL, CRYOGENICS SAFETY MANUAL, LONDON, 1970//PARKER, R. O., A STUDY OF DOWNWIND VAPOR TRAVEL FROM LNG SPILLS, PAPER PRESENTED AT THE A.G.A. OPERATING SECTION DISTRIBUTION CONFERENCE, SEATTLE, MAY 25-28, 1970//PARKER, R. O. AND SPATA, J. K., DOWNDWIND TRAVEL OF VAPORS FROM LARGE POOLS OF CRYOGENIC LIQUIDS, PAPER NO. 24 IN WHITE, J. W. AND NEWMANN, A. E. S., EDS., PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON LNG. CHICAGO. INSTITUTE OF GAS TECHNOLOGY, 1968//U.S. DEPARTMENT OF INTERIOR, BUREAU OF MINES, HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION. PITTSBURGH, FEB 1970//WELKER, J. R., WESSON, H. R. AND SLIEPCEVICH, C. M., LNG SPILLS. TO BURN OR NOT TO BURN. PAPER PRESENTED AT THE AGA OPERATING SECTION DISTRIBUTION CONFERENCE, PHILADELPHIA, MAY 12-15, 1969

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
JOURNAL PROCEEDINGS -
INTRODUCTION TO LNG FOR PERSONNEL SAFETY, CHAP. 5, AMERICAN GAS ASSOC., ARLINGTON, VA., 27-30 (1973)
OTHER INFORMATION -
0004 PAGES, 0000 FIGURES, 0003 TABLES, 0007 REFERENCES

PROCEDURES AND PRACTICES IN THE EVENT OF A SPILL

-ABSTRACT-

THIS CHAPTER DISCUSSES PROCEDURES AND PRACTICES TO BE FOLLOWED IN THE EVENT OF AN LNG SPILL. AFTER AN INTRODUCTORY DISCUSSION ON DISASTER PLANNING AND SAFETY EXERCISES, SPECIFIC SECTIONS OF THE CHAPTER DEAL WITH FIRST AIR, PROTECTIVE CLOTHING AND EQUIPMENT, FIRE PROTECTION AND FIRE CONTROL.

-PERTINENT FIGURES-

TAB.6.1 BUREAU OF MINES RECOMMENDATION FOR USE OF BREATHING APPARATUS IN LOW TEMPERATURE OPERATION, PAGE 33

-BIBLIOGRAPHY-

CICHETTI, J. J., TUNE HEARING CONSERVATION TO A SOUND APPROACH, SAF. MAINT. 173, 45-49 (1969) JANUARY//HYDROGEN HANDLING SUIT PROTECTS NASA TECHNICIANS, SAF. MAINT. 136, 23-24 (OCT 1968)//RECOMMENDED PROCEDURE AND TREATMENT OF CRYOGENIC FREEZING INJURIES, CRYOG. ENG. NEWS 3, 29 (APR 1968) //WALLS, W. L., LNG-A FIRE SERVICE APPRAISAL - PART 1, FIRE JOURNAL 66 NO. 1, 15-17 (1972), LNG-A FIRE SERVICE APPRAISAL - PART 11, FIRE JOURNAL 66, NO. 2, 30-33 (MAR 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
JOURNAL PROCEEDINGS -
INTRODUCTION TO LNG FOR PERSONNEL SAFETY, CHAP. 6, AMERICAN GAS ASSOC., ARLINGTON, VA., 31-8 (1973)
OTHER INFORMATICN -
0007 PAGES, 0000 FIGURES, 0001 TABLES, 0004 REFERENCES

ACCIDENT INVESTIGATION

-ABSTRACT-

THE FOCUS OF THIS CHAPTER IS THE INVESTIGATION OF ACCIDENTS IN WHICH LNG, ITS REFRIGERANTS, CONTAMINANTS, TREATMENT CHEMICALS, OR EQUIPMENT PECULIAR TO LNG ARE INVOLVED. THESE ARE SUBSTANCES WITH WHICH THE TYPICAL GAS PLANT OR UTILITY OPERATOR IS NOT FAMILIAR BY VIRTUE OF PAST EXPERIENCE. THE GREATEST NUMBER OF ACCIDENTS IN LNG PLANTS, HOWEVER, WILL PROBABLY BE THOSE OF A MORE PROSAIC TYPE, THAT IS, THOSE INVOLVING ELECTRIC APPARATUS, HAND TOOLS, VEHICLES, ETC. PROBLEMS OF THE INVESTIGATIONS OF THESE MORE COMMON TYPE ACCIDENTS ARE NOT CONSIDERED HERE SIMPLY BECAUSE THEY HAVE BEEN EXPERIENCED AND INVESTIGATED BEFORE AND HAVE LITTLE TO DO WITH LNG PER SE.

-BIBLIOGRAPHY-

AMERICAN GAS ASSOCIATION, LNG INFORMATION BOOK. NEW YORK (ARLINGTON, VA.), JULY 1968//BLAKE, R. P., ED., INDUSTRIAL SAFETY, CHAP. V, VI, VII, X, XXVII, NEW YORK. PRENTICE-HALL, 1943//DEUTSCH, I., INVESTIGATION OF FIRES AND EXPLOSIONS, PT. 1, GAS 42, 92-93, 96 (NOV 1966)//NATIONAL FIRE PROTECTION ASSOCIATION, FIRE PROTECTION HANDBOOK, 12TH ED. BOSTON, 1962// NATIONAL SAFETY COUNCIL, ACCIDENT PREVENTION MANUAL FOR INDUSTRIAL OPERATIONS, CHAP. 9, 10, 11, 3RD ED. (6TH ED. 1972). CHICAGO, 1955// ZABETAKIS, M. G., SAFETY WITH CRYOGENIC FLUIDS, 147, NEW YORK, PLENUM PRESS, 1967

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
JOURNAL PROCEEDINGS -
INTRODUCTION TO LNG FOR PERSONNEL SAFETY, CHAP. 7, AMERICAN GAS ASSOC., ARLINGTON, VA., 39-46 (1973)
OTHER INFORMATION -
0008 PAGES, 0000 FIGURES, 0000 TABLES, 0008 REFERENCES

key 21427

IDENTIFICATION OF CODES, STANDARDS AND SAFETY REGULATIONS FOR PROPOSED LNG DEVELOPMENT AND TESTING LABORATORIES AT NMRC-GALVESTON

by

LANEY, W. M.

08/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS REPORT IDENTIFIES THE SAFETY REGULATIONS, CODES AND STANDARDS RELEVANT TO THE DESIGN AND OPERATION OF LIQUEFIED NATURAL GAS (LNG) RESEARCH AND DEVELOPMENT CAPABILITIES PROPOSED FOR THE NATIONAL MARITIME RESEARCH CENTER-GALVESTON. THE STUDY WAS CONDUCTED BETWEEN OCTOBER 1972 AND MAY 1973. THE REPORT WILL BE USED IN THE DEVELOPMENT OF CONCEPTUAL DESIGNS FOR TESTING CAPABILITIES FOR USE IN THE MARITIME ADMINISTRATION PROGRAM FOR THE MARINE TRANSPORTATION OF LNG.

-PERTINENT FIGURES-

TAB.1.1 SOURCES FOR VOLUNTARY SAFETY CODES AND STANDARDS FOR OTHER LNG INSTALLATIONS, PAGE 1-6//TAB.1.2 SOURCES FOR SAFETY DATA ON VARIOUS TYPES OF EQUIPMENT USED IN OTHER LNG INSTALLATIONS, PAGE 1-7//TAB.1.3 OUTLINE OF GENERAL COVERAGE OF NATIONAL FIRE PROTECTION ASSOCIATION STANDARD NO. 59A-1971, STANDARD FOR THE PROTECTION AND HANDLING OF LIQUEFIED NATURAL GAS (LNG), PAGE 1-10//TAB.1.4 CODES AND STANDARDS REFERENCED AND INCORPORATED IN NFPA-59A-1971, PAGE 1-13

-BIBLIOGRAPHY-

CHEMICAL ENGINEERING, SAFETY STANDARDS, CODES AND PRACTICES FOR PLANT DESIGN, C. RAY BURKLIN, BROWN AND ROOT, INC., OCTOBER 2, 1972, OCTOBER 16, 1972 AND NOVEMBER 13, 1972 ISSUES//BALL, W. L., CURRENT STATUS OF NATIONAL, STATE, AND LOCAL LNG CODES AND STANDARDS, PIPELINE AND GAS JOURNAL, AIR PRODUCTS AND CHEMICALS, INC., APRIL, 1973 ISSUE//NATIONAL FIRE PROTECTION ASSOCIATION, STANDARD NO. 59A-1971, STANDARD FOR THE PRODUCTION, STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS (LNG)//NATIONAL FIRE PROTECTION ASSOCIATION NEWSLETTER, CLEVELAND GAS EXPLOSION AND FIRE, NOVEMBER 15, 1944 ISSUE

-SOURCE INFORMATION-

CORPORATE SOURCE -
MARITIME ADMINISTRATION, GALVESTON, TEX.
REPORT NUMBER -
NMRC-273-37000-R2//COM-73-11549
OTHER INFORMATICN -
0037 PAGES, 0000 FIGURES, 0005 TABLES, 0005 REFERENCES

keys 21428 through 21430

RECOMMENDED RULES FOR DESIGN AND CONSTRUCTION OF LARGE, WELDED, LOW-PRESSURE STORAGE TANKS - 5TH EDITION

-ABSTRACT-

THE PROVISIONS OF THIS STANDARD FORM A GUIDE FOR MATERIALS, DESIGN, AND FABRICATION OF TANKS TO BE USED FOR STORAGE OF LIQUEFIED ETHANE, ETHYLENE, AND METHANE. A REFRIGERATED TANK MAY BE A SINGLE-WALL INSULATED TANK OR A DOUBLE-WALL TANK CONSISTING OF AN INNER TANK FOR STORING THE REFRIGERATED LIQUID AND AN OUTER TANK ENCLOSING AN INSULATION SPACE AROUND THE INNER TANK. A DOUBLE-WALL TANK IS A COMPOSITE TANK AND THE OUTER TANK IS NOT REQUIRED TO CONTAIN THE PRODUCT OF THE INNER TANK. IN A DOUBLE-WALL TANK, DIFFERENCES IN MATERIALS, DESIGN, AND TESTING EXIST BETWEEN THE INNER AND OUTER TANKS. THE REQUIREMENTS FOR AN API STANDARD 620 TANK ARE SUPERSEDED BY ANY REQUIREMENTS OF THIS APPENDIX WHICH DIFFER THEREFROM. ALL OTHER REQUIREMENTS FOR AN API STANDARD 620 TANK SHALL APPLY.

-PERTINENT FIGURES-

TAB.Q2.1 ASTM MATERIALS FOR PRIMARY COMPONENTS, PAGE 105//TAB.Q3.3 MAXIMUM ALLOWABLE STRESS VALUES, PAGE 107

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN PETROLEUM INST., WASHINGTON, D.C.
REPORT NUMBER -
API STANDARD 620
OTHER INFORMATION -
0129 PAGES, 0029 FIGURES, 0015 TABLES, 0010 REFERENCES

LP-GAS TANK TRUCK ACCIDENT AND FIRE, BERLIN, NEW YORK

by

WALLS, W. L.

07/00/63

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

AT 5:30 PM ON JULY 25, 1962, FAILURE OF THE CARGO TANK OF A TRACTOR-TANK SEMITRAILER UNIT RESULTED IN THE SUDDEN AND COMPLETE RELEASE OF ABOUT 7,000 GALLONS OF LP-GAS. SUBSEQUENT IGNITION, BY AN UNKNOWN SOURCE, OF THE VAPOR-AIR MIXTURE CLOUD RESULTING FROM VAPORIZATION OF THE LIQUIFIED GAS CULMINATED IN THE DEATHS OF 10 PERSONS, INJURIES TO 17 OTHERS AND PROPERTY DAMAGE TO 20 STRUCTURES AND 11 VEHICLES ESTIMATED AT OVER $200,000. LESSONS LEARNED INCLUDE A NEED TO CLARIFY THE REQUIREMENTS FOR DESIGN AND FABRICATION OF A STRUCTURALLY SOUND VEHICLE FOR TRANSPORTATION OF LP-GAS AND OTHER FLAMMABLE COMPRESSED GASES AND A NEED TO CLARIFY ROUTING OPERATIONAL PRACTICES TO REDUCE THE PROBABILITY OF CIRCUMSTANCES WHICH WOULD LEAD TO SUCH ACCIDENTS.

-PERTINENT FIGURES-

FIG. 1 SCENE OF THE LP-GAS TANK TRUCK ACCIDENT AT BERLIN, NEW YORK, PAGE 2.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
PUBLISHER -
NATIONAL FIRE PROTECTION ASSOCIATION
SPONSOR -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
OTHER INFORMATION -
0008 PAGES, 0005 FIGURES, 0000 TABLES, 0000 REFERENCES

PETROLEUM REFINERY PIPING

-ABSTRACT-

THIS PETROLEUM REFINERY PIPING CODE IS A SECTION OF THE AMERICAN NATIONAL STANDARD B31 CODE FOR PRESSURE PIPING. THE CODE CONTAINS BASIC REFERENCE DATA AND FORMULAS NECESSARY FOR DESIGN. IT IS INTENDED TO STATE THESE REQUIREMENTS IN TERMS OF BASIC DESIGN PRINCIPLES TO THE FULLEST POSSIBLE EXTENT, SUPPLEMENTED WITH SPECIFIC REQUIREMENTS WHERE NECESSARY TO OBTAIN UNIFORM INTERPRETATION OF PRINCIPLE. IT CONTAINS PROHIBITIONS IN AREAS WHERE PRACTICES OR DESIGNS ARE KNOWN TO BE UNSAFE. IN OTHER AREAS THE CODE CONTAINS WARNINGS OR FLAGS WHERE CAUTION IS KNOWN TO BE NECESSARY, BUT WHERE IT WAS CONSIDERED THAT A DIRECT PROHIBITION WOULD BE UNWISE. THE CODE INCLUDES, (1) MATERIAL SPECIFICATIONS AND COMPONENT STANDARDS WHICH HAVE BEEN ACCEPTED FOR CODE USAGE. (2) THE DESIGNATION OF PROPER DIMENSIONAL STANDARDS FOR THE ELEMENTS COMPRISING PIPING SYSTEMS. (3) REQUIREMENTS FOR THE DESIGN OF COMPONENT PARTS AND ASSEMBLED UNITS, INCLUDING NECESSARY PIPE SUPPORTING ELEMENTS. (4) REQUIREMENTS FOR THE EVALUATION AND LIMITATION OF STRESSES, REACTIONS, AND MOVEMENTS ASSOCIATED WITH PRESSURE, TEMPERATURE, AND EXTERNAL FORCES. (5) REQUIREMENTS FOR THE FABRICATION, ASSEMBLY, AND ERECTION OF PIPING SYSTEMS. (6) REQUIREMENTS FOR TESTING AND INSPECTING OF ELEMENTS BEFORE ASSEMBLY OR ERECTION AND OF THE COMPLETED SYSTEMS AFTER ERECTION.

-PERTINENT FIGURES-

TAB.319.3.1A THERMAL EXPANSION DATA, PAGE 28//TAB.319.3.1B THERMAL EXPANSION DATA, PAGE 29//TAB.319.3.2A MODULUS OF ELASTICITY FOR FERROUS MATERIAL, PAGE 30//TAB.319.3.2B MODULUS OF ELASTICITY OF NONFERROUS MATERIAL, PAGE 31//TAB.1 APPENDIX A ALLOWABLE STRESSES IN TENSION FOR MATERIALS, PAGE 76//TAB.2 APPENDIX A DESIGN STRESSES FOR BOLTING MATERIALS, PAGE 100

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK
JOURNAL PROCEEDINGS -
AMERICAN NATIONAL STANDARDS INST., NEW YORK, STANDARD NO. ANSI B31.3, 114PP (1973), ADDENDA, 114PP (1974), ADDENDA, 103PP (1975)
OTHER INFORMATION -
0331 PAGES, 0023 FIGURES, 0024 TABLES, 0212 REFERENCES

keys 21435 through 21437

COLD CARGO

by

FAY, J. A.
MACKENZIE, J. J.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE REVIEWS THE PROPERTIES OF NATURAL GAS AFFECTING ITS TRANSPORTABILITY, SOME OF THE HISTORICAL DEVELOPMENTS LEADING UP TO THE PRESENTLY PLANNED IMPORTATION PROGRAM, AND SOME OF THE SAFETY HAZARDS POSED BY THE TRANSPORTATION OF LARGE AMOUNTS OF LIQUID NATURAL GAS (LNG) TO MAJOR U.S. METROPOLITAN PORTS.

-BIBLIOGRAPHY-

FAY, J. A., UNUSUAL FIRE HAZARD OF LNG TANKER SPILLS, TO BE PUBLISHED// HOULT, D. P., THE FIRE HAZARD OF LNG SPILLED ON WATER, 1972 PROCEEDINGS OF THE CONFERENCE ON LNG IMPORTATION AND TERMINAL SAFETY, NATIONAL ACADEMY OF SCIENCES, BOSTON, MASS., 87-102 (JUN 13-4 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
MASSACHUSETTS INST. OF TECH., CAMBRIDGE
JOURNAL PROCEEDINGS -
ENVIRONMENT VOL 14, NO. 9, 21-2 PLUS 27-9 (NOV 1972)
OTHER INFORMATION -
0005 PAGES, 0003 FIGURES, 0002 TABLES, 0006 REFERENCES

TOLERABLE LEVELS OF LNG SPILL HAZARDS

-ABSTRACT-

TO CALCULATE SAFE SEPARATION DISTANCES FROM POTENTIAL LNG SPILL SITES, ONE MUST DEFINE THE TOLERABLE LEVELS FOR THE EXPECTED HAZARDS. SOME OF THE HAZARDS RESULTING FROM AN LNG SPILL ARE COMMON TO OTHER CRYOGENIC LIQUIDS AND HAVE BEEN TREATED IN DETAIL ELSEWHERE. THESE HAZARDS ARE USUALLY MINIMIZED BY WHAT HAVE BECOME STANDARD PLANT PROTECTION SYSTEMS AND SAFE OPERATIONAL PROCEDURES. THE PURPOSE OF THIS CHAPTER IS TO REVIEW THE HAZARDS RESULTING FROM AN LNG SPILL AND TO CITE THE TOLERABLE HAZARD LEVELS FOR PEOPLE AND PROPERTY.

-PERTINENT FIGURES-

TAB.II-1 EFFECT OF DIFFERENT OXYGEN CONCENTRATIONS ON HUMANS, PAGE 14// TAB.II-2 EXPOSURE AND RADIATION LEVELS LEADING TO EXTREME PAIN, PAGE 16// TAB.II-3 EXPOSURE AND RADIATION LEVELS LEADING TO BLISTERING, PAGE 16// TAB.II-4 IGNITION LEVELS OF DIFFERENT CELLULOSIC MATERIALS, PAGE 17// TAB.II-5 CONDITIONS OF FAILURE OF PEAK OVERPRESSURE-SENSITIVE ELEMENTS, PAGE 20

-BIBLIOGRAPHY-

MANNING, W. H., KATZ, J. J. AND HOEKSTRA, H. R., ANL-WMM-596, ARGONNE NATIONAL LABORATORY, ARGONNE, ILL. (JAN 27, 1950)//WEST, J. M. AND WEILLS, J. T., ARGONNE NATIONAL LAB. 4503 (OCT 1, 1950) AND ARGONNE NATIONAL LAB. 4549 (DEC 29, 1950)//PLOTT, R. F., REACTIONS PRODUCED BY THE ELECTRICAL EXPLOSION OF METAL IMMERSED IN A FLUID, ARGONNE NATIONAL LAB. 5040 (DEC 8, 1950)//WILSON, R. E., BARNES, C., JR., KOONZ, R. AND BAKER, L., JR., ISOTHERMAL REACTION OF URANIUM WITH STEAM BETWEEN 400 AND 1600 DEGREES C., NUCL. SCIENCE AND ENGINEERING VOL 25, 109-115 (1966)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM REPT. NO. 2. LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS., REPT. TO AMERICAN GAS ASSOC., ARLINGTON, VA., 12-22 (JAN 1971)
SPONSOR -
AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IU-2-1
OTHER INFORMATION -
0011 PAGES, 0000 FIGURES, 0005 TABLES, 0016 REFERENCES

VAPOR DISPERSION

-ABSTRACT-

ALTHOUGH LNG PLANT ACCIDENTS ARE RARE AND GENERALLY INVOLVE MINOR GAS LEAKS OR SMALL LIQUID SPILLS, THE GAS INDUSTRY AND REGULATORY AGENCIES ARE CONCERNED WITH THE POTENTIAL HAZARDS OF A BROAD SPECTRUM OF ACCIDENTS INCLUDING LARGER SPILLS. FOR EXAMPLE, A BREAK IN A STORAGE TANK PIPE CONNECTION MIGHT LEAD TO GRADUAL FILLING OF A SURROUNDING DIKED AREA WITH LNG. SUCH A DIKED AREA, WOULD BE A SIGNIFICANT SOURCE FOR A VAPOR PLUME. IN AN UNCONFINED SPILL, EITHER ON GROUND OR ON WATER, A SPREADING LNG POOL COULD ALSO BE A SIGNIFICANT VAPOR SOURCE. CONSIDERABLE AMOUNTS OF METHANE VAPOR COULD BE RELEASED FROM STORAGE TANK RELIEF VALVES UNDER CERTAIN ABNORMAL CONDITIONS AND THE EXTENT OF THE FLAMMABLE PLUME WOULD BE OF INTEREST IN THIS CASE ALSO. VARIOUS PUBLICATIONS HAVE BEEN ADDRESSED TO PREDICTION OF VAPOR PLUME MIGRATION FROM DIKES FILLED WITH LNG. OF PARTICULAR NOTE AT THE TIME OF THIS REPORT WERE PAPERS BY PARKER, PARKER AND SPATA, AND WELKER, WESSON AND SLIEPCEVICH WHICH CONSIDERED DOWNWIND MIGRATION OF BOILOFF VAPORS GENERATED FROM A MASSIVE LNG SPILL INTO A DIKED AREA. THESE APPROACHES ARE DESCRIBED HERE AS WELL AS SEVERAL MORE RECENT ANALYSES.

-PERTINENT FIGURES-

FIG.III-1 DISPERSION COEFFICIENTS FOR ATMOSPHERIC TURBULENCE CATEGORIES, PAGE 35//FIG.III-3 VAPORIZATION RATES OF LNG ON AVERAGE SOIL AND WATER, PAGE 43//FIG.III-4 TYPICAL VAPOR HOLDUP TIMES, T(OV), PAGE 44//FIG.III-10 PREDICTIONS OF VARIOUS MODELS FOR PIPE BREAK MODEL, PAGE 61

-BIBLIOGRAPHY-

BURGESS, D. S., MURPHY, J. N. AND ZABETAKIS, M. G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, FINAL REPORT ON CONTRACT MIPR NO. Z-70099-9-92317 TO U. S. COAST GUARD, SRC REPORT NO. S-4105, BUREAU OF MINES, PITTSBURGH, PA. (FEB 1970)//MEMPHIS GAS COMPANY, PRIVATE COMMUNICATION//WISCONSIN NATURAL GAS COMPANY, PRIVATE COMMUNICATION//WALL STREET JOURNAL, TESTS ON LIQUID NATURAL GAS MAY PRODUCE STRICTER SAFETY RULES OVER ITS SHIPMENT (JAN 1971)//MANNING, W. H., KATZ, J. J. AND HOEKSTRA, H. R., ANL-MM-596, ARGONNE NATIONAL LAB., ARGONNE, ILL. (JAN 27, 1950)//WEST, J. M. AND WEILLS, J. T., ARGONNE NATIONAL LAB. 4503 (OCT 1, 1950) AND ARGONNE NATIONAL LAB. 5040 (DEC 8, 1950)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.

JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM REPT. NO. 2. LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS., REPT. TO AMERICAN GAS ASSOC., ARLINGTON, VA., 23-70 (JAN 1971)
SPONSOR -
AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IU-2-1
OTHER INFORMATION -
0048 PAGES, 0011 FIGURES, 0000 TABLES, 0021 REFERENCES

keys 21449 through 21453

VESSEL TRANSPORTATION AND HAZARDS OF LIQUEFIED NATURAL GAS

by

WILLIAMS, H. D.

09/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE PRESENTS SOME DISCUSSION ON THE TRANSPORTATION AND HAZARDS OF LIQUEFIED NATURAL GAS FROM THE VIEWPOINT OF THE CHEMICAL ENGINEERING BRANCH CHIEF OF THE HAZARDOUS MATERIALS DIVISION, U.S. COAST GUARD. BRIEFLY DISCUSSED ARE APPLICABLE SECTIONS FROM THE CODE OF FEDERAL REGULATIONS, THE REQUIREMENTS FOR VAPOR BOILOFF CONTAINMENT AND SECONDARY BARRIERS, OPERATIONAL CONTROLS, AND A HYPOTHETICAL SPILL RESULTING IN VAPOR CLOUD GENERATION AND VAPOR EXPLOSIONS. ALSO, THE EFFECT OF WATER AS A HEAT SINK OF POSSIBLE VALUE IN PREVENTING BRITTLE FRACTURE OF A TANKERS HULL IS CONSIDERED.

-PERTINENT FIGURES-

FIG 4 LNG CONTAINMENT IN MEMBRANE TANK WITH SECONDARY BARRIER,
FIG 4 LNG CONTAINMENT IN MEMBRANE TANK WITH SECONDARY BARRIER,
PAGE 167

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNITED STATES COAST GUARD, CHEMICAL ENGINEERING BRANCH, HAZARDOUS MATERIALS DIVISION, HEADQUARTERS
JOURNAL PROCEEDINGS -
PROC. MAR. SAF. COUNC. VOL 28, NO. 9, 162-8 (SEP 1971)

keys 21443 through 21445

FIRE HAZARDS

-ABSTRACT-

UPON FORMATION, AN LNG VAPOR CLOUD WILL TRAVEL DOWNWIND AND ASSUME THE VELOCITY OF THE WIND. SHOULD AN IGNITION SOURCE SUCH AS AN OPEN FLAME OR AN ELECTRIC SPARK OF ADEQUATE ENERGY (A MINIMUM OF 0.5 MILLIJOULE) BE PRESENT WITHIN THE FLAMMABLE REGION, THE CLOUD WILL IGNITE AND THE FLAME MAY THEN PROPAGATE BACK ALONG THE GROUND (WHERE THE CLOUD VELOCITY IS SMALL) TO THE SOURCE OF THE SPILL. IF THERE IS AN ACCUMULATION OF LNG AT THE SOURCE, THE RESULTING FIRE WILL PREVENT FURTHER CLOUD FORMATION BUT WILL PRESENT A SOURCE OF THERMAL RADIATION TO THE SURROUNDINGS WHICH WILL PERSIST UNTIL THE FUEL IS EXHAUSTED OR THE FIRE EXTINGUISHED. IN ADDITION TO THE THERMAL RADIATION HAZARD FROM THE FIRE AT THE SOURCE, THE VAPOR CLOUD ITSELF PRESENTS AN ADDITIONAL HAZARD. ANY OBJECT WITHIN OR BELOW THE VAPOR CLOUD WILL BE EXPOSED TO RADIATIVE AS WELL AS CONVECTIVE HEATING DURING THE IGNITION PROCESS FOR THE PERIOD OF TIME IT TAKES THE HOT BURNT CLOUD TO RISE, MIX WITH COLD AIR, AND DISPERSE. IN THIS CHAPTER, THE METHODS THAT HAVE BEEN OR CAN BE USED TO ASSESS THESE TWO HAZARDS ARE EVALUATED, LNG FIRE PROTECTION SYSTEMS ARE DISCUSSED, AND AREAS WHERE EXPERIMENTAL INFORMATION IS NEEDED ARE INDICATED.

-PERTINENT FIGURES-

TAB.IV-1 HEAT TRANSFER RATE TO LARGE POOLS OF BURNING LIQUIDS, PAGE 82// TAB.IV-2 FLAME HEIGHT TO POOL DIAMETER RATIO (L/D) AT DIFFERENT BURNING RATES AND POOL DIAMETERS, PAGE 84//FIG.IV-1 COMPARISON OF DIFFERENT MODELS FOR THE PREDICTION OF RADIATION FLUX FROM 400-FT. DIKE FIRE, PAGE 90

-BIBLIOGRAPHY-

BURGESS, D. S., MURPHY, J. N. AND ZABETAKIS, M. G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, FINAL REPORT ON CONTRACT MIPR NO. Z-70099-9-92317 TO U. S. COAST GUARD, SRC REPORT NO. S-4105, BUREAU OF MINES, PITTSBURGH, PA. (FEB 1970)//MEMPHIS GAS COMPANY, PRIVATE COMMUNICATION//MANNING, W. H., KATZ, J. J. AND HOEKSTRA, H. R., ANL-WMM-596, ARGONNE NATIONAL LAB., ARGONNE, ILL. (JAN 27, 1950)//WEST, J. AND ARGONNE NATIONAL LAB. 4549 (DEC 29, 1950)//DIETRICH, J. R., BORAX-I EXPERIMENTS, ARGONNE NATIONAL LAB. 5323, (CONF-TD) (1954)//IVINS, R. O., LIIMATAINEN, R. C. AN[D] TESTS, F. J., REACTION OF URANIUM WITH WATER AS INITIATED BY [A] POWER EXCURSION IN A NUCLEAR REACTOR (TREAT). NUCL. SCIENCE AN[D] ENGINEERING VOL 25, 131-40 (1966)

-SOURCE INFORMATION-

CORPORATE SOURCE -

LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM REPT. NO. 2. LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS., REPT. TO AMERICAN GAS ASSOC., ARLINGTON, VA., 71-102 (JAN 1971)
SPONSOR -
AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IU-2-1
OTHER INFORMATION -
0032 PAGES, 0001 FIGURES, 0004 TABLES, 0034 REFERENCES

LNG-WATER EXPLOSIONS

-ABSTRACT-

IN LABORATORY AND MEDIUM-SCALE EXPERIMENTS PERFORMED AT THE BUREAU OF MINES AND ELSEWHERE, IT WAS FOUND THAT UNDER CERTAIN CIRCUMSTANCES, AN EXPLOSION WOULD OCCUR WHEN LNG AND WATER CAME INTO CONTACT. THE PAUCITY OF EXPERIMENTAL DATA AND THE DIFFICULTY IN REPRODUCING LNG-WATER EXPLOSIONS HAVE MADE IT DIFFICULT TO PREDICT WHETHER OR NOT THE EXPLOSIVE YIELD WILL INCREASE WITH SIZE OF SPILL, WITHOUT FURTHER INVESTIGATION. THE LNG-WATER EXPLOSIONS BEAR A MARKED RESEMBLANCE TO METAL-WATER AND SMELT-WATER EXPLOSIONS, WHERE TWO LIQUIDS WITH A LARGE TEMPERATURE DIFFERENCE ARE BROUGHT INTO CONTACT. THESE POTENTIALLY DESTRUCTIVE EXPLOSIONS HAVE BEEN STUDIED SINCE THE 1950S, BUT TO DATE THERE IS NO DEFINITE EXPLANATION OF THE MECHANISM BY WHICH THEY PROCEED. VARIOUS MECHANISMS HAVE BEEN PROPOSED TO EXPLAIN THE LNG-WATER EXPLOSIONS. THESE ARE REVIEWED HERE.

-PERTINENT FIGURES-

FIG.V-1 HEAT TRANSFER DURING QUENCHING, PAGE 114//FIG.V-2 INTERFACE-EXPLOSION CONCEPT APPLIED TO TWO DIFFERENT CONTACTING CONDITIONS, PAGE 114

-BIBLIOGRAPHY-

BURGESS, D. S., MURPHY, J. N. AND ZABETAKIS, M. G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, FINAL REPORT ON CONTRACT MIPR NO. Z-70099-9-92317 TO U. S. COAST GUARD, SRC REPORT NO. S-4105, BUREAU OF MINES, PITTSBURGH, PA. (FEB 1970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM REPT. NO. 2. LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS., REPT. TO AMERICAN GAS ASSOC., ARLINGTON, VA., 103-23 (JAN 1971)
SPONSOR -
AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IU-2-1
OTHER INFORMATION -
0021 PAGES, 0002 FIGURES, 0000 TABLES, 0053 REFERENCES

key 21448

CONCRETE HULLS A BRIGHT FUTURE AHEAD

by

TURNER, F. H.

03/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE USE OF CONCRETE FOR HULLS AND FLOATING STRUCTURES IS NOT NEW, BUT BECAME WIDESPREAD ONLY DURING THE CRISIS YEARS OF WORLD WARS I AND II. RECENT DEVELOPMENTS HAVE LED TO A REAPPRAISAL, AND THE ACCEPTANCE OF THE MATERIAL FOR SPECIALIZED VESSELS NOW SEEMS CERTAIN. IN THIS ARTICLE, THE REASONS FOR THE USE OF CONCRETE ARE OUTLINED, AND THE PRESENT STAGE OF DEVELOPMENT IS REVIEWED.

-PERTINENT FIGURES-

FIG.2 HOW CONCRETE IS PRESTRESSED USING TENSIONED CABLES ANCHORED TO THE CONCRETE, PAGE 289

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
SHIPP. WORLD SHIPBUILD. VOL 168, NO. 3093, 287-90 (MAR 1975)
OTHER INFORMATION -
0004 PAGES, 0004 FIGURES, 0000 TABLES, 0000 REFERENCES

PIPELINE ACCIDENT REPORT, PHILLIPS PIPE LINE COMPANY, PROPANE GAS EXPLOSION, FRANKLIN COUNTY, MISSOURI, DECEMBER 9, 1970

-ABSTRACT-

ON DECEMBER 9, 1970, A RUPTURE OCCURRED IN THE PHILLIPS PIPELINE COMPANY SYSTEM IN FRANKLIN COUNTY, MISSOURI, WHICH RELEASED 4,538 BARRELS OF PROPANE. AN EXPLOSION, EQUIVALENT TO 100,000 POUNDS OF TNT AND A FIRE RESULTED IN EXTENSIVE PROPERTY DAMAGE WITHIN A 2 MILE RADIUS. NO FATALITIES OCCURRED, BUT TEN PERSONS SUSTAINED INJURIES. THE PROBABLE CAUSE OF THE ACCIDENT WAS THE RUPTURE OF AN INSUFFICIENTLY BONDED LONGITUDINAL WELD, FURTHER WEAKENED BY INTERNAL CORROSION. CONTRIBUTING TO THE RUPTURE WAS A PUMP STATION WHICH SHUT DOWN AND PRODUCED A HIGHER PRESSURE ON THE FAILED PIPELINE SECTION THAN IT HAD BEEN SUBJECTED TO DURING RECENT OPERATIONS. THE EXPLOSION AND FIRE WERE CAUSED BY THE IGNITION OF THE RELEASED PROPANE WHICH HAD BEEN CONFINED IN A CONCRETE BLOCK BUILDING. THE EXPLOSION INSIDE THE BUILDING INITIATED A SHOCK WAVE WHICH CAUSED THE DETONATION OF THE ENTIRE UNCONFINED PROPANE AIR CLOUD. CONTRIBUTING TO THE INTENSITY OF THE EXPLOSION AND FIRE WERE THE WEATHER INVERSION PRESENT AT THE TIME, WHICH ACTED AS A LID ON THE DETONATION AND HELPED TO DEFLECT THE RESULTANT FORCES EARTHWARD, THE DELAY IN SHUTTING DOWN THE PUMPING STATIONS AND THE AMOUNT OF TIME TAKEN TO CLOSE THE MANUALLY OPERATED VALVES ON EITHER SIDE OF THE SPLIT.

-PERTINENT FIGURES-

FIG.1 OVERALL VIEW OF ACCIDENT AREA SHOWING RUPTURE SITE, EXPLOSION ORIGIN AND RESIDENTS' HOUSES, PAGE 3//FIG.2 RUPTURED PIPE SECTION SHOWING COLD-STITCHED LONGITUDINAL WELD, PAGE 5//FIG.5 HYDRAULIC GRADIENT BETWEEN ROSEBUD AND VILLA RIDGE PUMP STATIONS, PAGE 11//FIG.7 PROPANE BURNING AT RUPTURE SITE, PAGE 15//FIG.10 TOPOGRAPHIC MAP SHOWING EXTENT OF BLAST DAMAGE, PAGE 21//FIG.12 ORIGIN OF DETONATION.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, D. C.
REPORT NUMBER -
NTSB-PAR-72-1
PUBLISHER -
NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, D. C.
SPONSOR -
NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, D. C.
OTHER INFORMATION -
0049 PAGES, 0013 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21454 through 21455

INERT GAS GENERATING SYSTEM FOR LIQUEFIED NATURAL GAS CARRIERS

by

MEYER, G. M.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

LNG TANKERS MUST BE INERTED PRIOR TO THE FIRST LOADING AND BEFORE AND AFTER TANK REPAIRS OR DOCKING. THIS PAPER DESCRIBES THE INERT GAS GENERATING SYSTEMS THAT WILL BE INSTALLED ON BOARD THE THREE TANKERS NOW BEING BUILT AT AVONDALE SHIPYARDS FOR EL PASO NATURAL GAS COMPANY.

-PERTINENT FIGURES-

TAB.1 INERT GAS DATA FOR 125,000 M(3) LNG CARRIERS//FIG.3 FREE JET COMBUSTION CHAMBER//FIG.8 STRUCTURAL ELEMENTS OF INERT GAS SYSTEMS

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CRYOGENIC ENGINEERING CONF. AND INTERNATIONAL CRYOGENIC MATERIALS CONF. JOINT MEETING (QUEENS UNIV., KINGSTON, ONTARIO, CANADA, JUL 22-5, 1975). PAPER, 25PP (1975)
OTHER INFORMATION -
0025 PAGES, 0008 FIGURES, 0001 TABLES, 0000 REFERENCES

keys 21460 through 21465

MORE DETAIL ON THE HAZARDS OF LIQUEFIED NATURAL GAS IN MARINE TRANSPORTATION

by

WILLIAMS, H. D.

10/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE PROVIDES A DISCUSSION BY AN OFFICER OF THE U. S. COAST GUARD ON THE HAZARDS OF LIQUEFIED GAS IN MARINE TRANSPORTATION - CONCLUDING THAT THE NEW LNG VESSELS MUST BE DESIGNED, CONSTRUCTED AND OPERATED WITH THE UTMOST CARE IN ORDER THAT THE ODDS OF A CATASTROPHIC CASUALTY WILL BE MINIMIZED. IT IS INDICATED THAT THE HAZARDS OF LNG ARE GENERALLY REPRESENTATIVE OF ALL LIQUEFIED FLAMMABLE GASES.

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNITED STATES COAST GUARD, CHEMICAL ENGINEERING BRANCH, HAZARDOUS MATERIALS DIVISION, HEADQUARTERS
JOURNAL PROCEEDINGS -
PROC. MAR. SAF. COUNC. VOL 29, NO. 10, 203-7 (OCT 1972)
OTHER INFORMATION -
0005 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21474

THE IMCO CODE FOR LIQUEFIED GAS TANKERS

by

LAKEY, R. J.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE IMCO CODE FOR LIQUEFIED GAS TANKERS - THE PREPARATION AND STATUS OF WHICH IS DISCUSSED HERE - HAS BEEN DEVELOPED TO PROVIDE AN INTERNATIONAL STANDARD FOR THE SAFE CARRIAGE BY SEA IN BULK OF LIQUEFIED GASES, AND CERTAIN OTHER SUBSTANCES, BY PRESCRIBING THE DESIGN AND CONSTRUCTION FEATURE OF THE SHIPS INVOLVED IN SUCH CARRIAGE AND THE EQUIPMENT THEY CARRY, SO AS TO MINIMIZE THE RISK TO THE SHIP, THE ENVIRONMENT AND TO THE CREW. THE BASIC PHILOSOPHY IS ONE OF SHIP TYPES RELATED TO HAZARDS OF THE PRODUCTS COVERED BY THE CODE. EACH OF THE PRODUCTS MAY HAVE ONE OR MORE HAZARD PROPERTIES WHICH INCLUDE FLAMMABILITY, TOXICITY, CORROSIVITY AND REACTIVITY. A FURTHER POSSIBLE HAZARD MAY ARISE DUE TO THE GASES BEING TRANSPORTED UNDER CRYOGENIC OR PRESSURE CONDITIONS. THROUGHOUT THE DEVELOPMENT OF THE CODE IT WAS RECOGNIZED THAT IT MUST BE BASED UPON SOUND NAVAL ARCHITECTURAL AND ENGINEERING PRINCIPLES AND THE BEST UNDERSTANDING AVAILABLE AS TO THE HAZARDS OF THE VARIOUS PRODUCTS COVERED. FURTHERMORE, IT WAS UNDERSTOOD AND RECOGNIZED THAT GAS SHIP DESIGN TECHNOLOGY IS NOT ONLY A COMPLEX TECHNOLOGY, BUT IS RAPIDLY EVOLVING AND THAT THE CODE SHOULD NOT REMAIN STATIC BUT SHOULD BE CONTINUALLY RE-EVALUATED AND REVISED. IN PREPARING THE CODE IT WAS RECOGNIZED THAT SEVERE COLLISIONS OR STRANDINGS COULD LEAD TO CARGO TANK DAMAGE AND RESULT IN UNCONTROLLED RELEASE OF CARGO. SUCH RELEASE COULD RESULT IN RAPID EVAPORATION AND DISPERSION OF THE CARGO AND IN SOME CASES CAUSE BRITTLE FRACTURE OF A SHIPS HULL. THE REQUIREMENTS IN THE CODE ARE INTENDED TO MINIMIZE THIS RISK AS FAS AS IS PRACTICABLE BASED ON PRESENT KNOWLEDGE AND TECHNOLOGY. THE CODE PRIMARILY DEALS WITH SHIP DESIGN AND EQUIPMENT.

-PERTINENT FIGURES-

TAB.1 PRODUCTS UNDER CONSIDERATION FOR INCLUSION IN THE CODE FOR GAS CARRIERS, PAGE 215//TAB.2 MAXIMUM EXTENT OF DAMAGE, PAGE 216

-SOURCE INFORMATION-

CORPORATE SOURCE -
COAST GUARD, WASHINGTON, D.C.//INTERGOVERNMENTAL MARITIME

CONSULTATIVE ORGANIZATION (IMCO) AD HOC GROUP ON GAS CARRIERS
JOURNAL PROCEEDINGS -
GASTECH 74 LNG AND LPG TECHNOLOGY CONGRESS, (PRES. AT)
AMSTERDAM, NETHERLANDS, NOV 13-4, 1974. PAPER, 211-9 (1975)
PUBLISHER -
GASTECH EXHIBITIONS LTD.
OTHER INFORMATION -
0009 PAGES, 0000 FIGURES, 0002 TABLES, 0000 REFERENCES

keys 21475 through 21476

DEVELOPMENT OF A RISK MANAGEMENT SYSTEM - AN OVERVIEW OF US COAST GUARD MARINE SAFETY PROJECTS

by

CECE, J. M.
GARDENIER, J. S.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE U.S. COAST GUARD (USCG) IS THE COUNTRYS REGULATORY AGENCY FOR MERCHANT MARINE SAFETY AND PORT AND WATERWAY SAFETY. IT IS CONDUCTING RESEARCH TO DEVELOPE OPERATIONS ANALYSIS TECHNIQUES TO SUPPORT A WIDE RANGE OF REGULATORY DECISIONS BEARING ON THE THREAT TO PUBLIC SAFETY AND TO THE ENVIRONMENT FROM THE TRANSPORT AND HANDLING OF HAZARDOUS MATERIALS IN, AND NEAR, US PORTS. THE OBJECTIVES OF THE RESEARCH IS SIMPLE, ATTAINMENT OF THOSE OBJECTIVES IS NOT. THE OBJECTIVE OF THE RESEARCH IS TO EVALUATE THE COSTS AND BENEFITS OF A WIDE VARIETY OF ALTERNATIVE COAST GUARD REGULATORY AND ENFORCEMENT ACTIONS TO PROMOTE CONSISTENT AND EFFECTIVE PROTECTION OF THE PUBLIC AND THE ENVIRONMENT FROM ACCIDENT HAZARDOUS MATERIAL SPILLS. THE DIFFICULTIES ARE SO DIVERSE AND COMPLEX THAT THERE HAS BEEN VERY SERIOUS CONCERN THAT THE PROBLEM MAY BE ANALYTICALLY INTRACTABLE. THE USCG IS NOW PREPARED, AFTER THREE YEARS OF RESEARCH, TO DEMONSTRATE THAT MAJOR PORTIONS OF SUCH ANALYSIS ARE BOTH FEASIBLE AND POWERFUL. NOT THAT ALL OF THE DIFFICULTIES HAVE BEEN OVERCOME, BY ANY MEANS, BUT ENOUGH OF THE CONCEPTUAL DESIGN, MATHEMATICAL, AND DATA PUZZLES HAVE BEEN SOLVED THAT RISK ANALYSIS CAN BEGIN TO HAVE A SIGNIFICANT INFLUENCE ON MANAGEMENT OF THE REGULATORY PROGRAMME. FUTURE RESEARCH WILL NOW BE ORIENTED TO EXPANDING AND REFINING THE CORE TECHNIQUES. DISCUSSED HERE ARE THE PROBLEMS OF PORT SAFETY AND PROTECTION OF THE MARINE ENVIRONMENT. THE QUESTIONS FACING DECISION-MAKERS CONCERNED HAVE BEEN POSED, AND THE U.S. COAST GUARDS RESEARCH AND DEVELOPMENT PROGRAMS TO DEVELOP ANSWERS TO THESE QUESTIONS HAS BEEN OUTLINED.

-PERTINENT FIGURES-

FIG.1 RISK MANAGEMENT - THE SYSTEMS APPROACH, PAGE 228//FIG.2 DISTRIBUTION OF SIGNIFICANT SPILLS OF VESSEL CASUALTY TYPE (CY 70-72) TOTAL INCIDENTS AND (VOLUME), PAGE 228//FIG.3 SCHEMATIC DIAGRAM OF THE ANALYTICAL SPILL-RISK MODEL, PAGE 229//FIG.4 SAMPLE PROCESS OUTLINE OF VULNERABILITY MODEL, PAGE 229

-BIBLIOGRAPHY-

CECE, J. M. AND MILTCN, J. T., ENERGY UTILIZATION AND SAFETY ASPECTS OF SHIPBOARD CRYOGENICS, CRYOGENIC SOCIETY OF AMERICA SYMPOSIUM AND EXPOSITION (OCT 1973)//U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES, HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, U.S. COAST GUARD, OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C., (NTIS AD 705 078) (FEB 1970)// U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES, HAZARDS OF SPILLAGE OF LNG INTO WATER. U.S. COAST GUARD, OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C., (NTIS AD 754 498) (SEP 1971)//DRAKE, E. M. AND PUTNAM, A. A., VAPOR DISPERSION FROM SPILLS OF LNG ON LAND, CRYOGENIC ENGINEERING CONF. (AUG 1973)//U.S. NAVAL WEAPONS CENTER, EXPLOSION HAZARDS ASSOCIATED WITH SPILLS OF LARGE QUANTITIES OF HAZARDOUS MATERIALS, U.S. COAST GUARD, OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C., (NTIS AD 000 000) (MAR 1974)//NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER, PUBLICATION OF LIFETIME EXTREME ACCELERATIONS FOR DESIGN OF LNG CARGO TANKS. U.S. COAST GUARD OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C., (NTIS AD 779 635) (MAR 1974)

-SOURCE INFORMATION-

CORPORATE SOURCE -
COAST GUARD, WASHINGTON, D.C.
JOURNAL PROCEEDINGS -
GASTECH 74 LNG AND LPG TECHNOLOGY CONGRESS, (PRES. AT) AMSTERDAM, NETHERLANDS, NOV 13-4, 1974. PAPER, 221-30 (1975)
PUBLISHER -
GASTECH EXHIBITIONS LTD.
OTHER INFORMATION -
0010 PAGES, 0006 FIGURES, 0003 TABLES, 0020 REFERENCES

keys 21477 through 21479

LNG CARGO TANKS - A SHIPS MOTIONS ANALYSIS OF INTERNAL DYNAMIC LOADING

by

BAITIS, A. E.
MEYERS, W. G.
BALES, S. L.
DWYER, J. R.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

PROGRESS AND RESULTS ARE OFFERED FROM A TWO YEAR RESEARCH PROJECT DEVOTED TO LNG CARGO TANK DESIGN GUIDELINES. THE WORK WAS UNDERTAKEN BY THE NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER AND SPONSORED BY THE U.S. COAST GUARD FOR ASSISTANCE IN ITS REGULATORY PROGRAM. FIVE LNG TANK VESSELS WERE EXAMINED RANGING IN CAPACITIES FROM 29,000 TO 200,000 CU. M, INCLUDING SPHERICAL AND MEMBRANE TANK SYSTEMS. EXTREME ACCELERATIONS AND MOTIONS ARE DEVELOPED BY APPLYING SHORT-TERM STATISTICS TO HULL RESPONSES PREDICTED FOR SEVERE SEA CONDITIONS. HISTORICAL DATA FROM OCEAN AREAS SERVING LNG SHIPPING ROUTES PROVIDES THE SEA INPUT. DESIGN ACCELERATIONS ARE SELECTED FROM THE EXTREME VALUES BY APPLYING OPERATOR STRATEGIES IN STORMS. THIS INVOLVES SPEED REDUCTION, HEADING CHANGE TO LIMIT VESSEL MOTIONS, MOST LIKELY HEADINGS, ETC. THE IMPACT OF STRATEGIES CHOSEN IS MEASURED BY THE EXCLUSION OF EXTREMES FROM THE RANGE OF ACCELERATIONS WHICH THE VESSEL MAY ENCOUNTER IN ITS LIFETIME. THE INFLUENCE OF SHIP LOAD VARIATION ON DESIGN ACCELERATIONS IS SIMILARLY EXAMINED. THE INTERNAL TANK PRESSURE IS OBTAINED BY COMBINING ACCELERATION COMPONENTS AND STATIC TANK POSITIONS AS PREDICTED IN TIME HISTORIES. IT IS SHOWN THAT THE INTERNAL TANK PRESSURES DUE TO SHIP MOTIONS AND GRAVITY ARE DETERMINED PRIMARILY BY THE DESIGN VERTICAL ACCELERATIONS AND NOT BY LATERAL OR LONGITUDINAL ACCELERATIONS. COMPARISONS ARE MADE WITH DESIGN VERTICAL ACCELERATIONS CALCULATED FROM THE JUNE 1974 ACCELERATION GUIDANCE RULES OF THE INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES.

-BIBLIOGRAPHY-

BAITIS, A. E., BALES, S. L. AND MEYERS, W. G., DESIGN ACCELERATION AND SHIP MOTIONS OF LNG CARGO TANKS, TENTH SYMPOSIUM ON NAVAL HYDROMECHANICS (JUNE 1974)//BAITIS, A. E., MEYERS, W. G. AND BALES, S. L., SUMMARY OF DEVELOPMENT FOR LNG TANK DESIGN ACCELERATION RULES, NSRDC SHIP PERFORMANCE DEPARTMENT REPORT SPD-517-03 (TO BE PUBLISHED)//WITHRINGTON, J. K., ANALYTICAL

METHODS FOR VERIFYING THE STRUCTURAL INTEGRITY OF LNG CARRIERS, PAPER PRESENTED AT THIRD INTERNATIONAL CONFERENCE ON LIQUIFIED NATURAL GAS, WASHINGTON, D.C. (SEP 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER//COAST GUARD, WASHINGTON, D.C.
JOURNAL PROCEEDINGS -
GASTECH 74 LNG AND LPG TECHNOLOGY CONGRESS, (PRES. AT) AMSTERDAM, NETHERLANDS, NOV 13-4, 1974. PAPER, 233-67 (1975)
PUBLISHER -
GASTECH EXHIBITICNS LTD.
SPONSOR -
COAST GUARD, WASHINGTCN, D.C.
OTHER INFORMATION -
0035 PAGES, 0030 FIGURES, 0000 TABLES, 0034 REFERENCES

keys 21480 through 21482

DISPERSION OF HYDROGEN OR METHANE FUELS RELEASED INTO AN AUTOMOBILE INTERIOR

by

ARVIDSON, J. M.
HORD, J.
MANN, D. B.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

GASOLINE-POWERED AUTOMOBILES ARE BEING CONVERTED TO OPERATE ON GASEOUS FUELS SUCH AS HYDROGEN (H(2)) OR METHANE (CH(4)). THE FUEL IS OFTEN STORED AS A CRYOGENIC LIQUID (H(2) AT 20 K AND CH(4) AT 112 K) IN DEWAR-LIKE VESSELS LOCATED IN THE TRUNK OF THE CAR. CRYOGENIC STORAGE PROVIDES FOUR TO FIVE TIMES GREATER VEHICLE RANGE THAN GAS STORAGE IN HIGH PRESSURE CYLINDERS OF COMPARABLE VOLUME. POTENTIAL LEAKAGE OF THESE GASEOUS FUELS INTO THE PASSENGER COMPARTMENT OF THE VEHICLE CONSTITUTES A SAFETY THREAT. DEFINITIVE EXPERIMENTS WERE PERFORMED TO IDENTIFY THE EXPLOSION HAZARDS AND ESTABLISH VENTING CRITERIA AND GENERAL SAFE-GUARDS FOR H(2) OR CH(4) FUELED PASSENGER VEHICLES. INITIAL TESTS WERE CONDUCTED USING METHANE AT THREE INLET TEMPERATURES (300, 200, AND 121 K) AND IT WAS DETERMINED THAT THE GAS DISPERSION PATTERNS WERE NOT TEMPERATURE DEPENDENT. APPROPRIATELY DESIGNED VENTILATION SYSTEMS CAN SIGNIFICANTLY REDUCE THE SAFETY HAZARDS ASSOCIATED WITH ACCUMULATED COMBUSTIBLE GASES. VENTS ARE RECOMMENDED FOR ALL AUTOS CONVERTED TO BURN H(2) OR CH(4) AND MAY POSSIBLY BE ELIMINATED IN NEW CARS THAT ARE DESIGNED FOR GASEOUS FUEL OPERATION. COMBUSTIBLE GAS WARNING SYSTEMS ARE RECOMMENDED, AT LEAST IN THE INTERIM, FOR ALL (CONVERTED AND NEW-DESIGN) GASEOUS FUELD VEHICLES. H(2) AND CH(4) GASES APPEAR EQUALLY SAFE AS VEHICULAR FUELS IF USED IN PROPERLY DESIGNED VEHICLES.

-PERTINENT FIGURES-

FIG.2 TYPICAL DISPERSION CHARACTERISTICS FOR HYDROGEN GAS RELEASED (LEAKED) INTO THE PASSENGER COMPARTMENT OF A 1970 SEDAN, PAGE 7//FIG.3 TYPICAL DISPERSION CHARACTERISTICS FOR METHANE GAS RELEASED (LEAKED) INTO THE PASSENGER COMPARTMENT OF A 1970 SEDAN, PAGE 8//FIG.4 TYPICAL DISPERSION CHARACTERISTICS FOR HYDROGEN OR METHANE GAS INJECTED INTO THE PASSENGER COMPARTMENT OF A 1970 SEDAN, PAGE 9//FIG.5 THRESHOLD CONCENTRATION (100 PERCENT LEL) AS A FUNCTION OF TIME AND FLOW RATE FOR H(2) AND CH(4) GASES IN THE PASSENGER COMPARTMENT OF A 1970 SEDAN, PAGE 10//FIG.7 EFFECT OF VENT AREA AND A SUSTAINED LEAKAGE FLOW RATE ON EQUILIBRIUM

CONCENTRATIONS OF CH(4) GAS IN THE PASSENGER COMPARTMENT OF A 1970 STANDARD SIZE SEDAN, PAGE 12//FIG.8 POTENTIAL FIRE AND EXPLOSION HAZARDS IN THE PASSENGER COMPARTMENT OF A 1970 SEDAN AS A FUNCTION OF VENT AREA AND LEAKAGE FLOW RATE, PAGE 13

-BIBLIOGRAPHY-

JOHNSON, E. F., FIRE PROTECTION DEVELOPMENTS IN CNG-FUELED VEHICLE OPERATIONS, FIRE J. VOL 66, NO. 6 (NOV 1972)//SHOOTER, D. AND KALELKER, A., THE BENEFITS AND RISKS ASSOCIATED WITH GASEOUS FUELED VEHICLES, REPORT TO THE MASSACHUSETTS TURNPIKE AUTHORITY, ARTHUR D. LITTLE CASE 74400-2 (MAY 1972)//ENSERINK, E., DUAL-FUEL MOTOR VEHICLE SAFETY IMPACT TESTING, DOT/HS-800 622, AVAILABLE FROM NTIS (NOV 1971)//AN EDITORIAL STAFF SUMMARY OF CALIFORNIA REGULATIONS FOR LNG AUTO INSTALLATIONS, CRYO. TECH., 132-4 (JUL-AUG 1972)//JOHNSON, R. K., INSTALLATION OF LIQUEFIED NATURAL GAS FUEL CONTAINERS AND SYSTEMS ON MOTOR VEHICLES, CRYOGENS AND GASES, TESTING METHODS AND STANDARDS DEVELOPMENT, ASTM STP537, 12-6 (1973)// ARVIDSON, M. H., HORD, J. AND MANN, D. B., EFFLUX OF GASEOUS HYDROGEN OR METHANE FUELS FROM THE INTERIOR OF AN AUTOMOBILE, NAT. BUR. STAND. TECH. NOTE 666, 50PP (MAR 1975)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL BUREAU OF STANDARDS, BOULDER, COLO.
JOURNAL PROCEEDINGS -
CRYOGENIC ENGINEERING CONF. AND INTERNATIONAL CRYOGENIC MATERIALS CONF. JOINT MEETING, QUEENS UNIV., KINGSTON, ONTARIO, CANADA, JUL 22-5, 1975. PAPER (1975)
SPONSOR -
GENERAL SERVICES ADMINISTRATION, WASHINGTON, D.C.
OTHER INFORMATION -
0019 PAGES, 0008 FIGURES, 0000 TABLES, 0019 REFERENCES

keys 21483 through 21484

PLANNING IS THE KEY TO LNG TANK PURGING, ENTRY, AND INSPECTION

by

DEVANNA, L.
DOULAMES, G.

09/08/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DESCRIBES THE DETAILED SAFETY, OPERATING AND TRAINING PROCEDURES UTILIZED BY LOWELL GAS COMPANY FOR THE SUCCESSFUL PURGING OUT OF SERVICE, ENTRY, REPAIR WORK, MODIFICATION, AND RETURN TO SERVICE OF ITS ONE BILLION CUBIC FOOT LNG TANK IN TEWKSBURY, MASSACHUSETTS. NO FLAMMABLE GAS WAS VENTED TO THE ATMOSPHERE, AND A NITROGEN ATMOSPHERE WAS MAINTAINED IN THE TANK THROUGHOUT THE OPERATION.

-PERTINENT FIGURES-

LNG TANK CROSS SECTION, PAGE 74//FIG.2 QUANTITY OF PURGE GAS REQUIRED ASSUMING PURE DILUTION MODEL COMPARED WITH QUANTITY OF GAS ACTUALLY REQUIRED BY ACHIEVING PISTON EFFECT, PAGE 76

-SOURCE INFORMATION-

CORPORATE SOURCE -
LOWELL GAS CO., LOWELL, MASS.
JOURNAL PROCEEDINGS -
OIL GAS J. VOL 73, NO. 36, 74-82 (SEP 1975)
OTHER INFORMATION -
0006 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21485 through 21487

HOW LNG BOILS ON SOILS

by

DRAKE, E. M.
REID, R. C.

05/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE REVIEWS VARIOUS SPILL TESTS THAT HAVE CONDUCTED WITH LNG, LIQUID METHANE AND LIQUID NITROGEN - DESCRIBING THE RESULTS AND KNOWLEDGE GAINED FROM EACH TEST. A BRIEF RESUME OF SEVERAL OF THE MORE NOTABLE MATHEMATICAL MODELS DEVELOPED AS A RESULT OF THESE TESTS IS ALSO GIVEN. IT IS CONCLUDED THAT. (1) BOILING RATES OF LNG ON COMPACTED SOILS MAY BE INFLUENCED SIGNIFICANTLY BY SOIL TYPE, MOISTURE CONTENT AND LNG COMPOSITION. RAIN, HUMIDITY AND DISTURBANCE OF THE INITIALLY COMPACTED SOIL ARE LIKELY TO HAVE SIGNIFICANT EFFECTS ON BOILING RATES IN THE EVENT OF A SPILL. TO ACCURATELY CHARACTERIZE BEHAVIOR OF A SPECIFIC DIKE FLOOR SOIL, IT APPEARS THAT EXPERIMENTAL DATA ON SIMILARLY COMPACTED AND TREATED MATERIALS ARE NEEDED. (2) SIGNIFICANT REDUCTIONS IN BOILING RATES CAN BE OBTAINED BY SEALING THE DIKE SURFACE TO PREVENT PERCOLATION. THE SEAL MUST NECESSARILY REMAIN INTACT UNDER THERMAL SHOCK CONDITIONS ASSOCIATED WITH AN LNG SPILL. (3) DIKES FINISHED WITH CRUSHED ROCK OR STONE WILL YIELD MUCH HIGHER VAPORIZATION RATES THAN COMPACTED SOIL DIKES BECAUSE OF EASY PERCOLATION AND HIGH SURFACE AREA OF ROCK PER UNIT FLOOR AREA. LIKEWISE, DIKES FINISHED WITH AN INSULATING CONCRETE, MAY REDUCE LNG SPILL BOILING RATES BY AN ORDER OF MAGNITUDE OR MORE BELOW THOSE FOR COMPACTED SOIL DIKES. FOAM INSULATIONS, PROPERLY SEALED, OFFER STILL FURTHER POSSIBILITY FOR REDUCING BOILING RATES, ALTHOUGH INSTALLATION AND MAINTENANCE OF SUCH DIKE COVERINGS MAY BE DIFFICULT. (FOAM INSULATED FLOORS REMAINED IN PLACE AND EFFECTIVE IN ONLY ONE OF FOUR TESTS FOR WHICH THEY WERE INSTALLED.) (4) MORE EXPERIMENTAL WORK IS NEEDED TO ASSESS THE BEHAVIOR AND PRACTICALITY OF POTENTIAL INSULATING OR SEALING MATERIALS UNDER LNG SPILL CONDITIONS. ALSO, FURTHER STUDY OF LNG FOAMING BEHAVIOR (AS A FUNCTION OF COMPOSITION) AND ITS CONNECTION, IF ANY, TO PERCOLATION EFFECTS IN COMPACTED SOILS WOULD BE A MOST INTERESTING RESEARCH AREA.

-PERTINENT FIGURES-

TAB.1 THERMAL PROPERTIES OF SOIL, PAGE 192//FIG.2 BOILING RATES OF LIQUID NITROGEN ON AGA TEST SOIL, PAGE 193//FIG.3 BOILING RATES OF LIQUID METHANE ON AGA TEST SOIL, PAGE 193//FIG.4 BOILING RATES OF

LIQUID METHANE ON FINE SAND, PAGE 194//FIG.5 BOILING RATES OF AN LNG (93 PERCENT METHANE-7 PERCENT ETHANE) ON AGA TEST SOIL, PAGE 194

-BIBLIOGRAPHY-

PARKER, R. O., A STUDY OF DOWNWIND VAPOR TRAVEL FROM LNG SPILLS, AMERICAN GAS ASSOCIATICN DISTRIBUTION CONFERENCE, SEATTLE, WASH. (MAY 1970)// WELKER, J. R., WESSON, H. R. AND SLIEPCEVICH, C. M., TO BURN OR NOT TO BURN, PAPER PRESENTED AT THE AMERICAN GAS ASSOCIATION DISTRIBUTION CONF., PHILADELPHIA, PA. (MAY 1969)//HUMBERT-BASSET, R. AND MONTET, A., DISPERSION DANS L ATMOSPHERE D UN NAUGE GAZEUX FORME PAR EPANDAGE DE G.N.L. SUR LE SOL, THIRD INTERNATICNAL CONFERENCE ON LIQUEFIED NATURAL GAS, WASHINGTON, D.C. (SEP 1972)//LNG SAFETY PROGRAM. PHASE II, AMERICAN GAS ASSOCIATICN, PROJ. IS-3-1 (JUL 1974)//DRAKE, E. M. AND PUTNAM, A. A., VAPOR DISPERSION FROM LNG SPILLS ON LAND, ADV. IN CRYO. ENG., 20, PAPER D-1 (1975)// EVALUATION OF LNG VAPOR CONTROL METHODS, A. D. LITTLE, INC., REP. 76285, AMERICAN GAS ASSOCIATION (OCT 1974)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.//MASSACHUSETTS INST. OF TECH., CAMBRIDGE, MASS.
JOURNAL PROCEEDINGS -
HYDROCARBCN PROCESS. VOL 54, NO. 5, 191-4 (MAY 1975)
OTHER INFORMATION -
0004 PAGES, 0005 FIGURES, 0001 TABLES, 0009 REFERENCES

keys 21488 through 21489

A NEW MODEL FOR LNG TANK ROLLOVER

by

GERMELES, A. E.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

A NEW MATHEMATICAL MODEL IS PRESENTED FOR THE DYNAMICS OF ROLLOVER IN LNG STORAGE TANKS. THE MODEL IS BASED ON THE CONCEPT THAT AN INITIALLY STRATIFIED TANK CAN BE REPRESENTED BY A SPECIFIED NUMBER OF DENSITY LAYERS OR CONVECTION CELLS. DIFFERENTIAL EQUATIONS OF ENERGY AND MASS CONSERVATION ARE WRITTEN FOR EACH CELL TAKING INTO ACCOUNT THE TURBULENT TRANSPORT OF HEAT AND MASS ACROSS THE CELL INTERFACES BY DOUBLE-DIFFUSIVE CONVECTION. HEAT LEAK INTO THE TANK AND THE EFFECTS OF METHANE BOIL-OFF FROM THE FREE SURFACE ARE ALSO INCLUDED IN THE MODEL. THE MODEL HAS BEEN COMPUTERIZED. THE LA SPEZIA ROLLOVER OF 1971 HAS BEEN SIMULATED SUCCESSFULLY BY THE MODEL. THE PREDICTED ROLLOVER TIME IS ABOUT 30 HOURS AFTER THE ONSET OF THE CARGO TRANSFER, WHICH IS ALSO THE OBSERVED TIME. THIS ALMOST EXACT AGREEMENT WAS NOT EXPECTED AND MUST BE FORTUITOUS. THERE WERE SOME INSTRUMENT FAILURES DURING THE PEAK OF THE LA SPEZIA ROLLOVER, BUT WHEN THE AVAILABLE RECORDED DATA ARE EXTRAPOLATED, THERE IS ALSO GOOD AGREEMENT (WITHIN 40 PERCENT) BETWEEN PREDICTED AND ACTUAL BOIL-OFF RATES DURING THE ROLLOVER. THE MODEL HAS BEEN DEVELOPED TO PROVIDE PREDICTIONS OF ROLLOVER TIMES AND INTENSITIES AND MAY BE USED IN ROLLOVER PREVENTION STRATEGIES. A NORMALIZED PARAMETRIC SOLUTION IS PRESENTED IN GRAPHICAL FORM. THE SOLUTION IS INTENDED FOR QUICK ENGINEERING ESTIMATES OF ROLLOVER TIMES AND INTENSITIES.

-PERTINENT FIGURES-

FIG.1 STRATIFIED TANK WITH THREE CELLS, PAGE 2

-BIBLIOGRAPHY-

SARSTEN, J. A., LNG STRATIFICATION AND ROLLOVER, PIPELINE AND GAS JOURNAL VOL 199, 37-9 (1972)//CHATTERJEE, N. AND GEIST, J. M., THE EFFECTS OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS, PIPELINE AND GAS JOURNAL VOL 199, 40-5 (1972)//DRAKE, E. M., GEIST, J. M. AND SMITH, K. A., PREVENT LNG ROLLOVER, HYDROCARBON PROCESSING VOL 52, 87-90 (1973)// SMITH, K. A., LEWIS, J. P., RANDALL, G. A. AND MELDON, J. H., PREVENTION OF ROLLOVER BY MIXING DURING THE FILLING OF LNG STORAGE TANKS, CRYOGENIC ENGINEERING CONFERENCE, ATLANTA,

GEORGIA (AUG 1973)//SMITH, K. A. AND GERMELES, A. E., LNG TANK STRATIFICATION CONSEQUENT TO FILLING PROCEDURES, FOURTH INTERNATIONAL CONFERENCE ON LIQUEFIED NATURAL GAS, ALGIERS, ALGERIA (JUN 1974)//HASHEMI, H. T. AND WESSON, H. R., CUT LNG STORAGE COSTS, HYDROCARBON PROCESSING, 117-20 (AUG 1971)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CABOT CORP., BILLERICA, MASS.
JOURNAL PROCEEDINGS -
CRYOGENIC ENGINEERING CONF. AND INTERNATIONAL CRYOGENIC MATERIALS CONF. JOINT MEETING, KINGSTON, ONTARIO, CANADA, JUL 22-5, 1975. PAPER (1975)
OTHER INFORMATION -
0006 PAGES, 0001 FIGURES, 0000 TABLES, 0008 REFERENCES

keys 21490 through 21491

HIGHLIGHTS OF REVISED API TANK STANDARDS

by

MCGRATH, R. V.

05/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

FOR MANY YEARS THE TWO API TANK STANDARDS, 650 AND 620, HAVE COVERED CARBON STEEL MATERIALS, WITH STATED LIMITATIONS ON STRESS, THICKNESS AND DETAILS. IN THE LAST 10 YEARS, PROGRESS IN MATERIALS, WELDING AND DESIGN HAS NECESSITATED FREQUENT REVISIONS TO THE STANDARDS, WITH SIGNIFICANT EFFECTS ON PURCHASERS AND MANUFACTURERS. TWO FACTORS WHICH HAVE BEEN INSTRUMENTAL IN ENCOURAGING SOME OF THE IMPORTANT ACTIONS BY THE SUBCOMMITTEE ON PRESSURE VESSELS AND TANKS, ARE THE NEED FOR SUPER-SIZED OIL TANKS AT TERMINALS WHERE SUPERTANKERS LOAD AND UNLOAD THEIR TREMENDOUS QUANTITIES OF CRUDE OIL, AND THE INCREASED DEMAND FOR TANKS CAPABLE OF STORING LIQUEFIED GASES (LPG AND LNG) AT REFRIGERATED AND CRYOGENIC TEMPERATURES. THESE FACTORS HAVE LED TO CONSIDERATION OF MATERIAL THICKNESS LIMITATIONS, MATERIAL AND WELDING TOUGHNESS REQUIREMENTS, INCREASED DESIGN STRESSES WITH MORE WELD INSPECTION, LARGER TANK CONNECTIONS HAVING IMPROVED DETAILS AND CONSTRUCTION TOLERANCES FOR TANK SHELLS. DESCRIBED HERE ARE THE MORE RECENT REVISIONS IN API-650 AND API-620 TANK STANDARDS WHICH ARE SIGNIFICANT TO PURCHASERS AND MANUFACTURERS OF SUCH TANKS, AND WHICH WARRANT SOME EMPHASIS, PARTICULARLY TO THOSE NOT HAVING THE BACKGROUND OF COMMITTEE DISCUSSIONS. REVISIONS AND ADDITIONS DESCRIBED ARE MAINLY FROM THE FIFTH EDITION (JULY 1973) OF THE API STANDARDS AND THE SUBSEQUENT SUPPLEMENTS TO THOSE EDITIONS.

-BIBLIOGRAPHY-

STEEL TANKS FOR LIQUID STORAGE, PUBLISHED BY THE AMERICAN IRON AND STEEL INSTITUTE IN COOPERATION WITH THE STEEL PLATE FABRICATORS ASSOCIATION// WOZNIAK, R. S., LATERAL SEISMIC LOADS ON FLAT-BOTTOMED TANKS, WATER TOWER (CHICAGO BRIDGE AND IRON CO.) (NOV 1971)

-SOURCE INFORMATION-

CORPORATE SOURCE -
    CHICAGO BRIDGE AND IRON CO., ILL.
JOURNAL PROCEEDINGS -

HYDROCARBON PROCESS, VOL 54, NO. 5, 89-94 (MAY 1975)
OTHER INFORMATICN -
0006 PAGES, 0001 FIGURES, 0001 TABLES, 0006 REFERENCES

03890-03891

SOME QUESTIONS RAISED BY FLIXBOROUGH

by

KLETZ, T. A.

03/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

THE PAPER SUMMARIZES THE L974 EXPLOSION AT FLIXBOROUGH AND ASKS A NUMBER OF QUESTIONS CONCERNING SAFETY MEASURES IN AN INDUSTRIAL PLANT AND WHETHER THEY ARE SUFFICIENT OR NOT. THE REPORT ALSO CONCLUDES THAT FLASHING LIQUIDS ARE MUCH MORE DANGEROUS THAN GASES OR LIQUIDS BELOW THEIR NORMAL BOILING POINTS.

-PERTINENT FIGURES-

FIG.1 COLUMN HOLD UP, PAGE 23

-BIBLIOGRAPHY-

1. R A STREHLOW, "UNCONFINED VAPOUR CLOUD EXPLOSIONS - AN OVERVIEW," L4TH SYMPOSIUM ON COMBUSTION, THE COMBUSTION INSTITUTE, L973.// 2. K COEVERT, T M GROOTHUIZEN, H J PASSMAN AND R W TRENSE, "EXPLOSIONS OF UNCONFINED VAPOUR CLOUDS," PROCEEDINGS OF THE SYMPOSIUM ON LOSS PREVENTION AND SAFETY PROMOTION IN THE PROCESS INDUSTRIES, HELD IN DELFT, HOLLAND, ELSEVIER, L974, P. 145//3. T A "MAJOR LOSS PREVENTION IN THE PROCESS INDUSTRIES," L97L, P. 75//4. T A KLETZ, LOSS PREVENTION, VOLUME 6, 1972, P. 15// 5. H G SIMPSON, "DESIGN FOR LOSS PREVENTION, PLANT LAYOUT," AS REF 3, P. 105//6. H G SIMPSON, "THE ICI VAPOUR BARRIER," POWER AND WORKS ENGINEERING, 8 MAY 1974, P. 8.

-SOURCE INFORMATION-

CORPORATE SOURCE -
IMPERIAL CHEMICAL INDUSTRIES, LTD., LONDON (ENGLAND)
PUBLISHER -
IMPERIAL CHEMICAL INDUSTRIES, LTD., LONDON (ENGLAND)
SPONSOR -
IMPERIAL CHEMICAL INDUSTRIES, LTD., LONDON (ENGLAND)

keys 21507 through 21511

LIQUID NATURAL GAS - STORAGE AND SEA TRANSPORT

by

TUTTON, R. C.

03/00/65

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE COMPARES THE COMBUSTION CHARACTERISTICS OF METHANE WITH THOSE OF OTHER FUELS TO ILLUSTRATE THE RELATIVE HAZARD OF HANDLING AND USING LIQUEFIED NATURAL GAS. ALSO, A BRIEF RESUME IS GIVEN OF THE SAFETY ADVANTAGES OF STORING LNG COMPARED WITH OTHER HYDROCARBONS. OCEAN TRANSPORTATION AND CARGO HANDLING PROCEDURES FOR LNG ARE DESCRIBED IN THE CONCLUSION OF THE PAPER.

-PERTINENT FIGURES-

TAB. 1 COMPARISON OF COMBUSTION CHARACTERISTICS OF METHANE WITH THOSE OF OTHER FUELS, PAGE CE37

-SOURCE INFORMATION-

CORPORATE SOURCE -
    CONCH METHANE SERVICES LTD., LONDON, ENGLAND
JOURNAL PROCEEDINGS -
    CHEM. ENG. (LONDON) VOL 43, NO. 2, CE36-40 (MAR 1965)
OTHER INFORMATION -
    0005 PAGES, 0000 FIGURES, 0002 TABLES, 0000 REFERENCES

key 21526

HOW TO FIGHT GAS FIRES

by

GUISE, A. B.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE IS AN INTERVIEW WITH A. B. GUISE, A CONSULTING ENGINEER AND AN AUTHORITY ON FIRE PROTECTION FOR THE GAS INDUSTRY. IT PRESENTS A RESUME OF DEVELOPMENTS IN FIRE SUPPRESSION AND FIRE EXTINGUISHMENT AS THEY HAVE AFFECTED THE GAS INDUSTRY AND PROVIDES IMPORTANT POINTERS ON FIGHTING GAS AND LIQUEFIED GAS FIRES.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
GAS AGE VOL 135, NO. 10, 15-9 (OCT 1968)
OTHER INFORMATION -
0005 PAGES, 0004 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21527 through 21532

LNG PIPELINES - A STATUS SURVEY

by

NORRIE, D. H.
WALKER, G.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

WHEN NATURAL GAS IS LIQUEFIED BY COOLING BELOW THE CRITICAL TEMPERATURE OF -115 DEGREES F THE VOLUME OF A GIVEN MASS DECREASES TO APPROXIMATELY 1/600TH OF ITS VOLUME AT ATMOSPHERIC PRESSURE AND TEMPERATURE. THIS SUGGESTS THAT THE MOST ECONOMICAL WAY OF TRANSPORTING AND STORING NATURAL GAS IS IN THE LIQUID FORM (LNG). THIS CONSIDERATION HAS, IN RECENT YEARS, LED TO THE DEVELOPMENT OF MARINE TRANSPORT OF LNG IN SPECIALLY CONSTRUCTED TANKER SHIPS AND TO THE STORAGE OF LNG IN TANKS FOR PEAK-SHAVING PURPOSES. THE POSSIBILITY THAT AN LNG PIPELINE MAY BE MORE ECONOMICAL THAN A CONVENTIONAL GAS TRANSMISSION LINE FOR LONG-DISTANCE TRANSPORT OVER LAND HAS NOT, HOWEVER, BEEN FULLY INVESTIGATED. VARIOUS STUDIES OF LNG PIPELINES HAVE BEEN MADE IN THE LAST TWENTY YEARS. THE TECHNICAL FEASIBILITY IS NOT DISPUTED BUT THERE IS A LACK OF AGREEMENT CONCERNING THE ECONOMICS OF SUCH LINES. THE CONCLUSIONS OF THESE STUDIES CAN BE QUESTIONED ON SEVERAL GROUNDS. FIRSTLY, MOST OF THE STUDIES ASSUME THE USE OF PIPELINING TECHNIQUES SIMILAR TO THOSE USED FOR GAS TRANSMISSION LINES BUT MODIFIED TO INCLUDE CRYOGENIC INSULATION. SECONDLY, FACTORS SUCH AS CONSTRUCTION COSTS, MAINTENANCE, EXPANSION, LIQUEFACTION TECHNIQUES AND SAFETY DEVICES ARE EITHER NEGLECTED OR OVER SIMPLIFIED. THIRDLY, INADEQUATE TECHNICAL DATA ARE OFTEN USED. IN THIS PAPER THE PRESENTLY AVAILABLE INFORMATION ON LNG PIPELINES IS REVIEWED. IT IS CONCLUDED THAT FURTHER TECHNICAL AND ECONOMIC STUDIES ARE REQUIRED BEFORE LNG PIPELINES CAN BE ADEQUATELY COMPARED WITH COMPRESSED GAS LINES.

-PERTINENT FIGURES-

TAB.1 OPTIMUM DIAMETER OF A LNG PIPELINE AND DISTANCE BETWEEN TWO REFRIGERATED STATIONS, PAGE 68//TAB.2 COMPARATIVE TRANSPORTATION COST OF NATURAL GAS AND LNG, PAGE 68//FIG.1 TEMPERATURE INCREASE AND PRESSURE DROP OF URETHANE FOAM INSULATED LNG PIPELINES (AFTER DUFFY AND DIANORA (12)), PAGE 68//FIG.2 TEMPERATURE INCREASE AND PRESSURE DROP OF EVACUATED PERLITE AND MULTILAYER INSULATED LNG PIPELINES (AFTER DUFFY AND DIANORA (12)), PAGE 69

-BIBLIOGRAPHY-

GLASER, P. E., THE DEVELOPMENT OF THERMAL INSULATIONS AND TECHNIQUES FOR USE AT VERY LOW TEMPERATURES, PROCEEDINGS, 12TH INTERNATIONAL CONGRESS OF REFRIGERATION, MADRID (1967)//ANDERSON, J. H., LIQUID-METHANE PIPELINE. NEXT GAS TRANSMISSION STEP., OIL AND GAS J. VOL 63, NO. 6, 74-80 (FEB 1965) //DIMENTBURG, M., TRANSMISSION OF NATURAL GAS IN LIQUID PHASE BY LONG DISTANCE PIPELINE, ANNUAL CONF., CHEMICAL INST. OF CANADA (1967)// CARBONNELL, E., GUERIN, J. Y. AND SOLENTE, P., THE TRANSPORT OF LNG BY PIPELINES. TECHNICAL AND ECONOMIC ASPECTS, ADVANCES IN CRYOGENIC ENGINEERING VOL 12, PP452-7, PLENUM PRESS, NEW YORK (1967)//DUFFY, A. R. AND DIANORA, J., LNG PIPELINES APPEAR TECHNICALLY FEASIBLY, OIL AND GAS J. VOL 65, NO. 19, 80-9 (MAY 1967)//WALKER, G., VENART, J. E. S., NORRIE, D. H. AND GROVES, T. K., THE UNIVERSITY OF CALGARY RESEARCH PROGRAM ON FUNDAMENTAL PROPERTIES AND PIPELINE TRANSPORT OF LIQUEFIED NATURAL GAS, 1ST INTERNATIONAL CONFERENCE ON LNG, INST. OF GAS TECHNOLOGY, CHICAGO (MAY 7-11, 1968)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CALGARY UNIV. (ALBERTA).
JOURNAL PROCEEDINGS -
NATURAL GAS PROCESSORS ASSOC. (PROC. OF 47TH ANNUAL CONVENTION, NEW ORLEANS, LA., MAR 19-21, 1968) TECHNICAL PAPERS, 65-70 (1968)
OTHER INFORMATION -
0006 PAGES, 0004 FIGURES, 0002 TABLES, 0013 REFERENCES

THERMAL RADIATION AND OVERPRESSURES FROM INSTANTANEOUS LNG RELEASE INTO THE ATMOSPHERE. FINAL REPORT OF PHASE 1 RESEARCH PROGRAM, CONDUCTED FOR AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.

-ABSTRACT-

THIS IS THE FINAL REPORT OF PHASE I OF AGA PROJECT IS-33-3. THREE QUARTERLY REPORTS HAVE BEEN ISSUED ON THIS PROJECT. THE FINAL REPORT PRESENTS THE PROGRESS DURING THE ENTIRE TWELVE MONTHS OF PHASE I WITH EMPHASIS ON THE FINAL THREE MONTHS, WHICH HAS NOT PREVIOUSLY BEEN REPORTED. THE RESEARCH CONDUCTED IS DESIGNED TO DESCRIBE THE THERMAL RADIATION AND OVERPRESSURE THAT MIGHT EXIST IN THE AREA SURROUNDING A LARGE LNG STORAGE TANK IN THE EVENT OF MASSIVE RELEASE OF THE TANKS CONTENTS TO THE ATMOSPHERE. THE INITIAL THREE MONTHS EFFORT WAS CONCERNED WITH THE FORMULATION OF THE BASIC MATHEMATICAL MODELS FOR THE RADIATION TASK AND WITH TEST PLANNING AND PREPARATION FOR THE OVERPRESSURE TASK. THE SECOND THREE MONTHS ENTAILED DETAILED DEVELOPMENT AND INITIAL COMPUTER PROGRAMMING OF THE BASIC MATHEMATICAL MODELS FOR THE RADIATION TASK AND THE PERFORMANCE OF 5-FOOT DIAMETER BALLOON TESTS FOR THE OVERPRESSURE TASK. THE THIRD QUARTERLY REPORT INDICATED THAT PROGRAMMING OF THE RADIATION SUBROUTINE WAS COMPLETED, THAT THE FLAME FLOW MODEL WAS EXPANDED TO INCLUDE THE EFFECT OF SIDE WINDS, THAT THE 20-FOOT DIAMETER BALLOON TESTS WERE CONDUCTED AND ANALYZED AND THAT A LABORATORY EXPERIMENT CONCERNED WITH THE PYROLYSIS OF NATURAL GAS WAS BEING PLANNED. DURING THE FINAL QUARTER, THE RADIATION SUBROUTINES WERE CHECKED OUT AND PROGRAMMING OF THE FLUID MECHANIC EQUATIONS WAS INITIATED. THE PYROLYSIS EXPERIMENT WAS COMPLETED AND PRELIMINARY RESULTS OF THE EXPERIMENT INDICATE THAT A RELATIVELY SIMPLE THERMOCHEMICAL MODEL SHOULD BE ADEQUATE. ANALYSIS OF THE EXPERIMENTAL RESULTS IS TO CONTINUE DURING PHASE II.

-PERTINENT FIGURES-

FIG.1 BLOCK DIAGRAM OF TRW LNG FIRE ANALYSIS, PAGE 5//FIG.2 FLAME SCHEMATIC, PAGE 7//TAB.1 CARBON FORMATION FROM PYROLYSIS OF METHANE, PAGE 23

-BIBLIOGRAPHY-

KOGARKO, S. M., ADUSHKIN, V. V. AND LYAMIN, A. G., AN INVESTIGATION OF SPHERICAL DETONATIONS OF GAS MIXTURES, INTERNATIONAL CHEMICAL ENGINEERING VOL 6, NO. 3, 393-401 (JUL 1966)//KOGARKO, S. M., DETONATION OF METHANE-AIR MIXTURES AND THE DETONATION LIMITS OF HYDROCARBON-AIR MIXTURES IN A LARGE-DIAMETER PIPE, ACAD. SCIENCES USSR, SOVIET PHYSICS-TECHNICAL PHYSICS VOL 3, NO. 9, 1904-1016 (SEP 1958)

-SOURCE INFORMATION-

CORPORATE SOURCE -
TRW SYSTEMS GROUP, REDONDO BEACH, CALIF.
SPONSOR -
AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IS-33-3
OTHER INFORMATION -
0155 PAGES, 0029 FIGURES, 0009 TABLES, 0012 REFERENCES

HELIUM PRESSURIZATION SYSTEMS FOR LIQUID-METHANE FUEL IN SUPERSONIC TRANSPORTS

by

EISENBERG, J. D.

10/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

USING LIQUID-METHANE FUEL IN PLACE OF JP FUEL IN AIRCRAFT PROMISES ECONOMIC IMPROVEMENTS. HOWEVER, WITH FUEL LOADED IN A SATURATED CONDITION, A CONSIDERABLE AMOUNT WILL FLASH OFF AS TANK PRESSURE LOWERS DURING CLIMB. SUBCOOLED FUEL SOLVES THIS PROBLEM BUT REQUIRES THAT USE OF SCARCE PRESSURANTS, THE LOSS OF WHICH MUST BE PREVENTED. THREE SYSTEMS FOR USING HELIUM FOR PRESSURIZATION ARE STUDIED IN THIS REPORT, ONE HOLDING THE HELIUM WITHIN THE FUEL TANKS, ONE RETURNING THE HELIUM TO ITS HIGH-PRESSURE BOTTLE, AND ONE ALLOWING, BUT MINIMIZING, HELIUM LOSS. RESULTS INDICATE THAT THESE SYSTEMS OFFER POTENTIAL SOLUTIONS TO THE TANKAGE PROBLEM BUT ARE EXCEEDINGLY COMPLEX.

-PERTINENT FIGURES-

TAB.1 FUEL PROPERTIES, PAGE 5//TAB.7 COMPARISON OF PAYLOAD GAINS, PAGE 25// TAB.8 COMPARISON OF SYSTEMS, PAGE 28//FIG.3 HELIUM CIRCULATION SYSTEM, PAGE 11//FIG.7 HELIUM REBOTTLED SYSTEM, PAGE 18

-BIBLIOGRAPHY-

WEBER, R. J., DUGAN, J. F., JR. AND LUIDENS, R. W., METHANE-FUELED PROPULSION SYSTEMS. PAPER 66-685, AIAA (JUN 1966)//WHITLOW, J. B., JR., EISENBERG, J. D. AND SHOVLIN, M. D., POTENTIAL OF LIQUID-METHANE FUEL FOR MACH 3 COMMERCIAL SUPERSONIC TRANSPORTS. NASA TN D-3471 (1966)//EISENBERG, J. D. AND CHAMBELLAN, R. E., TANKAGE SYSTEMS FOR A METHANE-FUELED SUPERSONIC TRANSPORT. PAPER 68-196, AIAA (FEB 1968)//WEBER, R. J., THE BOILOFF PROBLEM WITH METHANE FUEL IN SUPERSONIC AIRCRAFT. NASA TM X-1604 (1968)//JOSLIN, C. L., THE POTENTIAL OF METHANE AS A FUEL FOR ADVANCED AIRCRAFT. AVIATION AND SPACE. PROGRESS AND PROSPECTS. ASME, PP351-5 (1968)//EISENBERG, J. D., HIGH-ENERGY FUELS FOR SUPERSONIC TRANSPORT RESERVES, NASA TN D-3987 (1967)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO
REPORT NUMBER -
NASA-TN-D-5519//N68-40329
OTHER INFORMATION -
0044 PAGES, 0011 FIGURES, 0008 TABLES, 0017 REFERENCES

keys 21540 through 21545

SAFETY CONSIDERATICNS IN THE INSTALLATION OF AN LNG TANK

by

SEROKA, S.
BOLAN, R. J.

09/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE PURCHASER AND ENGINEERING PERSONNEL INVOLVED IN THE INSTALLATION OF AN LNG STORAGE TANK HAVE SEVERAL REFERENCE SOURCES OF INFORMATION AVAILABLE TO ASSIST THEM IN THE FINAL DETERMINATION OF INSTRUMENTATION AND SAFETY REQUIREMENTS. THE AMERICAN PETROLEUM INSTITUTE ISSUES STANDARD API 2510A, DESIGN AND CONSTRUCTION OF LNG INSTALLATIONS AT PETROLEUM TERMINALS, NATURAL GAS PROCESSING PLANTS. REFINERIES AND OTHER INDUSTRIAL PLANTS. THE NATIONAL FIRE PROTECTION ASSOCIATION PUBLISHES STANDARD NFPA NO. 59A, STANDARD FOR STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS AT UTILITY PLANTS. IN ADDITION THE TANK MANUFACTURER AND INVOLVED PROCESS ENGINEERS ARE OTHER SOURCES OF INFORMATION. EITHER OF THE STANDARDS MENTIONED ABOVE MAY BE MANDATORY FOR AN INSTALLATION IN AN AREA. APPLICABLE REGULATORY AGENCIES SHOULD BE CONSULTED TO DETERMINE WHAT REGULATICNS APPLY TO THE SELECTED LOCATION. IN THIS ARTICLE THE TANK VARIABLES AS RELATED TO SAFETY AND INSTRUMENTATION ARE DISCUSSED AS WELL AS THE APPLICATION OF THE ABOVE STANDARDS.

-PERTINENT FIGURES-

FIG.1 LNG STORAGE TANK PRESSURE INSTRUMENTATION AND CONTROL SYSTEMS, PAGE 23//FIG.2 LNG STORAGE TANK TEMPERATURE INSTRUMENTATION AND CONTROL SYSTEMS, PAGE 24//FIG.3 LNG STORAGE TANK LIQUID LEVEL INSTRUMENTATION AND CONTROL SYSTEMS, PAGE 25//FIG.4 LNG STORAGE TANK MISCELLANEOUS INSTRUMENTATION AND CONTROL SYSTEMS, PAGE 27

-SOURCE INFORMATION-

CORPORATE SOURCE -
STANLEY SEROKA ASSOCIATES, INC.//SYNERGISTIC SERVICES, INC.
JOURNAL PROCEEDINGS -
CRYOG. IND. GASES VOL 5, NO. 8, 22-7 (SEP-OCT 1970)
OTHER INFORMATION -
0005 PAGES, 0004 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21548 through 21549

THE SIGNIFICANCE OF LIQUID METHANE AS A FUEL

by

EGERTON, A. C.
PEARCE, M.

08/00/45

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS RATHER OLD, BUT VERY THOROUGH DISCUSSION OF THE USE OF LIQUID METHANE AS AN AUTOMOTIVE FUEL IS INTERESTING FROM A HISTORICAL POINT OF VIEW AS IT SUMMARIZES RESULTS OF EXPERIMENTS DATING FROM 1939. DETAILED RESULTS OF SEVERAL ROAD TRIALS ARE GIVEN. THE PAPER SPENDS MUCH TIME ON THE STORAGE SYSTEM WHICH IS OF LITTLE USE NOW. THE PAPER GIVES A REASONABLE DISCUSSION OF THE SAFETY ASPECTS OF THE AUTOMOTIVE INSTALLATIONS, PARTICULARLY WITH REGARD TO VENTING WHEN NOT IN USE. THE PAPER ALSO THOROUGHLY COVERS THE SOURCES OF METHANE (COAL GAS, COKE-OVEN GAS, REFINERIES, ETC.) AND LIQUEFACTION.

-PERTINENT FIGURES-

TAB.4 SUMMARY OF THE BEHAVIOR OF THE VACUUM-JACKETED TANKS, PAGE 164//TAB.6 NATURAL GAS PRODUCTION - (1934), PAGE 166//FIG.2 TRIPLE CASCADE FOR METHANE LIQUEFACTION, PAGE 168//FIG.3 PERCENTAGE OF TOTAL METHANE IN A COAL GAS LIQUEFIED AT VARIOUS PRESSURES AT -161.5 PERCENT C, PAGE 169//FIG.4 BASIC FLOW DIAGRAM FOR THE SEPARATION OF METHANE FROM COKE OVEN GAS, PAGE 169

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
J. INST. FUEL VOL 18, NO. 103, 161-70 + 193 (AUG 1945) (PRES. TO THE INST. OF FUEL, LONDON, ENGLAND, JAN 10, 1945 AND TO THE INST. OF FUEL AND THE SOCIETY OF THE CHEMICAL INDUSTRY JOINT MEETING, BRISTOL, ENGLAND, JAN 11, 1945)
OTHER INFORMATION -
0011 PAGES, 0004 FIGURES, 0007 TABLES, 0004 REFERENCES

keys 21552 through 21556

A CLASSIFICATION SOCIETYS APPROACH TO VESSELS DESIGNED FOR THE CARRIAGE OF LIQUEFIED GASES

by

ATKINSON, F. H.

00/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Gcod/Excel.

-ABSTRACT-

THE PAPER OUTLINES THE INTEREST LLOYDS REGISTER OF SHIPPING HAS IN VESSELS DESIGNED FOR THE CARRIAGE OF LIQUEFIED GASES. VARIOUS TYPES OF CARGO CONTAINMENT ARE DISCUSSED AS WELL AS THE CRITERIA FOR ACCEPTING THE MATERIALS USED FOR BOTH THE CONSTRUCTION OF THE SHIP AND CARGO TANKS. PROTOTYPE TESTING FOR NEW DESIGNS AND SOME OF THE SAFETY FEATURES NECESSARY FOR LIQUEFIED GAS CARRIERS ARE CONSIDERED. TESTS PRIOR TO COMMISSIONING AND HOW THE VESSELS CLASS NOTATION IS FINALLY ASSIGNED, ARE EXPLAINED. THE SOCIETYS INTEREST THROUGHOUT THE LIFE OF THE VESSEL IS DEMONSTRATED STARTING WHEN THE VESSEL IS ORIGINALLY DESIGNED, AND PROGRESSING TO THE SURVEYS NECESSARY FOR THE MAINTENANCE OF CLASS WHEN THE VESSEL IS IN SERVICE.

-PERTINENT FIGURES-

FIG.3 CHARPY V-NOTCH IMPACT STRENGTH VERSUS TEMPERATURE FOR VARIOUS COMMERCIAL STEELS, PAGE 28//FIG.7 CARGO TANK COOLDOWN TECHNIQUE, PAGE 29

-SOURCE INFORMATION-

CORPORATE SOURCE -
LLOYDS REGISTER OF SHIPPING, LONDON (ENGLAND)

JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS (PROC. INTERNATIONAL CONF. AND EXHIBITION, 2ND, PARIS, FRANCE, OCT 19-23, 1970), VOL 2, SESSION 7, PAPER 1, 29PP (1970)

OTHER INFORMATION -
0029 PAGES, 0007 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21565 through 21567

EFFECT OF BAROMETRIC PRESSURE CHANGES ON BOIL-OFF IN AN LNG STORAGE TANK

by

HASHEMI, H. T.
WESSON, H. R.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

A REDUCTION IN THE ABSOLUTE PRESSURE OF AN ATMOSPHERIC LNG STORAGE TANK CAUSED BY DECLINING BAROMETRIC PRESSURE MAY SUBSTANTIALLY INCREASE THE RATE OF BOIL-OFF IN THE STORAGE TANK. A MODEL IS PRESENTED WHICH RELATES QUANTITATIVELY THE RATE OF EXCESS BOIL-OFF TO THE MAGNITUDE OF ABSOLUTE PRESSURE REDUCTIONS IN AN LNG STORAGE TANK. THE MODEL PREDICTS THAT EVEN A RELATIVELY SEVERE DECLINE OF THE BAROMETRIC PRESSURE (SAY TWO INCHES OF MERCURY IN ONE HOUR), RESULTS IN A BOIL-OFF RATE WHICH IS WITHIN THE DESIGN VENTING CAPACITY OF MOST EXISTING LNG STORAGE TANKS. THE COMMONLY USED EQUILIBRIUM MODEL WHICH ASSUMES THAT THE ENTIRE MASS OF THE STORED LNG INSTANTANEOUSLY COMES TO EQUILIBRIUM WITH THE VAPOR SPACE PRESSURE, PREDICTS UNREALISTICALLY HIGH BOIL-OFF RATES. THE PROPOSED MODEL ALLEGEDLY CAN BE USED NOT ONLY FOR DESIGNING REALISTIC VENTING CAPACITY FOR LNG TANKS BUT ALSO FOR SIZING THE BOIL-OFF GAS COMPRESSOR AND ITS OPTIMUM MODE OF OPERATION.

-PERTINENT FIGURES-

FIG.2 EFFECT OF SUPERSATURATION PRESSURE ON THE RATE OF SURFACE EVAPORATION OF A LIQUID POOL OF METHANE, PAGE 14//FIG.3 BOIL-OFF RATE FOLLOWING A SUDDEN REDUCTION IN THE ABSOLUTE PRESSURE OF A 600,000 BBL LNG TANK, PAGE 17//FIG.4 BOIL-OFF RATE DURING A PERIOD OF FALLING ABSOLUTE PRESSURE OF A 600,00 BBL LNG TANK, PAGE 18//FIG.5 PRESSURE CHANGE IN A 600,000 BARREL ATMOSPHERIC LNG STORAGE TANK CAUSED BY USE OF AN OVERSIZED BOIL-OFF COMPRESSOR, PAGE 20

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS 68TH NATIONAL MEETING - 6TH PETROCHEMICAL AND REFINING EXPOSITION, RICE HOTEL, HOUSTON, TEX., FEB 28-MAR 4, 1971. PAPER NO. 45B

INVESTIGATIONS INTO THE SPREADING AND EVAPORATION OF LIQUID NATURAL GAS SPILLED ON WATER.

by

OPSCHOOR, I. G.

01/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

USING THE RELATION DERIVED FOR THE SPREADING OF LNG ON WATER, THE EVAPORATION OF LNG ON WATER HAS BEEN CALCULATED. IN SO DOING, A DISTINCTION HAD TO BE MADE BETWEEN THE EVAPORATION OF LNG ON A RESTRICTED WATER SURFACE AND ON OPEN WATER. BASED ON THE THEORY DEVELOPED, A SPILLAGE OF 4,000 CUBIC M OF LNG ON OPEN WATER HAS BEEN CALCULATED AND COMPARED WITH THE RESULTS OF OTHER THEORIES.

-PERTINENT FIGURES-

FIG. 5 EVAPORATION RATE OF LNG ON CONFINED WATER, PAGE 37//FIG.7 EVAPORATION RATE OF LNG ON OPEN WATER, PAGE 38

-BIBLIOGRAPHY-

1. G.J. BOYLE AND A. KNEEBONE "LABORATORY INVESTIGATIONS INTO THE CHARACTERISTICS OF LNG SPILLS ON WATER" REPORT 6Z 32, SHELL RESEARCH LTD, CHESTER (1973)//2. G.F. FELDBAUER A.O. "SPILLS OF LNG ON WATER, REPORT EE 61 E - 72, ESSO RESEARCH AND ENGINEERING COMPANY (1973)//3. T. ENGER AND D. HARTMAN "RAPID PHASE TRANSFORMATION DURING LNG SPILLAGE ON WATER" THIRD CONFERENCE ON LNG, SEPTEMBER 24-28, 1972, WASHINGTON//4. D.S. BURGESS, J.N. MURPHY AND M.G. ZABETAKIS "HAZARDS ASSOCIATED WITH THE SPILLAGE OF LNG ON WATER" REPORT 7448, BUREAU OF MINES, PITTSBURGH (1970)//5. G. OPSCHOOR "INVESTIGATIONS INTO THE EXPLOSIVE BOILING OF LNG SPILLED ON WATER" REPORT NO. 74-03386E, CENTRAAL TECHNISCH INSTITUUT TNO, APELDOORN, (1974)//6. D.P. HOULT "THE FIRE HAZARD OF LNG SPILLED ON WATER" PROC. LNG-IMPORTATION AND TERMINAL SAFETY, JUNE 13-14, 1972, BOSTON MASSACHUSETTS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
CENTRAL TECHNICAL INST. TNO, APELDOORN (NETHERLANDS)
REPORT NUMBER -
FILE/DOSSIER 02-1-30091//REF. NO. 74-04694
PUBLISHER -
CENTRAL TECHNICAL INST. TNO, APELDOORN (NETHERLANDS)

key 21576

QUESTIONS ABOUT LNG EXPLOSIONS

by

WITTE, L. C.
COX, J. E.

03/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS IS A SHORT PUBLISHED DISCUSSION CONCERNED WITH A PREVIOUS PAPER - LNG WATER EXPLOSIONS. CAUSE AND EFFECT - ON EXPLOSIONS RESULTING FROM REACHING A LIMIT OF SUPERHEAT BY A THIN FILM OF LNG AFTER IT HAS BEEN SPILLED ON WATER. QUESTIONED IS WHETHER LNG SPILLED ATOP A BODY OF WATER COULD BE CONSIDERED A WORST CASE, OR WHETHER THE MIXING OF LNG AND WATER BELOW THE SURFACE AS IN THE CASE OF A BREECHED LNG CARGO CARRIER HULL MIGHT NOT BE WORSE. SIMILARITIES ARE DESCRIBED BETWEEN LNG/WATER AND MOLTEN METAL/WATER INTERACTIONS ABOVE AND BELOW THE WATER SURFACE - THE LATTER COMBINATION OCCURRING BELOW THE SURFACE OR THROUGH THE SURFACE BEING MUCH MORE VIOLENT, BASED ON EXPERIMENTAL AND INDUSTRIAL EVIDENCE.

-SOURCE INFORMATION-

CORPORATE SOURCE -
HOUSTON UNIV., TEX.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 51, NO. 3, 67-9 (MAR 1972)
OTHER INFORMATION -
0002 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21583

LNG BARGES MAY SOLVE MANY PROBLEMS

by

BIEDERMAN, N. P.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS ARTICLE DESCRIBES THE VARIOUS BARGE DESIGNS, PROPOSED AND/OR USED, FOR EITHER OCEAN OR RIVER TRANSPORTATION OF LNG. THE 30,000 BARREL DISTRIGAS BARGE CHARACTERISTICS, INCLUDING SOME DESIGN DETAILS, ARE PRESENTED ALONG WITH SIMILAR INFORMATION ON TWO ARCTIC TANKER BARGES - ONE OF 50,000 BARREL CAPACITY, THE OTHER 314,000 BARRELS.

-PERTINENT FIGURES-

FIG. 1 HULL SHAPES AND TWO CONFIGURATIONS FOR RIVER BARGES, PAGE 47//FIG. 2 DISTRIGAS BARGE SCHEMATIC AND ELEVATION, PAGE 48//TAB. 1 GENERAL CHARACTERISTICS OF DISTRIGAS LNG BARGE (30,000-BBL), PAGE 48//TAB. 2 CHARACTERISTICS OF TWO ARCTIC TANKER BARGE DESIGNS, PAGE 48

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
PIPELINE GAS J. VCL 199, NO. 7, 47-8 PLUS 52 (JUN 1972)
OTHER INFORMATION -
C002 PAGES, 0002 FIGURES, 0002 TABLES, 0000 REFERENCES

key 21584

THE LIQUID GAS INDUSTRY - TODAY AND TOMORROW

by

WARD, H.

01/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

SUPERCONDUCTING MOTORS FOR HIGH SPEED TRAINS, BASED ON LIQUID HELIUM CRYOGENICS, CRYOGENIC COOLING OF POWER TRANSMISSION CABLES, CAR ENGINES RUN ON LIQUEFIED NATURAL GAS - JUST SOME OF THE APPLICATIONS OF LIQUID GASES WHICH WE SHOULD SEE IN THE NEXT 10 YEARS. AS WELL AS THESE, STEEL INDUSTRIES WILL CONTINUE TO WANT ENORMOUS QUANTITIES OF OXYGEN AND NITROGEN, SPACE PROGRAMMES WILL DEMAND MORE LIQUID OXYGEN AND HYDROGEN AS FUEL AND LIQUID NITROGEN FOR SIMULATING THE LOW TEMPERATURES OF OUTER SPACE, AND VAST QUANTITIES OF LIQUID NITROGEN WILL BE NEEDED FOR FREEZING APPLICATIONS IN THE FOOD INDUSTRY. THIS ARTICLE BRIEFLY REVIEWS THE HISTORY AND THE FUTURE PROSPECTS FOR GROWTH IN THE LIQUEFIED GAS INDUSTRY.

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR PRODUCTS LTD., SURREY, ENGLAND
JOURNAL PROCEEDINGS -
CHEM. BRIT. VOL 8, NO. 1, 12-5 (JAN 1972)
OTHER INFORMATION -
0004 PAGES, 0005 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21590 through 21592

CONCRETE LNG STORAGE TANK USES MASTIC GAS BARRIER

-ABSTRACT-

THIS ARTICLE DESCRIBES THE SEALING TECHNIQUE USED TO SEAL THE INNER SURFACE OF A 50,000 BARREL CONCRETE LNG STORAGE TANK TO PREVENT GAS LEAKAGE THROUGH THE CONCRETE WHICH MIGHT SET UP CONVECTION WITHIN THE POLYURETHANE FOAM INTERNAL INSULATION SYSTEM. COLD GAS, FLOWING IN CONTACT WITH THE CONCRETE WALLS, COULD RESULT IN THE FORMATION OF ICE LENSES ON THE OUTER SURFACE WHICH WOULD BE UNDESIRABLE.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 12, 60-1 (OCT 1972)
OTHER INFORMATION -
0002 PAGES, 0003 FIGURES, 0000 TABLES, 0000 REFERENCES

MANY CARGO CONTAINMENT SYSTEMS ARE AVAILABLE

-ABSTRACT-

THIS ARTICLE BRIEFLY SUMMARIZES THE VARIOUS DESIGN CONCEPTS AVAILABLE FOR LNG CARGO SHIP CONSTRUCTION, ALONG WITH THEIR ADVANTAGES AND DISADVANTAGES. THE DESIGNS ARE CATEGORIZED INTO FOUR BASIC TYPES. PRISMATIC FREE-STANDING TANKS, SPHERICAL FREE-STANDING TRUCKS, MEMBRANE TANKS, AND SEMI-MEMBRANE TANKS.

-PERTINENT FIGURES-

FIG.2 TYPICAL SECTIONS OF TWO MEMBRANE TANK DESIGNS, PAGE 40//TAB.3 PRINCIPAL CHARACTERISTICS OF LNG CARRIER DESIGNS THAT ARE AVAILABLE NOW, PAGE 41//FIG.3 FREE STANDING TANKS, PAGE 42

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
MAR. ENG. LOG VOL 77, NO. 10, 40-3 (SEP 1972)
OTHER INFORMATION -
0004 PAGES, 0003 FIGURES, 0001 TABLES, 0001 REFERENCES

THE RISK OF COLLISION FOR AN LNG SHIP

by

WAHAB, IR. R.

10/00/07

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	None Given

-ABSTRACT-

THIS REPORT ATTEMPTS TO QUANTIFY THE RISK THAT RUNS A SHIP LOADED WITH LIQUIFIED NATURAL GAS (LNG) WHEN APPROACHING AN LNG TERMINAL ON THE MAASVLAKTE. MORE IN PARTICULAR, THIS REPORT CONSIDERS THE PROBABILITY OF AN LNG SHIP GETTING INVOLVED IN A COLLISION ON THE ROUTE-PART FROM THE MAAS CENTRE BUOY TO THE MAASVLAKTE. THIS INVESTIGATION HAS BEEN MADE WITHIN THE BRACKET OF A WIDER SCOPE INVESTIGATION INTO THE SAFETY ASPECTS OF THE LOCATIONS THAT ARE ELIGIBLE FOR ESTABLISHING AN LNG TERMINAL.

-BIBLIOGRAPHY-

1. DOBSON, R.J.C. AND F. WELD, PROBLEMS IN THE DESIGN AND CONSTRUCTION OF LIQUEFIED GAS CARRIERS. LNG/LPG CONFERENCE, LONDON, 1972// 2. GRIMES, G., A SURVEY OF MARINE ACCIDENTS WITH PARTICULAR REFERENCE TO TANKERS. JOURNAL OF THE INSTITUTE OF NAVIGATION, VOL. 25, NO. 4, 1972//3. BEER, W.J., ANALYSIS OF WORLD MERCHANT SHIP LOSSES. TRANSACTIONS OF THE ROYAL INSTITUTION OF NAVAL ARCHITECTS, 1969//4. WOISIN, G. AND M.P. MILDE, PASSIVE AND ACTIVE PROTECTION AGAINST COLLISION INCLUSIVE OF TECHNIQUE OF TESTING OF MODELS. PROCEEDINGS OF THE SYMPOSIUM ON NUCLEAR SHIPS, INTERNATIONAL ATOMIC ENERGY COMMISSION, HAMBURG, 1971//5. KAGAMI, K., T. HAMADA, T. TSUNODA, H. OCHI AND T. HARIMA, RESEARCH ON THE COLLISION RESISTING CONSTRUCTION OF SHIPS SIDES. PROCEEDINGS OF THE SYMPOSIUM ON NUCLEAR SHIP PROPULSION, WITH SPECIAL REFERENCE TO NUCLEAR SAFETY, VIENNA, AUSTRIA, 1961// 6. BROLSMA, J.U., PROGNOSIS OF SEA GOING AND INLAND SHIPPING. MUNICIPAL WORKS ROTTERDAM, JANUARY 1973.

-SOURCE INFORMATION-

CORPORATE SOURCE -
TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK, RIJWIJK (NETHERLANDS)
REPORT NUMBER -
REPORT NO. 11318/3//PROJECT NO. 11-1-11318
PUBLISHER -
TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK

key 21599

BARGE WILL EXTEND THE OCEANGOING PIPELINES

-ABSTRACT-

THIS BRIEF ARTICLE DESCRIBES THE 32,000 BARREL LNG BARGE MASSACHUSETTS, THE FIRST BARGE FOR COMMERCIAL CARRIAGE OF LNG BUILT IN THE UNITED STATES. THE BARGE, WHICH WILL BE UNMANNED AND NON-SELF-PROPELLED, IS CLASSED BY THE AMERICAN BUREAU OF SHIPPING AS AN A-1 PRESSURE TANK BARGE, FOR UNRESTRICTED FULL OCEAN SERVICE. THE LNG CARGO IS CARRIED IN FOUR CYLINDRICAL ALUMINUM TANKS DESIGNED FOR A MAXIMUM INTERNAL PRESSURE OF 4 BARS.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
MAR. ENG. LOG VOL 77, NO. 10, 46-7 (SEP 1972)
OTHER INFORMATION -
0002 PAGES, 0003 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21597 through 21598

GAZOCEANS NEW SHIP HAULS GAS TO BOSTON

-ABSTRACT-

THIS BRIEF ARTICLE DESCRIBES THE 50,000 CUBIC METER LNG CARGO SHIP, DESCARTES, DESIGNED PRIMARILY AS AN LNG CARRIER BUT FITTED WITH A RELIQUEFACTION PLANT THAT WILL ENABLE HER TO CARRY PROPANE, BUTANE AND OTHER LPG CARGOES. AT THE TIME OF WRITING, THE DESCARTES WAS THE LARGEST LNG CARRIER TO USE THE TECHNIGAZ/CONCH-OCEAN MEMBRANE TANK SYSTEM FOR CARGO CONTAINMENT.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
MAR. ENG. LOG VOL 77, NO. 10, 44-5 (SEP 1972)
OTHER INFORMATION -
0002 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21603

LNG SAFETY PROGRAM REPT. NO. 4 - NON-GRAY THERMAL RADIATION FROM A FLAME ABOVE A POOL OF LIQUID NATURAL GAS

by

WILCOX, D. C.

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IN ORDER TO ASSESS THE HAZARDS ASSOCIATED WITH SPILLAGE OF LIQUID NATURAL GAS (LNG) SEVERAL TOPICS MUST BE CONSIDERED. DOWNWIND DISPERSION AND THE POSSIBILITY OF DETONATION ARE TWO SPECIFIC TOPICS WHILE ANOTHER IS THE BURNING OF THE GAS ABOVE A POOL OF LNG. THERE ARE TWO ASPECTS OF THE BURNING PROBLEM. THE FIRST IS THE PREDICTION OF THE RATE OF EVAPORATION OF LNG FROM THE POOL. HEAT WILL BE PROVIDED BY THE GROUND THROUGH CONDUCTION AND THIS EFFECT CAN BE CALCULATED BY SOLVING A STANDARD HEAT CONDUCTION EQUATION. THERE IS ANOTHER SOURCE OF HEAT WHICH IS NOT SO EASILY CALCULATED HOWEVER. HEAT IS DELIVERED TO THE LNG POOL FROM THE BURNING GASES BY WAY OF THERMAL RADIATION. THE SECOND ASPECT IS THE PREDICTION OF THE THERMAL ENVIRONMENT ASSOCIATED WITH THE FLAME. ALTHOUGH IT MIGHT APPEAR THAT THESE TWO ASPECTS ARE HOPELESSLY COUPLED, A SIMPLE ARGUMENT SHOWS THIS TO NOT BE OF GREAT CONSEQUENCE IN CONSTRUCTING A SOLUTION TO BOTH PROBLEMS INDEPENDENTLY. IT IS THE SECOND ASPECT OF THE BURNING PROBLEM WHICH HAS BEEN ADDRESSED IN THIS STUDY. IN PARTICULAR, A MATHEMATICAL MODEL OF A FLAME OVER A POOL OF LNG HAS BEEN DEVELOPED. THE MOST IMPORTANT FEATURE OF THE FLAME MODEL IS THE FACT THAT THE GASES INVOLVED IN THE TRANSFER OF HEAT VIA THERMAL RADIATION ARE ASSUMED TO BE NON-GRAY.

-PERTINENT FIGURES-

FIG.1 A FLAME ABOVE AN LNG POOL, PAGE 6//FIG.2 IMPORTANT CONTOURS INSIDE THE PLUME, PAGE 19

-BIBLIOGRAPHY-

LNG INFORMATION BOOK, JULY 1968, PREPARED BY LNG INFORMATION BOOK TASK GROUP OF THE LIQUEFIED NATURAL GAS COMMITTEE (1968)//ZABETAKIS, M. G., FLAMMABILITY CHARACTERISTICS OF COMBUSTIBLE GASES AND VAPORS, BULLETIN 627, BUREAU OF MINES (1965)//SERGEANT, R. J. AND ROBINETT, F. E., AN EXPERIMENTAL INVESTIGATION OF THE ATMOSPHERIC DIFFUSION AND IGNITION OF BOIL-OFF VAPORS ASSOCIATED WITH A SPILLAGE OF LIQUEFIED NATURAL

GAS, TRW REPORT NO. 08072-7 (1968)//PETERSON, J. B., ET AL., THERMAL RADIATION AND OVERPRESSURES FROM INSTANEOUS LNG RELEASE INTO THE ATMOSPHERE, TRW FINAL REPORT NO. 08072-4 (1968)

-SOURCE INFORMATION-

CORPORATE SOURCE -
TRW SYSTEMS GROUP, REDONDO BEACH, CALIF.
SPONSOR -
AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IS-33-4
OTHER INFORMATION -
0126 PAGES, 0045 FIGURES, 0010 TABLES, 0019 REFERENCES

keys 21604 through 21609

LNG SAFETY PROGRAM REPT. NO. 3

by

DUFFY, A. R.
GIDEON, D. N.
PUTNAM, A. A.
BEARINT, D. E.
SLIEPCEVICH, C. M.
ET AL

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS REPORT PRESENTS DATA ON KNOWN SPILLS OF LNG OR OTHER CRYOGENS, A DISCUSSION AND ANALYSIS OF PROBLEM AREAS, AND A DISCUSSION OF CONSEQUENCES OF SPILLS INCLUDING DOWNWIND DISPERSION, RADIATION FROM FIRES, AND REACTIONS WITH WATER. A FINAL SECTION OF THE REPORT SUMMARIZES THE CONCLUSIONS BASED ON THIS INVESTIGATION AND RECOMMENDS CONTINUED INVESTIGATION AND FUTURE RESEARCH IN SEVERAL AREAS FOR THE PURPOSE OF FURTHER ENHANCING THE SAFETY AND RELIABILITY OF LNG PLANTS.

-PERTINENT FIGURES-

TAB.1 SUMMARY OF DATA ON KNOWN SPILLS OF CRYOGENS, PAGE 4-7//FIG.A-1 VAPORIZATION RATE OF LNG AFTER SPILLAGE ONTO 20C-SURFACE (SOLID CURVE) AND 32-F SURFACE (DASHED CURVE), PAGE A-3

-BIBLIOGRAPHY-

BURGESS, D. S., MURPHY, J. N. AND ZABETAKIS, M. G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, BUREAU OF MINES REPORT, FEBRUARY 1970 AD 705078// BURGESS, D. S., MURPHY, J. N. AND ZABETAKIS, M. G., HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED NATURAL GAS ON WATER, BUREAU OF MINES REPORT, RI 7448, NOV 1970//WELKER, J. R., WESSON, H. R. AND SLIEPCEVICH, C. M., PRESENTED AT A.G.A. DISTRIBUTION CONFERENCE, OPERATING SECTION, MAY 1969//PARKER, R. O. AND SPATA, J. K., DOWNWIND TRAVEL OF VAPORS FROM LARGE POOLS OF CRYOGENIC LIQUIDS, PROCEEDINGS, FIRST INTERNATIONAL CONFERENCE ON LNG, APRIL, 1968//TRW, THERMAL RADIATION AND OVERPRESSURES FROM INSTANTANEOUS LNG RELEASE INTO THE ATMOSPHERE, FINAL REPORT, TO A.G.A., NO. 08072-4, APR 26, 1968//BURGESS, D. AND ZABETAKIS, M. G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, U.S. DEPT. OF THE

INTERIOR, BUREAU OF MINES, RI 6099, 1962

-SOURCE INFORMATION-

CORPORATE SOURCE -
BATTELLE MEMORIAL INST., COLUMBUS, OHIO//UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
SPONSOR -
AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IU-3-5
OTHER INFORMATION -
0081 PAGES, 0001 FIGURES, 0002 TABLES, 0071 REFERENCES

LNG SAFETY PROGRAM REPT. NO. 1

-ABSTRACT-

THE OVERALL OBJECTIVE OF LIQUEFIED NATURAL GAS (LNG) SAFETY RESEARCH IS TO DEVELOP THE TECHNICAL INFORMATION NECESSARY FOR THE DESIGN, LAYOUT, INSTALLATION, AND OPERATION OF THE PLANT AND EQUIPMENT IN SUCH A WAY AS TO ACHIEVE MAXIMUM PROTECTION FOR OPERATING PERSONNEL AND THE PUBLIC. THE SPECIFIC OBJECTIVES OF THE WORK PRESENTED IN THIS VOLUME ARE, 1. TO DEFINE THE TYPES OF ACCIDENTS THAT MAY BE REASONABLY EXPECTED, AND 2. TO ESTABLISH METHODS OF PREVENTING THESE ACCIDENTS. THE METHODS OF ASSESSING THE CONSEQUENCES (OR HAZARDS) RESULTING FROM THE ACCIDENTAL RELEASE OF LNG ARE DISCUSSED IN VOLUME II - METHODS OF PREDICTING AND REDUCING LNG HAZARDS. THIS VOLUME IS CONCERNED WITH THE POTENTIAL FAILURE OF EQUIPMENT AT PEAK SHAVING, BASE LOAD, AND SATELLITE FACILITIES. IT IS ALSO CONCERNED WITH ACCIDENTS THAT MAY OCCUR IN LAND AND WATER TRANSPORT. THE RESULTS OF THIS STUDY SHOULD FORM THE BASIS FOR AN ASSESSMENT OF THE CURRENT LEVEL OF SAFETY THAT IS BEING ACHIEVED, DIRECTING FURTHER EFFORTS TO REDUCE THE OCCURRENCE OF ACCIDENTS, AND ESTABLISHING THE LEVEL AND TYPE OF PROTECTION THAT WILL ENHANCE SAFETY AT THESE FACILITIES.

-PERTINENT FIGURES-

TAB.1 LNG SPILLS REPORTED ON QUESTIONNAIRE, PAGE 9//TAB.3 EXPECTED REDUCTION IN LIFETIME FROM A CONTINUOUS, LIFE-LONG, LOW PROBABILITY THREAT OF FATALITY, PAGE 13//TAB.4 UPPER LIMIT OF RISK LEVEL BASED ON PLANT-YEARS OF SPILL-FREE OPERATION, PAGE 14//TAB.5 RANKING OF POTENTIAL ACCIDENTS IN DECREASING ORDER OF PROBABILITY OF OCCURRENCE, PAGE 46

-BIBLIOGRAPHY-

MOORE, W. T. AND ARNOLD, R. J., FAILURE OF APOLLO SATURN V LIQUID OXYGEN LOADING SYSTEM, ADVANCES IN CRYOGENIC ENGINEERING VOL 13, 534-44, PLENUM PRESS, NEW YORK (1968)//REPORT ON THE INVESTIGATION OF THE FIRE AT THE LIQUEFICATION STORAGE AND REGASIFICATION PLANT OF THE EAST OHIO GAS COMPANY, CLEVELAND, OHIO, OCTOBER 20, 1944, UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES REPORT R I 3867 (FEB 1946)//LOW PRESSURE STORAGE TANKS FOR LIQUEFIED NATURAL GAS, APPENDIX Q, SUPPLEMENT TO API STANDARD 620 (THIRD EDITION) RECOMMENDED RULES FOR DESIGN AND CONSTRUCTION OF LARGE, WELDED, LOW PRESSURE STORAGE TANKS. AVAILABLE FROM AMERICAN PETROLEUM INSTITUTE, NEW YORK (AUG 1968)//A STUDY OF UNIFORM REPORTING SYSTEM FOR ALL MODES OF TRANSPORTATION IN REPORTING INCIDENTS AND ACCIDENTS INVOLVING THE SHIPMENT OF HAZARDOUS MATERIALS, THE NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, D.C. SEE ALSO, A STUDY OF TRANSPORTATION OF HAZARDOUS MATERIALS, A REPORT TO THE OFFICE OF HAZARDOUS MATERIALS OF THE U.S. DEPT. OF TRANSPORTATION, MAY 1969, CONTRACT NO. DOT-OS-A9-106//DATA ON

ACCIDENTS AND INCIDENTS RELATED TO SPILLS OF CRYOGENIC FLUIDS AND FAILURES OF FLEXIBLE LINES AND HOSES, NASA PUBLICATIONS, MANNED SPACE PROGRAMS, ACCIDENT/INCIDENT SUMMARIES (MAR 1970), NASA WASHINGTON, D C

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
SPONSOR -
AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IU-2-1
OTHER INFORMATION -
0066 PAGES, 0000 FIGURES, 0005 TABLES, 0034 REFERENCES

key 21616

SPILLS OF LNG ON WATER

by

MAY, W. G.
MCQUEEN, W.
WHIPP, R. H.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

EARLY WORK BY THE BUREAU OF MINES SHOWED THAT THE VAPOR FROM AN LNG SPILL DOES NOT DISPERSE IN THE ATMOSPHERE IN QUITE THE SAME WAY AS OTHER MATERIALS WHICH HAVE BEEN STUDIED. THE DIFFERENCE WAS ATTRIBUTED TO THE HIGH DENSITY OF THE COLD VAPOR ARISING FROM A SPILL, THE VERTICAL MIXING APPEARED TO BE SUPPRESSED. THE BUREAU OF MINES WORK WAS DONE ON A VERY SMALL SCALE UNDER RATHER GUSTY WEATHER CONDITIONS. ANALYSIS SHOWED THAT THE DENSITY EFFECT WHICH THEY HAD OBSERVED SHOULD VARY WITH SPILL SIZE AND THE NATURE OF THE WEATHER. THIS WORK WAS UNDERTAKEN TO OBTAIN DATA UNDER SUBSTANTIALLY DIFFERENT CONDITIONS THAN THOSE STUDIED BY THE BUREAU OF MINES, MUCH LARGER SPILLS, WHERE THE EFFECT OF DENSITY WOULD BE DIFFERENT, AND WEATHER CONDITIONS CHARACTERISTIC OF A MARINE ENVIRONMENT. TESTS WERE CONDUCTED IN TWO SIZE RANGES - APPROXIMATELY 250 GALLONS AND 2,500 GALLONS. THE LNG WAS PUMPED ON TO THE WATER AT 5,000 GPM, SO THAT THE SPILLS WERE NEARLY INSTANTANEOUS. THIS TYPE OF EXPERIMENT WAS CHOSEN OVER THE ALTERNATIVE STEADY-STATE SPILLS RUN BY THE BUREAU OF MINES IN ORDER TO OBSERVE THE ANTICIPATED DENSITY EFFECT WITH A LARGE VAPOR CLOUD. THE TEN-FOLD RANGE IN SPILL SIZE WAS CHOSEN TO PROVIDE SCALE-UP DATA. THE TESTS WERE CARRIED OUT ON A LARGE BODY OF WATER - MATAGORDA BAY, TEXAS - SEVERAL MILES FROM THE NEAREST SIGNIFICANT LAND MASS.

-PERTINENT FIGURES-

FIG.8 MINIMUM LIQUID POOL THICKNESS SPREADING ON OPEN WATER, PAGE D-143// FIG.9 EFFECT OF SPILL SIZE ON MAXIMUM CALCULATED VAPORIZATION RATE AND MAXIMUM VAPOR FLOW RATE (5 MPH WIND), PAGE D-144//FIG.10 EFFECT OF WIND SPEED ON MAXIMUM VAPOR FLOW RATE, PAGE D-144//TAB.1 DATA. SPILL CONDITIONS AND PLUME DIMENSIONS, PAGE D-145//FIG.14 CALCULATED DENSITY OF COLD METHANE-AIR MIXTURES, PAGE D-147//FIG.18 EXTRAPOLATION OF DATA. COMPARISON WITH BUREAU OF MINES, PAGE D-149

-BIBLIOGRAPHY-

BURGESS, D. S., MURPHY, J. N. AND ZABETAKIS, M. G., HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED NATURAL GAS ON WATER. BUREAU OF MINES REPORT OF INVESTIGATIONS RI7448, U.S. DEPT. OF THE INTERIOR (NOV 1970)//HOULT, D. P., THE FIRE HAZARD OF LNG SPILLED ON WATER, CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY. BOSTON, NATIONAL ACADEMY OF SCIENCES (JUN 1972)//PARKER, R. O., A STUDY OF DOWNWIND TRAVEL FROM LNG SPILLS. A.G.A. DISTRIBUTION CONF., SEATTLE (MAY 1970)//MAY, W. G., ET AL., SPILLS OF LNG ON WATER - VAPORIZATION AND DOWNWIND DRIFT OF COMBUSTIBLE MIXTURES. REPORT TO THE API, REPORT NO. EE61E-72 (NOV 1972)//HUMBERT-BASSET, R. AND MONTET, A., FLAMMABLE MIXTURES PENETRATION IN THE ATMOSPHERE FROM SPILLAGE OF LNG. THIRD INTERNATIONAL CONF. ON LNG, WASHINGTON, D.C. (SEP 24-8, 1972) //BURGESS, D. S., MURPHY, J. N. AND ZABETAKIS, M. G., HAZARDS OF SPILLAGE OF LNG INTO WATER, U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES (SEP 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
ESSO RESEARCH AND ENGINEERING CO., LINDEN, N.J.
JOURNAL PROCEEDINGS -
AMERICAN GAS ASSOCIATION OPERATING SECTION PROCEEDINGS - 1973, AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA., D-141-50 (1973) (PROC. OF AGA TRANSMISSION CONF., EL PASO, TEX., APR 16-8, 1973 AND AGA DISTRIBUTION CONF., WASHINGTON, D.C., MAY 14-7, 1973)
OTHER INFORMATION -
0010 PAGES, 0018 FIGURES, 0003 TABLES, 0012 REFERENCES

key 21618

VAPOUR PRODUCTION FROM LNG SPILLS ON WATER

by

BOYLE, G. J.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE INCREASE IN MARINE TRANSPORT OF LNG HAS RESULTED IN A NEED FOR RELIABLE DATA FOR ASSESSING THE POTENTIAL HAZARDS WHICH MIGHT ARISE FROM AN ACCIDENTAL SPILLAGE OF THIS PRODUCT ONTO WATER. AN OBVIOUS QUESTION WHICH HAS BEEN POSED IS WHAT IS THE HAZARDOUS DOWNWIND DRIFT OF INFLAMMABLE VAPOUR FROM A VERY LARGE LNG SPILLAGE SUCH AS MIGHT OCCUR FROM A COLLISION INVOLVING AN LNG TANKER. THE COMPLETE RUPTURE OF AN LNG SHIPS TANK TO SUCH AN EXTENT THAT COMPLETE AND RAPID DISCHARGE OF THE CONTENTS WOULD OCCUR IS A HIGHLY UNLIKELY OCCURRENCE. HOWEVER, SUCH A SITUATION HAS BEEN POSTULATED WITH ESTIMATES OF THE INFLAMMABLE VAPOUR CLOUD SIZE WHICH WOULD RESULT. SUCH ESTIMATES ARE OBVIOUSLY EXTREME EXTRAPOLATIONS AND CLEARLY FOR THEM TO BE CREDIBLE THEY MUST BE BASED ON ACCURATE OBSERVATIONS OF MODERATE SIZED SPILLS OF LNG ON WATER AND ON RELIABLE DATA ON THE PHYSICAL PROCESSES INVOLVED IN THE GENERATION OF VAPOUR FROM SUCH A SPILL. THIS PAPER DESCRIBES A LABORATORY RESEARCH PROGRAM AIMED AT OBTAINING THE NECESSARY VAPOUR PRODUCTION DATA INCLUDING WIND TUNNEL STUDIES OF CERTAIN ASPECTS OF THE VAPOUR DISPERSION. THIS RESEARCH WAS UNDERTAKEN AS PART OF AN API PROJECT AS A PARALLEL TO A PROGRAM OF LARGE SCALE LNG SPILLS ON WATER UNDERTAKEN BY ESSO RESEARCH AND ENGINEERING COMPANY.

-PERTINENT FIGURES-

FIG.4 EFFECT OF VARIATION IN LNG QUANTITY OF EVAPORATION RATE MEASUREMENTS ON A 40.5 FT (2) TANK, PAGE D-183//FIG.5 THE EFFECT OF WATER TEMPERATURE ON LNG EVAPORATION RATE, PAGE D-183//FIG.6 THE EFFECT ON LNG COMPOSITIONS ON EVAPORATION RATE, PAGE D-183//FIG.13 SPREADING OF LNG3ON WATER, PAGE D-184 //FIG.14 VAPOR CLOUD DENSITY, PAGE D-185//TAB.1 SPREADING CHARACTERISTICS OF LNG SPILLED ONTO WATER, PAGE D-186

-BIBLIOGRAPHY-

BURGESS, D. S., ET AL., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, SRC REPORT NO. S4105//BURGESS, D. S., ET AL., HAZARDS OF SPILLAGE OF LNG INTO WATER. PMSRC REPORT NO.

4177//ENGER, T. AND HARTMAN, D. E., LNG SPILLAGE ON WATER - FINAL REPORT ON RAPID PHASE TRANSFORMATIONS. TECHNICAL PROGRESS REPORT NO. 1-72//PROCEEDINGS OF THE MARINE SAFETY COUNCIL. DEPARTMENT OF TRANSPORTATION, U.S. COAST GUARD VOL 29, NO. 10 (OCT 1972)// SPILLS OF LNG ON WATER - VAPORIZATION AND DOWNWIND DRIFT. ESSO RESEARCH AND ENGINEERING CO., NO. EE61E-72. (ISSUED BY API)//BOYLE, G. J. AND KNEEBONE, A., LABORATORY INVESTIGATIONS INTO THE CHARACTERISTICS OF LNG SPILLS ON WATER. EVAPORATION, SPREADING AND VAPOUR DISPERSION. SHELL RESEARCH LIMITED. THORNTON RESEARCH CENTRE, P.O. BOX 1, CHESTER, CHESHIRE, U.K. (ISSUED BY API)

-SOURCE INFORMATION-

CORPORATE SOURCE -
SHELL RESEARCH LTD., CHESTER (ENGLAND)
JOURNAL PROCEEDINGS -
AMERICAN GAS ASSOCIATION OPERATING SECTION PROCEEDINGS - 1973, AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA., D-182-91 (1973) (PROC. OF AGA TRANSMISSION CONF., EL PASO, TEX., APR 16-8, 1973 AND AGA DISTRIBUTION CONF., WASHINGTON, D.C., MAY 14-7, 1973)
OTHER INFORMATION -
0010 PAGES, 0017 FIGURES, 0006 TABLES, 0008 REFERENCES

keys 21619 through 21623

LNG IN AN URBAN ENVIRONMENT

by

FLYNN, J. A.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER PRESENTS THE VIEWPOINT AND REQUIREMENTS OF THE NEW YORK CITY FIRE DEPARTMENT ON SITING, DESIGN, AND CONSTRUCTION OF LARGE LNG PEAK SHAVING PLANTS AND IMPORT TERMINALS IN AN URBAN ENVIRONMENT. OF PRIME IMPORTANCE IS MAXIMUM SAFETY TO THE COMMUNITY WITHIN THE PRESENT STATE OF THE ART FOR CONSTRUCTION OF LNG INSTALLATIONS. ALSO DISCUSSED ARE THE SAFETY RAMIFICATIONS OF WATERBORNE TRANSPORT OF LNG.

-BIBLIOGRAPHY-

DU BARRY, T. W., LNG VESSEL DESIGN AND OPERATION EXPERIENCE. CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY HELD AT BOSTON, MASS., 166PP (JUN 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NEW YORK FIRE DEPT., BROOKLYN. FIRE PREVENTION DIV.
JOURNAL PROCEEDINGS -
CRYOGENIC ENGINEERING CONF., (PRES. AT) ATLANTA, GA., AUG 8-10, 1973. PAPER (1973)
OTHER INFORMATION -
0009 PAGES, 0000 FIGURES, 0000 TABLES, 0001 REFERENCES

keys 21624 through 21627

LNG - GROWTH OR SAFETY

by

DAVIS, J. C.

05/28/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DISCUSSES THE POSSIBLE REPERCUSSIONS OF THE TEXAS EASTERN TRANSMISSION COMPANY LNG TANK EXPLOSION ON STATEN ISLAND, FEBRUARY 10, 1973. IT ALSO TOUCHES ON THE STATE OF LNG STANDARDS AND CODES AND THE RESPONSIBILITIES OF SEVERAL FEDERAL REGULATORY AGENCIES IN THIS AREA. OVER-WATER SPILLS FROM LNG TANKERS INVOLVING VAPOR DISPERSION AND VAPOR EXPLOSION ALSO IS COVERED, AS WELL AS LAND SPILLS.

-PERTINENT FIGURES-

FIG.1 LNG TANK TYPES INCLUDE THE CONCRETE CONTAINER (LEFT), USED AT STATEN ISLAND, AND THE CONVENTIONAL DOUBLE-METAL-WALL (RIGHT), PAGE 50

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CHEM. ENG. VOL 80, NO. 12, 50-2 (MAY 1973)
OTHER INFORMATION -
0003 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

TECHNIQUES FOR SAMPLING NATURAL GAS, SNG AND LNG

by

MILLER, A. J.

09/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

SAMPLING METHODS FOR HYDROCARBON GASES HAVE BEEN GIVEN ATTENTION FOR AT LEAST TWO DECADES. BECAUSE OF VARIED TYPES OF GASES, CONDITIONS, AND OBJECTIVES INVOLVED, MANY TECHNIQUES HAVE BEEN DEVISED. ASTM D 1145, METHODS OF SAMPLING NATURAL GAS, WAS FIRST PUBLISHED IN 1950 AND DESCRIBES A VARIETY OF PROCEDURES AND TYPES OF CONTAINERS. DURING THE 1960S NGPA PUBLICATION 2166 RESULTED FROM COMMITTEE WORK BECAUSE OF SAMPLING NEEDS OF THE NATURAL GAS PROCESSING INDUSTRY FOR PLANT DESIGN, CONTROL, ETC., AND API RP 44 SIMILARLY RESULTED BECAUSE OF THE SAMPLING NEEDS FOR RESERVOIR STUDIES. THIS ARTICLE SUPPLEMENTS THESE PUBLICATIONS BY DISCUSSING CAUSES AND MINIMIZATION OF ERRORS THAT HAVE BEEN UNCOVERED BY EXPERIENCES AND DATA OBTAINED IN FIELD SAMPLING PROGRAMS, AND FROM COOPERATIVE TESTING BY THE NGPA ANALYTICAL COMMITTEE.

-PERTINENT FIGURES-

FIG.2 LNG SAMPLING SYSTEM, PAGE 72//TAB.1 NGPA GAS SAMPLING PROGRAM COMPARISON OF RESULTS BY VARIOUS METHODS, PAGE 71

-BIBLIOGRAPHY-

STYRING, R. E., JR., REPORT TO NGPA ANALYSIS COMMITTEE, NATURAL GAS PROCESSORS ASSOCIATION, TULSA, OKLA. (NOV 1965)//SEAWARD, H. E., VARIATIONS IN LNG HEATING VALUE DURING OCEAN TRANSPORTATION, PAPER 72-D-19, PROC. AMERICAN GAS ASSOCIATION OPERATING SECTION (1972)//GROBEY, H. A., JOHNSON, P. C. AND NORTON, R. G., OPERATING EXPERIENCES AT THE DISTRIGAS PROJECT, PAPER 72-D-77, PROC. AMERICAN GAS ASSOCIATION OPERATING SECTION (1972)//THE COSMODYNE CORP., CRYOGENIC SAMPLERS BULLETIN TDS-806-1// COOK, H. L., JR., U.S. PATENT 3,487,692, ASSIGNED TO VEHOC CORP. (JAN 6, 1970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
PHILLIPS PETROLEUM CO., BARTLESVILLE, OKLA.
JOURNAL PROCEEDINGS -

PIPE LINE IND. VOL 39, NO. 3, 70-2 (SEP 1973)
OTHER INFORMATICN -
0003 PAGES, 0002 FIGURES, 0001 TABLES, 0005 REFERENCES

keys 21630 through 21635

STATUS REPORT ON LNG TANKER DESIGNS

by

PASTUHOV, A.
GONDOUIN, M.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER DESCRIBES THE VARIOUS LNG CARGO TANK DESIGNS NOW USED IN COMMERCIAL LNG SHIPS AND ALSO BRIEFLY DISCUSSES NEW CONCEPTS. (A CAUTIONARY STATEMENT IS MADE THAT UNTIL APPRECIABLE OPERATIONAL EXPERIENCE IS GAINED WITH THE PRESENT DESIGNS, NEW DESIGNS SHOULD BE SHELVED.) DESCRIBED AND COMPARED ARE. (1) INTEGRATED TANKS UTILIZING THE GAZ TRANSPORT INVAR MEMBRANE AND THE TECHNIGAZ STAINLESS STEEL WAFFLE PLATE, (2) SELF-SUPPORTING TANKS (PRISMATIC ALUMINUM TANKS OF THE ESSO RESEARCH AND COUCH DESIGN, SPHERICAL ALUMINUM OR 9 PERCENT NICKEL STEEL TANKS OF THE MOSS-ROSENBERG OR TECHNIGAZ DESIGNS, AND SEMI-MEMBRANE TANKS OF THE BRIDGESTONE DESIGN), AND (3) NOVEL DESIGNS UTILIZING WET WALL INSULATION, CONCRETE TANKS, SINGLE HULL ALUMINUM VESSELS, ETC.

-PERTINENT FIGURES-

TAB.3 COMMON FEATURES OF INTEGRATED TANK DESIGNS, PAGE 284//TAB.4 INTEGRATED TANK DESIGNS, PAGE 284//TAB.5 SELF-SUPPORTING TANKS, PAGE 286// TAB.6 SEMIMEMBRANE TANKS (BRIDGESTONE), PAGE 288

-SOURCE INFORMATION-

CORPORATE SOURCE -
GAZOCEAN U.S.A. INC., BOSTON, MASS.//AMERICAN TECHNIGAZ INC., NEW YORK, N.Y.
JOURNAL PROCEEDINGS -
ADVANCES IN CRYOGENIC ENGINEERING VOL 19, 282-91 (1974), K. D. TIMMERHAUS, EDITOR. (PROC. OF 1973 CRYOGENIC ENGINEERING CONF., GEORGIA INST. OF TECH., ATLANTA, AUG 8-10, 1973)
PUBLISHER -
PLENUM PRESS
OTHER INFORMATION -
0013 PAGES, 0011 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21636 through 21640

MIXING AND ROLL-OVER IN LNG STORAGE TANKS

by

SMITH, K. A.
LEWIS, J. P.
RANDALL, G. A.
MELDON, J. H.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IT IS NOW A MATTER OF RECORD THAT SEVERAL LARGE LNG FACILITIES HAVE EXPERIENCED ROLL-OVER INCIDENTS. THIS PAPER HAS BEEN MOTIVATED BY THESE INCIDENTS AND IS ADDRESSED TO THE EXTENT AND NATURE OF THE MIXING PROCESSES WHICH OCCUR WITHIN AN LNG TANK. PARTICULAR ATTENTION IS FOCUSED ON THE MIXING WHICH TAKES PLACE DURING A TANK FILLING OPERATION, FOR WHICH REASON THE FLUID ADDED TO THE TANK IS HERE REFERRED TO AS CARGO AND THE INITIAL FLUID INVENTORY IS REFERRED TO AS HEEL. BY FAR THE BEST KNOWN OF ALL ROLL-OVERS TO DATE OCCURRED ON AUGUST 21, 1971, AT THE ESSO-DESIGNED SNAM LNG TERMINAL IN LA SPEZIA, ITALY. AS THE DETAILS OF THIS CASE HAVE BEEN REPORTED ELSEWHERE, A VERY BRIEF DESCRIPTION HERE IS SUFFICIENT. THE EVENT TOOK PLACE 18 HOURS AFTER THE RECEIPT (VIA A SIDE-ENTERING BOTTOM FILL LINE) OF A CARGO OF RATHER WEATHERED LIBYAN LNG, AND DURING THAT 18 HOUR PERIOD THE BOIL-OFF RATE WAS ABOUT 2,000 LBS/HR. IN THE NEXT 75 MINUTES, TOTAL VAPOR EVOLUTION WAS 300,000 LBS. DESPITE THIS ENORMOUS VENTING RATE, THERE WAS NO EXPLOSION, NO FIRE, AND NO STRUCTURAL DAMAGE. NONETHELESS, THE HAZARDS POSED WERE CONSIDERABLE, AND SAFE PRACTICE REQUIRES THAT THE PHENOMENON BE UNDERSTOOD AND THAT DESIGN AND OPERATING PROCEDURES BE DEVELOPED TO PROVIDE ASSURANCE THAT THE RECURRENCE OF SUCH EVENTS IS IMPOSSIBLE.

-PERTINENT FIGURES-

FIG.1 RECIRCULATION PATTERNS FOR, (A) AN IDEALIZED STRATIFICATION, AND (B) A NON-STRATIFIED FLUID, PAGE 125//FIG.2 SKETCH OF JET TRAJECTORY, PAGE 126

-BIBLIOGRAPHY-

SARSTEN, J. A., PIPELINE AND GAS J., 37 (SEP 1972)//BELLUS, M. AND GINESTE, M., PROCEEDINGS OF LNG-2, SESSION III, PAPER 2, PARIS (OCT 1970)//DRAKE, E. M., GEIST, J. M. AND SMITH, K. A.,

HYDROCARBON PROCESSING, 87 (MAR 1973)//CHATTERJEE, N. AND GEIST, J. M., PIPELINE AND GAS J., 40 (SEP 1972)//MAHER, J. B. AND VAN GELDER, L. R., PROCEEDINGS OF LNG-3, SESSION II, PAPER 6, WASHINGTON, D.C. (SEP 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
MASSACHUSETTS INST. OF TECH., CAMBRIDGE//DISTRIGAS CORP., BOSTON, MASS.// DISTRIGAS CORP., BOSTON, MASS.//CABOT CORP., BOSTON, MASS.

JOURNAL PROCEEDINGS -
ADVANCES IN CRYOGENIC ENGINEERING (A COLLECTION OF INVITED PAPERS AND CONTRIBUTED PAPERS PRESENTED AT NATIONAL TECHNICAL MEETINGS DURING 1973 AND 1974) VOL 20, 124-33 (1975), K. D. TIMMERHAUS, EDITOR. (PRESENTED AT CRYOGENIC ENGINEERING CONF., GEORGIA INST. TECH., ATLANTA, AUG 8, 1973. PAPER NO. G-6)

PUBLISHER -
PLENUM PRESS

OTHER INFORMATION -
0016 PAGES, 0006 FIGURES, 0000 TABLES, 0009 REFERENCES

VAPOR DISPERSION FROM SPILLS OF LNG ON LAND

by

DRAKE, E. M.
PUTNAM, A. A.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE MODEL LNG VAPOR DISPERSION DEVELOPED BY A. D. LITTLE, INC. HAS BEEN SHOWN TO PREDICT DOWNWIND VAPOR CLOUD CONCENTRATIONS FROM RAPID LNG SPILLS INTO LOW DIKES RANGING FROM 6 FT TO 80 FT DIAMETER. ALLOWANCES HAVE BEEN MADE FOR THE VAPOR CAPACITY OF THE DIKES AND VARIOUS METEOROLOGICAL CONDITIONS. THE AUTHORS EXPECT THAT THE MODEL PREDICTIONS SHOULD ALLOW RELIABLE SCALE-UP TO POOL SIZES IN THE 400 TO 500 FT DIAMETER RANGE. IT IS ALSO BELIEVED THAT THE DEMONSTRATION OF THE AGREEMENT BETWEEN MODEL AND EXPERIMENTAL RESULTS FOR THE ACTUAL TEST CONDITIONS (NEUTRAL TO SLIGHTLY UNSTABLE ATMOSPHERES) INDICATES THAT STANDARD ATMOSPHERIC PARAMETERS CAN BE USED TO PREDICT DOWNWIND VAPOR CLOUD TRAVEL FOR OTHER ATMOSPHERIC CONDITIONS (I.E. STABLE ATMOSPHERES). THE MODEL IS INACCURATE WITHIN ONE DIKE DIAMETER DOWNWIND OF THE SOURCE. THIS RESULTS BECAUSE THE MODEL ASSUMES A LINE SOURCE AT THE DIKE EDGE.

-PERTINENT FIGURES-

FIG.3 COMPONENTS OF EMPIRICAL RELATIONSHIP FOR LNG BOILING ON SAN CLEMENTE SOIL, PAGE 138

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.//BATTELLE MEMORIAL INST., COLUMBUS, OHIO
JOURNAL PROCEEDINGS -
ADVANCES IN CRYOGENIC ENGINEERING (A COLLECTION OF INVITED PAPERS AND CONTRIBUTED PAPERS PRESENTED AT NATIONAL TECHNICAL MEETINGS DURING 1973 AND 1974) VOL 20, 134-42, K. D. TIMMERHAUS, EDITOR (1975) (PRESENTED AT CRYOGENIC ENGINEERING CONF., GEORGIA INST. OF TECH., ATLANTA, AUG 8-10, 1973. PAPER NO. P-1)
PUBLISHER -
PLENUM PRESS
OTHER INFORMATION -

key 1193

FIRE DETECTORS

by

JOINT FIRE RESEARCH ORGANIZATION

03/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

Fire detectors and fire detection systems are reviewed beginning with the simplest system, the sprinkler. The bimetallic strip heat detector and air pressure heat detector are also discussed. Smoke detection systems include the ionization detector and optical detector. Optical detectors function by the effects of the smoke on a beam of light passing through it. Two phenomena are important, obscuration and scatter. The final category of fire detectors considered is that which depends upon the recognition of radiation from the burning zone. Infrared and ultraviolet detection are discussed briefly.

-PERTINENT FIGURES-

FIG. 1 BI-METALLIC STRIP HEAT DETECTOR PAGE 73//FIG. 2 AIR PRESSURE HEAT DETECTOR PAGE 74//FIG. 3 IONIZATION CHAMBER SMOKE DETECTOR PAGE 75//FIG. 4 LIGHT SCATTERING DETECTION SYSTEM PAGE 77//FIG. 5 LIGHT OBSCURATION DETECTOR PAGE 78

-SOURCE INFORMATION-

CORPORATE SOURCE -
JOINT FIRE RESEARCH ORGANIZATION, BOREHAM WOOD (ENGLAND).
JOURNAL PROCEEDINGS -
IFEQAN, INST FIRE ENG QUART, VOL. 32, NO. 85, 71-79 (MAR. 1972)
OTHER INFORMATION -
0009 PAGES, 0005 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21643 through 21644

THERMAL RADIATION FROM LNG SPILL FIRES

by

RAJ, P.
ATALLAH, S.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER REVIEWS THE PRESENT STATE OF KNOWLEDGE RELATING TO THERMAL RADIATION FROM LNG FIRES. UTILIZING DATA FROM RECENT AGA-SPONSORED LNG FIRES IN SEVEN 6-, SIX 20-, AND ONE 80-FOOT DIAMETER POOLS, EQUATIONS WERE DERIVED FOR PREDICTING LNG FLAME HEIGHT AND THE ANGLE OF TILT OF LNG FLAMES IN THE PRESENCE OF WIND. A MODEL FOR PREDICTING THE THERMAL RADIATIVE FLUX AT VARIOUS LOCATIONS AWAY FROM AN LNG FIRE IS PRESENTED.

-BIBLIOGRAPHY-

ARTHUR D. LITTLE, INC., A REPORT ON LNG SAFETY RESEARCH - VOL II, PREPARED FOR AMERICAN GAS ASSOCIATION (1971)//BURGESS, D. AND ZABETAKIS, M. G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, BUREAU OF MINES REPORT NO. 6099, U. S. DEPT. OF INTERIOR (1962)//DRAKE, E. M. AND PUTNAM, A. A., VAPOR DISPERSION FROM SPILLS OF LNG ON LAND, PAPER P-1, CRYOGENIC ENGINEERING CONFERENCE (AUG 1973)//MAY, W. G. AND MCQUEEN, W., RADIATION FROM LARGE LNG FIRES, LNG IMPORTATION AND TERMINAL SAFETY CONFERENCE PROCEEDINGS, BOSTON, MASS., 106-21 (JUN 13-4, 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
JOURNAL PROCEEDINGS -
ADVANCES IN CRYOGENIC ENGINEERING VOL 20, 143-50 (1975), K. D. TIMMERHAUS, EDITOR. (A COLLECTION OF INVITED PAPERS AND CONTRIBUTED PAPERS PRESENTED AT NATIONAL TECHNICAL MEETINGS DURING 1973 AND 1974)
PUBLISHER -
PLENUM PRESS
OTHER INFORMATION -
0008 PAGES, 0000 FIGURES, 0001 TABLES, 0008 REFERENCES

keys 21645 through 21647

CONTROL OF LNG SPILL FIRES ON LAND

by

WESSON, H. R.
WELKER, J. R.
BROWN, L. E.

00/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER DISCUSSES THE RESULTS OF AN EXPERIMENTAL PROGRAM TO DETERMINE. (1) THE CAPABILITIES OF HIGH EXPANSION FOAMS TO PROMOTE A FASTER DISPERSION OF BOIL-OFF VAPORS (FROM AN LNG SPILL) TO REDUCE THE IGNITION POTENTIAL. (2) THE CAPABILITIES OF HIGH EXPANSION FOAMS TO CONTROL LNG SPILL FIRES ON LAND AND (3) THE RELATIVE EFFECTIVENESS OF VARIOUS DRY CHEMICAL AGENTS IN EXTINGUISHING LNG SPILL FIRES ON LAND. EXPERIMENTAL DATA CORRELATIONS DEFINING THE EFFECTS OF FOAM APPLICATION RATE, FOAM EXPANSION RATIO AND FOAM QUALITY ON VAPOR DISPERSION AND SPILL FIRE CONTROL ARE PRESENTED AND DISCUSSED. CORRELATIONS DEFINING MINIMUM APPLICATION RATES THAT WILL ACCOMPLISH SPILL FIRE EXTINGUISHMENT, THE EFFECTS OF INCREASED APPLICATION RATE ON FIRE EXTINGUISHING TIME AND A COMPARISON OF THE PERFORMANCE CAPABILITIES OF THE VARIOUS DRY CHEMICAL AGENTS TESTED ARE ALSO PRESENTED AND DISCUSSED. RECOMMENDATIONS ON DESIGN FACTORS FOR BOTH HIGH EXPANSION FOAM AND DRY CHEMICAL SYSTEMS ARE PRESENTED.

-PERTINENT FIGURES-

TAB.1 COMPARISON OF DRY CHEMICAL AGENT THRESHOLD LIMITS FOR THE EXTINGUISHMENT OF EXPOSED LNG POOL FIRES WITH A TOTAL LNG EVAPORATION RATE OF NOT MORE THAN 0.5 INCHES PER MINUTE, PAGE 162//FIG.1 CORRELATION OF THE HIGH EXPANSION FOAM FIRE CONTROL TIMES, PAGE 153//FIG.2 EFFECTS OF FOAM EXPANSION RATIO ON EXTERNAL RADIATION HEAT FLUX LEVELS WITH FOAM BRAND AS A PARAMETER, PAGE 154//FIG.8 RECOMMENDED MINIMUM DRY CHEMICAL APPLICATION RATES FOR EXTINGUISHMENT OF LNG SPILL FIRES WITH DRY CHEMICAL TYPES AS PARAMETERS, PAGE 161

-BIBLIOGRAPHY-

BURGESS, D. AND ZABETAKIS, M. G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, BUREAU OF MINES REPORT RI-6099 (1962)// WESSON, H. R., WELKER, J. R. AND BROWN, L. E., CONTROL OF LNG SPILL FIRES WITH HIGH EXPANSION FOAMS, PRESENTED AT

1972 ASME PETROLEUM MECHANICAL ENGINEERING CONFERENCE, NEW ORLEANS, LA., PAPER NO. 72-PET-46, HYDROCARBON PROCESSING VOL 15, NO. 12, 61 (1972)//WALLS, W. L., FIRE J. VOL 61, NO. 1, 15 (1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
ADVANCES IN CRYOGENIC ENGINEERING (A COLLECTION OF INVITED PAPERS AND CONTRIBUTED PAPERS PRESENTED AT NATIONAL TECHNICAL MEETINGS DURING 1973 AND 1974) VOL 20, 151-63 (1975), K. D. TIMMERHAUS, EDITOR. (PRESENTED AT CRYOGENIC ENGINEERING CONF., GEORGIA INST. TECH., ATLANTA, AUG 8-10, 1973. PAPER NO. P-4)
PUBLISHER -
PLENUM PRESS
OTHER INFORMATION -
0036 PAGES, 0008 FIGURES, 0001 TABLES, 0004 REFERENCES

keys 21648 through 21650

AN OVERVIEW OF LNG SAFETY

by

HINCKLEY, R. B.
REID, R. C.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS IS A VERY BRIEF INTRODUCTION TO THE SESSION ON LNG SAFETY HELD AT THE 1973 CRYOGENIC ENGINEERING CONFERENCE. KEY AREAS REQUIRING FURTHER RESEARCH TO ENHANCE THE SAFETY OF HANDLING AND USING LNG ARE IDENTIFIED.

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.//MASSACHUSETTS INST. OF TECH., CAMBRIDGE
JOURNAL PROCEEDINGS -
CRYOGENIC ENGINEERING CONF., GEORGIA INST. OF TECH., ATLANTA, AUG 8-10, 1973. PAPER NO. N-3
OTHER INFORMATION -
0005 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

FIRE PROTECTION DEVELOPMENTS IN CNG-FUELED VEHICLE OPERATIONS

by

JOHNSON, E. F.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE PROBLEM OF AIR POLLUTION IN METROPOLITAN AREAS HAS PROMPTED A VARIETY OF SOLUTIONS WITH REGARD TO MOTOR VEHICLES. ONE SOLUTION IS TO USE COMPRESSED NATURAL GAS AS A MOTOR FUEL. REDUCED EMISSIONS TOGETHER WITH COST SAVINGS HAVE PROMPTED SEVERAL THOUSAND FLEET VEHICLE CONVERSIONS IN THE LOS ANGELES BASIN AREA ALONE. THE EXPANDING MARKET INDICATES A NEED FOR POINTERS ON VARIOUS FIRE SAFETY DEVELOPMENTS THAT WILL HELP INDIVIDUALS OR COMPANIES CONTEMPLATING USE OF COMPRESSED GAS FOR THEIR VEHICLES. AS STATED IN A REPORT BY THE INSTITUTE OF GAS TECHNOLOGY FOR THE AIR POLLUTION CONTROL OFFICE, THE USE OF COMPRESSED NATURAL GAS IN A MOTOR VEHICLE MAY BE SAFER THAN THE USE OF GASOLINE. CURRENT RESEARCH AND TECHNOLOGY SUPPORT THE POTENTIAL, IF NOT ACTUAL, TRUTH OF THAT STATEMENT. THE PROBLEM LIES IN ACQUAINTING CONCERNED INDIVIDUALS WITH THE AVAILABLE INFORMATION FOR PLANT AND VEHICLE CONSIDERATIONS. TWO SPECIFIC AREAS OF FIRE SAFETY ARE CONSIDERED IN THIS PAPER - THE VEHICLE AND THE PLANT FILLING OPERATION. ALTHOUGH THE EMPHASIS HERE IS ON COMPRESSED NATURAL GAS, THE BULK OF THE DISCUSSION IS DIRECTLY APPLICABLE TO LNG-FUELED VEHICLES AS WELL.

-PERTINENT FIGURES-

FIG.1 AUTOMOBILE COMPRESSED NATURAL GAS SYSTEM, PAGE 11

-SOURCE INFORMATION-

CORPORATE SOURCE -
ROLLINS BURDICK HUNTER COMPANY
JOURNAL PROCEEDINGS -
FIRE J. VOL 66, NO. 6, 11-5 (NOV 1972)
OTHER INFORMATION -
0005 PAGES, 0001 FIGURES, 0000 TABLES, 0003 REFERENCES

keys 21662 through 21665

FRACTURE MECHANICS IN THE DESIGN OF LARGE SPHERICAL TANKS FOR SHIP TRANSPORT OF LNG

by

TENGE, P.
SOLLI, O.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IT IS THE OBJECT OF THIS PAPER TO DESCRIBE THE CONSEQUENCES OF THE LEAK-BEFORE-FAILURE CRITERION IN THE CONSTRUCTION OF LNG TANKS WITH RESPECT TO MATERIAL AND DESIGN REQUIREMENTS. THE INVESTIGATION IS RELATED TO THE DEVELOPMENT OF THE LNG CARRIERS OF MOSS-ROSENBERG DESIGN FOR DIFFERENT CARGO CAPACITIES UP TO 125,000 M(3). FRACTURE MECHANICS TESTING AND ANALYSIS, AS WELL AS DETAILED STRESS ANALYSIS HAVE BEEN INVOLVED. THE EXPERIMENTAL INVESTIGATION OF BOTH 9 PERCENT NI-STEEL AND ALUMINUM ALLOY 5083-O, REGARDING FATIGUE CRACK CONFIGURATION, PROPAGATION RATE AND CRITICAL CRACK SIZES, HAS DEMONSTRATED THAT THE REQUIREMENTS IMPOSED BY THE LEAK-BEFORE-FAILURE CRITERION ARE CONTAINED. A CLOSE AGREEMENT BETWEEN THE FRACTURE MECHANICS ANALYSIS AND THE TEST RESULTS HAS BEEN OBTAINED.

-PERTINENT FIGURES-

FIG.1 87,600 M(3) LNG SHIP WITH MOSS-ROSENBERG DESIGN TANKS (UNDER CONSTRUCTION), PAGE 11//FIG.2 MOSS-ROSENBERG SELF-SUPPORTING LNG TANK, PAGE 12//FIG.3 CROSS-SECTION OF EQUATORIAL RING OF MOSS-ROSENBERG LNG TANK, PAGE 13

-BIBLIOGRAPHY-

KVAMSDAL, R., RAMSTAD, H., BOGNAES, R. AND FRANK, H. J., THE DESIGN OF AN 88000 M(3) LNG-CARRIER WITH SPHERICAL CARGO TANKS AND SMALL LEAK PROTECTION SYSTEM, EUROPEAN SHIPBUILDING NO. 5 (1970)//HANSEN, H. R., SOME ASPECTS CONCERNING THE DESIGN OF LNG-CARRIERS, DET NORSKE VERITAS, INFORMATION NO. 10 (NOV 1972)//TENGE, P. AND SOLLI, O., 9 PERCENT NICKEL STEEL IN LARGE SPHERICAL TANKS FOR MOSS-ROSENBERG 87,600 M(3) LNG CARRIER, EUROPEAN SHIPBUILDING NO. 1 (1972)//NELSON, F. G., KAUFMAN, J. G. AND WANDERER, E. T., TEAR TESTS OF 5083 PLATE AND OF 5183 WELDS IN 5083 PLATE AND EXTRUSIONS, CRYOGENIC ENGINEERING CONF. IN LOS ANGELES, CALIF. (1969)// KAUFMAN, J. G., NELSON, F. G. AND WYGONIK, R. H., MECHANICAL PROPERTIES AND FRACTURE CHARACTERISTICS

OF 5083-0 PRODUCTS AND 5183 WELDS IN 5083 PRODUCTS, ALCOA REPORT NO. 9-72-11 (APR 1972), (NOT RELEASED FOR PUBLICATION)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NORSKE VERITAS, OSLO.
JOURNAL PROCEEDINGS -
NORW. MARIT. RES. VOL 1, NO. 2, 1-18 (1973)
OTHER INFORMATION -
0018 PAGES, 0014 FIGURES, 0010 TABLES, 0017 REFERENCES

key 21666

APPENDIX TO LNG-WATER INTERACTIONS

by

NAKANISHI, E.
REID, R. C.

06/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

BOILING HEAT FLUXES FOR LIQUID NITROGEN, LIQUID ETHANE, LIQUID METHANE, AND LIQUEFIED NATURAL GAS ON WATER (LIQUID AND ICE), MERCURY AND ETHYLENE GLYCOL WERE MEASURED. GRAPHICAL REPRESENTATIONS OF THE EXPERIMENTAL RESULTS ARE GIVEN (BOILING HEAT FLUX VS. TIME).

-PERTINENT FIGURES-

FIG.5 HEAT FLUXES FOR LIQUID NITROGEN SPILLS//FIG.7 HEAT FLUXES FOR SPILLS OF CONDENSED PIPELINE GAS ON WATER//FIG.8 TEMPERATURE PROFILE FOR SPILLS OF CONDENSED PIPELINE GAS ON 0 DEGREES C AND 5 DEGREES C WATER//FIG.11 HEAT FLUXES FOR LIQUID METHANE ON MERCURY AND WATER//FIG.12 HEAT FLUXES FOR LIQUID ETHANE ON MERCURY AND WATER

-SOURCE INFORMATION-

CORPORATE SOURCE -
MASSACHUSETTS INST. OF TECH., CAMBRIDGE
REPORT NUMBER -
NATIONAL AUXILIARY PUBLICATIONS SERVICE REPT. NO. NAPS-01622
PUBLISHER -
CCM INFORMATION CORP., NEW YORK
OTHER INFORMATION -
0014 PAGES, 0009 FIGURES, 0000 TABLES, 0000 REFERENCES

CASE FOR INERT-GAS GENERATORS ON LNG TANKERS

by

ROOS, P. W.

04/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

ON LNG AND LPG CARGO SHIPS, THE TANKS AND THE SPACES SURROUNDING THEM MUST BE TOTALLY INERTED. THIS ARTICLE DESCRIBES SMALL INERT GAS GENERATORS THAT PRODUCE A PURE, CLEAN MIXTURE OF NITROGEN AND CARBON DIOXIDE IN LARGE QUANTITIES.

-PERTINENT FIGURES-

FIG. FLOW DIAGRAM OF SMIT NYMEGAN INERT GAS GENERATING SYSTEM, PAGE 65

-SOURCE INFORMATION-

CORPORATE SOURCE -
SMIT NYMEGEN CORP., WALTHAM, MASS.
JOURNAL PROCEEDINGS -
MAR. ENG./LOG VOL 79, NO. 4, 64-6 + 152 (APR 1974)
OTHER INFORMATION -
0004 PAGES, 0004 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21678

PRESTRESSED CRYOGENIC PIPELINES

by

GARDNER, JR., M..B.

05/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE CONCLUDES THAT PRESTRESSED LNG PIPELINES ARE ENTIRELY FEASIBLE USING AVAILABLE MATERIALS AND DESIGNS THAT ARE WITHIN THE FRAMEWORK OF EXISTING TECHNOLOGY. SUCH PIPELINES ARE DETAILED, INCLUDING ATTENDANT PROBLEMS AND SOLUTIONS, THE DESIRABILITY OF FULL-SCALE TESTING, AND A DESCRIPTION OF ASSEMBLY AND INSTALLATION TECHNIQUES.

-PERTINENT FIGURES-

FIG.1 INSULATED CONVEYING PIPE, PAGE 492//FIG.2 INTERNALLY INSULATED CASING, PAGE 492//FIG.7 LINE ASSEMBLY AND PRESTRESSING, PAGE 497//FIG.8 COMMON PIPEWAY AND RAILROAD, PAGE 499//FIG.9 COMMON PIPEWAY AND TRAMWAY, PAGE 499//FIG.10 COMMON PIPEWAY AND ROADWAY, PAGE 499

-BIBLIOGRAPHY-

COULTER, D. M., COOL-DOWN REQUIREMENTS FOR LONG DISTANCE, HIGH CAPACITY BURIED LNG PIPELINES, PROGRESS IN REFRIGERATION SCIENCE AND TECHNOLOGY VOL 1, 335-41 (1972)//GARDNER, M. B., PRESTRESSED PIPING SYSTEM FAVORED FOR LNG TRANSPORT, OIL GAS J., 179-82 (APR 1968)//HOOVER, T. E., TECHNICAL FEASIBILITY AND COST OF LNG PIPELINES, LNG-2 PAPERS (1970)//TRIPLE PIPELINE PRESTRESSED TO CARRY LIQUEFIED GAS UNDERWATER, ENGINEERING NEWS-RECORD (DEC 1966)//VEERLING, C. W. N., A SUBMARINE OFFSHORE UNLOADING LINE FOR LNG, LNG-3 PAPERS, SESSION II, PAPER 8 (1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
    GARDNER (M.B.) CO., INC., ROSELLE PARK, N.J.
JOURNAL PROCEEDINGS -
    TRANSP. ENG. J. VOL 100, NO. TE-2, 489-504 (MAY 1974) (PRES. AT ASCE NATIONAL TRANSPORTATION ENGINEERING MEETING, TULSA, OKLA., JUL 9-12, 1973)

keys 20967 through 20970

U.S. COAST GUARD REGULATIONS AND IMCO RECOMMENDATIONS FOR LNG TANKERS

by

DICKEY,T.R.
LUCKRITZ,R.T.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

AS THE TITLE IMPLIES, THIS PAPER DISCUSES U.S. COAST GUARD REGULATIONS AND INTER-GOVERNMENTAL MARITIME CONSULTATIVE ORGANIZATION (IMCO) RECOMMENDATIONS FOR LNG TANKERS. AT THE REQUEST OF THE COAST GUARD, IMCO ESTABLISHED A SUBCOMMITTEE ON SHIP DESIGN AND EQUIPMENT UNDER WHOSE AUSPICES AN AD HOC WORKING GROUP UNDER U.S. CHAIRMANSHIP WAS CREATED TO, AMONG OTHER THINGS, DEVELOP AN INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK. CERTAIN ASPECTS OF THIS CODE ARE GIVEN HERE - THE GOVERNING PREMISE BEHIND ITS DEVELOPMENT BEING TO ENSURE THAT ANY GAS CARRIER BUILT ANYWHERE IN THE WORLD WOULD MEET STANDARDS ACCEPTABLE TO ALL OF THE MAJOR SHIPPING COUNTRIES.

-SOURCE INFORMATION-

CORPORATE SOURCE -
COAST GUARD, WASHINGTON, D.C.
JOURNAL PROCEEDINGS -
AMERICAN GAS ASSOCIATION OPERATING SECTION PROC., D-168 - D-171 (1974) (PROC. OF DISTRIBUTION CONF., MINNEAPOLIS, MINN., MAY 6-8, 1974. PAPER 74-D-37)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0004 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21722

JAPANESE LNG TANK-BUILDERS SEEK CHEAPER AND FASTER TECHNIQUES

by

KIMURA, T.
HIRANO, N.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

AS JAPANS INFLOW OF REFRIGERATED GAS FROM ALL OVER THE WORLD GROWS, THE PROBLEM OF STORING IT MULTIPLIES. IN ORDER TO FABRICATE ABOVEGROUND AND INGROUND CONTAINERS CHEAPER AND FASTER, JAPANESE COMPANIES ARE LOOKING AT NEW MATERIALS, WELDING METHODS, AND BUILDING IDEAS - DISCUSSED IN THIS ARTICLE.

-PERTINENT FIGURES-

FIG.1 ROOF AIR-RAISING METHOD, PAGE 70//FIG.2 TANK AIR-LIFTING METHOD, PAGE 70

-SOURCE INFORMATION-

CORPORATE SOURCE -
ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO. LTD., TOKYO (JAPAN)
JOURNAL PROCEEDINGS -
PETROL. PETROCHEM. INT. VOL 13, NO. 9, 68-71 (SEP 1973)
OTHER INFORMATION -
0004 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21725 through 21727

PIPELINE ACCIDENT REPORT - EQUITABLE GAS CO., NATURAL GAS DISTRIBUTION SYSTEM, PITTSBURGH, PA., NOV 17, 1971

-ABSTRACT-

ON NOVEMBER 17, 1971, WHILE IN THE PROCESS OF REVAMPING A REGULATOR STATION, EMPLOYEES OF THE EQUITABLE GAS COMPANY WERE ATTEMPTING TO REPLACE A VALVE ON THE LOW-PRESSURE SIDE OF A REGULATOR IN A VAULT WITHOUT FIRST STOPPING THE FLOW OF GAS. TWO MEN WORKING IN THE VAULT WERE OVERCOME BY GAS LEAKING INTO THE VAULT. FOUR OTHERS ALSO WERE OVERCOME ATTEMPTING TO RESCUE THE FIRST TWO. ALL SIX MEN DIED OF ASPHYXIATION. THREE OTHER MEN ALSO WERE INJURED. THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINES THAT THE PROBABLE CAUSE OF DEATH BY ASPHYXIATION OF THE FIRST TWO MEN WAS THE INHALATION OF NATURAL GAS RELEASED INTO THE VAULT IN WHICH THEY WERE WORKING, WHEN AN ATTEMPT WAS MADE TO CHANGE A VALVE IN THE VAULT WITHOUT FIRST STOPPING THE FLOW OF GAS. FOUR OTHER WORKMEN ALSO DIED OF ASPHYXIATION WHILE THEY WERE ATTEMPTING TO RESCUE THE FIRST TWO. CONTRIBUTING TO THE ACCIDENT WERE THE LACK OF (1) USE BY ANY OF THE WORKMEN OF RESPIRATORS, AIR BLOWERS, OR VAPOR DETECTORS, (2) ANY WRITTEN PROCEDURES FOR ACCOMPLISHING THE REGULATOR STATION REVAMPING, AND (3) PROPER PERSONNEL TRAINING.

-PERTINENT FIGURES-

FIG. 1 PHOTOGRAPH-REGULATOR STATION R.B.-26 LOOKING SOUTHWEST, PAGE 3//TAB. PROPERTIES OF FLAMMABLE AND EXPLOSIVE LIQUIDS AND GASES WHICH HAVE BEEN FOUND IN UNDERGROUND STRUCTURES, PAGE 20

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, D.C.
REPORT NUMBER -
NTSB-PAR-72-2//PB-211000
OTHER INFORMATION -
0029 PAGES, 0005 FIGURES, 0002 TABLES, 0000 REFERENCES

key 21732

STUDY OF COSTS OF PRODUCTION AND POTENTIAL FUTURE MARKETS FOR (PHASE I) LOW BTU INDUSTRIAL FUEL GAS (PRODUCER GAS) AND (PHASE II) INDUSTRIAL HYDROGEN FINAL REPORT

by

NELSON, H. W.
LAYNE, H. N.
HEIN, G. M.

01/20/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Acceptable

-ABSTRACT-

COST AND MARKET INFORMATICN RELATED TO INDUSTRIAL HYDROGEN WERE OBTAINED TO PROVIDE A BASIS FOR EVALUATING PRESENT AND POTENTIAL ROUTES FOR MAKING INDUSTRIAL HYDROGEN. ESTIMATES FOR THE PRICE OF HYDROGEN FROM AVAILAELE LARGE-SCALE INDUSTRIAL PROCESSES USING VARIOUS FUELS ARE PRESENTED AND COMPARED WITH ESTIMATES PREVIOUSLY AVAILABLE FOR SEVERAL POTENTIAL COAL-BASED PROCESSES. ESTIMATES WERE ALSO MADE OF CURRENT CONSUMPTION AND ANTICIPATED FUTURE MARKETS TO 1980 FOR HYDROGEN IN THE UNITED STATES. EVENTS SINCE 1965 WOULD QUITE DRASTICALLY CHANGE MANY OF THE ESTIMATES, BOTH FOR PRICES AND FOR DEMANDS. THE MARKETS CONSIDERED FOR HYDROGEN DO NOT INCLUDE ANY USE AS A SUBSTITUTE FUEL OR AS AN ENERGY TRANSFER OF STORAGE MEDIUM, AS IN MORE RECENT PROPOSALS FOR A HYDROGEN ECONOMY. AN EXTENSIVE BIBLIOGRAPHY IS INCLUDED IN THE REPORT.

-PERTINENT FIGURES-

TAB.22 COST ESTIMATES FOR HYDROGEN FROM POTENTIAL COAL-BASED PROCESSES, PAGE 84//TAB.23 SUMMARY OF SELLING PRICES FOR HYDROGEN MANUFACTURED BY STEAM-REFORMING OF NATURAL GAS, PAGE 89//TAB.24 SUMMARY OF ESTIMATEC SELLING PRICES OF HYDROGEN FROM PRESENT INDUSTRIAL PROCESSES AND POTENTIAL COAL-BASED PROCESSES, PAGE 96//TAB.25 SUMMARY OF MAXIMUM FUEL AND FEEDSTOCK COSTS TO OBTAIN A SELLING PRICE OF 25 CENTS PER MSCF FOR HYDROGEN FROM PRESENT INDUSTRIAL PROCESSES AND POTENTIAL COAL-BASED PROCESSES, PAGE 98//FIG.18 HYDROGEN MARKET ESTIMATES, PAGE 100//TAB.26 ESTIMATED MARKETS FOR HYDROGEN IN THE U.S.A., PAGE 101

-BIBLIOGRAPHY-

STORMONT, D. H., HOW HYDROGEN WILL BE USED, HOW HYDROGEN IS SYNTHESIZED, OIL AND GAS J., PP115-23 (MAR 1962)//LEE, G. T., LESLIE, J. D. AND RCDEKOHR, H. M., THE COST OF HYDROGEN MADE FROM NATURAL GAS, HYDROCARBON PROCESS. PETROL. REFINER VOL 24, NO. 9,

125-8 (1963)//JAMES, G. R., WHICH PROCESS BEST FOR PRODUCING HYDROGEN, CHEM. ENG., PP161-6 (DEC 1960)// NELSON, W. L., OPERATING COSTS. HYDROGEN MANUFACTURE, OIL AND GAS J., PP70-3 (JUN 1964)//KATELL, S. AND FABER, J. H., AN ECONOMIC EVALUATION OF BITUMINOUS COAL AS A SOURCE OF HYDROGEN, SYMPOSIUM ON PRODUCTION OF HYDROGEN, PRESENTED BEFORE THE DIVISION OF PETROLEUM CHEMISTRY, AMERICAN CHEMICAL SOCIETY, NEW YORK MEETING (SEP 1963)//HEFFNER, W. H., PIERONI, L. J., GRIFFIN, R. P. AND SKAPERDAS, G. T., AN EVALUATION OF THE PRODUCTION OF HYDROGEN BY GASIFICATION OF COAL USING NUCLEAR HEAT, SYMPOSIUM ON PRODUCTION OF HYDROGEN, PRESENTED BEFORE THE DIVISION OF PETROLEUM CHEMISTRY, AMERICAN CHEMICAL SOCIETY, NEW YORK CITY MEETING (SEP 1963)

-SOURCE INFORMATION-

CORPORATE SOURCE -
BATTELLE MEMORIAL INST., COLUMBUS, OHIO
REPORT NUMBER -
PB-174835
SPONSOR -
INTERIOR DEPT., WASHINGTON, D.C.
CONTRACT NUMBER -
CONTRACT NO. 14-01-0001-474
OTHER INFORMATION -
0138 PAGES, 0023 FIGURES, 0031 TABLES, 0080 REFERENCES

SEALS AND SEALING TECHNIQUES

-ABSTRACT-

DEVELOPMENTS BY THE AEROSPACE INDUSTRY IN SEALS AND SEALING TECHNIQUES ARE ANNOUNCED FOR POSSIBLE USE IN OTHER AREAS. THE ANNOUNCEMENTS PRESENTED ARE GROUPED AS SEALING TECHNIQUES FOR CRYOGENIC FLUIDS, HIGH PRESSURE APPLICATIONS, AND MODIFICATION FOR IMPROVED PERFORMANCE. EACH OF THE SEALING-TECHNIQUE ANNOUNCEMENTS INCLUDES A BRIEF DESCRIPTION, USUALLY WITH A DIAGRAM, AND A SOURCE FOR FURTHER INFORMATION.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, WASHINGTON, D.C.//SMALL BUSINESS ADMINISTRATION, WASHINGTON, D.C.
REPORT NUMBER -
N72-21480//NASA-SP-5905(03)
OTHER INFORMATION -
0031 PAGES, 0042 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21751 through 21753

NATURAL GAS MANUAL - 1ST EDITION

by

OATES, J. A.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

PUBLISHED IN THIS FIRST EDITION OF THE NATURAL GAS MANUAL IS AN EDITED SELECTION OF SOME OF THE MOST IMPORTANT ARTICLES THAT HAVE APPEARED IN THE JOURNAL NATIONAL GAS - LNG AND LPG. THE ARTICLES COVER PRODUCTION, DISTRUBITION, STORAGE AND UTILIZATION OF NATURAL GAS IN BOTH GASEOUS AND LIQUID PHASES.

-SOURCE INFORMATION-

PUBLISHER -
SCIENTIFIC SURVEYS LTD., BEACONSFIELD, ENGLAND
OTHER INFORMATION -
0230 PAGES, 0106 FIGURES, 0020 TABLES, 0030 REFERENCES

keys 21754 through 21755

ENERGY UTILIZATION AND SAFETY ASPECTS OF SHIPBOARD CRYOGENICS

by

CECE, J. M.
MILTON, J. T.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS BRIEF PAPER ADDRESSES A MAJOR SAFETY IMPLICATION OF HANDLING LARGE QUANTITIES OF LIQUEFIED GASEOUS FUELS AT CRYOGENIC TEMPERATURES AT LARGE TERMINALS. DISCUSSED ARE THE NUMBER AND SIZE OF LNG TERMINALS AND A U.S. COAST GUARD RESEARCH AND DEVELOPMENT EFFORT TO EXAMINE THE HAZARDOUS CONDITIONS THAT MAY OCCUR DURING TRANSPORTATION OVER WATER.

-PERTINENT FIGURES-

TAB. U.S. COAST GUARD ACCIDENT STATISTICS, PAGE 28

-BIBLIOGRAPHY-

U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES, HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, U.S. COAST GUARD OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C., (NTIS AD 705 078) (FEB 1970)//U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES, HAZARDS OF SPILLAGE OF LNG INTO WATER, U.S. COAST GUARD, OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C., (NTIS AD 754 498) (SEP 1971)//AMERICAN PETROLEUM INSTITUTE, REPORT 6Z32 (MAR 1973)// GARLAND, F. AND ATKINSON, G., THE INTERACTION OF LIQUID HYDROCARBONS WITH WATER, U.S. COAST GUARD, OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C., (NTIS AD 753 561) (OCT 1971)//DRAKE, E. M. AND PUTNAM, A. A., VAPOR DISPERSION FROM SPILLS OF LNG ON LAND, CRYOGENIC ENGINEERING CONFERENCE (AUG 1973)//GARDENIER, J. S., II, CONCEPTS FOR ANALYSIS OF MASSIVE SPILL ACCIDENT RISK IN MARITIME BULK LIQUID TRANSPORTATION, U.S. COAST GUARD, OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C. (NTIS AD 746 035) (JUN 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
COAST GUARD, WASHINGTON, D.C.

JOURNAL PROCEEDINGS -
CRYOG. IND. GASES VOL 9, NO. 5, 27-8 (SEP-OCT 1974)
OTHER INFORMATION -
0002 PAGES, 0000 FIGURES, 0000 TABLES, 0012 REFERENCES

INTEGRATED TUG-BARGE UNITS FOR OCEAN TRANSPORTATIONS OF LNG

by

WITHERS,D.D.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

A RECENT JOINT FEDERAL AGENCY STUDY ESTIMATES THAT 70 LNG TANKERS WILL BE BUILT IN THE NEXT TEN YEARS, ACCORDING TO THE FEB 22, 1972 LONDON TIMES. THESE WILL DELIVER ABOUT 7 BILLION CUBIC FEET A DAY, MOST OF IT TO THE U.S.A. AS AMERICAN GAS COMPANIES GAIN MARINE EXPERIENCE, THIS AUTHOR IS CONFIDENT THAT THEY WILL RECOGNIZE THE ADVANTAGES OF U.S.-FLAG INTEGRATED OCEAN TUG BARGE UNITS FOR LNG TRANSPORTATION. SOME ARGUMENTS FOR SUCH UNITS ARE PRESENTED IN THIS PAPER.

-PERTINENT FIGURES-

FIG.19 LIQUID GAS CARRIER LAUNCHING IN HOUSTON AREA, PAGE 10//FIG.20 LIQUID GAS CARRIER LAUNCHING IN HOUSTON AREA, PAGE 10//FIG.22 ARCTIC TANKER GROUPS LNG TUG-BARGE DESIGN FOR PACIFIC OCEAN - GULF OF ALASKA SERVICE, PAGE 11

-BIBLIOGRAPHY-

WALLER,D.B., INTEGRATED TUG-BARGE UNITS FOR OCEAN TRANSPORTATION, PAPER PRESENTED BEFORE THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS, FEB 11, 1972//WITHERS,D.D., VICKERS,R.L. AND WALLER,D.B., LNG TRANSPORTATION UNDER THE JONES ACT, PAPER PRESENTED BEFORE THE AMERICAN GAS ASSOCIATION, MAY 10, 1071

-SOURCE INFORMATION-

CORPORATE SOURCE -
ARCTIC TANKER GROUP, INC., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
ASME PETROLEUM MECHANICAL ENGINEERING AND PRESSURE VESSELS AND PIPING CONF., (PRES. AT) NEW ORLEANS, LA., SEP 17-21, 1972. PAPER 72-PET-58
OTHER INFORMATION -
0012 PAGES, 0022 FIGURES, 0001 TABLES, 0007 REFERENCES

key 20907

LNG TRUCK, RAIL, AND BARGE TRANSPORTATION

by

BIEDERMAN,N.P.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

LIQUEFIED NATURAL GAS HAS RECENTLY ASSUMED AN IMPORTANT ROLE BOTH AS A SUPPLEMENTAL SOURCE OF NATURAL GAS TO THE UNITED STATES AND AS A MEANS OF MEETING WINTER PEAK DEMANDS. THIS PAPER REVIEWS THE STATE-OF-THE-ART OF TRUCK, RAIL, AND BARGE TRANSPORT OF LNG AND SUMMARIZES THE RELATIVE COSTS AND INVESTMENT REQUIREMENTS OF EACH METHOD.

-PERTINENT FIGURES-

TAB.1 LNG SATELLITE FACILITIES, PAGE 4

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -
ASME PETROLEUM MECHANICAL ENGINEERING AND PRESSURE VESSELS AND PIPING CONF., (PRES. AT) NEW ORLEANS, LA., SEP 17-21, 1972. PAPER 72-PET-55
OTHER INFORMATION -
0012 PAGES, 0009 FIGURES, 0004 TABLES, 0000 REFERENCES

DESIGN COMPARISONS BETWEEN LARGE CAPACITY LNG AND VAPOR PHASE NATURAL GAS PIPELINES

by

DIMENTBERG,M.

09/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

LNG PIPELINES HAVE INHERENT ADVANTAGES FOR THE TRANSMISSION OF NATURAL GAS IN LARGE VOLUMES OVER LONG DISTANCES. THE AUTHOR DESCRIBES THESE ADVANTAGES IN TERMS OF THE MAJOR PARAMETERS OF PIPELINE DESIGN. COMPARISONS WITH VAPOR PHASE PIPELINES ARE PRESENTED WITH EMPHASIS ON THE TRANSMISSION OF 3BSCFD FROM THE ARCTIC. THE PAPER INDICATES THAT LNG PIPELINES ARE TECHNICALLY FEASIBLE USING EXISTING TECHNOLOGY, AND COMPARE VERY FAVORABLY WITH THEIR VAPOR PHASE COUNTERPARTS IN ECONOMY, RELIABILITY OF OPERATION, AND ADAPTABILITY TO ENVIRONMENTAL EFFECTS.

-PERTINENT FIGURES-

TAB.1 COMPARISON BETWEEN LNG AND VAPOR PHASE TRANSMISSION, PAGE 5//FIG.4 RELATIONSHIP OF PARAMETERS AFFECTING RAPID CRACK PROPAGATION WITH TEMPERATURE - LNG PIPELINES, PAGE 3//FIG.5 REQUIRED PIPE WALL THICKNESS, PAGE 3//FIG.6 REQUIRED PIPE WALL THICKNESS, PAGE 3

-BIBLIOGRAPHY-

IVANTSOV,O., STUDIES ON LNG PIPELINE TRANSMISSION PROBLEM, PROCEEDINGS OF LNG 3 CONFERENCE//GOODWIN,R.D., THERMODYNAMICS OF METHANE, PROCEEDINGS OF LNG 3 CONFERENCE

-SOURCE INFORMATION-

CORPORATE SOURCE -
LIQUEFACTION LTD., WINNIPEG, MANITOBA
JOURNAL PROCEEDINGS -
ASME PETROLEUM MECHANICAL ENGINEERING CONF., (PRES. AT) LOS ANGELES, CALIF., SEP 16-20, 1973. PAPER 73-PET-33
OTHER INFORMATION -
0008 PAGES, 0007 FIGURES, 0003 TABLES, 0005 REFERENCES

key 20915

THE SPREADING AND EVAPORATION OF LNG ON WATER

by

MAY,W.G.
PERUMAL,P.V.K.

11/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE PREDICTION OF VAPOR TRAVEL DOWNWIND FROM A SPILL OF LIQUEFIED NATURAL GAS (LNG) IS AIDED BY A KNOWLEDGE OF THE EVAPORATING CONDITIONS. THIS PAPER EXTENDS THE KNOWLEDGE OF THESE CONDITIONS FOR SPILLS ON WATER. PUBLISHED DATA ON FREE SPILLS COVERING A SIZE RANGE FROM 2 1/4 TO 4500 KG HAVE BEEN USED TO PROVIDE INFORMATION ON LNG SPREAD RATE, MAXIMUM POOL DIAMETER REACHED, AND EVAPORATION RATE.

-PERTINENT FIGURES-

FIG.9 MAXIMUM LNG POOL DIAMETER AS A FUNCTION OF SPILL SIZE, PAGE 9

-BIBLIOGRAPHY-

BURGESS,D.S., BIORDI,J. AND MURPHY,J.N., HAZARDS OF SPILLAGE OF LNG INTO WATER, DEPT. OF INTERIOR, BUREAU OF MINES, REPORT SUPPORTING INVESTIGATION MIPR NO. Z-70099-9-12395, (SEP 1972)//FELDBAUER,G.G., ET AL., SPILLS OF LNG ON WATER - VAPORIZATION AND DOWNWARD DRIFT OF COMBUSTIBLE MIXTURES, REPORT TO THE API (NOV 1972)//BOYLE,G.J. AND KNEEBONE,A., LABORATORY INVESTIGATIONS INTO THE CHARACTERISTICS OF LNG SPILLS ON WATER, EVAPORATION, SPREADING AND VAPOR DISPERSION, SHELL RESEARCH, LTD., REPORT TO THE API//BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.C., HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED NATURAL GAS ON WATER, U.S. DEPARTMENT OF INTERIOR, BUREAU OF MINES, WASHINGTON (1970)//HSU,Y.Y., A REVIEW OF FILM BOILING AT CRYOGENIC TEMPERATURES, ADVANCES IN CRYOGENIC ENGINEERING, VOL 17, 361, TIMMERHAUS,K.D., ED., PLENUM PRESS, LONDON (1972) //HOULT,D.P., THE FIRE HAZARD OF LNG SPILLED ON WATER, CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY (NATIONAL ACADEMY OF SCIENCES), BOSTON, MASS. (JUNE 13-14, 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
STEVENS INST. OF TECH., HOBOKEN, N.J.
JOURNAL PROCEEDINGS -
ASME WINTER ANNUAL MEETING, (PRES. AT) NEW YORK, NOV 17-22, 1974. PAPER 74-WA/PID-15
OTHER INFORMATION -
0007 PAGES, 0009 FIGURES, 0000 TABLES, 0011 REFERENCES

keys 20916 through 20920

ENGINEERING STUDIES SHOW POSSIBILITIES FOR LNG PIPE LINE

by

DUFFY,A.R.
DAINORA,J.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS INVESTIGATION HAS INDICATED THAT MATERIALS OF CONSTRUCTION EXIST SUCH THAT TRANSMISSION OF LNG OVER CONSIDERABLE DISTANCE APPEARS TO BE TECHNICALLY FEASIBLE. CHIEF AMONG THE PIPE MATERIALS ARE THE ALUMINUM ALLOYS (E.G., 5456-0, 5083-0, 6061-T6, 7039-T6, ETC.), STAINLESS-STEEL (E.G., TYPE 304), AND HIGH NICKEL CONTENT STEELS (E.G., 9 PERCENT NICKEL STEEL). WHILE IT HAS BEEN POSSIBLE TO MAKE THIS EVALUATION ON THE BASIS OF AVAILABLE STRENGTH AND TOUGHNESS DATA PUBLISHED IN THE LITERATURE, IT HAS BEEN NOTED THAT ADDITIONAL WORK WILL BE REQUIRED TO OBTAIN, FOR THE CANDIDATE MATERIALS, SPECIFIC PHYSICAL AND MECHANICAL PROPERTY DATA CONSIDERED MORE DIRECTLY APPLICABLE TO AN LNG PIPE LINE ENVIRONMENT. ALSO, OTHER MATERIALS MAY BE CONSIDERED IF RESEARCH DEMONSTRATES THAT THE SPEED OF A PROPAGATING FRACTURE IS SUFFICIENTLY BELOW THE DECOMPRESSION VELOCITY OF LNG AND THE RESISTANCE TO FRACTURE INITIATION IS SUFFICIENTLY HIGH.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BATTELLE MEMORIAL INST., COLUMBUS, OHIO
JOURNAL PROCEEDINGS -
PIPE LINE IND. (1968)
OTHER INFORMATION -
0008 PAGES, 0016 FIGURES, 0002 TABLES, 0013 REFERENCES

keys 20921 through 20922

SPILLS OF LNG ON WATER - VAPORIZATION AND DOWNWIND DRIFT OF COMBUSTIBLE MIXTURES

by

FELDBAUER,G.F.
HEIGL,J J.
MCQUEEN,W.
WHIPP,R.H.
MAY,W.G.

11/24/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	Incremental	Good/Excel.

-ABSTRACT-

THIS REPORT PRESENTS THE RESULTS OF A RESEARCH PROGRAM CARRIED OUT BY ESSO RESEARCH AND ENGINEERING COMPANY ENTITLED SPILLS OF LNG ON WATER - VAPORIZATION AND DOWNWIND DRIFT OF COMBUSTIBLE MIXTURES. THE WORK WAS CARRIED OUT UNDER CONTRACT WITH THE AMERICAN PETROLEUM INSTITUTE AND UNDER THE DIRECTION OF THE LNG RESEARCH STEERING GROUP OF THE API. EARLY WORK BY THE BUREAU OF MINES SHOWED THAT A LARGE LNG SPILL MIGHT PRODUCE FLAMMABLE CONCENTRATIONS EXTENDING A LONG WAY DOWNWIND. THE BUREAU OF MINES WORK WAS DONE ON A VERY SMALL SCALE, HOWEVER, SO THAT VERY LONG-RANGE EXTRAPOLATION WAS REQUIRED IN APPLYING THE DATA TO POTENTIAL INDUSTRIAL ACCIDENTS. ANALYSIS SHOWED SEVERAL SIGNIFICANT QUESTIONS ARISING FROM SUCH AN EXTRAPOLATION, E.G., WILL THE EFFECT OF HIGH DENSITY VAPOR DIFFER IN A LARGE SPILL, COMPARED WITH A SMALL SPILL. THIS WORK WAS UNDERTAKEN PRIMARILY TO OBTAIN DATA ON LARGER SCALE SPILLS IN ORDER TO DEMONSTRATE SIZE EFFECTS AND PERMIT MORE RELIABLE EXTRAPOLATION. A SECONDARY OBJECTIVE OF THE PROGRAM WAS TO OBTAIN DOWNWIND DISPERSION DATA CHARACTERISTIC OF A MARINE ENVIRONMENT - THAT IS, UNDER ATMOSPHERIC MIXING CONDITIONS OVER WATER. FOR THIS REASON THE WORK WAS CARRIED OUT ON A LARGE BODY OF WATER (MATAGORDA BAY, TEXAS) SEVERAL MILES FROM THE NEAREST SIGNIFICANT LAND MASS.

-PERTINENT FIGURES-

FIG.26 THCIKNESS OF LNG LAYER AS A FUNCTION OF POOL DIAMETER, PAGE 53// FIG.28 MAXIMUM LNG VAPORIZATION RATE AS A FUNCTION OF SPILL SIZE, PAGE 58// FIG.43 EFFECT OF STABILITY ON DISTANCE TO 1 LFL FOR INSTANTANEOUS SPILLS IN 5 MPH WIND, PAGE 95//FIG.51 CALCULATED MINIMUM SPILL SIZE FOR LNG VAPOR EXPLOSION, PAGE 111

-BIBLIOGRAPHY-

BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED NATURAL GAS ON WATER, U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES, WASHINGTON (1970)//ENGER,T., EXPLOSIVE BOILING OF LIQUEFIED GASES ON WATER, CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY, NATIONAL ACADEMY OF SCI/ENG., COMMITTEE ON HAZARDOUS MATERIALS, BOSTON, MASS. (JUN 13-4, 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
ESSO RESEARCH AND ENGINEERING CO., LINDEN, N.J.
REPORT NUMBER -
EE61E-72
OTHER INFORMATION -
0212 PAGES, 0092 FIGURES, 0010 TABLES, 0019 REFERENCES

keys 20923 through 20925

REVIEW OF LNG SAFETY RESEARCH

by

GIDEON,D.N.
PUTNAM,A.A.
DUFFY,A.R.

07/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER DESCRIBES THE LNG SAFETY PROGRAM, AMERICAN GAS ASSOCIATION PROJECT IS-3-1, AND THE FOLLOW-ON PROGRAM TO ANALYZE DISPERSION DATA FROM LNG SPILLS OVER LAND AND WATER. PROJECT SI-3-7. THE OBJECTIVE OF THE SAFETY PROGRAM INCLUDED DEVELOPMENT OF DATA AND METHODS FOR PREDICTION OF THE EXTENT OF HAZARDOUS ZONES OF FLAMMABLE MIXTURES AND OF RADIATION FROM FIRES, AND ALSO ACQUISITION OF DATA ON METHODS OF REDUCTION OF THE HAZARDOUS ZONES. LNG WAS SPILLED QUICKLY INTO DIKES UP TO 80 FEET IN DIAMETER. EXPERIMENTS INCLUDED (1) DISPERSION OF VAPOR CLOUDS, (2) RADIATION EFFECTS FROM FIRES, (3) OBSERVATIONS OF CONTROL OF DISPERSION, AND (4) CONTROL AND EXTINGUISHMENT OF FIRES. EXPERIMENTAL DETAILS ARE DISCUSSED AND RESULTS ARE PRESENTED. ANALYTICAL DISPERSION MODELS WERE DEVELOPED WHOSE PREDICTIONS AGREE REASONABLY WELL WITH CORRELATIONS OF THE DISPERSION DATA, TAKING INTO ACCOUNT THE OBSERVED PEAK-TO-AVERAGE RATIOS. EXAMPLES OF PREDICTIONS OF EXTENT OF HAZARDOUS PLUME ARE SHOWN. FLAME RADIATION DATA WERE OBTAINED AND CORRELATED BY A MODEL INCLUDING FACTORS FOR SOURCE STRENGTH, DIAMETER OF THE FLAME, VIEW FACTOR, AND ATMOSPHERIC TRANSMISSIVITY. EXAMPLES OF PREDICTED RADIATION LEVELS VERSUS POOL SIZE, DISTANCE, HUMIDITY, AND WIND ARE SHOWN. AFTER COMPLETION OF THE A.G.A. LAND SPILL PROGRAM AND THE A.P.I.-ESSO WATER SPILL PROGRAM, FURTHER ANALYSIS AND CORRELATION OF ALL PUBLISHED DATA ON DISPERSION OF LNG VAPORS WAS SPONSORED BY A.G.A. PEAK CONCENTRATIONS WERE EMPHASIZED. DATA WERE CORRELATED IN TERMS OF SEVERAL DIMENSIONLESS OR PARTLY DIMENSIONLESS GROUPS, FOR INSTANTANEOUS LAND AND WATER SPILLS AND FOR STEADY-STATE WATER SPILLS. SOME OF THE DIFFICULTIES IN CORRELATING VARIOUS KINDS OF DATA ARE DISCUSSED, AND THE PROCEDURE EXPLAINED. EXAMPLES OF CORRELATIONS ARE SHOWN AND CONCLUSIONS ARE DISCUSSED.

-PERTINENT FIGURES-

FIG.1 CORRELATION OF PEAK METHANE CONCENTRATIONS FOR INSTANTANEOUS SPILLS, PAGE 6//FIG.2 CORRELATION OF PEAK METHANE CONCENTRATIONS FOR CONTINUOUS SPILLS, PAGE 8//FIG.3 NORMALIZED CONCENTRATION TIMES WIND VELOCITY VERSUS DISTANCE FOR INSTANTANEOUS SPILLS ON

WATER, PAGE 9//FIG.5 PREDICTIONS OF MAXIMUM DISTANCES TO 5 PERCENT PEAK METHANE CONCENTRATIONS, PAGE 12//FIG.6 RADIANT FLUX ON TARGET ORIENTED FOR MAXIMUM INTENSITY WITH NO WIND, PAGE 17//FIG.7 EFFECT OF WIND ON RADIANT FLUX ON TARGET ORIENTED FOR MAXIMUM INTENSITY, PAGE 18

-BIBLIOGRAPHY-

LNG SAFETY PROGRAM, PHASE I - POTENTIAL LNG SPILLS, REPORT BY BATTELLE COLUMBUS LABORATORIES TO THE AMERICAN GAS ASSOCIATION, FEB 25, 1971//A REPORT ON LNG SAFETY RESEARCH, VOLUMES I, II, AND III, REPORT BY ARTHUR D. LITTLE, INC. TO THE AMERICAN GAS ASSOCIATION, JAN 31, 1971//LNG SAFETY PROGRAM, INTERIM REPORT OF PHASE II WORK, FINAL REPORT TO THE AMERICAN GAS ASSOCIATION ON PROJECT IS-3-1 FROM BATTELLE COLUMBUS LABORATORIES, A.G.A. CATALOG NO. M 19874, JUL 1, 1974//GIDEON,D.N., PUTNAM,A.A. AND DUFFY,A.R., COMPARISON OF DISPERSION FROM LNG SPILLS OVER LAND AND WATER, REPORT TO THE AMERICAN GAS ASSOCIATION ON PROJECT SI-3-7 FROM BATTELLE COLUMBUS LABORATORIES, SEP 4, 1974//AN EXPERIMENTAL STUDY ON THE MITIGATION OF FLAMMABLE VAPOR DISPERSION AND FIRE HAZARDS IMMEDIATELY FOLLOWING LNG SPILLS ON LAND, REPORT TO THE AMERICAN GAS ASSOCIATION BY UNIVERSITY ENGINEERS, INC., FEB 1974

-SOURCE INFORMATION-

CORPORATE SOURCE -
BATTELLE COLUMBUS LABS., OHIO
JOURNAL PROCEEDINGS -
CRYOGENIC ENGINEERING CONF., (PRES. AT) KINGSTON, ONTARIO, JUL 22-5, 1975. PAPER NO. S-2
OTHER INFORMATION -
0021 PAGES, 0007 FIGURES, 0000 TABLES, 0006 REFERENCES

keys 20926 through 20928

CRYOGENIC FUEL SYSTEMS FOR MOTOR VEHICLES

by

HIBL,J.J.

07/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

WITH A BROAD BACKGROUND IN CRYOGENIC TECHNOLOGY, ESPECIALLY CRYOGENIC FUEL STORAGE, BEECH AIRCRAFT CORPORATION UNDERTOOK A PROGRAM TO DEVELOP STORAGE CONTAINERS FOR CRYOGENIC FUELS ON MOTOR VEHICLES. EXTENSIVE DATA WAS ALREADY AVAILABLE FOR POLLUTION LEVELS AND COMBUSTION ENGINE PERFORMANCE WITH THESE FUELS. STORAGE CONTAINER AND FLOW SYSTEM DEVELOPMENT FOR FLEET VEHICLE APPLICATION WAS EMPHASIZED. NO-LOSS STORAGE FOR UP TO TWO WEEKS LOCK-UP TIME WAS DEMONSTRATED WITH LNG. A SELF-PRESSURIZING FLOW CONTROL SYSTEM PROVIDED VAPOR OR LIQUID FEED TO THE ENGINE, DEPENDING ON TANK PRESSURE. SEVERAL AREAS FOR SYSTEM AND COMPONENT IMPROVEMENT WERE IDENTIFIED DURING A ONE-YEAR FIELD DEMONSTRATION PROGRAM. A PROTOTYPE LNG CONTAINER WAS UTILIZED TO DEMONSTRATE THAT CONTAINERS AND SYSTEMS FOR LH(2) FUELED VEHICLES COULD ACHIEVE SAFE AND EFFICIENT OPERATION.

-PERTINENT FIGURES-

FIG.1 FLOW SYSTEM SCHEMATIC, PAGE 7//FIG.2 CLOSE-UP PROTOTYPE PLUMBING ASSEMBLY, PAGE 8//FIG.3 BEECH TANK IN LH(2) FUELED AUTOMOBILE, PAGE 10

-BIBLIOGRAPHY-

CALIFORNIA AIR RESOURCES BOARD, AIR RESOURCES LABORATORY, LOS ANGELES, CA, FEB 1969, PROJECT M175 - EMISSION TEST OF SAN DIEGO LNG FUEL SYSTEM// GENERAL SERVICES ADMINISTRATION, 1971, A REPORT ON THE GSAS DUAL-FUEL VEHICLE EXPERIMENT - POLLUTION REDUCTION WITH COST SAVINGS, (U.S. GOVERNMENT PRINTING OFFICE, STOCK NO. 2205-0002)//MCJONES,R.W. AND CORBEIL,R.J., NATURAL GAS FUELED VEHICLES EXHAUST EMISSIONS AND OPERATIONAL CHARACTERISTICS, SOCIETY OF AUTOMOTIVE ENGINEERS, 1970// MURRAY,R.G. AND SCHOEPPEL,R.J., EMISSION AND PERFORMANCE CHARACTERISTICS OF AN AIR-BREATHING HYDROGEN - FUELED INTERNAL COMBUSTION ENGINE, SAE 719009, 1971//FINEGOLD,J.G., ET AL., THE UCLA HYDROGEN CAR, DESIGN, CONSTRUCTION AND PERFORMANCE, SAE 730507, 1973

-SOURCE INFORMATION-

CORPORATE SOURCE -
BEECH AIRCRAFT CORP., BOULDER, COLO.
JOURNAL PROCEEDINGS -
CRYOGENIC ENGINEERING CONF., (PRES. AT) KINGSTON, ONTARIO, JUL 22-5, 1975. PAPER H-4
OTHER INFORMATION -
0015 PAGES, 0003 FIGURES, 0000 TABLES, 0007 REFERENCES

keys 18838 through 18841

BOSTON GAS LNG TERMINAL EXPERIENCE

by

BLEAKNEY,R.A.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER BRIEFLY DESCRIBES OPERATING EXPERIENCES OF THE BOSTON GAS COMPANY LNG TERMINAL AT COMMERCIAL POINT, MASS. AND RECOMMENDATIONS PERTAINING TO SAFE OPERATION OF LNG FACILITIES DERIVED FROM THOSE EXPERIENCES.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BOSTON GAS CO., MASS.
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
LNG IMPORTATION AND TERMINAL SAFETY CONF., 185 & 187-90, (PROC. OF) BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
0005 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

RADIATION FROM LARGE LNG FIRES

by

MAY,W.G.
MCQUEEN,W.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

RADIATION FROM FLAMES OF BURNING LNG HAS BEEN MEASURED AND COMPARED WITH THAT FROM EARLIER WORK (BUREAU OF MINES), THE LARGEST BEING FROM A POOL 20 FEET BY 20 FEET. THE PRESENT TESTS AFFORDED THE OPPORTUNITY TO MEASURE RADIATION HEAT FLUX FROM MUCH LARGER FLAMES, WITH AN LNG CONSUMPTION RATE OF TEN TO TWENTY TIMES THE LARGEST REPORTED BUREAU OF MINES TEST. THE DATA FROM THESE LARGE FIRES ARE SUMMARIZED IN THIS REPORT.

-PERTINENT FIGURES-

TAB.2 LNG BURN PIT RADIATION MEASUREMENTS, PAGE 112//FIG.1 PLOT PLAN BURN PIT AREA, PAGE 113//FIG.4 HEAT FLUX RECEIVED VS DISTANCE FROM FLAME CENTER WITH PARAMETER OF FIRE SIZE, PAGE 116//FIG.5 DISTANCE FROM CONTAINMENT OF BURNING LNG POOL TO RECEIVE SPECIFIED HEAT FLUX, PAGE 11M

-BIBLIOGRAPHY-

BURGESS,D. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, U.S. DEPARTMENT OF INTERIOR, BUREAU OF MINES, REPORT NO. RI-6099 (1962)

-SOURCE INFORMATION-

CORPORATE SOURCE -
ESSO RESEARCH AND ENGINEERING CO., LINDEN, N.J.
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
LNG IMPORTATION AND TERMINAL SAFETY CONF., 106-18, (PROC. OF) BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
0013 PAGES, 0005 FIGURES, 0002 TABLES, 0001 REFERENCES

keys 18830 through 18836

LNG VESSEL DESIGN AND OPERATING EXPERIENCE

by

THOMAS,W.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THE GREAT AMOUNT OF INTEREST SHOWN IN THE CONSTRUCTION OF LNG CARRIERS OF LATE, BOTH IN THIS COUNTRY AND ABROAD, HAS BROUGHT ABOUT A VAST PROLIFERATION OF PAPERS ON ALL PHASES OF THE SUBJECT - SOME VERY USEFUL AND IMPORTANT, OTHERS QUITE CLEARLY MERELY SALES INSTRUMENTS. THIS AUTHOR, TOGETHER WITH MR. A. H. SCHWENDTNER, ATTEMPTED TO PRESENT THE STATE OF THE ART OF LNG CARRIER DESIGN AS OBJECTIVELY AS POSSIBLE IN A PAPER PRESENTED BEFORE THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS IN NOVEMBER 1971. THE CURRENT PAPER DRAWS HEAVILY UPON PORTIONS OF THE NOVEMBER 1971 WORK IN ORDER TO PRESENT BRIEF DESCRIPTIONS OF THE CURRENTLY AVAILABLE COMPETITIVE DESIGNS WHICH, IT IS FELT, WILL BE THE BASIS OF THE LNG CARRIER FLEET TO BE BUILT OVER THE NEXT FEW YEARS. NOT INCLUDED ARE SEVERAL TECHNICALLY INTERESTING DESIGNS WHICH MAY NOT YET BE READY FOR COMMERCIAL EXPLOITATION AND SEVERAL OTHERS WHICH HAVE BEEN USED IN THE PAST BUT ARE NOT CURRENTLY BEING CONSIDERED. OMISSION OF THESE DESIGNS, UPON WHICH, IN SOME CASES, A GREAT DEAL OF ENGINEERING AND DEVELOPMENT HAS BEEN ACCOMPLISHED, HAS BEEN DONE SOLELY IN THE INTEREST OF ECONOMY OF TIME AND SPACE, AND NOT BECAUSE THEY ARE TO BE CONSIDERED LESS INTERESTING OR ACCEPTABLE THAN THE OTHERS. THOSE DESIGNS DESCRIBED HERE ARE THE CONCH PRISMATIC FREE-STANDING TANK, THE GAZ-TRANSPORT INVAR MEMBRANE TANK, THE TECHNIGAZ STAINLESS STEEL MEMBRANE TANK, AND THE KVAERNER-MOSS SPHERICAL FREE-STANDING TANK. OPERATING EXPERIENCES ARE ALSO DISCUSSED.

-SOURCE INFORMATION-

CORPORATE SOURCE -
    HENRY (J.J.) CO., INC., QUINCY, MASS.
REPORT NUMBER -
    AD-754326
JOURNAL PROCEEDINGS -
    LNG IMPORTATION AND TERMINAL SAFETY CONF., 153 & 155-66, (PROC. OF) BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
    0013 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 20933

ON THE GEOMETRIC STABILITY OF CYLINDRICAL DOUBLE WALLED CRYOGENIC TANK STRUCTURES

by

PADAWER,G.E.

07/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

A BALSA BLOCK FOOTING SYSTEM SUPPORTING THE INNER WALL OF VERY LARGE, CYLINDRICAL, DOUBLE-WALLED CRYOGENIC STORAGE TANKS IS ANALYZED FOR GEOMETRIC STABILITY WITH RESPECT TO EXCENTRIC MOVEMENTS OF THE INNER CONTAINER. A VARIABLE DISTRIBUTION FUNCTION IS EMPLOYED TO MODEL THE POSSIBLE NONUNIFORM DISTRIBUTION OF FRICTION FORCES WHICH MAY RESULT IN EXCENTRIC DISPLACEMENTS OF THE INNER TANK DURING COOL-DOWN AND WARM-UP, OR IN RESPONSE TO VARYING INVENTORY LEVELS. THE DEGREE OF NONUNIFORMITY OF FRICTION COULD BE MODELED AT WILL OVER THE FULL RANGE OF POSSIBILITIES. IT WAS FOUND THAT, FOR ANY DEGREE OF NONUNIFORMITY, THE EXCENTRIC DISPLACEMENTS DID NOT EXCEED AN ASYMPTOTIC LIMIT OF ABOUT 2 PERCENT OF THE NORMALLY OCCURING CIRCULAR-SYMMETRIC DISPLACEMENTS. THE ASSOCIATED ELASTIC SHEAR DID NOT EXCEED TWICE THE DESIGN AVERAGE SHEAR LOADING, EVEN IN THE WORST CASE. REPEATED CYCLING WAS FOUND TO HAVE NO CUMMULATIVE EFFECTS. IN THE EXAMPLE OF AN ACTUAL STRUCTURE, IT WAS FOUND THAT IN THE WORST PRACTICAL CASE, THE DESIGN FACTORS OF SAFETY REMAINED WITHIN ACCEPTABLE BOUNDS. IT WAS CONCLUDED THAT THE DESCRIBED BALSA BLOCK FOUNDATION SYSTEM WAS GEOMETRICALLY STABLE AND COULD THEREFORE BE REGARDED AS STRUCTURALLY RELIABLE.

-PERTINENT FIGURES-

FIG.1 900,000 BARREL LNG TANK SHEAR BAR ARRANGEMENT (SCHEMATIC), PAGE 3// FIG.2 PLAN VIEW (SCHEMATIC) OF DOUBLE WALL CYLINDRICAL TANK, SHOWING DISPLACEMENTS AND COORDINATES, PAGE 5

-BIBLIOGRAPHY-

STILES,R.E., 900,000 - BARREL LNG TANKS ARE DESIGNED FOR SAFETY, PIPE LINE INDUSTRY 39 (4), 25-26, (OCT 1973)//P AND GJ STAFF REPORT, WORLDS LARGEST LNG STORAGE TANKS UNDER CONSTRUCTION, PIPELINE AND GAS JOURNAL VOL 199, (11), 62, 64 (SEP 1972)//GOLDBERG,E. AND SALTZ,E.X., LNG TERMINAL IS DESIGNED FOR SAFETY, PIPELINE AND GAS JOURNAL VOL 200 (3), 42-44 (MAR 1973)

-SOURCE INFORMATION-

CORPORATE SOURCE -
    CABOT (GODFREY L.), INC., BOSTON, MASS.
JOURNAL PROCEEDINGS -
    CRYOGENIC MATERIALS INTERNATIONAL CONF., (PRES. AT) KINGSTON, ONTARIO, JUL 22-5, 1975. PAPER M-1
OTHER INFORMATION -
    0032 PAGES, 0006 FIGURES, 0002 TABLES, 0005 REFERENCES

keys 20934 through 20935

SOME LNG VEHICLE DEVELOPMENTS

by

GIBSON,C.J.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE CONVERSION OF VEHICLES TO USE LIQUEFIED NATURAL GAS AS A FUEL WAS UNDERTAKEN IN THE FORM OF VARIOUS PILOT PROGRAMS IN THE LATE 1960S. SINCE THESE EARLY EFFORTS, USING CRYOGENIC TECHNOLOGY DEVELOPED DURING THE SPACE PROGRAMS, A SERIES OF INNOVATIONS AND REFINEMENTS HAS TAKEN PLACE. THE LNG POWERED VEHICLE IS NOW A PRACTICAL MEANS OF REDUCING AIR POLLUTION, EXTENDING ENGINE LIFE AND USING AN ALTERNATE FUEL AS GASOLINE PRICES RISE. THIS PAPER REVIEWS THE DEVELOPMENTAL PROCESS WHICH HAS TAKEN PLACE, DESCRIBES CURRENT STATE-OF-THE-ART FOR THE LNG CONVERSION SYSTEM AS WELL AS THE VEHICLE FUELING STATION, AND PRESENTS AUTO EMISSIONS TEST RESULTS AND LOOKS AT FUTURE LNG AVAILABILITY. THE LNG POWERED VEHICLE IS PLACED IN PERSPECTIVE FOR FLEET OPERATIONS WHILE CONCLUDING THAT AS A LOW EMISSION ALTERNATE TO GASOLINE, LNG HAS A DEFINITE PLACE AS AN AUTOMOTIVE FUEL.

-PERTINENT FIGURES-

FIG.8-6 ELECTRICAL/MECHANICAL SCHEMATIC DUAL FUEL SYSTEM MODIFICATION, PAGE 102

-SOURCE INFORMATION-

CORPORATE SOURCE -
KAISER BRENCAR, EL CAJON, CALIF.
JOURNAL PROCEEDINGS -
APPLICATIONS OF CRYOGENIC TECHNOLOGY VOL 6, 94-109 (1974)
(PROC. OF CRYO/73, LOS ANGELES, CALIF., OCT 2-4, 1973)
PUBLISHER -
SCHOLIUM INTERNATIONAL INC., FLUSHING, N.Y.
OTHER INFORMATION -
0016 PAGES, 0008 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20936 through 20937

A NEW CONTAINMENT SYSTEM FOR LNG CARRIERS

by

ICHINOSE,Y.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

A NEW CONTAINMENT SYSTEM FOR THE LNG CARRIER HAS BEEN DEVELOPED BY IHI (ISHIKAWAJIMA-HARIMA HEAVY IND., CO., LTD.). IT IS A HYBRID OF THE SELF-STANDING SYSTEM AND THE MEMBRANE SYSTEM INVOLVING THE MERITS OF THE TWO SYSTEMS. THE SYSTEM IS DEVELOPED TO ATTAIN HIGH RELIABILITY TO ASSURE HIGHEST OPERATIONAL PERFORMANCE. THE PRIMARY BARRIER, MADE OF ALUMINUM ALLOY, HAS A VERY SIMPLE, RECTANGULAR, PRISMATIC CONSTRUCTION WITH FLAT WHEELS AND CURVED CORNERS TO ABSORB CONTRACTION. THE HIGH RELIABILITY OF THE PRIMARY BARRIER ALLOWS A REDUCED SECONDARY BARRIER. THE MATERIALS OF INSULATION ARE PLASTIC FOAM AND THE SECONDARY BARRIER IS PLYWOOD.

-PERTINENT FIGURES-

FIG.3-1 CUTAWAY OF A TYPICAL LNG TANK, PAGE 43//FIG.3-2 GENERAL ARRANGEMENT, PAGE 45

-SOURCE INFORMATION-

CORPORATE SOURCE -
ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD., JAPAN
JOURNAL PROCEEDINGS -
APPLICATIONS OF CRYOGENIC TECHNOLOGY VOL 6, 35-46 (1974)
(PROC. OF CRYO/73, LOS ANGELES, CALIF., OCT 2-4, 1973)
PUBLISHER -
SCHOLIUM INTERNATIONAL INC., FLUSHING, N.Y.
OTHER INFORMATION -
0012 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20938 through 20943

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT PROVIDENCE, RHODE ISLAND. ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION. ANALYSIS OF PUBLIC SAFETY SECTION 3J, 3-18 - 3-61 (AUG 1974)

-ABSTRACT-

THERE IS AS YET NOT MUCH DIRECT EXPERIENCE WITH THE EXTENT OF HAZARDS TO THE PUBLIC FROM THE TYPE OF LNG IMPORT TERMINAL SIMILAR TO THE PROPOSED ALGONQUIN LNG, INC. PROVIDENCE FACILITY. HOWEVER, THERE IS A BASE OF EXPERIMENTS WITH LNG SPILLS, WELL-FOUNDED ANALYTICAL TECHNIQUES, AND CONSIDERABLE EXPERIENCE WITH THE TRANSPORT AND STORAGE OF OTHER FLAMMABLE FLUIDS. FOR THIS SAFETY ANALYSIS, OPERATIONS ARE CONSIDERED IN FOUR PHASES. (1) AT SEA TRANSPORT, (2) HARBOR TRANSPORT AND DOCKING, (3) UNLOADING, AND (4) STORAGE AND REGASIFICATION. THIS SECTION OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT EXAMINES. 1. THE TYPE OF ACCIDENTS THAT CAN OCCUR. 2. BEHAVIOR OF LNG WHEN RELEASED, BOTH AS A SINGLE MASSIVE SPILL AND AS LONG-TERM SOURCE. 3. THE POSSIBLE CONSEQUENCES OF LNG RELEASES. 4. THE RELATIVE DEGREES OF RISK, BASED ON THE FEDERAL POWER COMMISSION STAFFS PROFESSIONAL JUDGMENT, ASSOCIATED WITH THE VARIOUS CLASSES OF ACCIDENTS.

-PERTINENT FIGURES-

TAB. 10 SUMMARY OF LNG BEHAVIOR IN SPILLS, PAGE 3-40

-SOURCE INFORMATION-

CORPORATE SOURCE -
FEDERAL POWER COMMISSION, WASHINGTON, D.C.
OTHER INFORMATION -
0044 PAGES, 0000 FIGURES, 0014 TABLES, 0018 REFERENCES

keys 20944 through 20947

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT PROVIDENCE, RHODE ISLAND. MEASURES TO ENHANCE THE ENVIRONMENT OR TO AVOID OR MITIGATE ADVERSE ENVIRONMENTAL EFFECTS SECTION 4, 4-1 - 4-19 (AUG 1974)

-ABSTRACT-

THIS SECTION OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED ALGONQUIN LNG, INC. PROVIDENCE, R.I. MARINE TERMINAL DISCUSSES SAFETY MEASURES INCORPORATED IN THE FACILITY TO PROTECT THE ENVIRONMENT, THE COMMUNITY, AND THE TERMINAL PERSONNEL IN THE SHIPPING AND UNLOADING OF LNG.

-PERTINENT FIGURES-

FIG.21 ALGONQUIN LNG FIRE PROTECTION PLOT PLAN, PAGE 4-15

-SOURCE INFORMATION-

CORPORATE SOURCE -
FEDERAL POWER COMMISSION, WASHINGTON, D C.
OTHER INFORMATION -
0019 PAGES, 0001 FIGURES, 0002 TABLES, 0009 REFERENCES

keys 20948 through 20951

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT PROVIDENCE, RHODE ISLAND. ATTACHMENT 1. EXPECTED BEHAVIOR OF AN LNG RELEASE UNDER SPECIFIED CONDITIONS

-ABSTRACT-

THE ESCAPE OF LNG INTO THE ATMOSPHERE HAS BEEN INVESTIGATED UNDER TWO SETS OF CONDITIONS. (1) 100,000 M(3) SPILLED ON WATER INSTANTANEOUSLY FROM THE VIOLENT AND COMPLETE RUPTURE OF AN LNG TANKER, AND (2) THE LID OF A 900,000 BBL STORAGE TANK IS REMOVED ACCIDENTALLY ALLOWING THE LNG TO EVAPORATE SLOWLY. FOR EACH CASE, THE SIZE OF THESE SPILLS AND THE TIME REQUIRED FOR THE VAPOR TO REACH THE 5 PERCENT FLAMMABILITY LIMIT HAS BEEN DETERMINED FOR SEVERAL WIND AND WEATHER CONDITIONS.

-PERTINENT FIGURES-

TAB.1 DISTANCE TO FLAMMABILITY LIMIT, PAGE 17//TAB.4 DISTANCE TO FLAMMABILITY LIMIT, PAGE 24//FIG.5 VAPOR PLUME FROM LNG TANK UNDER 5 MPH WINDS, PAGE 25//FIG.6 VAPOR PLUME FROM LNG TANK UNDER 70 MPH WINDS, PAGE 25//FIG.7 LNG TANK BOILOFF UNDER CALM WINDS, PAGE 26

-BIBLIOGRAPHY-

AMERICAN PETROLEUM INSTITUTE, ESSO RESEARCH AND ENGINEERING COMPANY, REPORT NO. EE61E-72, SPILLS OF LNG ON WATER - VAPORIZATION AND DOWNWIND DRIFT OF COMBUSTIBLE MIXTURES, MAY 24, 1972. REVISIONS NOV 24, 1972. (REFERENCE 2 IN OUR STUDY)//BURGESS,D., BIORDI,J. AND MURPHY,J.; HAZARDS OF SPILLAGE OF LNG INTO WATER, U.S. DEPARTMENT OF INTERIOR - BUREAU OF MINES, SEP 1972, INVEST. MIPR NO. Z-70099-12395//BURGESS,D., MURPHY,J. AND ZABETAKIS,M.G., HAZARDS ASSOCIATED WITH SPILLAGE OF LIQUEFIED NATURAL GAS ON WATER, U.S. DEPARTMENT OF INTERIOR - BUREAU OF MINES, INTERIOR LIBRARY CATEGORY TN 23.U7 NO. 7488-622.06173//BURGESS,D. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, 1962, INTERIOR LIBRARY CATEGORY TN 23.U7 NO. 6099-622.06173//FAY,J.A. AND MACKENZIE,J.J., COLD CARGO, ENVIRONMENT VOL 14, NO. 9, NOV 1972// HANNA,S.R., A SIMPLE METHOD OF CALCULATING DISPERSION FROM URBAN AREA SOURCES, JOURNAL OF THE AIR POLLUTION CONTROL ASSOCIATION, DEC 1971, VOL 21, NOL 12, 774-777

-SOURCE INFORMATION-

CORPORATE SOURCE -
FEDERAL POWER COMMISSION, WASHINGTON, D.C.
OTHER INFORMATION -
0034 PAGES, 0007 FIGURES, 0004 TABLES, 0015 REFERENCES

keys 20952 through 20953

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT PROVIDENCE, RHODE ISLAND. ATTACHMENT 3. BARGE PLUME ANALYSIS

-ABSTRACT-

IN ATTACHMENT 1 OF THIS REPORT THE CHARACTERISTICS OF THE VAPOR CLOUD FROM AN LNG SPILL FROM THE MASSIVE RUPTURE OF ALL THE TANKS OF AN LNG SHIP WERE INVESTIGATED. THE SPILL SIZE WAS TAKEN TO BE 100,000 M(3) WHICH IS THE APPROXIMATE AMOUNT CARRIED BY THE PROPOSED GENERAL DYNAMICS SHIPS. THIS SHIP AND OTHERS OF ITS CLASS MAY SERVE THE PROPOSED STATEN ISLAND, NEW YORK AND PROVIDENCE, RHODE ISLAND LNG IMPORT TERMINALS. THE STATEN ISLAND STORAGE TERMINAL (2 TANKS, 900,000 BBL EACH) MAY, IN TURN, SERVE THE BROOKLYN UNION GAS COMPANY TERMINAL AT GREENPOINT, BROOKLYN, AND THE CONSOLIDATED EDISON ELECTRIC GENERATING PLANT AT ASTORIA, QUEENS, NEW YORK. THESE PLANTS MAY RECEIVE LNG FROM STATEN ISLAND BY LNG BARGE TRANSFER VIA THE SOUTHERN PORTION OF THE NEW YORK-NEW JERSEY CHANNEL, THE UPPER BAY, AND THE EAST RIVER. THE LNG BARGE HAS 4 TANKS THAT HOLD A TOTAL OF 5,000 M(3) OF LNG, WHICH IS 4 PERCENT OF THE CAPACITY OF THE BEN FRANKLIN (125,000 M(3)). THE BARGE MANHATTAN IS 297 FEET LONG, 60 FEET WIDE, WITH A DRAFT OF 16 FEET WHEN LOADED. IN THIS ATTACHMENT A SPILL OF 5,000 M(3) OF LNG ON WATER IS INVESTIGATED, WHICH IS CHARACTERISTIC OF A MASSIVE RUPTURE OF ALL TANKS ABROAD THE BARGE MANHATTAN. THIS IS THE WORST CASE SPILL FOR THIS BARGE. THE CALCULATIONS ARE BASED ON THE TREATMENT PRESENTED IN ATTACHMENT 1.

-PERTINENT FIGURES-

TAB. 1 DISTANCE OF FLAMMABILITY LIMIT, PAGE 3

-SOURCE INFORMATION-

CORPORATE SOURCE -
FEDERAL POWER COMMISSION, WASHINGTON, D.C.
OTHER INFORMATION -
0004 PAGES, 0000 FIGURES, 0001 TABLES, 0000 REFERENCES

key 20954

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT PROVIDENCE, RHODE ISLAND. APPENDIX A. GENERAL AND SPECIFIC REQUIREMENTS FOR LNG/LPG OPERATIONS

-ABSTRACT-

THIS SECTION (APPENDIX) OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE ALGONQIUM LNG PROVIDENCE, R.I. IMPORT TERMINAL PRESENTS BOTH GENERAL AND SPECIFIC REQUIREMENTS FOR LNG/LPG OPERATIONS ON THE WATERWAY OVER WHICH THE TANKERS WILL MOVE AND AT THE TERMINAL ITSELF. THE PRESENTATION IS BRIEF - ONLY FOUR PAGES.

-SOURCE INFORMATION-

CORPORATE SOURCE -
FEDERAL POWER COMMISSION, WASHINGTON, D.C.
OTHER INFORMATION -
0004 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT PROVIDENCE, RHODE ISLAND. APPENDIX 2. ANALYSIS OF ALGONQUIN GAS TRANSMISSION CO. STORAGE FACILITY FOR ACCEPTING VARIOUS LNG MIXTURES

-ABSTRACT-

THE LNG TERMINAL BEING CONSTRUCTED AT PROVIDENCE, R.I., BY ALGONQUIN GAS TRANSMISSION CO. WILL CONSIST OF ONE OR MORE 600,000 BBL LNG STORAGE TANKS AND ASSOCIATED REVAPORIZATION FACILITIES. THE SUPPLY FOR THE TERMINAL MAY COME FROM A VARIETY OF SOURCES, AND MAY BE BROUGHT IN BY TRUCK, BARGE OR TANKER. BECAUSE LNG IS A MIXTURE OF HYDROCARBONS, LIQUIDS OBTAINED FROM DIFFERENT SOURCES WILL DIFFER IN COMPOSITION AND, CONSEQUENTLY, IN DENSITY AND TEMPERATURE. IF TWO OR MORE DENSITY-STRATIFIED LAYERS OF LNG OCCUR IN A STORAGE TANK (DUE TO LOADING A LIGHT LNG ON TOP OF A HEAVIER LNG MIXTURE OR VICE VERSA), THERE IS THE POSSIBILITY OF A DELAYED RAPID MIXING OF THE LAYERS AFTER HEAT AND MASS TRANSFER EFFECTS IN THE STORAGE TANK EQUALIZE LAYER DENSITIES OR INITIATE BOILING IN THE LOWER LAYER. THIS RAPID MIXING CAN GENERATE LARGE QUANTITIES OF VAPOR AT VERY HIGH RATES. ALTHOUGH THE PHENOMENA INVOLVES A MIXING PROCESS, THE WORD ROLLOVER HAS BEEN COMMONLY USED TO DESCRIBE THE CAUSE OF SUDDEN RELEASES OF LARGE QUANTITIES OF VAPOR FROM LNG STORAGE TANKS. IN THIS REPORT, NORMAL CONVECTIVE MIXING FIRST IS EXAMINED IN A HOMOGENEOUS LNG FILLED TANK (SECTION III). IN SECTION IV VAPOR HANDLING CAPACITY REQUIREMENTS ARE CONSIDERED DURING THE LOADING PERIOD ITSELF RESULTING FROM COMPOSITIONAL AND SATURATION PRESSURE DIFFERENCES BETWEEN LNG BEING LOADED AND THE RESIDUAL LNG IN STORAGE. FINALLY IN SECTION V, THE MAXIMUM PRESSURE RISE THAT MIGHT SUBSEQUENTLY OCCUR IN THE EVENT OF A NON-VENTED ROLLOVER IS ESTIMATED. CONCLUSIONS ARE GIVEN IN SECTION IX.

-PERTINENT FIGURES-

FIG.1 TYPICAL CONVECTIVE CIRCULATION IN HOMOGENEOUS LNG STORAGE TANK, PAGE6//FIG.2 VAPOR GENERATION FROM UNLOADING 600,000 BARRELS OF LNG, PAGE 21//FIG.3 CONVECTIVE CIRCULATIONS IN A STRATIFIED LNG TANK, PAGE 23//FIG.4 PRESSURE RISE DURING NON-VENTED ROLLOVER PROVIDENCE TERMINAL TANK T-1, PAGE 25

-BIBLIOGRAPHY-

CHATTERJEE,N. AND GEIST,J.M., THE EFFECTS OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS, PRESENTED AT AGA DISTRIBUTION CONFERENCE, ATLANTA, GEORGIA, MAY 8-10, 1972//SARATEN,J.A., LNG OPERATING EXPERIENCES AT LA SPEZIA, ITALY, PRESENTED AT AGA DISTRIBUTION CONFERENCE, ATLANTA, GEORGIA, MAY 8-10, 1972//MEHAR,J.B. AND LA FAVE,I.V., THERMAL OVERFILL AND THE TOP LAYER PHENOMENON IN FLAT BOTTOM LNG TANKS, PRESENTED AT AGA

DISTRIBUTION CONFERENCE, ATLANTA, GEORGIA, MAY 8-10, 1972//MAHER,J.B. AND VAN GELDER,L.R., II-6, LNG-3, WASHINGTON, D.C., SEP 1972

-SOURCE INFORMATION-

CORPORATE SOURCE -
FEDERAL POWER COMMISSION, WASHINGTON, D.C.
OTHER INFORMATION -
0029 PAGES, 0004 FIGURES, 0004 TABLES, 0008 REFERENCES

key 18837

THE COAST GUARD ROLE IN LNG/LPG IMPORTATION

by

HANSEN,S.F.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Acceptable

-ABSTRACT-

A BRIEF DESCRIPTION IS GIVEN OF U.S. COAST GUARD RESPONSIBILITIES IN THE DESIGN AND APPROVAL OF VESSELS CARRYING HAZARDOUS MATERIALS, INCLUDING LNG AND LPG.

-SOURCE INFORMATION-

CORPORATE SOURCE -
COAST GUARD, BOSTON, MASS.
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
LNG IMPORTATION AND TERMINAL SAFETY CONF., 172-7, (PROC. OF) BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
0006 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

DETONABILITY OF SOME NATURAL GAS-AIR MIXTURES

by

VANTA, E.B.
FOSTER, JR., J.C.
PARSONS, G.H.

04/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Other	Govt. Only	Incremental	Acceptable

-ABSTRACT-

SEVEN MIXTURES (RANGING FROM 5.2 TO 12.5 PERCENT BY VOLUME) OF NATURAL GAS IN AIR WERE SCREENED FOR THEIR DETONABILITY USING A BAG TEST METHOD. ERRATIC, UNEVEN DETONATIONS WERE INITIATED AT THE 8.6 TO 8.8 PERCENT CONCENTRATION LEVEL, WITH EXPLOSIVE CHARGES RANGING FROM 1001 TO 1020 GRAMS. AT ALL OTHER TESTED FUEL CONCENTRATIONS, DEFLAGRATIONS OCCURRED. ALTHOUGH THE DETONATIONS SUCCESSFULLY PROPAGATED THE ENTIRE LENGTH OF THE BAG, A STEADY CHAPMAN-JOUGUET TYPE WAVE FRONT WAS NOT OBSERVED. THE EXPERIMENTAL DETONATION VELOCITIES AND MINIMUM INITIATOR WEIGHT REQUIREMENTS ARE COMPARED TO THOSE OBTAINED IN OTHER STUDIES UNDER SIMILAR EXPERIMENTAL CONDITIONS.

-PERTINENT FIGURES-

FIG.1 COMPARATIVE VELOCITY RECORDS, PAGE 10// FIG.2 TIME-PRESSURE HISTORY OF A NATURAL GAS-AIR DETONATION, PAGE 11//FIG.3 CUMULATIVE IMPULSE OF A NATURAL GAS-AIR DETONATION, PAGE 12.

-BIBLIOGRAPHY-

1. KOGARKO, S.M., "DETONATION OF METHANE-AIR MIXTURES AND THE DETONATION LIMITS OF HYDROCARBON-AIR MIXTURES IN A LARGE-DIAMETER PIPE," SOVIET PHYSICS TECH PHYS. V3, 1958 (TRANSLATION OF JOURNAL OF TECH PHYS, USSR, V28)//2. BENEDICK, W.B., J.D. KENNEDY, AND B. MOROSIN, "DETONATION LIMITS OF UNCONFINED HYDROCARBON-AIR MIXTURES," COMBUSTION AND FLAME L5, 83, 1970//3. COLLINS, P.M., G.H. PARSONS, AND P.J. UNREIN, CRITICAL ENERGY THRESHOLD FOR DETONATION INITIATION IN MAPP-AIR MIXTURES. AFATL-TR-92-192, AIR FORCE ARMAMENT LABORATORY, SEPTEMBER 1972// 4. ZABETAKIS, M.G., FLAMMABILITY CHARACTERISTICS OF COMBUSTIBLE GASES AND VAPORS. BUREAU OF MINES BULLETIN 627, 1965// 5. GORDON, S., AND B. MCBRIDE, COMPUTER PROGRAM FOR CALCULATION OF COMPLEX CHEMICAL EQUILIBRIUM COMPOSITIONS, ROCKET PERFORMANCE, INCIDENT AND REFLECTED SHOCKS AND CHAPMAN-JOUGUET DETONATIONS, NASA SP-273, 1971// 6. KOGARKO, S.M., V.V. ADUSHKIN, AND A.G. LYAMIN, "AN

INVESTIGATION OF SPHERICAL DETONATIONS OF GAS MIXTURES," INTERNATIONAL CHEMICAL ENGINEERING V6, NO. 3, JULY 1966 (FIRST PUBLISHED IN NAUCHC-TECHNICHESKIE PROBLEMY GORENIYA I VZRYUA NO. 2 PP. 22-34, 1966).

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR FORCE ARMAMENT LAB., EGLIN AFB, FLA.
REPORT NUMBER -
AFATL-TR-74-80//PROJECT 2513 07 03
PUBLISHER -
AIR FORCE ARMAMENT LAB., EGLIN AFB, FLA.
SPONSOR -
AIR FORCE ARMAMENT LAB., EGLIN AFB, FLA.
CONTRACT NUMBER -
AFATL-TR-74-80//PROJECT 2513 07 03
OTHER INFORMATION -
0015 PAGES, 0003 FIGURES, 0002 TABLES, 0007 REFERENCES

keys 20963 through 20966

NATURAL GAS. A STUDY, SECOND EDITION

by

TIRATSOO,E.N.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THREE CHAPTERS OF THIS BOOK ARE DEVOTED TO THE STORAGE AND TRANSPORTATION OF NATURAL GAS, LPG AND LNG. TAKEN IN ITS ENTIRETY, THE BOOK PROVIDES A VERY COMPREHENSIVE STUDY OF ALL ASPECTS OF THE FOSSIL FUEL NATURAL GAS.

-SOURCE INFORMATION-

PUBLISHER -
SCIENTIFIC PRESS LTD., BEACONSFIELD, ENGLAND
OTHER INFORMATION -
0418 PAGES, 0091 FIGURES, 0109 TABLES, 0184 REFERENCES

keys 18842 through 18846

DESIGN AND OPERATING EXPERIENCE AT DISTRIGAS LNG TERMINALS

by

OAKLEY,D.W.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER BRIEFLY DESCRIBES THE DESIGN OF THE DISTRIGAS LNG MARINE TERMINALS AT EVERETT, MASS. AND STATEN ISLAND, N.Y. DISCUSSED ARE GENERAL CRITERIA FOR MARINE TERMINALS, INCLUDING A NUMBER OF SAFETY CONSIDERATIONS FOR SUCH FACILITIES.

-PERTINENT FIGURES-

TAB.1 LNG TANKER CHARACTERISTICS, PAGE 202//TAB.2 GENERAL CHARACTERISTICS OF DISTRIGAS LNG BARGE, PAGE 203//TAB.3 DISTRIGAS LNG TERMINAL CHARACTERISTICS, PAGE 204//FIG.1 LNG BARGE SCHEMATIC, PAGE 205//FIG.3 DISTRIGAS LNG STORAGE TANK, EVERETT, PAGE 207//FIG.4 DISTRIGAS LNG STORAGE TANK, NEW YORK, PAGE 208 .

-SOURCE INFORMATION-

CORPORATE SOURCE -
    DISTRIGAS CORP., BOSTON, MASS.
REPORT NUMBER -
    AD-754326
JOURNAL PROCEEDINGS -
    LNG IMPORTATION AND TERMINAL SAFETY CONF., 191 & 193-209, (PROC. OF) BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
    0018 PAGES, 0005 FIGURES, 0003 TABLES, 0000 REFERENCES

keys 20971 through 20973

LNG SPILLS ON LAND

by

DUFFY,A.R.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

PHASE II WORK OF THE LNG SAFETY PROGRAM SPONSORED BY THE AMERICAN GAS ASSOCIATION WAS ORGANIZED TO TAKE ADVANTAGE OF EXPERTISE IN LNG AND CRYOGENIC TECHNOLOGY IN SEVERAL ORGANIZATIONS. BATTELLES COLUMBUS LABORATORIES WAS CHOSEN TO COORDINATE THE PROJECT RESEARCH TEAM, WHICH CONSISTED OF RESEARCH PERSONNEL FROM UNIVERSITY ENGINEERS, ARTHUR D. LITTLE, BATTELLES COLUMBUS LABORATORIES, TRW SYSTEMS, INC., MIT, AND POLYTECHNIC INSTITUTE OF NEW YORK. THE PROGRAM WAS PLANNED TO OBTAIN SPECIFIC RESULTS IN FOUR AREAS. 1. IMPROVEMENT OF PREDICTION OF VAPOR DISPERSION HAZARD. 2. EVALUATION OF DISPERSION HAZARD REDUCTION TECHNIQUES. 3. IMPROVEMENT OF PREDICTION OF RADIATION HAZARD. 4. EVALUATION OF RADIATION HAZARD REDUCTION TECHNIQUES. TO ACHIEVE THE SPECIFIC OBJECTIVES IN THESE AREAS AND THE OVERALL OBJECTIVE OF THE PROJECT, THE TOTAL EFFORT WAS DIVIDED INTO TASK ELEMENTS, THE TASK ELEMENTS WERE THE BASIS OF THE ASSIGNED WORK SCOPE FOR THE MEMBERS OF THE RESEARCH TEAM. WORK WAS STARTED ON THE SITE AND THE INSTRUMENTATION IN AUGUST 1971, EXPERIMENTS WERE COMPLETED IN JANUARY 1973, AND A FINAL REPORT ON THE PHASE II PROGRAM WAS DELIVERED TO THE A.G.A. ON NOVEMBER 15, 1973. THIS PAPER SUMMARIZES PART OF THIS WORK.

-PERTINENT FIGURES-

FIG.1 PEAK CONCENTRATION CORRELATION WITH DISTANCE FROM SPILL, PAGE D-189// FIG.2 PREDICTIONS OF METHANE CONCENTRATIONS, PAGE D-190//FIG.3 RADIANT FLUX ON TARGET ORIENTED FOR MAXIMUM INTENSITY - NO WIND, PAGE D-191//FIG.4 EFFECT OF WIND ON RADIANT FLUX ON TARGET ORIENTED FOR MAXIMUM INTENSITY, PAGE D-192

-BIBLIOGRAPHY-

AMERICAN GAS ASSOCIATION, PROJECT IS-3-1, LNG SAFETY PROGRAM, PHASE II, CONSEQUENCES OF LNG SPILLS ON LAND (NOV 1973)

-SOURCE INFORMATION-

CORPORATE SOURCE -
BATTELLE COLUMBUS LABS., OHIO
JOURNAL PROCEEDINGS -
AMERICAN GAS ASSOCIATION OPERATING SECTION PROC., D-189 - D-194 (1974) (PROC. OF DISTRIBUTION CONF., MINNEAPOLIS, MINN., MAY 6-8, 1974. PAPER 74-D-56)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0006 PAGES, 0004 FIGURES, 0000 TABLES, 0001 REFERENCES

keys 20974 through 20975

VAPOR DISPERSION, FIRE CONTROL, AND FIRE EXTINGUISHMENT OF HIGH EVAPORATION RATE LNG SPILLS

by

WESSON,H.R.
BROWN,L.E.
WELKER,J.R.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

UNDER THE SPONSORSHIP OF THE AMERICAN GAS ASSOCIATION, A SERIES OF FIRE CONTROL, FIRE EXTINGUISHMENT, AND VAPOR DISPERSION TESTS WERE CONDUCTED UNDER THE HIGH BOIL-OFF RATES WHICH OCCUR IMMEDIATELY FOLLOWING AN LNG SPILL ON LAND. CORRELATIONS OF THE RESULTS PROVIDE FIRE CONTROL AND EXTINGUISHMENT TIMES WITH DRY CHEMICAL AGENTS AND HIGH EXPANSION FOAMS. THE MAGNITUDE OF THE REDUCTION IN DOWNWIND CONCENTRATIONS OF METHANE VAPORS BY THE APPLICATION OF HIGH EXPANSION FOAM ON THE SPILL WAS ALSO DETERMINED.

-PERTINENT FIGURES-

FIG.6 EFFECTS OF FOAM EXPANSION RATIO AND FOAM BRANDS ON THE REDUCTIONS IN DOWNWIND HEAT FLUX LEVELS, PAGE D-197//FIG.7 EFFECTS OF FOAM APPLICATION RATE, FOAM EXPANSION RATIO AND LNG BURN RATE ON SPILL FIRE CONTROL TIME, PAGE D-197//FIG.9 CORRELATION OF SODIUM BICARBONATE DRY CHEMICAL APPLICATION RATE AND LNG LINEAR BURNING RATE EFFECTS UPON THE EXTINGUISHING TIME FOR LNG SPILL FIRES, PAGE D-198//FIG.10 CORRELATION OF POTASSIUM BICARBONATE DRY CHEMICAL APPLICATION RATE AND LNG LINEAR BURNING RATE EFFECTS UPON THE EXTINGUISHING TIME FOR LNG SPILL FIRES, PAGE D-198//FIG.11 CORRELATION OF UREA-POTASSIUM BICARBONATE DRY CHEMICAL APPLICATION RATE AND LNG LINEAR BURNING RATE EFFECTS UPON THE FIRE EXTINGUISHING TIMES FOR LNG SPILL FIRES, PAGE D-199//FIG.12 CORRELATION OF LINEAR BURNING RATE EFFECTS UPON THE MINIMUM DRY CHEMICAL APPLICATION RATES REQUIRED FOR FIRE EXTINGUISHMENT, PAGE D-199

-BIBLIOGRAPHY-

WESSON,H.R., WELKER,J.R. AND BROWN,L.E., CONTROL LNG-SPILL FIRES, HYDROCARBON PROCESSING, PP61 (DEC 1972)//AMERICAN GAS ASSOCIATION PROJECT IS-3-1, PTASE II, CONSEQUENCES OF LNG SPILLS ON LAND, FINAL REPORT (1974)

-SOURCE INFORMATION-

CORPORATE SOURCE -
    UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
    AMERICAN GAS ASSOCIATION OPERATING SECTION PROC., D-194 - D-199 (1974) (PROC. OF DISTRIBUTION CONF., MINNEAPOLIS, MINN., MAY 6-8, 1974. PAPER 74-D-36)
PUBLISHER -
    AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
    0006 PAGES, 0012 FIGURES, 0000 TABLES, 0002 REFERENCES

keys 20976 through 20979

PURGING LNG TANKS INTO AND OUT OF SERVICE CONSIDERATIONS AND EXPERIENCE

by

HANKE,JR.,C.C.
LA FAVE,I.V.
LITZINGER,L.F.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE PURGING OF LNG TANKS IN AND OUT OF SERVICE REQUIRES EXPERIENCE, KNOWLEDGE AND INVOLVES MANY CONSIDERATIONS. PREDICTABLE RESULTS IN PURGING OPERATIONS ARE OF GREAT IMPORTANCE TO OPERATORS AND OWNERS OF LNG FACILITIES. TO DATE, ON A WORLD-WIDE BASIS, OVER 100 LNG TANKS HAVE BEEN PLACED INTO OPERATION SAFELY, PROVIDING BROAD EXPERIENCE UNDER A WIDE VARIETY OF CONDITIONS. ALSO, TO DATE, A NUMBER OF LNG TANKS HAVE BEEN PURGED OUT OF SERVICE SO THAT REPAIRS OR MODIFICATIONS COULD BE SAFELY UNDERTAKEN. TO ASSIST IN DEVELOPING SAFE PROCEDURES FOR TAKING LNG TANKS OUT OF SERVICE, THE CHICAGO BRIDGE AND IRON COMPANY HAS CARRIED OUT A NUMBER OF RESEARCH PROJECTS WHICH MAY SHED SOME LIGHT ON THE BEHAVIOR, UNDER PURGE CONDITIONS, OF THE MATERIALS USED IN THE TANKS. THIS WORK INCLUDED INVESTIGATIONS OF PERLITE-METHANE BURNING BEHAVIOR, DESORPTION OF METHANE FROM MINERAL WOOL, ADSORPTION OF METHANE ON PERLITE, DESORPTION OF METHANE FROM PERLITE WHEN PURGED WITH NITROGEN AND A METHOD FOR CALCULATING QUANTITIES OF PURGE GAS REQUIRED IN AN ACTUAL LNG TANK. EACH ONE OF THESE INVESTIGATIONS COULD BE A SUBSTANTIAL REPORT BY ITSELF. HOWEVER, FOR THE PURPOSE OF THIS PAPER A BRIEF SUMMARY OF THESE INVESTIGATIONS IS GIVEN.

-PERTINENT FIGURES-

FIG.2 LNG TANK CROSS SECTION OPEN TOP SUSPENDED DECK WITH PURGE FITTINGS, PAGE D-202//FIG.3 PURGING INNER TANK INTO SERVICE PERCENT OXYGEN VS QUANTITY NITROGEN USED FOR PURGE, PAGE D-202//FIG.4 PURGING INNER TANK INTO SERVICE PERCENT OXYGEN VS QUANTITY NITROGEN USED FOR PURGE, PAGE D-203// FIG.5 PURGING INNER TANK OUT OF SERVICE PERCENT METHANE CH(4) VS QUANTITY NITROGEN USED FOR PURGE, PAGE D-203//FIG.6 PURGING PERLITE ANNULAR SPACES OUT OF SERVICE, PAGE D-204//FIG.7 FIELD DATA FROM PURGING PERLITE ANNULAR SPACES INTO SERVICE, PAGE D-205

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.
JOURNAL PROCEEDINGS -
AMERICAN GAS ASSOCIATION OPERATING SECTION PROC., D-200 - D-207 (1974) (PROC. OF DISTRIBUTION CONF., MINNEAPOLIS, MINN., MAY 6-8, 1974. PAPER 74-D-67)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0008 PAGES, 0007 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20980 through 20985

UNIQUE DESIGN FEATURES--PHILADELPHIA GAS WORKS LNG PLANTS

by

HOLMAN,O.B.
POST,H.J.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER DESCRIBES THE DESIGN FEATURES AND INNOVATIONS INCORPORATED IN THE PHILADELPHIA GAS WORKS RICHMOND LNG PLANT. (NARRATIVE DESCRIPTION IS COMPLEMENTED BY EXTENSIVE PHOTOGRAPHIC DETAIL RECORDING THE VARIOUS PHASES OF CONSTRUCTION AS WELL AS THE UNIQUE DESIGN FEATURES.) IT IS VERY EVIDENT FROM THE CONTENT OF THIS PAPER THAT CONSIDERABLE ATTENTION WAS GIVEN TO PLANT SAFETY AND HAZARD REDUCTION.

-PERTINENT FIGURES-

FIG.1 MODEL OF TWO 583,000 BBL. LNG STORAGE TANKS, PIPE TOWER, BRIDGES, OPERATING PLATFORMS, ETC., PAGE D-211//FIG.2 PARTIAL SECTION OF LNG STORAGE TANK, PAGE D-211//FIG.4 ERECTION OF PRESTRESSED CONCRETE PANELS FOR OUTER TANK, PAGE D-211//FIG.18 PRESSURE AND VACUUM RELIEF VALVE MANIFOLD, VERTICAL DISCHARGE PIPING AND TEMPERATURE SENSORS AT RELIEF VALVE OUTLETS, PAGE D-214//FIG.39 SINGLE PLATE AND INLET AND OUTLET HEADERS OF AN LNG VAPORIZER UNIT, EACH UNIT CONTAINS TEN PLATES, PAGE D-218//FIG.41 LNG VAPORIZER ASSEMBLY IN HOUSING, PAGE D-219

-SOURCE INFORMATION-

CORPORATE SOURCE -
PHILADELPHIA GAS WORKS, PA.
JOURNAL PROCEEDINGS -
AMERICAN GAS ASSOCIATION OPERATING SECTION PROC., D-208 - D-219 (1974) (PROC. OF DISTRIBUTION CONF., MINNEAPOLIS, MINN., MAY 6-8, 1974. PAPER 74-D-55)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0012 PAGES, 0041 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21086 through 21087

FIRE PROTECTION FOR LNG PLANTS

by

WESSON,H.R.
SLIEPCEVICH,C.M.

06/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER DISCUSSES THE NATURE OF POTENTIAL FIRE HAZARDS IN AN LNG FACILITY, THE EXPERIENCES GAINED TO DATE (1968) ON EXTINGUISHMENT OF LNG FIRES, A METHOD USED TO DETERMINE ACCEPTABLE MINIMUM PERFORMANCE REQUIREMENTS, AND GENERALIZED RECOMMENDATIONS REGARDING HEAT EXPOSURE CONTROL SYSTEMS. ITEMS TO BE CONSIDERED IN LNG FACILITY DESIGN ARE LISTED. PLOTS ARE PRESENTED GIVING COMPARISON OF THE TRENDS FOR LNG AND CONVENTIONAL HYDROCARBON EXTINGUISHING FLOW RATES AND COMPARISON OF TEMPERATURES ATTAINED BY AN OBJECT NEAR THE GROUND AND DOWNWARD FROM AN LNG FIRE UNDER WIND AND CALM AIR CONDITIONS. PARAMETERS ASSOCIATED WITH LNG RADIATION HEAT TRANSFER ARE LISTED AS ARE PARAMETERS FOR THE SELECTION OF CONTROL SYSTEM MODE OF FIRE DETECTION AND AREAS OF SPECIAL CONSIDERATION IN FIRE PROTECTION ANALYSIS OF LNG PLANTS. LAYOUTS OF FIRE PROTECTION SYSTEMS FOR TYPICAL ABOVEGROUND AND INGROUND STORAGE FACILITIES ARE PRESENTED.

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN OKLA.//OKLAHOMA UNIV., NORMAN
JOURNAL PROCEEDINGS -
PIPE LINE IND. VOL 28, 39-42 (JUN 1968)
OTHER INFORMATION -
0004 PAGES, 0004 FIGURES, 0000 TABLES, 0003 REFERENCES

keys 18775 through 18780

LNG. A FIRE SERVICE APPRAISAL. PART 2

by

WALLS,W.L.

03/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS IS PART 2 OF A TWO-PART ARTICLE BY MR. WALLS IN WHICH HE COVERS METHODS AND AGENTS THAT CAN BE USED TO CONTROL LNG SPILLS, EXTINGUISH FIRES AND PROVIDE EXPOSURE PROTECTION AT LNG FACILITIES. THE ARTICLE IS WELL WRITTEN, PROVIDES GOOD GENERAL COVERAGE OF THE TOPIC AND HAS BEEN WELL RECEIVED - AS EVIDENCED BY WIDE REFERENCING IN LATER PUBLICATIONS OF STATURE IN THE FIELD.

-BIBLIOGRAPHY-

NFPA NO. 59A STANDARD//USE OF WATER ON LP-GAS SPILLS IS SHOWN IN THE NFPA FILM HANDLING LP-GAS EMERGENCIES (NO. FL-5, 25 MINUTES, COLOR, SOUND, 16MM, PRICE $175)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
JOURNAL PROCEEDINGS -
FIRE J. VOL 66, NO. 2, 30-3 (MAR 1972)
OTHER INFORMATION -
0004 PAGES, 0001 FIGURES, 0000 TABLES, 0001 REFERENCES

keys 18781 through 18783

LNG TERMINAL IS DESIGNED FOR SAFETY

by

SALTZ,E.X.

03/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS ARTICLE BRIEFLY DESCRIBES THE LARGEST U. S. LNG MARINE TERMINAL, BEING BUILT ON STATEN ISLAND, NEW YORK BY THE DISTRIGAS OF NEW YORK CORPORATION. IT WILL RECEIVE LNG FROM ALGERIA, STORE IT FOR PEAK SHAVING SERVICE DURING WINTER MONTHS, AND REDISTRIBUTE AS LNG BY BARGE OR TO HIGH PRESSURE GAS PIPELINE SYSTEMS. TWO 900,000-BBL STORAGE TANKS ARE UNDER CONSTRUCTION AND SPACE HAS BEEN PROVIDED FOR THREE MORE. THE FACT THAT THIS VERY LARGE TERMINAL IS LOCATED WITHIN A METROPOLITAN COMMUNITY HAS LED TO THE DEVELOPMENT OF SAFETY MEASURES NOT PREVIOUSLY INCORPORATED IN ANY ONE TERMINAL.

-PERTINENT FIGURES-

FIG.1 LNG TERMINAL SITE PLAN, PAGE 44//FIG.2 TYPICAL CROSS-SECTION OF 900,000-BBL LNG STORAGE TANK, PAGE 44

-BIBLIOGRAPHY-

NFPA NO. 59A STANDARD

-SOURCE INFORMATION-

CORPORATE SOURCE -
SINGMASTER AND BREYER, NEW YORK
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 200, NO. 3, 42 & 44 (MAR 1973)
OTHER INFORMATION -
0002 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18790 through 18793

CURRENT STATUS OF NATIONAL, STATE, AND LOCAL LNG CODES AND STANDARDS

by

BALL,W.L.

04/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE PROVIDES AN EXCELLENT REVIEW OF TODAYS STANDARDS PERTAINING TO LNG FACILITIES TOGETHER WITH A BRIEF HISTORY OF STANDARD WRITING ACTIVITY OVER THE PAST TWO DECADES, IN PARTICULAR FOLLOWING THE DEVELOPMENT OF NFPA NO. 59A STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS. SEVERAL SUGGESTIONS ARE MADE FOR THE INCLUSION OF ADDITIONAL TOPICS IN FUTURE CODES.

-BIBLIOGRAPHY-

ANSI B31.3 CODE//API STANDARD 620-APPENDIX Q//API STANDARD 2510//API STANDARD 2510A//NFPA NO. 59 STANDARD//NFPA NO. 59A STANDARD

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 200, NO. 5, 46 & 49 & 59-60 & 62 & 64 (APR 1973)
OTHER INFORMATION -
0006 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18804 through 18813

CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY

by

FAWCETT,H.H.

07/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	State Of Art	Good/Excel.

-ABSTRACT-

THE PURPOSE OF THIS TWO-DAY CONFERENCE WAS TO REVIEW THE CURRENT STATE OF KNOWLEDGE OF LNG SAFETY. PAPERS INDEXED FOR ASRDI ARE ENGER,T., EXPLOSIVE BOILING OF LIQUEFIED GASES ON WATER//SARSTEN,J.A., LNG STRATIFICATION AND ROLLOVER//GEIST,J.M. AND CHATTERJEE,N., THE EFFECT OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS//WEST,H.H., WELKER,J.R., AND SLIEPCEVICH,C.M., RADIATION, HEAT FLUX, AND OVERPRESSURE IN LNG TANKS//HOULT,D.P., THE FIRE HAZARD OF LNG SPILLED ON WATER//MAY,W.G. AND MCQUEEN,W., RADIATION FROM LARGE LNG FIRES//BURGESS,D.S., SUMMATION AND CRITIQUE OF TECHNICAL KNOWLEDGE FOR THE SAFE HANDLING AND SHIPMENT OF LNG//THOMAS,W., LNG VESSEL DESIGN AND OPERATING EXPERIENCE//HANSEN,S.F., THE COAST GUARD ROLE IN LNG/LPG IMPORTATION//BLEAKNEY,R.A., BOSTON GAS LNG TERMINAL EXPERIENCE//OAKLEY,D.W., DESIGN AND OPERATING EXPERIENCE AT DISTRIGAS LNG TERMINALS//LEVY,M.M., THE COVE POINT TERMINAL//BOSNAK,R.J., SUMMARY, QUESTIONS AND ANSWERS FOLLOWING PRESENTATIONS BY MEMBERS OF PANEL II//WALLS,W.L., LNG. A FIRE SERVICE APPRAISAL PART 1//FFOOKS,R.C., CONCH METHANE SERVICES LNG EXPERIENCE.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL ACADEMY OF SCIENCES - NATIONAL RESEARCH COUNCIL, WASHINGTON, D.C.
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
LNG IMPORTATION AND TERMINAL SAFETY CONF., (PROC. OF) BOSTON, MASS., JUN 13-4, 1972
SPONSOR -
COAST GUARD, WASHINGTON, D.C.
CONTRACT NUMBER -
CONTRACT DOT-OS-00035
OTHER INFORMATION -
0308 PAGES, 0077 FIGURES, 0016 TABLES, 0051 REFERENCES

keys 18817 through 18821

LNG STRATIFICATION AND ROLLOVER

by

SARSTEN,J.A.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS REPORT COVERS AN INCIDENT WHERE LNG WAS STRATIFIED IN AN LNG STORAGE TANK DURING FILLING AND HOW THAT STRATIFICATION SUBSEQUENTLY RESULTED IN A ROLLOVER OF THE TANK CONTENTS AND THE RELEASE OF A LARGE QUANTITY OF GAS. ON AUGUST 21, 1971, LNG STORAGE TANK S-1 OF THE ESSO DESIGNED, SNAM LNG TERMINAL IN LA SPEZIA, ITALY, EXPERIENCED A SUDDEN INCREASE IN PRESSURE CAUSING A DISCHARGE FROM THE TANK SAFETY VALVES AND TANK VENT. THE SAFETY VALVES DISCHARGED FOR ABOUT ONE HOUR AND 15 MINUTES AND THE VENT RELEASED AT HIGH RATES FOR ABOUT THREE HOURS AND 15 MINUTES. THE PRESSURE ROSE TO ABOUT 710 MM. OF WATER AT ITS PEAK WHICH IS 210 MM. OF WATER ABOVE THE NOMINAL TANK DESIGN PRESSURE OF 500 MM. OF WATER. THE PRESSURE RISE OCCURRED IN THE TANK ABOUT 18 HOURS AFTER IT WAS FILLED BY THE LNG SHIP ESSO BREGA. WHEN THE SAFETY VALVES BEGAN TO DISCHARGE, PLANT MANAGEMENT INFORMED THE POLICE, FIRE, AND PORT AUTHORITIES WHO CLOSED VEHICULAR AND PERSONNEL TRAFFIC ON THE MAIN ROAD TO PORTOVENERE AND REMOVED THE ESSO BREGA FROM THE UNLOADING DOCK. THE LNG PLANT WAS NOT IN OPERATION AT THE TIME, HAVING BEEN SHUT DOWN FOR EXCHANGER REPAIRS. THE OVERPRESSURE OF THE TANK WAS SELF-INITIATED AND UNCONTROLLABLE. IT WAS CAUSED BY A ROLLOVER WITHIN THE TANK OF BOTTOM STRATIFIED, HIGH VAPOR PRESSURE, SHIPS CARGO WHOSE NORMAL VAPORIZATION AT STORAGE TANK PRESSURE HAD BEEN TEMPORARILY SUPPRESSED BY THE STATIC PRESSURE OF AN INITIAL LOW VAPOR PRESSURE, HEEL. A REPETITION WILL BE POSITIVELY PREVENTED BY THE INSTALLATION OF A JET MIXING NOZZLE THAT WILL THOROUGHLY MIX OFF LOADED CARGO WITH DIFFERENT COMPOSITION INITIAL TANK HEELS.

-PERTINENT FIGURES-

FIG.1 SNAM LNG TERMINAL STORAGE TANKS, PAGE 33//FIG.3 LNG STORAGE TANK S-1 LOADING HISTORY, SNAM LNG TERMINAL, PAGE 35//FIG.5 LNG STORAGE TANK S-1 HEAT TRANSFER SUMMARY PRIOR TO ROLLOVER, PAGE 37

-SOURCE INFORMATION-

CORPORATE SOURCE -
ESSO RESEARCH AND ENGINEERING CO., LINDEN, N.J.

REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
LNG IMPORTATION AND TERMINAL SAFETY CONF., 26-38, (PROC. OF)
BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
0013 PAGES, 0006 FIGURES, 0001 TABLES, 0003 REFERENCES

keys 18822 through 18824

THE EFFECT OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS

by

GEIST,J.M.
CHATTERJEE,N.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THE ADDITION OF LNG TO A PARTIALLY FILLED TANK CONTAINING LIQUID OF A DIFFERENT DENSITY MAY LEAD TO THE TEMPORARY FORMATION OF STRATIFIED LAYERS. THE SUBSEQUENT MIXING OF THE STRATIFIED LAYERS IS ACCOMPANIED BY INCREASES IN VAPORIZATION RATES WHICH USUALLY ARE INSIGNIFICANT BUT WHICH SOMETIMES ARE IMPORTANT. THE PHYSICAL PHENOMENA ASSOCIATED WITH A MIXING OF STRATIFIED LAYERS OF LNG HAVE BEEN SIMULATED ON A COMPUTER. THE CALCULATED TIMES TO REACH PEAK VAPORIZATION RATES AGREE SATISFACTORILY WITH THOSE WHICH HAVE BEEN RECORDED FOR THREE DIFFERENT TANKS. OPERATING CRITERIA HAVE BEEN DEVELOPED FROM SIMULATIONS OF THE BEHAVIOR OF TANKS FILLED FROM SHIPS, TRAILERS, AND LIQUEFACTION PLANTS FOR VARIOUS FILL RATES, LAYER HEIGHTS, AND INITIAL DENSITY AND TEMPERATURE DIFFERENCES BETWEEN LAYERS. ONE METHOD FOR MITIGATING POTENTIAL HAZARDS ASSOCIATED WITH STRATIFICATION IS BY LIMITING THE DENSITY AND THE TEMPERATURE DIFFERENCES BETWEEN FRESH LIQUID AND LNG IN THE TANKS. IN CASE OF LARGE DENSITY DIFFERENCES, MIXING OF TANK CONTENTS DURING FILLING, OR AFTER FILLING, MAY BE REQUIRED.

-PERTINENT FIGURES-

TAB.1 PROPERTIES OF LNGS FROM DIFFERENT SOURCES AT SATURATION, PAGE 52// FIG.1 MODEL OF STRATIFIED LNG TANK USED FOR SIMULATION STUDIES, PAGE 55// FIG.3 BOIL-OFF RATE IN STRATIFIED LNG TANKS, CASE 1. HIGH BOTTOM FILL RATE, SMALL QUANTITY OF HEAVY LIQUID, PAGE 57//FIG.4 BOIL-OFF RATE IN STRATIFIED LNG TANK, CASE 2. HIGH BOTTOM FILL RATE, LARGE QUANTITY OF HEAVY LIQUID, PAGE 58//FIG.5 BOIL-OFF RATE VARIATIONS IN STRATIFIED LNG TANKS, CASE 3. LOW TOP FILL RATE, LARGE QUANTITY OF BOTTOM LAYER, PAGE 59

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -

LNG IMPORTATION AND TERMINAL SAFETY CONF., 39 & 41-66, (PROC. OF) BOSTON, MASS., JUN 13-4, 1972

OTHER INFORMATION -

0027 PAGES, 0012 FIGURES, 0001 TABLES, 0004 REFERENCES

keys 18847 through 18849

THE COVE POINT TERMINAL

by

LEVY,M.M.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER BRIEFLY DESCRIBES THE COLUMBIA-CONSOLIDATED COVE POINT, MARYLAND, LNG MARINE TERMINAL. INCLUDED ARE SHORT DISCUSSIONS ON SEVERAL SAFETY ASPECTS OF THE TERMINAL - SITING, PIPING PROTECTION AND ROLLOVER PREVENTION.

-SOURCE INFORMATION-

CORPORATE SOURCE -

COLUMBIA GAS SYSTEMS SERVICE CORP., COLUMBUS, OHIO

REPORT NUMBER -

AD-754326

JOURNAL PROCEEDINGS -

LNG IMPORTATION AND TERMINAL SAFETY CONF., 210-24, (PROC. OF) BOSTON, MASS., JUN 13-4, 1972

OTHER INFORMATION -

0015 PAGES, 0009 FIGURES, 0000 TABLES, 0000 REFERENCES

HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION

by

BURGESS, D.S.
MURPHY, J.N.
ZABETAKIS, M.G.

02/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

AN INVESTIGATION OF THE HAZARD OF SPILLAGE OF LIQUEFIED NATURAL GAS (LNG) ONTO WATER IS DESCRIBED. ABOUT 2000 GALLONS OF LNG WERE CONSUMED IN VARIOUS TESTS. THE INITIAL VAPORIZATION RATE OF LNG FOLLOWING SPILLAGE WAS FOUND TO BE 0.037 LBS/SQ FT SEC; WHEN THE SPILL WAS CONFINED, THIS VAPORIZATION RATE WAS MODERATED AFTER ABOUT 20 SECONDS BY THE GROWTH OF AN ICE LAYER ON THE WATER SURFACE; WHEN THE SPILL WAS UNCONFINED, A COHERENT ICE FLOE WAS NOT OBSERVED AND THE VAPORIZATION RATE WAS ESSENTIALLY TIME-INDEPENDENT. THE MAXIMUM DIAMETER (IN FEET) OF THE SPREADING LNG POOL WAS FOUND TO BE GIVEN BY 6.3W 1/3 WHERE W IS THE WEIGHT OF LNG IN POUNDS. DOWNWIND OF A NATURAL GAS SOURCE, TIME-AVERAGED METHANE CONCENTRATIONS WERE GIVEN IN GOOD APPROXIMATION BY STANDARD AIR POLLUTION EQUATIONS. HOWEVER, PEAK CONCENTRATIONS WERE AS MUCH AS TWENTYFOLD HIGHER THAN AVERAGE, ADDING AN ADDITIONAL FACTOR TO THE ASSESSMENT OF HAZARD. THE EFFECT OF LAYERING BY THE COLD VAPORIZED NATURAL GAS WAS SIMILAR TO THE EFFECT OF A TEMPERATURE INVERSION ON NORMAL GASES IN THE ATMOSPHERE. SMALL-SCALE EXPLOSIONS WERE OBSERVED ON POURING LNG ONTO A WATER SURFACE. THESE EXPLOSIONS ARE DISCUSSED BUT NO SINGLE EXPLANATION SEEMS PERTINENT TO ALL OF THE INCIDENTS OBSERVED.

-PERTINENT FIGURES-

FIG.6 VAPORIZATION OF LNG ON WATER//FIG.8 TEMPERATURE PROFILES AFTER LNG SPILLS ON WATER//FIG.29 FREQUENCY OF SMALL-SCALE EXPLOSIONS IN THE LNG DISPERSION TEST.

-BIBLIOGRAPHY-

1. BURGESS, D., AND M.G. ZABETAKIS. FIRE AND EXPLOSION HAZARDS OF LIQUEFIED NATURAL GAS. BUREAU OF MINES REPORT OF INVESTIGATIONS 6099, 1962, 34 PP.//2. MERTE, H., JR., AND J.A. CLARK. "BOILING HEAT TRANSFER WITH CRYOGENIC FLUIDS AT STANDARD, FRACTIONAL AND NEAR-ZERO GRAVITY." TRANS. ASME, C, VOL. 86, 1964, PP. 351-9.//3. MANSON, L. "A PERIODIC NONUNIFORM HEAT-TRANSFER MECHANISM IN FILM

BOILING." JOURNAL OF HEAT TRANSFER, FEBRUARY 1967, PP. 111-2.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
REPORT NUMBER -
REPORT NO. S-4105
PUBLISHER -
COAST GUARD, WASHINGTON, D.C.
SPONSOR -
COAST GUARD, WASHINGTON, D.C.
CONTRACT NUMBER -
MIPR NO. Z-70099-9-92317//PROJECT NO. 714152/002
OTHER INFORMATION -
0038 PAGES, 0029 FIGURES, 0011 TABLES, 0029 REFERENCES

keys 20670 through 20671

ACCURACY IN CRYOGENIC LIQUID MEASUREMENTS

by

SHAMP, F. F.

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

MEASUREMENT OF CRYOGENS IN THE LIQUID STATE UNDER PRESSURE SUFFICIENT TO PREVENT VAPORIZATION IS VERY DESIRABLE. HUMBLE PIPE LINE COMPANY HAS ESTABLISHED THE MERIT OF THE BI-DIRECTIONAL PISTON PROVER AS AN INVALUABLE TOOL FOR ACCURATE LIQUID CRYOGEN MEASUREMENT. BY PROVING A ONE-IN. TURBINE METER OPERATING BETWEEN 33 AND 71 GAL/MIN IN LIQUID NITROGEN SERVICE, WITH A 100 GAL/MIN CAPACITY BI-DIRECTIONAL PISTON PROVER, AND DEMONSTRATING A COMBINED METER-PROVER REPEATABILITY VARIATION BETWEEN 0.110 PERCENT AND 0.008 PERCENT, IT WAS CONCLUDED THAT SCALE-UP OF THE PROVER IS NOT ONLY PRACTICAL BUT HIGHLY RECOMMENDED. A COST ANALYSIS FOR CAPITAL INVESTMENT REQUIRED TO INSTALL PROVER FACILITIES FOR TURBINE METERS IN LNG TANKER LOADING AND UNLOADING IS DISCUSSED. PROVERS OF SUFFICIENT SIZE HAVE NOT YET BEEN BUILT, SO THAT COSTS ARE A MATTER OF SPECULATION, BUT A ROUGH ESTIMATE FOR SUCH A FACILITY INDICATES A COST OF 2 OR 3 TIMES THAT OF CONVENTIONAL CRUDE OIL FACILITIES.

-PERTINENT FIGURES-

-BIBLIOGRAPHY-

VANCE,R.W. AND DUKE,W.M., EDS., ADVANCED CRYOGENIC ENGINEERING, NEW YORK, JOHN WILEY AND SONS, 1962//USA STANDARD Z11.171-1965 FOR MECHANICAL DISPLACEMENT METER PROVERS

-SOURCE INFORMATION-

CORPORATE SOURCE -
HUMBLE PIPE LINE CO., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
ISA TRANS. VOL 10, NO. 3, 219-23 (1971) (PRES. AT ISA ANNUAL CON'

METHANE FUEL SYSTEMS FOR HIGH MACH NUMBER AIRCRAFT

by

GREENBERG, S.

10/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

PROBLEMS AND LIMITATIONS ASSOCIATED WITH JP FUELS AT HIGH MACH NUMBERS HAVE LED TO AN INTEREST IN FUELS WITH BETTER HEAT SINK AND HIGH TEMPERATURE CAPABILITIES SUCH AS METHANE. STUDIES HAVE SHOWN METHANE TO OFFER PERFORMANCE ADVANTAGES FOR SSTS RELATIVE TO JP, BUT THE OVERALL ATTRACTIVENESS OF METHANE WILL DEPEND UPON THE EXTENT ADVANTAGES ARE NULLIFIED BY PRACTICAL DISADVANTAGES. PROBLEMS AND PENALTIES OF STORING METHANE IN AN AIRCRAFT CONSTITUTE SOME OF THE IMPORTANT PRACTICAL DISADVANTAGES. SEVERAL REPRESENTATIVE METHANE STORAGE SCHEMES FOR MACH 3-6 TRANSPORT AIRCRAFT ARE EVALUATED, PRIMARILY ON THE BASIS OF MINIMUM WEIGHT. FUEL SYSTEM WEIGHT (INCLUDING TANKAGE, INSULATION, PLUMBING, BOILOFF, ETC.) IS SHOWN TO BE 6.3-13.6 PERCENT OF THE FUEL WEIGHT FOR METHANE DEPENDING UPON THE TYPE OF STORAGE SCHEME USED AND UPON THE AIRCRAFT SPEED AND RANGE. BY CONTRAST, FUEL SYSTEM WEIGHT FOR JP IS 2.5-3 PERCENT OF THE FUEL WEIGHT. EFFECTS OF THE FUEL SYSTEM FRACTION (RATIO OF FUEL SYSTEM TO FUEL WEIGHT) UP PAYLOAD ARE SHOWN. THIS REPORT SERVES AS A PRIMER ON THE TOPIC OF METHANE STORAGE IN AIRCRAFT. IT ALSO BRINGS UNRESOLVED ISSUES INTO SHARPER PERSPECTIVE AND SUGGESTS WHAT SHOULD BE DONE TO CLARIFY THE FUTURE ROLE OF METHANE AS AN AIRCRAFT FUEL.

-PERTINENT FIGURES-

TAB.1 BASIC STORAGE SCHEMES, PAGE 5//FIG.1 REPRESENTATIVE STORAGE CONDITIONS FOR LIQUID METHANE FUEL, PAGE 4//FIG.2 TYPICAL MACH 3-7 METHANE FUELED TRANSPORT SHOWING VOLUME AVAILABLE FOR FUEL TANKS, PAGE 7// FIG.3 BASIC APPROACHES TO HIGH MACH NUMBER AIRCRAFT FUEL TANK DESIGN, PAGE 7

-BIBLIOGRAPHY-

CHAMBELLAN, LUBOMSKI AND BEVEVINO, STRUCTURAL FEASIBILITY STUDY OF PRESSURIZED TANKS FOR LIQUID-METHANE FUELED SUPERSONIC AIRCRAFT, NASA TN D-4295 (DEC 1967)//EISENBERG AND CHAMBELLAN, TANKAGE SYSTEMS FOR A METHANE-FUELED SUPERSONIC TRANSPORT, AIAA PAPER NO. 68-196 (FEB 1968) AND NASA TM X-1591 (MAY 1968)//WEBER,R.J., LIQUEFIED NATURAL GAS AS A FUEL FOR SUPERSONIC AIRCRAFT, NASA TM

X-52282 (MAY 1967)//WEBER,R.J., PROBLEMS BESET USE OF LNG AS SUPERSONIC TRANSPORT FUEL, OIL GAS J., 60-3 (JUL 1967) //WEBER, DUGAN AND LUIDENS, METHANE-FUELED PROPULSION SYSTEMS, AIAA PAPER NO. 66-685 (JUN 1966) AND ASTRONAUTICS AND AERONAUTICS, 48-55 (OCT 1966)//WHITLOW, EISENBERG AND SHOVLIN, POTENTIAL OF LIQUID-METHANE FUEL FOR MACH 3 COMMERCIAL SUPERSONIC TRANSPORT, NASA TN D-3471 (JUL 1966)

-SOURCE INFORMATION-

CORPORATE SOURCE -
PRATT AND WHITNEY AIRCRAFT, WEST PALM BEACH, FLA.
JOURNAL PROCEEDINGS -
SAE NATIONAL AERONAUTIC AND SPACE ENGINEERING AND MFG. MEETING, (PRES. AT) LOS ANGELES, CALIF., OCT 6-10, 1969. PAPER 690668
OTHER INFORMATION -
0016 PAGES, 0004 FIGURES, 0009 TABLES, 0019 REFERENCES

keys 20643 through 20645

DESIGN OF LNG PIPING SUPPORTED ON A FLEXIBLE WHARF

by

SCHMITZ, J. M.

09/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

A 1380-FT LONG WHARF, BUFFETED BY ICE FLOES AND THE DOCKING OF SHIPS, SUPPORTS LARGE DIAMETER LIQUEFIED NATURAL GAS (LNG) AND LNG VAPOR PIPING. THIS PAPER PRESENTS AN UNUSUAL DESIGN PROBLEM AND ITS SOLUTION. THE DESIGN INVOLVES THE STUDY OF LONG RUNS OF PIPING UNDER BUCKLING IN COLUMN ACTION WHILE ABSORBING LARGE LATERAL DEFLECTIONS. THE DETAILS OF SUPPORTING THE INSULATED CRYOGENIC PIPING WHILE PERMITTING LARGE CONTRACTIONS AND FLUCTUATING LATERAL LOADINGS ARE ALSO EXPLAINED.

-PERTINENT FIGURES-

FIG. 1 WHARF LAYOUT SHOWING TYPICAL PIPE SUPPORT MEMBERS FOR EACH SECTION, PAGE 3//FIG.2 WHARF MOVEMENTS AND DESIGN MOVEMENTS AFFECTING LNG PIPING, PAGE 4//FIG.3 TYPICAL SADDLE-TYPE SUPPORTS FOR LNG PIPING, INCLUDING GUIDED SUPPORTS, PAGE 7//FIG.4 TYPICAL PIPE ANCHOR FOR LNG PIPING, PAGE 7

-SOURCE INFORMATION-

CORPORATE SOURCE -
    BECHTEL CORP., SAN FRANCISCO, CALIF.
JOURNAL PROCEEDINGS -
    ASME PETROLEUM MECHANICAL ENGINEERING CONF., (PRES. AT) TULSA, OKLA., SEP 21-5, 1969. PAPER 69-PET-28
OTHER INFORMATION -
    0007 PAGES, 0004 FIGURES, 0003 TABLES, 0001 REFERENCES

keys 19329 through 19330

THE TRANSPORTATION OF LNG BY SHIP

by

PASTUHOV,A.V.

00/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE CHOICE AMONG THE THREE LNG SHIP TANK CONCEPTS WILL BE MADE ACCORDING TO SEVERAL FACTORS, ALL INTERRELATED. UNDOUBTEDLY, TANK COST WILL BE ONE OF THE MAJOR FACTORS BUT ITS IMPORTANCE WILL DEPEND UPON THE SIZE OF THE SHIPS, THE COST OF THE GAS AND ITS DELIVERED SELLING PRICE, AND ANY PATENTS AND ROYALTIES WHICH MAY BE INVOLVED. THE CHOICE OF TANK DESIGN MAY ALSO BE INFLUENCED BY REGULATORY CHANGES RESULTING FROM OPERATING EXPERIENCE WITH PRESENT LNG TANKERS. FOR EXAMPLE, IT WOULD SEEM REASONABLE TO EXPECT A CHANGE IN THE SIMULTANEOUS REQUIREMENTS FOR BOTH AN OUTER TANK INSPECTION AND A SECONDARY BARRIER IF THE TANKS CAN BE INSPECTED FROM THE INSULATION SIDE AS WELL AS FROM THE CARGO SIDE, A SATISFACTORY EXPERIENCE WITH FREE-STANDING TANKS MAY MAKE SECONDARY BARRIERS SUPERFLUOUS. NEVERTHELESS, THE THREE TANK CONCEPTS - FREE-STANDING, SEMI-MEMBRANE, AND FULLY INTEGRATED - HAVE BEEN PROVEN AND ARE READY TO BE APPLIED IN FUTURE LNG TRANSPORT PROJECTS. UNTIL VERY RECENTLY, THIS COHICE WAS NOT AVAILABLE, BECAUSE IT IS NOW POSSIBLE AND NECESSARY TO MAKE THE CHOICE, THE DESIGN ENGINEER HAS A GREATER CHALLENGE AND THEREFORE WILL NEED TO COORDINATE EXTENSIVELY WITH THE NAVAL ARCHITECT, THE REGULATORY BODIES, AND THE ECONOMIST TO ENSURE THAT THE CHOSEN TANK SYSTEM IS ULTIMATELY SAFE AND RELIABLE. ONE CERTAIN CONCLUSION IS THAT AS THE WORLD POPULATION INCREASES AND ITS STANDARD OF LIVING IMPROVES, THE DEMAND FOR A CLEAN SOURCE OF ENERGY WILL INCREASE AND NATURAL GAS FROM UNPOPULATED REGIONS OF THE WORLD WILL BE BROUGHT AT LNG TO THOSE AREAS UNDERGOING THE LARGEST INDUSTRIAL EXPANSION.

-PERTINENT FIGURES-

TAB.1 DESIGN CONSIDERATIONS, PAGE 24//TAB.2 PROPERTIES OF MATERIALS, PAGE 26//FIG.1 CONCH SELF-SUPPORTING TANK, PAGE 27//FIG.3 GENERAL OUTLINE AND DETAIL OF JULES VERNE TANK, PAGE 28//FIG.7 CONCH MEMBRANE SYSTEM, PAGE 31//FIG.8 CONSTRUCTION PRINCIPLE OF THE WALL OF AN INTEGRATED TANK (WORMS), PAGE 32

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 12, 23-36 (1967) (PROC. OF CRYOGENIC ENGINEERING CONF., 12TH, BOULDER, COLO., JUN 13-5, 1966. PAPER A-3)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0014 PAGES, 0010 FIGURES, 0002 TABLES, 0000 REFERENCES

key 21056

TRY CAPACITANCE TRANSDUCERS

by

LEVINE,R.J.

03/15/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS REVIEW OF CAPACITANCE TRANSDUCERS BEGINS WITH SOME TYPICAL APPLICATIONS, THEN GIVES A GOOD SUMMARY OF THE POSSIBLE GEOMETRIES OF CAPACITANCE TRANSDUCERS WITH FORMULAS FOR THE CAPACITANCE OF EACH CONFIGURATION. A SELECTION OF SOME OF THE MANY POSSIBLE MEASURING CIRCUITS ASSOCIATED WITH THE TRANSDUCERS COMPLETES THE REVIEW.

-PERTINENT FIGURES-

TAB. CAPACITANCE TRANSDUCER APPLICATIONS, PAGE 188//FIG.3 TRANSDUCER ARRANGEMENTS AND CAPACITANCE FORMULAS, PAGE 190

-BIBLIOGRAPHY-

BOTTCHER,C.J.F., THEORY OF ELECTRIC POLARIZATION, ELSEVIER PUBLISHING CO., AMSTERDAM, NETHERLANDS, 28-48 AND 228-91 (1952)//SELBY,M.C., ANALYSIS OF COAXIAL TWO-TERMINAL CONICAL CAPACITOR, MONOGRAPHY, VOL 46, (APR 1962), U.S. DEPT. OF COMMERCE, NBS, WASHINGTON, D.C.//LION,K.S., U.S. PATENT NO. 3,012,192

-SOURCE INFORMATION-

CORPORATE SOURCE -
ELECTRON. DES. VOL 14, NO. 6, 188-94 (MAR 1966)
OTHER INFORMATION -
0007 PAGES, 0013 FIGURES, 0000 TABLES, 0003 REFERENCES

MATERIALS OF CONSTRUCTION FOR CRYOGENIC PLANT

by

COULSON, K. J.

06/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

SPECIAL ATTENTION HAS TO BE PAID TO THE SELECTION OF MATERIALS OF CONSTRUCTION FOR CRYOGENIC PLANTS IN ORDER TO AVOID PROBLEMS OF BRITTLE FRACTURE. MATERIALS SUCH AS NICKEL STEELS, ALUMINUM AND COPPER ALLOYS ARE COMMONLY EMPLOYED FOR STORAGE VESSELS, PIPING, ETC. THE AUTHOR DISCUSSES THESE, TOGETHER WITH THE CHOICE OF WELD METALS AND WELDING TECHNIQUES.

-PERTINENT FIGURES-

FIG.1 VARIATION OF UTS AND PROOF STRESS WITH TEMPERATURE, PAGE 97//TAB.1 MECHANICAL PROPERTIES AND COSTS OF ALLOYS FOR CRYOGENIC PROCESS EQUIPMENT, PAGE 98//TAB.2 PROPERTIES OF 2 1/4 PERCENT AND 3 1/2 PERCENT NI STEELS, PAGE 98//TAB.3 SPECIFIED COMPOSITION AND AMBIENT TEMPERATURE PROPERTIES OF 9 PERCENT NI STEEL, PAGE 99//FIG.2 TEMPERATURE RANGES OVER WHICH ALLOYS MAY BE USED, PAGE 99//TAB.4 AMBIENT TEMPERATURE PROPERTIES OF AUSTENITIC STAINLESS STEELS, WITH AND WITHOUT N(2) ADDITIONS, PAGE 100

-BIBLIOGRAPHY-

INTERNATIONAL NICKEL CO., OPERATION CRYOGENICS//MURRAY AND HAGUE, PROPERTIES OF WELD JOINTS IN HI-PROOF STAINLESS STEEL, INST. OF WELDING, AUTUMN MEETING (1967)//DEMONEY,F., ADVANCES IN CRYOGENIC ENGINEERING, VOL 9 (1963)//GIBSON AND SHONE, WELDING THIN INVAR SHEET FOR CRYOGENIC SERVICE, INST. OF WELDING, AUTUMN MEETING (1967)

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR PRODUCTS LTD., ENGLAND
JOURNAL PROCEEDINGS -
CHEM. PROCESS ENG. VOL 49, NO. 6, 97-101 + 106 (JUN 1968)
OTHER INFORMATION -
0006 PAGES, 0005 FIGURES, 0005 TABLES, 0000 REFERENCES

keys 20899 through 20904

DESIGN ASPECTS OF LNG SHIP CONTAINMENT AND HANDLING SYSTEMS

by

BEAZER,C.W.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER BRIEFLY REVIEWS THE VARIOUS TYPES OF LNG SHIP CARGO CONTAINMENT SYSTEMS AND INCLUDES SEVERAL ILLUSTRATIONS OF THE NECESSARY DESIGN, CONSTRUCTION, AND OPERATIONAL CONSIDERATIONS. ONLY CERTAIN DESIGN ASPECTS OF THE CARGO HANDLING, SYSTEM ARE DISCUSSED IN DETAIL SINCE THE PAPER IS NOT INTENDED TO BE A COMPREHENSIVE DESIGN MANUAL.

-SOURCE INFORMATION-

CORPORATE SOURCE -
    PHILLIPS PETROLEUM CO., BARTLESVILLE, OKLA.
JOURNAL PROCEEDINGS -
    ASME PETROLEUM MECHANICAL ENGINEERING AND PRESSURE VESSELS AND PIPING CONF., (PRES. AT) NEW ORLEANS, LA., SEP 17-21, 1972. PAPER 72-PET-47
OTHER INFORMATION -
    0009 PAGES, 0000 FIGURES, 0000 TABLES, 0001 REFERENCES

ADVANCEMENTS IN CONSTRUCTION AND PERFORMANCE OF ABOVEGROUND STORAGE TANKS FOR LNG

by

DORNEY, D. C.
LUSK, D. T.

00/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

DESCRIPTIONS ARE GIVEN OF FIVE LNG STORAGE TANKS COMPLETED IN 1967 AND 1968, ILLUSTRATING ADVANCES MADE AT THAT TIME IN TANK DESIGN, PERFORMANCE AND ECONOMY. THESE TANKS WERE CONSTRUCTED IN NEW YORK CITY, MEMPHIS, TENNESSEE, PORTLAND, OREGON, AND MARSA EL BREGA, LIBYA.

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.//HORTON N. V., NETHERLANDS
JOURNAL PROCEEDINGS -
PROGRESS IN REFRIGERATION SCIENCE AND TECHNOLOGY, 251-7 (1969) (PROC. OF INT. CONGR. OF REFRIGERATION, 12TH, MADRID, SPAIN, AUG 30-SEP 6, 1967. PAPER 1.19)
OTHER INFORMATION -
0005 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20725 through 20726

WALL FILM FLOW EFFECTS WITH LIQUEFIED NATURAL GAS

by

BOOTH, D. A.
BULSARA, A.
JOYCE, F. G.
MORTON, I. P.
SCURLOCK, R. G.

10/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

DURING THE COURSE OF SOME FLOW VISUALIZATION STUDIES ON BOILING LIQUEFIED NATURAL GAS (LNG) IN A TRANSPARENT DEWAR, IT WAS OBSERVED THAT THE COLD DEWAR WALL UP TO A HEIGHT OF ABOUT 50 MM ABOVE THE LIQUID LEVEL WAS COVERED WITH FILM TOGETHER WITH FLUID DROPLETS. THIS PAPER REPORTS SOME VISUAL OBSERVATIONS AND SIMPLE EXPERIMENTS WHICH EXPLAIN THIS PHENOMENON IN TERMS OF A SURFACE-TENSION-DRIVEN PROCESS - A MANIFESTATION OF THE MARANGONI EFFECT. CLOSER OBSERVATION OF THE FILM FLOW REVEALED THE GENERAL RESULTS DESCRIBED HERE, USING LNG PREPARED BY THE COMPLETE CONDENSATION OF NORTH SEA GAS WITH THE APPROXIMATE COMPOSITION, NITROGEN 1.6 PERCENT, METHANE 93.6 PERCENT, CARBON DIOXIDE 0.1 PERCENT, ETHANE 4.1 PERCENT, PROPANE 0.6 PERCENT, BUTANE LESS THAN 0.1 PERCENT, WATER LESS THAN 0.02 PERCENT (-40 DEGREES F DEW-POINT).

-PERTINENT FIGURES-

FIG. 1 SCHEMATIC DIAGRAM SHOWING APPEARANCE OF TRANSPARENT DEWAR WALL ABOVE LNG, TOGETHER WITH OBSERVED TEMPERATURES, PAGE 563

-BIBLIOGRAPHY-

BOARDMAN,J. AND SCURLOCK,R.G., CRYOGENICS VOL 13, P 520 (1973)

-SOURCE INFORMATION-

CORPORATE SOURCE -
SOUTHAMPTON UNIV., ENGLAND
JOURNAL PROCEEDINGS -
CRYOGENICS VOL 14, NO. 10, 562-3 (OCT 1974)
OTHER INFORMATION -
0002 PAGES, 0001 FIGURES, 0000 TABLES, 0004 REFERENCES

keys 20776 through 20777

III. LEAK REPORTING REQUIREMENTS FOR GAS LINES

-ABSTRACT-

THIS IS A PORTION OF TITLE 49, CODE OF FEDERAL REGULATIONS, PRESENTED IN A TRADE PUBLICATION FOR PEOPLE CONCERNED WITH PIPELINES. THIS FORM OF PUBLICATION MAKES THE LATEST PROVISIONS OF THE FEDERAL SAFETY STANDARDS EASILY AVAILABLE TO THE PEOPLE MOST AFFECTED BY THESE STANDARDS. THIS PART OF TITLE 49 DEALS WITH THE REPORTING REQUIREMENTS FOR LEAKS IN PIPELINES CARRYING NATURAL GAS.

-SOURCE INFORMATION-

REPORT NUMBER -
49-CFR-191
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 202, NO. 4, 61-2 (MAR 1975)
OTHER INFORMATION -
0002 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20868 through 20869

CONTAINMENT DIKE SYSTEM FOR LONG TERMINAL

-ABSTRACT-

THIS BRIEF ARTICLE DESCRIBES THE SECONDARY CONTAINMENT DIKE TO BE BUILT AROUND THE LNG STORAGE AT THE COVE POINT TERMINAL BY THE REINFORCED EARTH COMPANY PROCESS. THE STRUCTURE WILL BE 14 FEET HIGH AND 15 FEET WIDE AND WILL SIT ATOP A 10-FOOT EARTH MOUND. THE DIKE STRUCTURE WILL CONSIST OF EARTH, REINFORCED WITH THIN METAL STRIPS AND FACED WITH PRE-CAST CONCRETE PANELS.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
GAS WORLD VOL 180, NO. 4677, 209 (APR 1975)
OTHER INFORMATION -
0001 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

NEW DEVELOPMENTS IN ABOVE GROUND METAL LNG CONTAINERS PART I

by

HANKE, C. C.

00/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS IS PART I OF A TWO PART ARTICLE ON NEW (IN 1969) DEVELOPMENTS IN ABOVEGROUND METAL LNG STORAGE TANKS. DISCUSSED HERE IS THE SUSPENDED DECK INSULATION CONCEPT WHICH ELIMINATES THE EXPENSIVE CRYOGENIC MATERIAL SELF-SUPPORTING ROOF ON THE INNER TANK. DRY GAS VAPOR FROM THE STORED LNG CIRCULATES FREELY IN THE INSULATION SPACES TO PROVIDE A CONTINUOUS, POSITIVE PRESSURE, DRY GAS PURGE ON THE INSULATION. ALSO, THE PROBLEM OF DIFFERENTIAL PRESSURES ON THE INNER TANK SHELL IS ELIMINATED WITH THE OUTER CARBON STEEL CONTAINER ACCOMMODATING THE OPERATING PRESSURE.

-PERTINENT FIGURES-

FIG.1 THE DOUBLE WALL TANK WITH THE SUSPENDED DECK INSULATION, PAGE 166// FIG.2 THE DOUBLE WALL TANK WITH THE CONVENTIONAL INNER TANK ROOF, PAGE 167

-BIBLIOGRAPHY-

WISSMILLER,I.L. AND CLAPP,M.B., CHICAGO BRIDGE AND IRON COMPANY, LIQUEFIED NATURAL GAS STORAGE IN ABOVE GROUND TANKS, AMERICAN GAS ASSOCIATION PRODUCTION CONFERENCE, BOSTON, MASS., JUNE, 1962//PETSINGER,R.E., UNITED STATES STEEL CORP., HANKE,C.C.,JR., CHICAGO BRIDGE AND IRON COMPANY, DESIGN OF 9 PERCENT NICKEL STEEL LNG STORAGE TANKS, ASME PETROLEUM MECHANICAL ENGINEERING CONFERENCE, HOUSTON, TEXAS, SEP 1965//HANKE,C.C., CHICAGO BRIDGE AND IRON COMPANY, ABOVEGROUND STORAGE OF LNG IS SAFE AND PRACTICAL, THE OIL AND GAS JOURNAL, FEB 1966//WISSMILLER,I.L., CHICAGO BRIDGE AND IRON COMPANY, ABOVEGROUND STORAGE TANKS FOR LIQUEFIED NATURAL GAS, WINTER ANNUAL MEETING ASME, NOV 1966//BRUNT,W.R., HORTON STEEL WORKS, LIMITED, CLAPP,M.B., CHICAGO BRIDGE AND IRON COMPANY, DESIGN OF ETHYLENE AND LNG LIQUEFACTION AND STORAGE FACILITIES, 50TH CONFERENCE AND EXHIBITION OF THE CHEMICAL INSTITUTE OF CANADA, TORONTO, JUNE 1967//LUSK,D.T., CHICAGO BRIDGE AND IRON COMPANY, DORNEY,D.C., CHICAGO BRIDGE LTD., ADVANCEMENTS IN CONSTRUCTION AND PERFORMANCE OF ABOVEGROUND STORAGE TANKS FOR LNG, 12TH INTERNATIONAL CONGRESS OF

REFRIGERATION, MADRID, SPAIN, SEP 1967

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.
JOURNAL PROCEEDINGS -
CRYOG. TECHNOL. VOL 5, NO. 4, 165-7 (JUL/AUG 1969) (PRES. AT THE AMERICAN GAS ASSOCIATION DISTRIBUTION CONF.)
OTHER INFORMATION -
0003 PAGES, 0002 FIGURES, 0000 TABLES, 0021 REFERENCES

CRYOGENIC TECHNOLOGY AND SCALEUP PROBLEMS OF VERY LARGE LNG PLANTS

by

BOURGUET, J. M.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

DESIGNING VERY LARGE LNG PLANTS REQUIRES A THOROUGH ANALYSIS OF THE RISKS INVOLVED WHENEVER THE SELECTION OF TECHNICAL SOLUTIONS IS MADE IN AREAS FAR BEYOND KNOWN BOUNDARIES OF CURRENT KNOWLEDGE. THE EXPERIENCE OF THE FIRST LARGE LNG PLANT IN THE WORLD, THAT OF CAMEL, AT ARZEW, AS WELL AS THAT OF SOMALGAZ AT SKIKDA, IS REVIEWED WITH PARTICULAR EMPHASIS ON THERMODYNAMIC PROPERTIES OF HYDROCARBON MIXTURES AT TEMPERATURES BETWEEN AMBIENT AND -265 DEGREES F, THE USE OF COMPUTERS FOR PROCESS OPTIMIZATION AND SELECTION OF PROCESSES, CRYOGENIC HEAT EXCHANGERS, TURBOCOMPRESSION SYSTEMS, OVERALL CONCEPT OF THE PLANTS, ANNUAL CAPACITY AND SEA WATER COOLING SYSTEMS. THIS PAPER PRESENTS ALTERATIONS MADE ON THE CAMEL PLANT AT STARTUP TIME TO TAKE FULL ADVANTAGE OF POTENTIAL CAPACITY BUILT IN THROUGH A CONSERVATIVE DESIGN PHLOSOPHY CHOSEN TO ELIMINATE RISKS WHILE SCALING UP IN UNCERTAIN AREAS. THE CAMEL EXPERIENCE AND THE LESSONS LEARNED WERE A DECISIVE FACTOR WHEN THE SAME DESIGN GROUP HANDLED THE SOMALGAZ WORK. IT WAS DECIDED THEN THAT IT WOULD BE BEST TO SEEK AN OVERALL EFFICIENCY THROUGH THE SELECTION OF TECHNICAL SOLUTIONS MINIMIZING ROTATING MACHINERY AND APPLYING STATIC SOLUTIONS WHENEVER AVAILABLE. THE SINGLE REFRIGERATING FLUID PROCESS SELECTED FOR THE PLANT MET THESE CONDITIONS SINCE, FOR EACH UNIT, THERE IS ONLY ONE TURBOCOMPRESSOR WHICH TAKES THE PLACE OF FIVE COMPRESSORS AND SEVEN CRYOGENIC PUMPS FOR EACH CAMEL UNIT. SCALEUP PROBLEMS OF THE SOMALGAZ LNG UNITS ARE REVIEWED WITH INDICATIONS OF THE EARLY OPERATING RESULTS.

-PERTINENT FIGURES-

TAB.1 COMPARISON OF EQUIPMENT NECESSARY FOR ONE LIQUEFACTION UNIT, PAGE 10// TAB.2 LIQUEFACTION OF NATURAL GAS, COMPRESSOR CHARACTERISTICS, PAGE 23// TAB.3 LIQUEFACTION OF NATURAL GAS, MAXIMUM CAPACITY OF CLASSICAL CASCADE UNIT WITH FOUR CENTRIFUGAL COMPRESSORS IN SERIES (PROPANE, ETHYLENE, METHANE, FLASH GAS), PAGE 25//TAB.4 LIQUEFACTION OF NATURAL GAS, MAXIMUM CAPACITY OF A TEALARC LNG UNIT USING ONE STEAM TURBINE DRIVEN AXIAL COMPRESSOR, PAGE 25//TAB.5 LIQUEFACTION OF NATURAL GAS, MAXIMUM CAPACITY OF A TEALARC LNG UNIT WITH PROPANE CYCLE USING THREE CENTRIFUGAL

-BIBLIOGRAPHY-

PIEROT,M., OPERATING EXPERIENCE OF THE ARZEW PLANT, PAPER PRESENTED AT FIRST INTERNATIONAL LNG CONFERENCE, CHICAGO, ILLINOIS, APRIL 7-12 (1968)// LAUR,C.E., USINE DE LIQUEFACTION D ARZEW, PAPER PRESENTED AT SECOND INTERNATIONAL LNG CONFERENCE, PARIS, FRANCE, OCTOBER 19-23 (1970)// BOURGEUT,J.M., GARNAUD,R. AND GRENIER,M., OIL AND GAS J. VOL 69, NO. 35A, P 71 (1971)//BARBE,C., ROGER,D. AND GRANGE,A., ECHANGES DE CHALEUR ET PERTES DE CHARGE EN ECOULEMENT DIPHASIQUE DANS LA CALANDRE DE ECHANGEURS BOBINES, PAPER PRESENTED AT 13TH INTERN. INSTITUTE OF REFRIGERATION CONGRESS, WASHINGTON, D.C., AUGUST 27-SEPTEMBER 3 (1971)//BARBE,C., MORDILLAT,D. AND ROGER,D., PERTES DE CHARGE EN ECOULEMENT MONOPHASIQUE ET DIPHASIQUE DANS LA CALANDRE DES ECHANGEURS BOBINES, PAPER PRESENTED AT 12 EME JOURNEES DE L HYDRAULIQUE, PARIS, FRANCE, JUNE 6-8 (1972)// SCHLATTER,R. AND NOEL,C., LARGE AXIAL COMPRESSORS AND THE NATURAL GAS LIQUEFACTION PROCESS, PAPER PRESENTED AT ASME MEETING, NEW ORLEANS, LOUISIANA, SEPTEMBER 17-21 (1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
TEAL, PARIS, FRANCE
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 18, 9-26 (1973) (PROC. OF CRYOGENIC ENGINEERING CONF., 18TH, BOULDER, COLO., AUG 9-11, 1972. PAPER A-2)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0018 PAGES, 0019 FIGURES, 0005 TABLES, 0008 REFERENCES

keys 19758 through 19763

SAFETY AND DESIGN PRIORITIES FOR LNG IMPORT TERMINALS

by

BOLAN, R. J.

06/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IN THIS ARTICLE, COMPARISON IS MADE OF CERTAIN VARIABLES IN TYPICAL LNG FACILITIES - IMPORT TERMINALS, PEAK-SHAVING PLANTS AND LARGE SATELLITE PLANTS. THE AUTHOR DISCUSSES OPERATING PROCEDURES AND DESIGN CRITERIA FOR SUCH FACILITIES, POINTING OUT AREAS WHERE IMPROVEMENTS SHOULD BE, OR ARE EXPECTED TO BE, MADE. DESCRIBED ARE UNLOADING AND VAPOR HANDLING SYSTEMS, VALVE CHARACTERISTICS AND REQUIREMENTS, STORAGE TANK ROLLOVER, AND SENDOUT HEATING VALVE CONTROL.

-PERTINENT FIGURES-

TAB.1 COMPARISON OF CERTAIN VARIABLES FOR TYPICAL LNG FACILITIES, PAGE 46// FIG.1 CENTRIFUGAL THRUST DEVELOPED IN LNG PIPING TURNS, PAGE 46//FIG.3 COMPARISON OF WATER HAMMER SURGE PRESSURE TO NOMINAL OPERATING PRESSURE FOR LNG TANK FILL LINES AT HYPOTHETICAL FACILITIES, PAGE 51//FIG.4 VALVE CHARACTERISTICS, PAGE 51

-SOURCE INFORMATION-

CORPORATE SOURCE -
SYNERGISTIC SERVICES, INC., TEMPE, ARIZONA
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 201, NO. 7, 46-7 & 51 & 54 & 56 (JUN 1974)
OTHER INFORMATION -
0005 PAGES, 0004 FIGURES, 0001 TABLES, 0000 REFERENCES

LNG TERMINALS--A COMPARISON OF EXISTING AND PROPOSED SYSTEMS

by

ANDERSON, P. J.

05/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

TERMINAL OPERATIONS INVOLVING LNG DIFFER FROM OPERATIONS WITH MOST OTHER LIQUIDS, WHICH ARE HANDLED AT CORRESPONDINGLY HIGH TRANSFER RATES AND LARGE VOLUMES, IN THAT LNG IS A BOILING CRYOGENIC LIQUID. THIS PAPER DISCUSSES THE DESIGN AND OPERATION OF TERMINAL SYSTEM COMPONENTS INCLUDING SHIP HANDLING, LIQUID/VAPOR TRANSFER, STORAGE, AND VAPORIZATION.

-PERTINENT FIGURES-

TAB.1 LNG BASE-LOAD EXPORT TERMINALS//TAB.2 LNG BASE-LOAD RECEIVING TERMINALS//FIG.1 FLOW DIAGRAM FOR AN LNG RECEIVING TERMINAL//FIG.2 EXPANSION JOINT ASSEMBLY

-BIBLIOGRAPHY-

CHORL,R.E., AN LNG SHIP-LOADING PIPELINE, LNG/CRYOG. 1, 6-11 (1973) APRIL-MAY//CRAWFORD,D.B. AND DURR,C.A., DESIGN OF LNG RECEIVING TERMINALS. PAPER NO. G-4 PRESENTED AT THE CRYOGENIC ENGINEERING CONFERENCE, ATLANTA, AUGUST 8-10, 1973//AARTS,J.J. AND BENVEGNU,J.A., FACTORS AFFECTING LNG STORAGE TANK SIZING FOR MARINE IMPORTATION/BASE-LOAD TERMINALS. PAPER PRESENTED AT THE NATIONAL SYMPOSIUM CRYO/73, LOS ANGELES, OCTOBER 2-4, 1973

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -
A.G.A. OPERATING SECTION DISTRIBUTION CONF., (PRES. AT) MINNEAPOLIS, MINN., MAY 6, 1974
OTHER INFORMATION -
0016 PAGES, 0002 FIGURES, 0003 TABLES, 0004 REFERENCES

keys 19777 through 19780

LNG TANK STRATIFICATION CONSEQUENT TO FILLING PROCEDURES

by

GERMELES, A. E.
SMITH, K. A.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

LARGE LNG STORAGE TANKS ARE CAPABLE OF EXHIBITING, APPARENTLY SPONTANEOUSLY, EXCEEDINGLY LARGE AND UNEXPECTED OVER-PRESSURES WHICH IN TURN CREATE VERY LARGE VENTING RATES. IT IS COMMONLY BELIEVED THAT SUCH UNDESIRABLE EVENTS ARE DUE TO TANK ROLL-OVER. HERETOFORE, A MAJOR OBSTACLE TO QUANTITATIVE ROLL-OVER PREDICTIONS, E.G. VENTING RATES, HAS BEEN THE LACK OF A WELL-POSED INITIAL CONDITION. IN PARTICULAR, IT HAS NOT BEEN POSSIBLE TO SPECIFY THE DENSITY VS. HEIGHT PROFILE WHICH WOULD EXIST IN AN LNG TANK UPON COMPLETION OF THE TRANSFER OF CARGO WHICH IS OF A DENSITY DIFFERENT FROM THAT OF THE TANK INVENTORY. THIS PAPER PRESENTS THE RESULTS FROM BOTH AN EXPERIMENTAL PROGRAM, WHICH USED MODEL FLUIDS IN A SMALL TANK, AND A COMPUTER SIMULATION OF THE HYDRODYNAMIC MIXING PROCESS DURING THE CARGO TRANSFER. IT IS SHOWN THAT THE EXPERIMENTAL AND COMPUTED DENSITY PROFILES ARE IN GOOD AGREEMENT WITH EACH OTHER, AND THAT THE INITIAL DENSITY PROFILES OF LNG TANKS ARE THEREFORE SUSCEPTIBLE TO PREDICTION.

-PERTINENT FIGURES-

FIG.1A ADDITION OF HEAVY LNG VIA A BOTTOM NOZZLE, PAGE 14//FIG.1B ADDITION OF LIGHT LNG VIA A BOTTOM NOZZLE, PAGE 14//FIG.5 EFFECT OF BOTTOM FILL NOZZLE ORIENTATION, PAGE 18//FIG.6 TOP ADDITION OF HEAVY FLUID, PAGE 19// FIG.7 TOP ADDITION OF HEAVY FLUID, PAGE 20//FIG.8 TOP ADDITION OF LIGHT FLUID, PAGE 21

-BIBLIOGRAPHY-

BELLUS,F. AND GINESTE,J., ETUDES ET ESSAIS SUR L EBULLITION DU GNL AU COURS DE SON TRANSFERT ET DE STOCKAGE EN GRANDS RESERVOIRS, PROCEEDINGS OF LNG-2, SESSION III, PAPER 2, PARIS, OCTOBER 1970//CHATTERJEE,N. AND GEIST,J.M., THE EFFECTS OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS, PIPELINE AND GAS JOURNAL VOL 199, 40-45 (1972)//DRAKE,E.M., GEIST,J.M. AND SMITH,K.A., PREVENT LNG ROLL-OVER, HYDROCARBON PROCESSING VOL 52, 87-90 (1973)// SARSTEN,J.A., LNG STRATIFICATION AND ROLL-OVER, PIPELINE AND GAS JOURNAL VOL 199, 37-39 (1972)//SMITH,K.A., LEWIS,J.P.,

RANDALL,G.A. AND MELDON,J.H., PREVENTION OF ROLL-OVER BY MIXING DURING THE FILLING OF LNG STORAGE TANKS, PRESENTED AT THE CRYOGENIC ENGINEERING CONFERENCE IN ATLANTA, GEORGIA, AUGUST 1973, TO APPEAR IN ADVANCES IN CRYOGENIC ENGINEERING

-SOURCE INFORMATION-

CORPORATE SOURCE -
    CABOT (GODFREY L.), INC., BOSTON, MASS.
JOURNAL PROCEEDINGS -
    INTERNATIONAL LIQUEFIED NATURAL GAS CONF., 4TH, (PROC. OF, SESSION IV) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 3
PUBLISHER -
    INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
    0021 PAGES, 0008 FIGURES, 0000 TABLES, 0014 REFERENCES

keys 19781 through 19786

SAFETY CONSIDERATIONS IN THE DESIGN AND OPERATION OF LNG TERMINALS

by

ANDERSON, P. J.
BODLE, W. W.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

SAFETY CONSIDERATIONS ARE OF PRIME IMPORTANCE IN THE DESIGN AND OPERATION OF LNG BASE-LOAD TERMINALS. THIS PAPER OUTLINES SAFETY CONSIDERATIONS APPLICABLE TO THE MAJOR COMPONENTS OF A TERMINAL FACILITY, WHICH INCLUDE THE DOCKING FACILITY, LNG TANKER LIQUID TRANSFER AND VAPOR HANDLING, STORAGE, AND SENDOUT VAPORIZATION. THE DOCKING FACILITY MUST BE DESIGNED TO SAFELY WITHSTAND SHIP IMPACTS AND THE EFFECTS OF TIDES, WAVES, AND WINDS. LIQUID TRANSFER AND VAPOR HANDLING SYSTEMS MUST PROVIDE FOR THE SAFE OPERATION OF SHIP CONNECTIONS, UNLOADING ARMS, LIQUID AND VAPOR TRANSFER LINES, AND LIQUID-RECIRCULATION LOOPS. THE SAFETY OF STORAGE SYSTEMS IS AFFECTED BY MECHANICAL DESIGN FEATURES AS WELL AS BY OPERATIONAL CHARACTERISTICS SUCH AS LIQUID ROLL-OVER, LIQUID PUMPING RATES, AND CHANGES IN BAROMETRIC PRESSURE. VAPORIZATION EQUIPMENT MUST PROVIDE FOR CONTROL OF GAS SENDOUT TEMPERATURE. GENERAL SAFETY CONSIDERATIONS FOR THE ENTIRE FACILITY MUST INCLUDE PROVISIONS FOR COMBUSTIBLE-GAS DETECTION AND FOR THE LOCATION OF FIRE-SENSING DEVICES AT STRATEGIC LOCATIONS THROUGHOUT THE PLANT AREA. FIRE-CONTROL SYSTEMS MUST ALSO BE PROVIDED. FINALLY, THE PROPER SELECTION AND TRAINING OF PERSONNEL ARE VITAL FOR THE SAFE OPERATION OF LNG TERMINALS.

-PERTINENT FIGURES-

FIG.1 FLOW DIAGRAM FOR AN LNG RECEIVING TERMINAL, PAGE 14//FIG.2 LOCATION OF COMBUSTABLE GAS DETECTORS, FIRE SENSING DEVICES AND MANUAL ALARM BOXES AT AN LNG RECEIVING TERMINAL, PAGE 15//FIG.3 LOCATION OF FIRE FIGHTING EQUIPMENT AT AN LNG RECEIVING TERMINAL, PAGE 16

-BIBLIOGRAPHY-

AMERICAN GAS ASSOCIATION, ACCIDENT PREVENTION COMMITTEE OF THE OPERATING SECTION, INTRODUCTION TO LNG FOR PERSONNEL SAFETY. ARLINGTON, VA., 1973// CRAWFORD,D.B. AND DURR,C.A., DESIGN OF LNG RECEIVING TERMINALS. PAPER NO. G-4 PRESENTED AT THE CRYOGENIC

ENGINEERING CONFERENCE, ATLANTA, AUGUST 8-10, 1973//GOLDBERG,E., LNG TERMINAL IS DESIGNED FOR SAFETY, PIPELINE GAS J. VOL 200, 43-44 (1973) MARCH//LNG IMPORT TERMINAL. DESIGN CONSIDERATIONS, CRYOG. IND. GASES VOL 7, 41, 43, 45-48 (1972) SEPTEMBER-OCTOBER//NATIONAL ACADEMY OF SCIENCES, COMMITTEE ON HAZARDOUS MATERIALS, CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY. WASHINGTON, D.C., 1972//SEROKA,S. AND BOLAN,R.J., SAFETY CONSIDERATIONS IN THE INSTALLATION OF AN LNG TANK, CRYOG. IND. GASES VOL 5, 22-25 (1970) SEPTEMBER-OCTOBER

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -
INTERNATIONAL LIQUEFIED NATURAL GAS CONF., 4TH, (PROC. OF, SESSION V) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 4
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0016 PAGES, 0003 FIGURES, 0000 TABLES, 0010 REFERENCES

keys 19787 through 19789

SHIPBOARD JETTISON TESTS OF LNG ONTO THE SEA

by

KNEEBONE, A.
PREW, L. R.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE SEVEN SHELL 75 000 CUBIC METER LNG CARRIERS SCHEDULED FOR THE BRUNEI-JAPAN RUN ARE FITTED WITH A STERN LNG JETTISON LINE. THIS SYSTEM IS INTENDED TO ALLOW SAFE DISCHARGE OF LNG TO THE SEA UNDER THE FOLLOWING CONDITIONS. 1) WITH THE SHIP UNDERWAY BUT HAVING SUFFERED FAILURE OR DAMAGE TO THE CARGO CONTAINMENT SYSTEM TO THE EXTENT THAT IT IS ESSENTIAL TO EMPTY THE DAMAGED TANK TO PREVENT FURTHER SERIOUS SHIP FAILURE, AND 2) WITH THE SHIP STATIONARY, I.E. AGROUND, AND IT IS NECESSARY TO LIGHTEN THE SHIP AND REFLOAT TO AVOID FURTHER HULL DAMAGE AND POSSIBLE RISK OF MAJOR RELEASE OF CARGO. THE FIRST PART OF THE PAPER DESCRIBES THE PROCEDURES AND RESULTS OF A SERIES OF JETTISON TESTS CARRIED OUT ON BOARD THE 75 000 CUBIC METER SHIP GADILA WITH SHIP MOVING AND STATIONARY, AND DISCUSSES THE OPERATIONAL SAFETY ASPECTS OF SUCH DISCHARGES. THE SECOND PART IS CONCERNED WITH THE ENVIRONMENTAL HAZARDS ASSOCIATED WITH THE RELEASE OF LARGE QUANTITIES OF LNG TO THE SEA IN TERMS OF THE EXTENT OF VAPOUR CLOUD FORMED - ITS CHARACTERISTICS AND RATE OF DISPERSAL.

-PERTINENT FIGURES-

FIG.1 SCHEMATIC DIAGRAM OF JETTISON SYSTEM, PAGE 17//FIG.2 PLAN OF PLUME FROM TEST 4, PAGE 18//FIG.3 PLAN OF PLUME FROM TEST 6, PAGE 19//FIG.8 COMPARISON OF RESULTS WITH API TESTS, PAGE 24//PLATE 1 VIEW FROM BRIDGE, TEST 4, PAGE 25//PLATE 2 VIEW FROM BRIDGE, TEST 6, PAGE 25

-BIBLIOGRAPHY-

MAY,W.G., ET AL., SPILLS OF LNG ON WATER - VAPORIZATION AND DOWNWIND DRIFT OF COMBUSTIBLE MIXTURES, ESSO ENGINEERING CO., REPORT NO. EE61E-72// BURGESS,D., ET AL., HAZARDS OF SPILLAGE OF LNG INTO WATER, MIPR NO. Z-70099-9-12395, DEPARTMENT OF TRANSPORTATION, U.S. COAST GUARD PM SRG REPORT NO. 4177 U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF MINES, PITTSBURGH, PA., (1972)//BOYLE,G.J. AND KNEEBONE,A., LABORATORY INVESTIGATIONS INTO THE CHARACTERISTICS OF LNG SPILLS ON WATER, API PROJECT ON LNG

SPILLS ON WATER, REF. 6Z32 WASHINGTON, D.C., (1973)

-SOURCE INFORMATION-

CORPORATE SOURCE -
SHELL RESEARCH, LTD., CHESTER, ENGLAND//SHELL INTERNATIONAL MARINE LTD., LONDON, ENGLAND
JOURNAL PROCEEDINGS -
INTERNATIONAL LIQUEFIED NATURAL GAS CONF., 4TH, (PROC. OF, SESSION V) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 5
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0025 PAGES, 0008 FIGURES, 0004 TABLES, 0006 REFERENCES

keys 19790 through 19792

LNG STORAGE TANKS FOR METROPOLITAN AREAS

by

GLASSER, K. F.
MURPHY, J. C.
SCHULLER, M. R.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

IT IS THE DESIRE OF GAS COMPANIES AND/OR GOVERNING OFFICIALS IN SOME LARGE METROPOLITAN AREAS TO HAVE INCORPORATED IN THEIR LNG STORAGE FACILITY THE CONTAINMENT SAFETY FEATURE PROVIDED BY IN-GROUND STORAGE. THIS NEED CAN BE SATISFIED BY DESIGNING THEIR ABOVE GROUND DOUBLE-WALLED METAL STORAGE TANK HAVING ALL PENETRATIONS THROUGH THE ROOF AND SURROUNDED BY A 10 FOOT THICK CONCRETE WALL. A THREE-MODE LEVEL OF CONTAINMENT SAFETY CAN BE ATTAINED BY DESIGNING ALL THREE, THE INNER TANK, THE OUTER TANK, AND THE CONCRETE WALL, AS CONTAINERS FOR THE LNG. THE FOREMENTIONED FEATURES ARE A PART OF THE 290,000 BBL LNG STORAGE TANK BUILD FOR CONSOLIDATED EDISON COMPANY OF NEW YORK, INC. LOCATED IN ASTORIA, QUEENS, NEW YORK CITY. PARTICULAR ELEMENTS OF THIS TANK ARE DISCUSSED WITH EMPHASIS BEING GIVEN TO THE ASPECTS RELATED TO SAFETY.

-SOURCE INFORMATION-

CORPORATE SOURCE -
PITTSBURGH-DES MOINES STEEL CO., PITTSBURGH, PA.//CONSOLIDATED EDISON CO. OF NEW YORK, INC., NEW YORK
JOURNAL PROCEEDINGS -
INTERNATIONAL LIQUEFIED NATURAL GAS CONF., 4TH, (PROC. OF, SESSION VI) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 3
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0009 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 19793 through 19796

ENVIRONMENTAL AND SAFETY ASPECTS OF LNG STORAGE

by

CARNE, M.
DEAN, F. E.
WALTERS, W. J.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE PAPER DEALS WITH THE VARIOUS FACTORS WHICH MUST BE CONSIDERED WHEN FINDING A SITE, PLANNING AND OBTAINING PERMISSION FOR A NEW LNG STORAGE INSTALLATION. ENVIRONMENTAL ASPECTS OF SITE SELECTION ARE DEALT WITH FIRST. THE UNITED KINGDOM PLANNING PROCEDURES ARE DESCRIBED, INCLUDING THE PROCESSES OF CONSULTATION WITH LOCAL AUTHORITIES, GOVERNMENT DEPARTMENTS AND THE GENERAL PUBLIC. THE DESIGN CONSIDERATIONS RELATING TO THE APPEARANCE OF THE PLANT ARE NEXT DISCUSSED, WITH EMPHASIS ON THE IMPORTANCE OF TREATING EACH SITE IN A SYMPATHETIC AND INDIVIDUAL MANNER. THE SAFETY ASPECTS OF PLANT DESIGN ARE CONSIDERED. THE PROBLEMS POSED BY THE STORAGE TANKS ARE PARTICULARLY IMPORTANT. STEPS WHICH CAN BE TAKEN TO REDUCE THE LIKELIHOOD AND CONSEQUENCES OF ACCIDENTAL LNG ESCAPE ARE DESCRIBED. FINALLY THE PAPER OUTLINES THE PRINCIPLES BY WHICH THESE SOMETIMES CONFLICTING DEMANDS ARE RESOLVED.

-PERTINENT FIGURES-

TAB.1 VAPOUR EVOLVED WHEN LNG SPILLS INTO A CONCRETE BUND, PAGE 14

-BIBLIOGRAPHY-

ATALLAH,S. AND RAJ.,P., THERMAL RADIATION FROM LNG SPILL FIRES, CRYOG. ENG. CONF., AUG 1973. PAPER P-3//CRYOGENICS SAFETY MANUAL - A GUIDE TO SAFE PRACTICE. BRITISH CRYOGENICS COUNCIL SAFETY PANEL, 1970//DRAKE,E.M. AND PUTNAM,A.A., VAPOR DISPERSION FROM SPILLS OF LNG ON LAND, CRYOG. ENG. CONF., AUG 1973. PAPER P-1//NATIONAL FIRE PROTECTION ASSOCIATION. STANDARD FOR THE PRODUCTION, STORAGE AND HANDLING OF LNG. NFPA 59A - 1972//PARKER,R.O., STUDY OF DOWNWIND VAPOR TRAVEL FROM LNG SPILLS. AGA DISTRIBUTION CONF., MAY 1970. 70-D-99//WELKER,J.R., WESSON,H.R. AND SLIEPCEVICH,C.M., LNG SPILLS, TO BURN OR NOT TO BURN, AGA DISTRIBUTION CONF., MAY 1969, 69-D-23

-SOURCE INFORMATION-

CORPORATE SOURCE -
    BRITISH GAS CORP., LONDON, ENGLAND
JOURNAL PROCEEDINGS -
    INTERNATIONAL LIQUEFIED NATURAL GAS CONF., 4TH, (PROC. OF, SESSION VI) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 7
PUBLISHER -
    INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
    0017 PAGES, 0001 FIGURES, 0001 TABLES, 0023 REFERENCES

keys 19797 through 19798

THE DEVELOPMENT OF INSULATION SYSTEMS FOR LARGE CAPACITY DOUBLE WALLED METALLIC LNG STORAGE TANKS

by

DODD, P.
ENG, C.
TODD, G.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IN THE DESIGN OF LARGE CAPACITY LNG STORAGE TANKS SAFETY IS OF PARAMOUNT IMPORTANCE AND IT IS THEREFORE NECESSARY TO HAVE A FULL UNDERSTANDING OF THE PROPERTIES OF COMPONENT MATERIALS UNDER THE SPECIFIC OPERATING CONDITIONS. IN THE CASE OF THE INSULATION MATERIALS, THESE ARE GENERALLY CONVENTIONAL PRODUCTS WHICH ARE BEING USED IN AN UNCONVENTIONAL ENVIRONMENT SO THAT EXTENSIVE DEVELOPMENT WORK IS NECESSARY TO SUBSTANTIATE THEIR USE. THE PAPER PRESENTS THE DESIGN BASIS AND RESULTS OF DEVELOPMENT WORK ON BASE, SHELL AND ROOF INSULATION SYSTEMS RELATING TO THE CONSTRUCTION OF 2 - 50,000 CUBIC METER TANKS. IN PARTICULAR, RESULTS OF AN EXTENSIVE PROGRAM OF AMBIENT AND LOW TEMPERATURE TESTS ON THE LOAD BEARING CHARACTERISTICS OF FOAMED GLASS AND LIGHTWEIGHT CONCRETE BLOCKS ARE GIVEN, TOGETHER WITH THE DESIGN BASIS FOR CALCULATING THE HORIZONTAL PRESSURE DEVELOPED BY A PERLITE/GLASS FIBER BLANKET WALL INSULATION SYSTEM DUE TO THERMAL CYCLING OF THE INNER TANK. DETAILS ARE INCLUDED FOR THE SUBSTANTIATION OF THE USE OF PLYWOOD PANELS FOR THE SUSPENDED INNER ROOF. INFORMATION IS GIVEN ON PROBLEMS ASSOCIATED WITH THERMAL DESIGN AND THE THERMAL PERFORMANCE CALCULATIONS HAVE BEEN SUBSTANTIATED BY OBTAINING OPERATING DATA FROM A 12,000 CUBIC METER INSTALLATION. IN CONCLUSION, AN OUTLINE DESIGN IS GIVEN FOR A 100,000 CUBIC METER TANK WITH INDICATIONS OF FUTURE TRENDS OF DEVELOPMENT WORK.

-BIBLIOGRAPHY-

CARTER,W.P. AND HARRISON,J.D., THE USE OF 9 PERCENT NICKEL STEEL FOR LNG APPLICATION, CONFERENCE ON WELDING LOW TEMPERATURE CONTAINMENT PLANT, LONDON, 20TH-22ND NOVEMBER 1973

-SOURCE INFORMATION-

CORPORATE SOURCE -
WHESSOE LTD., DARLINGTON, ENGLAND
JOURNAL PROCEEDINGS -

INTERNATIONAL LIQUEFIED NATURAL GAS CONF., 4TH, (PROC. OF, SESSION VI) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 8
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0027 PAGES, 0003 FIGURES, 0001 TABLES, 0003 REFERENCES

keys 19799 through 19802

ENVIRONMENTAL FACTORS IN SITING LNG FACILITIES

by

DAVIS, R. J.
FIRSTENBERG, H.
JOYCE, T. J.
WARREN, F. H.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER SETS FORTH THE MAJOR ENVIRONMENTAL CONCERNS ENCOUNTERED IN THE PRODUCTION, TRANSPORTATION, STORAGE AND REVAPORIZATION OF LNG AND PROVIDES A METHOD OF ANALYZING AND EVALUATING THE ENVIRONMENTAL PROBLEMS. IT LISTS ENVIRONMENTAL FACTORS IN SITING LNG FACILITIES, ENVIRONMENTAL REGULATORY TRENDS, SPECIAL ENVIRONMENTAL FACTORS OF LNG FACILITIES OPERATIONS, AND SIGNIFICANT SAFETY ASPECTS TO BE CONSIDERED - INCLUDING A RESUME OF FURTHER RESEARCH TO BE UNDERTAKEN IN THE LATTER REGARD.

-PERTINENT FIGURES-

TAB. 1B SOME TYPICAL RESPONSE PROPERTIES OF LNG, PAGE 13//FIG.1 ABBREVIATED OUTLINE OF ENVIRONMENTAL REPORT FOR LNG FACILITIES, PAGE 16

-BIBLIOGRAPHY-

WALLS,W.L., LNG. A FIRE SERVICE APPRAISAL, FIRE JOURNAL, NFPA, JAN. 1972// GONDOUIN,M. AND MURAT,F., TRANSPORTATION AND STORAGE OF LNG, CHEM. AND ENG. PROG. VOL 68, 71-76 (1972)//DRAKE,E.M., GEIST,J.M. AND SMITH,K.A., PREVENT LNG ROLLOVER, HYDROCARBON PROCESSING, MAR., 1973, PP 87-90//KOBER,D. AND MARTIN,E., SAFETY ASPECTS OF LNG TRANSPORTATION WITH SPECIAL CONSIDERATION OF INLAND WATERWAYS AND COASTAL PORTS, THIRD INTERNATIONAL CONFERENCE OF EXHIBITION ON LNG, SEPT. 1972//FAY,J.A. AND MACKENZIE,J.J., COLD CARGO, ENVIRONMENT, VOL 14, NO. 9, PP 21-29, NOVEMBER 1972//FAY,J.A., UNUSUAL FIRE HAZARD OF LNG TANKER SPILLS, COMBUSTION SCIENCE AND TECHNOLOGY, VOL. 7, 1973

-SOURCE INFORMATION-

CORPORATE SOURCE -
NUS CORP., ROCKVILLE, MD.

JOURNAL PROCEEDINGS -
INTERNATIONAL LIQUEFIED NATURAL GAS CONF., 4TH, (PROC. OF, SESSION VIII) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 5
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0031 PAGES, 0003 FIGURES, 0001 TABLES, 0019 REFERENCES

keys 19826 through 19830

III. STORAGE. A. MINED CAVERNS, B. CRYOGENIC INGROUND STORAGE

-ABSTRACT-

THIS SECTION OF THE AGA LNG INFORMATION BOOK DISCUSSES CRYOGENIC INGROUND STORAGE CONCEPTS - MINED CAVERNS AND FROZEN HOLES - COVERING SUCH ITEMS AS MATERIALS AND METHODS OF CONSTRUCTION, INFLUENCE OF SITE CHARACTERISTICS, THERMAL ASPECTS, OPERATING TECHNIQUES, AND MAINTENANCE. ADVANTAGES AND DISADVANTAGES OF THIS TYPE OF STORAGE ARE PROVIDED AS WELL AS DETAILS OF PERFORMANCE OF EXISTING INSTALLATIONS.

-PERTINENT FIGURES-

TAB.3 THERMAL CONDUCTIVITY OF ROCKS//TAB.4 COMPRESSIVE STRENGTH OF ROCKS// TAB.5 PHYSICAL PROPERTIES OF GRANITE AND GLACIAL TILL AT TENNESSEE GAS LNG FACILITY SITE//FIG.21 CAVERN STORAGE OF LIQUEFIED NATURAL GAS AS CONCEIVED BY IGT//FIG.28 CIG STORAGE UNIT FOR TRANSCONTINENTAL GAS PIPELINE CORPORATION//FIG.31 SECTION THRU TENNESSEE GAS PIPELINE LNG STORAGE RESERVOIR

-BIBLIOGRAPHY-

TOCHE,J., UNDERGROUND STORAGE OF LIQUID METHANE. THEORETICAL STUDY, LABORATORY AND PILOT PLANT TEST, COMPTE RENDU DU CONGRES DE L INDUSTRIE DU GAZ 78, 683-706 (1961)//BECHTOL,M.G., CONSTRUCTION OF BELOW GROUND RESERVOIRS FOR THE STORAGE OF LIQUEFIED NATURAL GAS, PRESENTED AT THE AMERICAN GAS ASSOCIATION PRODUCTION CONFERENCE, BALTIMORE, MARYLAND (MAY 23-24, 1966)//KHAN,A.R., ANDERSON,P.J. AND EAKIN,B.E., CAVERN STORAGE OF LIQUEFIED NATURAL GAS, PRESENTED AT THE 7TH WORLD PETROLEUM CONFERENCE IN MEXICO CITY, MEXICO, APRIL 2-7, 1967//BRESSON,H., CAVERN STORAGE OF LIQUEFIED NATURAL GAS, PAPER CEP-62-12, OPERATING SECTION, AMERICAN GAS ASSOCIATION, 1962//KHAN,A.R. AND EAKIN,B.E., RECENT DEVELOPMENTS IN LNG STORAGE SYSTEMS, PAPER PRESENTED AT FIRST INTERNATIONAL CONFERENCE ON PETROLEUM AND THE SEA, MONACO, MAY 12-30, 1965

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
LNG INFORMATION BOOK...1973, 23-33 (1973)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0011 PAGES, 0013 FIGURES, 0003 TABLES, 0025 REFERENCES

key 19963

STORAGE OF L.N.G. IN METALLIC CONTAINERS

by

WARDALE, J. K. S.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE OBJECT OF THIS PAPER IS TO SHOW THAT DOUBLE WALL METALLIC LNG TANKS CAN BE BUILT LARGER THAN HITHERTO TO GIVE A SAFE AND ECONOMICAL UNIT. VALUABLE EXPERIENCE CAN BE DERIVED FROM THE DESIGN AND CONSTRUCTION OF LARGE OIL STORAGE TANKS.

-PERTINENT FIGURES-

FIG.1 GENERAL ARRANGEMENT OF CONVENTIONAL DOUBLE WALL LNG TANK, PAGE 453// FIG.2 GENERAL ARRANGEMENT OF LNG TANK WITH SUSPENDED ROOF, PAGE 454//FIG.3 GENERAL ARRANGEMENT OF LNG TANK WITH EXTERNALLY PRESSURIZED SUSPENDED ROOF, PAGE 455//FIG.4 TYPICAL RADIAL DISPLACEMENT OF LNG TANK SHELL AT -160 DEGREES C, PAGE 456

-BIBLIOGRAPHY-

API.620 APPENDIX Q - LOW PRESSURE STORAGE TANKS FOR LNG

-SOURCE INFORMATION-

CORPORATE SOURCE -
WHESSOE LTD., DARLINGTON, ENGLAND
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 435-56, (PROC. OF) LONDON, ENGLAND, MAR 25-8, 1969
PUBLISHER -
WILLIAM CLOWES AND SONS LTD., LONDON, ENGLAND
OTHER INFORMATION -
0022 PAGES, 0004 FIGURES, 0000 TABLES, 0007 REFERENCES

keys 19964 through 19966

PROBLEMS IN CONNECTION WITH THE FOUNDATION OF TANKS CONTAINING A LOWER TEMPERATURE MEDIA

by

ZELLERER, E.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IT IS EVIDENT FROM THE MATERIAL PRESENTED IN THIS PAPER THAT THE INCLUSION OF SOIL INTO THE CONCEPT OF LNG STORAGE TANK FOUNDATION MAY BRING ABOUT CONSIDERABLE SAVINGS IN THE COST OF ENERGY OR IN THE COST OF BOTTOM INSULATION. THIS IS BECAUSE THE LOWER THE TEMPERATURE AT THE INSULATION LEVEL IS, THE SMALLER IS THE EVAPORATION LOSS. HENCE SMALLER CAN BE THE EXPENSIVE INSULATION AT THE BOTTOM. UNDER CERTAIN CIRCUMSTANCES IT IS EVEN POSSIBLE TO OMIT HEATING AT THE BOTTOM ALTOGETHER. A PRECONDITION FOR THIS HOWEVER IS AN EXACT KNOWLEDGE OF THE SOIL CONDITIONS AND THEIR COEFFICIENTS OF THERMAL CONDUCTIVITY. ABOVE ALL ONE HAS TO KNOW IF THE FORMATION OF ICE LENSES IS POSSIBLE, I.E. WHETHER LAYERS SUSCEPTIBLE TO FROST ACTION AND THE SUPPLY OF WATER NECESSARY FOR THE GROWTH OF ICE LENSES ARE PRESENT. IN ADDITION THE POSITION AND THE THICKNESS OF THESE LAYERS ARE OF INTEREST.

-PERTINENT FIGURES-

FIG.2 DEPTH OF FROST PENETRATION WITHOUT BOTTOM INSULATION AS A FUNCTION OF TANK RADIUS AND THE TEMPERATURE OF THE TANK MEDIA, PAGE 412//FIG.4 DEPTH OF FROST PENETRATION WITH BOTTOM INSULATION AS A FUNCTION OF COEFFICIENT OF HEAT TRANSMISSION OF INSULATION, PAGE 416//FIG.4A DEPTH OF FROST PENETRATION WITH BOTTOM INSULATION AS A FUNCTION OF TANK RADIUS, PAGE 417//FIG.6 REDUCTION IN HEAT ENERGY BECAUSE OF UTILISATION OF SOIL HEAT AS A FUNCTION OF TANK RADIUS, PAGE 418

-SOURCE INFORMATION-

CORPORATE SOURCE -
LINDE A.G., MUNICH, WEST GERMANY
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 394-418, (PROC. OF) LONDON, ENGLAND, MAR 25-8, 1969
PUBLISHER -
WILLIAM CLOWES AND SONS LTD., LONDON, ENGLAND
OTHER INFORMATION -

LIQUID NATURAL GAS PIPELINES

by

COULTER, D. M.
WALKER, G.

00/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE DAY THAT LNG WILL BE TRANSPORTED OVER MEDIUM AND LONG DISTANCES BY PIPELINE APPEARS TO BE DRAWING CLOSER. THE RAPID ADVANCES IN THE FIELD OF CRYOGENICS IN RECENT YEARS HAVE PROVIDED THE MATERIALS, THE INSULATION, AND THE BASIC CONFIGURATION OF SUCH A PIPELINE. THE PROBLEMS THAT REMAIN ARE THOSE OF ECONOMICS, RESEARCH, AND DESIGN. THIS PAPER DEALS WITH SOME OF THE DESIGN ASPECTS OF LNG PIPELINES ON A BROAD BASE AND OUTLINES SOME OF THE EXISTING DESIGN APPROACHES AND PAST STUDIES INTO THE FEASIBILITY OF LNG PIPELINES. SOME OF THE INTERESTING POSSIBILITIES FOR FURTHER STUDY ARE PRESENTED.

-PERTINENT FIGURES-

FIG.3-7 ISOTHERM DISTRIBUTION AROUND A BURIED LNG PIPELINE//FIG.3-8 ISOTHERM DISTRIBUTION AROUND A BURIED GAS-PHASE PIPELINE

-BIBLIOGRAPHY-

DUFFY,A.R., DAINORA,J. AND ATTERBURY,T.J., MATERIALS OF CONSTRUCTION FOR USE IN AN LNG PIPELINE, CATALOGUE NO. L.4000 (NEW YORK AMERICAN GAS ASSOCIATION, 1968)//IVANTSOV,O.M., PROBLEMS OF LNG TRANSMISSION PIPELINE CONSTRUCTION, PRESENTED AT THE CONFERENCE ON LIQUEFIED NATURAL GAS OF THE INTERNATIONAL INSTITUTE OF REFRIGERATION AND THE BRITISH CRYOGENICS COUNCIL, LONDON, MARCH 25-28, 1969//WALKER,G., COULTER,D.M. AND SOOD,N., LIQUEFIED NATURAL GAS PIPELINES FOR ARTIC GAS RECOVERY, PRESENTED AT THE CONFERENCE ON LIQUEFIED NATURAL GAS OF THE INTERNATIONAL INSTITUTE OF REFRIGERATION AND THE BRITISH CRYOGENICS COUNCIL, LONDON, MARCH 25-28, 1969//COULTER,D.M., DESIGN CONSIDERATIONS FOR A LIQUEFIED NATURAL GAS PIPELINE, IN ADVANCES IN CRYOGENIC ENGINEERING, VOL 15 (NEW YORK. PLENUM PUBLISHING CORP., 1970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CALGARY UNIV., ALBERTA
JOURNAL PROCEEDINGS -
APPLICATIONS OF CRYOGENIC TECHNOLOGY VOL 2, 23-41 (1970)
(PROC. OF CRYO-69, LOS ANGELES, CALIF., JUN 15-8, 1969)
PUBLISHER -
TINNON-BROWN, INC., LOS ANGELES, CALIF.
OTHER INFORMATION -
0019 PAGES, 0010 FIGURES, 0000 TABLES, 0020 REFERENCES

keys 19992 through 19997

SAFETY AND RELIABILITY OF LNG FACILITIES

by

AMOROSO, L. A.
SEITER, R. H.
UHL, A. E.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

OPERATIONAL SAFETY AND RELIABILITY OF SERVICE OF LNG FACILITIES HAVE BEEN OUTSTANDING CHARACTERISTICS OF THE GROWTH OF THE LNG INDUSTRY SINCE 1959. THE PRIME FACTORS BEHIND THIS ENVIABLE RECORD ARE THE EARLY DEFINITION AND UNDERSTANDING OF THE NATURE OF LNG, THE ESTABLISHMENT AND UTILIZATION OF RELEVANT CODES, THE CASTING AND OBSERVATION OF PERTINENT QUALITY ASSURANCE PROGRAMS, AND THE THOROUGH TRAINING OF PLANT OPERATING PERSONNEL. THIS PAPER DISCUSSES EACH OF THESE FACTORS IN DETAIL.

-PERTINENT FIGURES-

TAB.3 CODES AND STANDARDS FOR LNG FACILITIES//TAB.5 COMPARISON OF REGULATIONS, NATIONAL AND STATE CODES AND STANDARDS//TAB.7 TYPICAL QUALITY CONTROL FACTORS FOR LNG FACILITIES//TAB.8 CRITICALITY MATRIX//TAB.9 MINIMUM TEST AND CONTROL REQUIREMENTS//FIG.3 EQUIPMENT QA/QC OPERATIONS LIST

-BIBLIOGRAPHY-

BURGESS,D.S., MURPHY,J.M. AND ZABETAKIS,M.G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, FINAL REPORT OF INVESTIGATION MIPR Z-70099-9-92317, U. S. BUREAU OF MINES, PITTSBURGH, PA., 1970//BURGESS,D.S. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUID NATURAL GAS. RI 6099, USBM, PITTSBURGH, PA., 1962//BURGOYNE,J.H. AND RICHARDSON,J.F., FIRE AND EXPLOSION RISKS ASSOCIATED WITH LIQUID METHANE, FUEL, VOL 27, NO. 2, 1948, PP 37-42//ELLIOTT,M.A., ET AL., REPORT ON THE INVESTIGATION OF THE FIRE AT THE LIQUEFACTION, STORAGE, AND REGASIFICATION PLANT OF THE EAST OHIO GAS COMPANY, CLEVELAND, OHIO, OCT. 20, 1944. RI 3867, USBM, PITTSBURGH, PA., 1946, 44 PP//PETERSON,J.B., MORIZUMI,S.J., AND CARPENTER,H.J., THERMAL RADIATION FROM STORED LNG RELEASE, SESSION 5, PAPER 25, PROCEEDINGS, FIRST INTERNATIONAL CONFERENCE ON LNG, INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL., 1968//TRW SYSTEMS GROUP, THERMAL RADIATION AND OVERPRESSURES FROM INSTANTANEOUS LNG RELEASE INTO THE ATMOSPHERE. (PUB. H-60015),

AMERICAN GAS ASSOCIATION, ARLINGTON, VA., 1968, 150 PP

-SOURCE INFORMATION-

CORPORATE SOURCE -
BECHTEL CORP., SAN FRANCISCO, CALIF.
JOURNAL PROCEEDINGS -
ASME PETROLEUM MECHANICAL ENGINEERING AND PRESSURE VESSELS AND PIPING CONF., (PRES. AT) NEW ORLEANS, LA., SEP 17-21, 1972
OTHER INFORMATION -
0017 PAGES, 0003 FIGURES, 0011 TABLES, 0013 REFERENCES

III. STORAGE. C. PRESTRESSED CONCRETE TANKS

-ABSTRACT-

THIS SECTION OF THE AGA LNG INFORMATION BOOK DISCUSSES PRESTRESSED CONCRETE TANKS - COVERING SUCH ITEMS AS MATERIALS AND METHODS OF CONSTRUCTION, INFLUENCE OF SITE CHARACTERISTICS, THERMAL ASPECTS, OPERATING TECHNIQUES, AND MAINTENANCE. ADVANTAGES AND DISADVANTAGES OF THIS TYPE OF STORAGE ARE PROVIDED AS WELL AS DETAILS OF PERFORMANCE OF EXISTING INSTALLATIONS.

-PERTINENT FIGURES-

FIG.36 BELOW GROUND PRESTRESSED CONCRETE LNG STORAGE DEMONSTRATION TANK// FIG.38 VARIOUS PRESTRESSED CONCRETE LNG STORAGE TANK CONFIGURATIONS//FIG.41 TEXAS EASTERN TRANSMISSION COMPANY PRESTRESSED CONCRETE LNG STORAGE TANK// FIG.47 PHILADELPHIA GAS WORKS PRESTRESSED CONCRETE LNG STORAGE TANK//FIG.49 PHILADELPHIA ELECTRIC COMPANY PRESTRESSED DIKE AND INSULATED MOAT

-BIBLIOGRAPHY-

DUFFY,A.R. AND SHOUP,A.J., 600,000-BBL LNG TANK TO USE INTERNAL INSULATION, FLEXIBLE LINER, OIL AND GAS JOURNAL, PART 1 (AUGUST 1, 1966), PART 2 (AUGUST 8, 1966)//EAKIN,B.E., BAIR,W.G., CLOSNER,J.J. AND MAROTI,R., BELOW-GROUND STORAGE OF LIQUEFIED NATURAL GAS IN PRESTRESSED CONCRETE TANKS, INSTITUTE OF GAS TECHNOLOGY TECHNICAL REPORT NO. 8 (COVERING PROJECT PB-35, PB-35A, AND PE-35A SPONSORED BY A.G.A. AND PARTICIPATING COMPANIES) (1963) JULY//CLOSNER,J.J., PRESTRESSED CONCRETE STORAGE TANKS FOR LNG, DISTRIBUTION CONFERENCE PROCEEDINGS, AMERICAN GAS ASSOCIATION, MAY 8, 1968 //MONFORE,G.E. AND LENTZ,A.E., PHYSICAL PROPERTIES OF CONCRETE AT VERY LOW TEMPERATURES, PORTLAND CEMENT ASSOCIATION RESEARCH BULLETIN NO. 145, CHICAGO, ILLINOIS, THE ASSOCIATION, 1962//CLOSNER,J.J., PRESTRESSED CONCRETE DIKE SYSTEMS FOR LNG STORAGE CONTAINERS, A.G.A. DISTRIBUTION CONFERENCE, CHICAGO (MAY 12, 1971)//CLOSNER,J.J., VERY LARGE PRESTRESSED CONCRETE TANKS FOR LNG STORAGE, SECOND INTERNATIONAL CONFERENCE AND EXHIBITION ON LIQUEFIED NATURAL GAS, SESSION 3, PARIS (OCTOBER 19-23, 1970)

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
LNG INFORMATION BOOK...1973, 33-45 (1973)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0013 PAGES, 0018 FIGURES, 0000 TABLES, 0009 REFERENCES

III. STORAGE. D. ABOVEGROUND METAL LNG TANKS

-ABSTRACT-

THIS SECTION OF THE AGA LNG INFORMATION BOOK DISCUSSES ABOVEGROUND METAL LNG TANKS - BOTH LARGE AND SMALL - COVERING SUCH ITEMS AS MATERIALS AND METHODS OF CONSTRUCTION, INFLUENCE OF SITE CHARACTERISTICS, THERMAL ASPECTS, OPERATIONS, AND MAINTENANCE. AN EIGHTEEN FIGURE PHOTO DISPLAY IS INCLUDED DEPICTING IN STEP-BY-STEP SEQUENCE THE ERECTION OF A TYPICAL LARGE METAL LNG STORAGE TANK FROM THE GROUND UP.

-PERTINENT FIGURES-

TAB.7 ALLOWABLE DESIGN STRESSES FOR PLATE AND STRUCTURAL MEMBERS API STANDARD 620, APPENDIX Q LNG TANKS//FIG.57 UPLIFT ILLUSTRATION//FIG.80 ILLUSTRATION OF RESILIENT BLANKET FUNCTION//FIG.81 TYPICAL SHOP-FABRICATED TANK SIZES AND FILLING SYSTEMS//FIG.82 TYPICAL ARRANGEMENT FOR AUTOMOTIVE FUEL SYSTEM USING LNG

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
LNG INFORMATION BOOK...1973, 45-62 (1973)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0018 PAGES, 0032 FIGURES, 0002 TABLES, 0000 REFERENCES

IV. LNG PUMPOUT AND REGASIFICATION

-ABSTRACT-

REGASIFICATION OF THE STORED LIQUID NATURAL GAS IS THE FINAL STEP IN THE OPERATION OF AN LNG FACILITY. THE REGASIFICATION OR VAPORIZATION IS ACCOMPLISHED BY THE ADDITION OF HEAT FROM AMBIENT AIR, AMBIENT WATER, INTEGRAL-FIRED OR REMOTE-FIRED VAPORIZERS. THIS SECTION OF THE AGA LNG INFORMATION BOOK DESCRIBES THE VARIOUS TYPES OF VAPORIZERS ALONG WITH THEIR ADVANTAGES AND DISADVANTAGES, AND ALSO DISCUSSES PUMPS USED TO FEED THE VAPORIZERS.

-PERTINENT FIGURES-

FIG.83 SIMPLIFIED FLOW DIAGRAM OF TYPICAL LNG VAPORIZER SYSTEM//FIG.88 DIAGRAMATIC CROSS-SECTION OF DIRECT-FIRED CONVECTIVE HEAT EXCHANGER (BLACK, SIVALLS AND BRYSON UNIFLUX DESIGN)//FIG.91 SUBMERGED COMBUSTION LNG VAPORIZER//FIG.93 INTERMEDIATE FLUID LNG VAPORIZER//FIG.96 WATER-BATH VAPORIZERS USED AT CANVEY ISLAND//FIG.97 AMBIENT AIR VAPORIZER (SAN DIEGO GAS AND ELECTRIC COMPANY)

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
LNG INFORMATION BOOK. 63-71 (1973)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0009 PAGES, 0015 FIGURES, 0000 TABLES, 0000 REFERENCES

V. TRANSPORTATION OF LNG

-ABSTRACT-

THIS SECTION OF THE AGA LNG INFORMATION BOOK DESCRIBES THE VARIOUS MODES OF LNG TRANSPORT - MARINE TRANSPORTATION AND OVERLAND TRANSPORTATION (TANK TRUCKS, TANK CARS, AND PIPELINES). DESIGNS OF TYPICAL TRANSPORT SYSTEMS ARE PRESENTED AND SOME ECONOMIC COMPARISONS ARE MADE. DETAILS OF THE THIRTEEN LNG TANKERS IN COMMERCIAL OPERATION ON JANUARY 1, 1972 ARE GIVEN.

-PERTINENT FIGURES-

TAB.8 LNG CARRIERS//FIG.98 CROSS-SECTION OF THE METHANE PIONEER AND TANK DETAILS//FIG.99 CROSS-SECTION OF THE BRITISH METHANE TANKERS AND DETAILS// FIG.101 CROSS-SECTION OF THE JULES VERNE//FIG.102 CONSTRUCTION PRINCIPLE OF THE WALL OF AN INVAR MEMBRANE TANK//FIG.106 FLOW SCHEMATIC FOR LIQUID METHANE TRAILER

-BIBLIOGRAPHY-

DUFFY,A.R. AND DAINORA,J., ENGINEERING STUDIES INTO POSSIBILITIES FOR LNG PIPELINE, PIPELINE INDUSTRY (AUG., 1967)//DUFFY,A.R. AND EIBER,R.J., FRACTURE BEHAVIOR IN PIPE PRESSURED WITH LNG, PROCEEDINGS OF FIRST CONFERENCE ON NATURAL GAS RESEARCH AND TECHNOLOGY, SPONSORED BY AMERICAN GAS ASSOCIATION AND INSTITUTE OF GAS TECHNOLOGY, SESSION II, PAPER 1, (FEBRUARY 28 TO MARCH 3, 1971)//PASTUHOV,A.V., THE TRANSPORTATION OF LNG BY SHIP, ADVANCES IN CRYOGENIC ENGINEERING, V. 12, PROCEEDINGS OF THE 1966 CRYOGENIC ENGINEERING CONFERENCE, UNIV. OF COLORADO//CHATTERJEE,N. AND GEIST,J.M., EFFECTS OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS A.G.A. DISTRIBUTION CONFERENCE, ATLANTA, GA. (MAY, 1972) D-215, OPERATING SECTION PROCEEDINGS//SARSTEN,J.A., LNG STRATIFICATION AND ROLLOVER, A.G.A. DISTRIBUTION CONFERENCE, ATLANTA, GA. (MAY, 1972) D-224, OPERATING SECTION PROCEEDINGS//MAHER,J.B. AND VAN GELDER,L.R., UNDERSTANDING ROLLOVER AND THERMAL OVERFILL IN FLAT BOTTOM LNG TANKS, A.G.A. DISTRIBUTION CONFERENCE, ATLANTA, GA. (MAY, 1972) D-251, OPERATING SECTION PROCEEDINGS

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
LNG INFORMATION BOOK...1973, 72-81 (1973)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0010 PAGES, 0011 FIGURES, 0001 TABLES, 0026 REFERENCES

VI. FACTORS FOR CONSIDERATION IN EVALUATING A LIQUEFIED NATURAL GAS FACILITY

-ABSTRACT-

A COMPANY WHICH IS CONSIDERING THE CONSTRUCTION OF A LIQUEFIED NATURAL GAS PLANT WILL HAVE MADE A PRELIMINARY INVESTIGATION OF ITS ECONOMIC FEASIBILITY. THE NEXT STEP WILL INVOLVE A MORE DETAILED EVALUATION. TO ASSIST IN THIS EVALUATION, THE LIST PROVIDED IN THIS DOCUMENT OFFERS A GUIDE TO THE MANY ITEMS WHICH SHOULD BE CONSIDERED, PARTICULARLY FOR PROJECTS INTENDED FOR PEAK-LOAD SHAVING. SOME OF THE ITEMS SHOWN MAY NOT APPLY TO A SPECIFIC PROJECT, HOWEVER, THIS LIST IS INTENDED TO ENCOMPASS MOST, IF NOT ALL, OF THE ITEMS ASSOCIATED WITH SUCH PROJECTS.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
LNG INFORMATION BOOK...1973, 82-5 (1973)
PUBLISHER -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0004 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18850 through 18855

LNG. A FIRE SERVICE APPRAISAL PART 1

by

WALLS,W.L.

01/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Good/Excel.

-ABSTRACT-

THIS IS PART 1 OF A TWO-PART ARTICLE BY MR. WALLS. IN THE FIRST PART HE HAS DIVIDED HIS ATTENTION ALMOST EQUALLY BETWEEN THE HAZARD PROPERTIES OF LNG AND CONTROL OF LNG HAZARDS. UNDER THE FIRST TOPIC IS DISCUSSED THE VAPORIZING CAPABILITIES OF VARIOUS SUBSTANCES (EARTH, WATER AND AIR) AND THE VAPORIZATION RATES OF LNG IN CONTACT WITH THESE MATERIALS. THE SIGNIFICANCE OF THE EVOLVED GAS TEMPERATURE-DENSITY RELATIONSHIP IS MENTIONED AS IT RELATES TO BUOYANCY OF THE VAPOR CLOUD EVOLVING FROM A SPILL OR SOME OTHER RELEASE MECHANISM. FLAMMABILITY LIMITS OF METHANE IN AIR ARE LISTED, AND THE RESULTS OF EXPERIMENTAL LNG SPILLS AND SUBSEQUENT FLAMMABLE MIXTURE DOWNWIND TRAVEL DISTANCES ARE RECORDED. FLAME AND COMBUSTION CHARACTERISTICS OF IGNITED LNG AND ITS VAPOR CLOUD ARE DISCUSSED - E.G., COMBUSTION RATE OF A BURNING POOL OF LNG, FLAME HEIGHT OVER THE POOL, THERMAL RADIATION FROM THE FLAME AS COMPARED TO BURNING GASOLINE, ETC. UNDER CONTROL OF LNG HAZARDS, THE AUTHOR RECALLS THE DISASTEROUS LNG STORAGE TANK FAILURE IN CLEVELAND (1944), THE PROBABLE CAUSE OF THAT FAILURE, AND THE SUBSEQUENT STEPS TAKEN BY THE NATIONAL FIRE PROTECTION ASSOCIATION (BY WHOM HE IS EMPLOYED) TO PREVENT SUCH OCCURRENCES TODAY. HE ACKNOWLEDGES THAT FAILURE OF A PIPING SYSTEM OR EQUIPMENT IS MORE LIKELY TO OCCUR THAN THAT OF AN LNG CONTAINER AND SETS FORTH CERTAIN GUIDELINES FOR THE DESIGN OF SUCH SYSTEMS. THE ENTIRE ARTICLE IS WELL WRITTEN AND GENERALLY CONSIDERED VALUABLE FOR THE APPRECIABLE AMOUNT OF INFORMATION PRESENTED. IT HAS BEEN WIDELY REFERENCED IN LATER PUBLICATIONS BY NUMEROUS AUTHORS.

-PERTINENT FIGURES-

TAB.1 APPROXIMATE PROPERTIES OF LNG, PAGE 233

-BIBLIOGRAPHY-

NFPA NO. 59A STANDARD//FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, R.I. 0099 (1962), AND HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED NATURAL GAS ON WATER, R.I. 7448 (1970)//NFPA, CLEVELAND GAS EXPLOSION AND FIRE, REPORT UNF-7

(BOSTON. NFPA, 1944), EIGHT PAGES, 35 CENTS//REFRIGERATED LIQUEFIED PETROLEUM GAS PLANT FIRE, NFPA QUARTERLY, VOL 57, NO. 1 (JULY 1963), PP 89-94

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
FIRE J. VOL 66 (JAN 1972) (PROC. OF THE LNG IMPORTATION AND TERMINAL SAFETY CONF., 230-7, BOSTON, MASS., JUN 13-4, 1972)
OTHER INFORMATION -
0006 PAGES, 0003 FIGURES, 0001 TABLES, 0004 REFERENCES

CONCH METHANE SERVICES LNG EXPERIENCE

by

FFOOKS,R.C.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER RECOUNTS SOME OF THE MORE VALUABLE LESSONS LEARNED AND EXPERIENCE GAINED BY CONCH METHANE SERVICES IN THE DESIGN, CONSTRUCTION AND OPERATION OF LNG TANKERS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
CONCH METHANE SERVICES, LTD., LONDON, ENGLAND
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
LNG IMPORTATION AND TERMINAL SAFETY CONF., 242-7, (PROC. OF)
BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
0006 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18865 through 18871

SUMMATION AND CRITIQUE OF TECHNICAL KNOWLEDGE FOR THE SAFE HANDLING AND SHIPMENT OF LNG

by

BURGESS,D.S.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER SUMMARIZES A PANEL DISCUSSION ON VARIOUS ASPECTS OF STORAGE, SAFE HANDLING AND SHIPPING OF LNG GIVEN AT THE LNG IMPORTATION AND TERMINAL SAFETY CONFERENCE IN BOSTON, MASS. ON JUNE 13-14, 1972. TOPICS INCLUDED ARE LNG SPILLS (BOTH ON LAND AND WATER), LNG POOL SPREADING RATES, VAPOR DISPERSION AND PLUME CHARACTERISTICS, ROLLOVER, STRATIFICATION AND MIXING OF LNG IN STORAGE TANKS, GEYSERING IN VERTICAL STORAGE TANK FILL LINES, IGNITION, EXPLOSIONS AND DETONATIONS OF FLAMMABLE MIXTURES OF HYDROCARBONS AND AIR, ETC. COVERAGE OF THESE TOPICS BY THE PANEL AND PARTICIPATION BY EXPERTS IN THE AUDIENCE IN SOME OF THESE AREAS CULMINATED IN AN ABBREVIATED BUT VERY INTERESTING PAPER.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
LNG IMPORTATION AND TERMINAL SAFETY CONF., 143-52, (PROC. OF) BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
0010 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18872 through 18874

SUMMARY, QUESTIONS AND ANSWERS FOLLOWING PRESENTATIONS BY MEMBERS OF PANEL II

by

BOSNAK,R.J.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THIS BRIEF REPORT DOCUMENTS THE QUESTION AND ANSWER PERIOD FOLLOWING PRESENTATION OF SEVERAL PAPERS ON LNG TERMINAL DESIGN AND EXPERIENCE AND THE U.S. COAST GUARDS ROLE IN LPG/LNG IMPORTATION - GIVEN AT THE LNG IMPORTATION AND TERMINAL SAFETY CONFERENCE IN BOSTON, MASS. ON JUNE 13-14, 1972.

-SOURCE INFORMATION-

REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -
LNG IMPORTATION AND TERMINAL SAFETY CONF., 225-9. (PROC. OF) BOSTON, MASS., JUN 13-4, 1972
OTHER INFORMATION -
0005 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18910 through 18912

PREDICT LNG FIRE RADIATION

by

BROWN,L.E.
WESSON,H.R.
WELKER,J.R.

05/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE DESTRUCTIVE EFFECTS OF LNG FIRES ON SURROUNDING PROPERTY RESULTS PRINCIPALLY FROM RADIANT HEAT FROM THE FLAME ESTIMATING THIS POTENTIAL FOR DAMAGE IS ESSENTIAL FOR BEST PLANT DESIGN, INCLUDING DESIGN OF THE FIRE PROTECTION SYSTEM. THE REQUIRED ESTIMATING TECHNIQUES HAVE BEEN IMPRECISE AND CUMBERSOME TO USE. THIS PAPER PRESENTS A PSEUDO-THEORETICAL APPROACH WHICH PREDICTS THE MAXIMUM RADIANT FLUX AS A FUNCTION OF DISTANCE AND AIR VELOCITY. THE RESULTS WERE CORRELATED SUCCESSFULLY WITH THE RESULTS OF LARGE SCALE LAND SPILL TESTS OF LNG PERFORMED UNDER CONTRACT TO THE AMERICAN GAS ASSOCIATION. THE SUCCESS OF THE TECHNIQUE HINGES ON THE ABILITY TO ACCURATELY PREDICT THE SURFACE FLUX OF THE FIRE.

-PERTINENT FIGURES-

FIG.1 COMPARISON OF PREDICTED AND MEASURED RADIANT FLUXES, PAGE 141//FIG.2 RADIANT FLUXES FROM A 100-FOOT LNG FIRE UNDER CALM CONDITIONS, PAGE 142// FIG.3 MAXIMUM RADIANT FLUXES DOWNWIND FROM A 100-FOOT LNG FIRE, PAGE 142// FIG.4 COMPARISON OF MEASURED FLAME HEIGHTS WITH THE PREDICTION OF THOMAS, PAGE 143//FIG.5 MEASURED AND PREDICTED FLAME ANGLES FOR LNG FIRES, PAGE 143 //FIG.6 SURFACE FLUXES FOR LNG FIRES, PAGE 143

-BIBLIOGRAPHY-

AMERICAN GAS ASSOCIATION PROJECT IS-3-1, PHASE II, CONSEQUENCES OF LNG SPILLS ON LAND, FINAL REPORT (1974)//REIN,R.G., SLIEPCEVICH,C.M. AND WELKER,J.R., RADIATION VIEW FACTORS FOR TILTED CYLINDERS, J. FIRE AND FLAMMABILITY, 1, 140 (1970)//THOMAS,P.H., THE SIZE OF FLAMES FROM NATURAL FIRES, NINTH INTERNATIONAL SYMPOSIUM ON COMBUSTION, ACADEMIC PRESS, NEW YORK (1963)//WELKER,J.R. AND SLIEPCEVICH,C.M., SUSCEPTIBILITY OF POTENTIAL TARGET COMPONENTS TO DEFEAT BY THERMAL ACTION, UNIVERSITY OF OKLAHOMA RESEARCH INSTITUTE REPORT NO. OURI-1578-FE, NORMAN, OKLAHOMA (1970)// WESSON,H.R., WELKER,J.R., BROWN,L.E. AND

SLIEPCEVICH,C.M., FIGHT LNG FIRES WITH FOAM. HYDROCARBON PROCESSING 52, 165 (OCT 1973)//WESSON,H.R., WELKER,J.R., BROWN,L.E. AND SLIEPCEVICH,C.M., FIGHT LNG FIRES WITH DRY CHEMICALS, HYDROCARBON PROCESSING 52, 234 (NOV 1973)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 53, NO. 5, 141-3 (MAY 1974)
OTHER INFORMATION -
0003 PAGES, 0006 FIGURES, 0000 TABLES, 0006 REFERENCES

keys 19003 through 19005

MOLECULAR SEAL

by

RUNES,E.

11/01/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	Incremental	Acceptable

-ABSTRACT-

THIS INFORMATIONAL NOTE GIVES A REVIEW OF THE DATA AVAILABLE ON A MOLECULAR SEAL BEING MARKETED BY JOHN ZINK CO. FOR INSTALLATION IN FLARE STACKS. THE DEVICE IS INTENDED TO REDUCE THE AMOUNT OF PURGE GAS REQUIRED TO SAFEGUARD THE STACK. THE COMPANYS RECOMMENDATIONS FOR PURGE GAS REQUIRED WITH THE SEAL ARE ACTUALLY LARGER THAN THOSE WITHOUT WHICH SEEMS RATHER STRANGE. ASSUMING THIS IS REALLY INCORRECT, THERE ARE STILL A NUMBER OF PROBLEMS WITH THIS SYSTEM, SUCH AS 1) THE SEAL WOULD ACT AS A CONDENSER IN COLD WEATHER, 2) THE DRAIN COULD FREEZE, 3) CORROSION COULD OCCUR WITH NO INSPECTION MEANS PROVIDED, 4) THE SEAL WILL RAISE THE PRESSURE IN THE LINE UPSTREAM. THE AUTHOR CONCLUDES THAT THE DEVICE IS NOT JUSTIFIED FOR INSTALLATION IN ANY FLARE STACKS UNDER ANY KNOWN CIRCUMSTANCES.

-PERTINENT FIGURES-

FIG.1 MOLECULAR SEAL FOR FLARE STACKS, PAGE 5

-BIBLIOGRAPHY-

HUSA,H.W., HOW TO COMPUTE SAFE PURGE RATES, HYDROCARBON PROCESSING AND PETROLEUM REFINER VOL 43, NO. 5, MAY 1964, PP 179-182

-SOURCE INFORMATION-

CORPORATE SOURCE -
    AMERICAN OIL CO., WHITING, IND.
REPORT NUMBER -
    INTERNAL MEMORANDUM
OTHER INFORMATION -
    0005 PAGES, 0001 FIGURES, 0000 TABLES, 0001 REFERENCES

key 19265

NUCLEATE AND FILM BOILING HEAT TRANSFER TO NITROGEN AND METHANE AT ELEVATED PRESSURES AND LARGE TEMPERATURE DIFFERENCES

by

PARK,JR.,E.L.
COLVER,C.P.
SLIEPCEVICH,C.M.

00/00/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

NUCLEATE AND FILM BOILING DATA, AS WELL AS CONVECTIVE HEAT TRANSFER DATA NEAR THE CRITICAL POINT, HAVE BEEN OBTAINED FOR NITROGEN AT PRESSURES UP TO 800 PSIG AND TEMPERATURE DIFFERENCES UP TO 1000 DEGREES F AND FOR METHANE UP TO 700 PSIG AND TEMPERATURE DIFFERENCES UP TO 700 DEGREES F. THE NITROGEN DATA INCLUDE BURNOUT HEAT FLUX MEASUREMENTS UP TO 0.9 OF THE CRITICAL PRESSURE. AN EMPIRICAL CORRELATION, BASED ON CORRESPONDING STATES THEORY, PREDICTS THE TEMPERATURE GRADIENT AT BURNOUT FOR NITROGEN REMARKABLY WELL. THE FILM BOILING CORRELATION PROPOSED BY BREEN AND WESTWATER DOES NOT FIT THE DATA OBTAINED ON NITROGEN AND METHANE IN THIS STUDY. THE DISCREPANCY IS ATTRIBUTED TO BOTH THE EFFECT OF PRESSURE AS WELL AS HEAT FLUX LEVEL, CLEARLY INDICATED IN THIS STUDY. FOR CONVECTIVE HEAT TRANSFER ABOVE THE CRITICAL PRESSURE, THE HEAT FLUX AT A GIVEN TEMPERATURE GRADIENT WAS FOUND TO BE INDEPENDENT OF PRESSURE FOR BOTH NITROGEN AND METHANE. HIGHER HEAT TRANSFER RATES ARE OBTAINED IN THE CONVECTIVE REGION THAN IN FILM BOILING.

-PERTINENT FIGURES-

FIG.3 NUCLEATE BOILING DATA FOR NITROGEN, PAGE 520//FIG.4 NUCLEATE BOILING DATA FOR METHANE, PAGE 520//FIG.9 FILM BOILING DATA FOR NITROGEN, PAGE 524//FIG.10 FILM BOILING DATA FOR METHANE, PAGE 524//FIG.13 CONVECTION HEAT TRANSFER DATA FOR NITROGEN ABOVE THE CRITICAL PRESSURE, PAGE 526//FIG.14 CONVECTION HEAT TRANSFER DATA FOR METHANE ABOVE THE CRITICAL PRESSURE, PAGE 526

-BIBLIOGRAPHY-

BRENTARI,E.G. AND SMITH,R.V., INTERNATIONAL ADVANCES IN CRYOGENIC ENGINEERING, PLENUM PRESS, NEW YORK (1965), P. 325//FREDERKING,T.H.K., ADVANCES IN CRYOGENIC ENGINEERING, VOL. 9, PLENUM PRESS, NEW YORK (1964) P. 71//LYON,D.N., KOSKY,P.G., AND

HARMAN,B.N., ADVANCES IN CRYOGENIC ENGINEERING, VOL. 9, PLENUM PRESS, NEW YORK (1964), P. 77

-SOURCE INFORMATION-

CORPORATE SOURCE -
OKLAHOMA UNIV., NORMAN
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 11, 516-29 (1966) (PROC. OF CRYOGENIC ENGINEERING CONF., 11TH, HOUSTON, TEX., AUG 23-5, 1965. PAPER H-3)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0014 PAGES, 0014 FIGURES, 0000 TABLES, 0024 REFERENCES

key 19290

THE TRANSPORT OF LNG BY PIPE LINES. TECHNICAL AND ECONOMIC ASPECTS

by

CARBONELL,E.
GUERIN,J.Y.
SOLENTE,P.

00/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

IT HAS BEEN SUGGESTED THAT NATURAL GAS PIPE LINES MAY BE REPLACED BY SPECIAL PIPE LINES CARRYING LNG. BY ALMOST COMPLETELY ELIMINATING THE RECOMPRESSION LOSSES, THIS METHOD OF TRANSPORTATION MAY BE MORE ADVANTAGEOUS. THIS PAPER PRESENTS THE THERMODYNAMIC AND ECONOMIC ASPECTS OF THIS PROBLEM. IT WILL BE SHOWN THAT THE TRANSPORTATION OF LNG OVER LONG DISTANCES, CANNOT BE ECONOMICALLY COMPETITIVE WITH THE CLASSICAL PROCEDURE OF TRANSPORTING NATURAL GAS IN THE GASEOUS STATE AT THE PRESENT STATE OF CRYOGENIC TECHNOLOGY. IF LNG IS AVAILABLE WITHOUT COST AND THE CUSTOMER DEMANDS NATURAL GAS IN LIQUID FORM (IN VIEW OF POSSIBLE STORAGE OR FOR REFRIGERATION PURPOSES), IT IS POSSIBLE TO CONSIDER THE CONSTRUCTION OF LNG PIPE LINES FOR TRANSPORTING NATURAL GAS OVER RELATIVELY SHORT DISTANCES.

-PERTINENT FIGURES-

TAB.1 OPTIMUM DIAMETER OF A LNG PIPE LINE AND DISTANCE BETWEEN TWO REFRIGERATING STATIONS, PAGE 455//TAB.2 COMPARATIVE TRANSPORTATION COSTS OF NATURAL GAS AND LNG, PAGE 455//FIG.1 TEMPERATURE RISE IN AN OPTIMIZED LNG PIPE LINE, PAGE 456//FIG.2 DISTANCE BETWEEN TWO REFRIGERATING STATIONS AS A FUNCTION OF DIAMETER, PAGE 456

-BIBLIOGRAPHY-

ANDERSON,A., OIL AND GAS J., (FEBRUARY 8, 1965), P. 75//ITTERBEEK,A.VAN, VERBECK,O. AND STAES,K., PHYSICA 29.742 (1963)//ROSSINI,F.D., SELECTED VALUES OF PHYSICAL AND THERMODYNAMICAL PROPERTIES OF HYDROCARBONS AND RELATED COMPOUNDS, CARNEGIE PRESS, PITTSBURGH (1953)

-SOURCE INFORMATION-

CORPORATE SOURCE -

SOCIETE L AIR LIQUIDE, SASSENAGE, FRANCE
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 12, 452-7 (1967) (PROC. OF CRYOGENIC ENGINEERING CONF., 12TH, BOULDER, COLO., JUN 13-5, 1966. PAPER F-5)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0005 PAGES, 0002 FIGURES, 0002 TABLES, 0003 REFERENCES

keys 18825 through 18826

RADIATION, HEAT FLUX, AND OVERPRESSURE IN LNG TANKS

by

WEST,H.H.
WELKER,J.R.
SLIEPCEVICH,C.M.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

AN IMPORTANT PARAMETER IN THE ANALYSIS OF LNG STORAGE FACILITIES IS THE VAPOR BOIL-OFF RATE. SINCE CRYOGENIC FLUIDS ARE STORED AS ESSENTIALLY SATURATED LIQUIDS, ANY CHANGES IN THE TANK HEAT TRANSFER CHARACTERISTICS OR SATURATED FLUID THERMODYNAMIC CONDITIONS WILL CAUSE A CHANGE IN BOIL-OFF RATE. THIS PAPER DISCUSSES THE FACTORS WHICH CONTROL THE TRANSIENT AS WELL AS THE STEADY-STATE BOIL-OFF RATE, REVIEWS VARIOUS MATHEMATICAL MODELS WHICH ATTEMPT TO PREDICT TRANSIENT AND STEADY-STATE BOIL-OFF RATES, AND CONCLUDES BY STATING THE NEED FOR EXPERIMENTAL VERIFICATION OF THE TRANSIENT MODEL.

-PERTINENT FIGURES-

TAB.1 COMPARISON BETWEEN PROPERTIES OF WATER AND LIQUID METHANE, PAGE 82// FIG.1 HEAT TRANSFER TO LNG VERSUS LIQUID LEVEL IN A MODEL LNG STORAGE TANK, PAGE 79//FIG.2 EFFECT OF LIQUID LEVEL ON LNG BOIL-OFF IN A MODEL LNG STORAGE TANK, PAGE 80//FIG.3 TRANSIENT BOIL-OFF RATE AS A FUNCTION OF INSTANTANEOUS PRESSURE DROP IN A 600,000 BARREL LNG STORAGE TANK, PAGE 81

-BIBLIOGRAPHY-

CHURCHILL,S.W., CHEM. ENGR. PROGR., 58, 55, (1962)//NEILL,D.T., HASHEMI,H.T. AND SLIEPCEVICH,C.M., CHEM. ENGR. PROGR., 64, 111, (1968)//HASHEMI,H.T. AND WESSON,H.R., HYDRO. PROC., 8, (1971)//BOYLE,G.J. AND REECE,D., PROCEEDINGS LNG-2, PARIS (1970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
FLAME DYNAMICS LAB., NORMAN, OKLA.
REPORT NUMBER -
AD-754326
JOURNAL PROCEEDINGS -

LNG IMPORTATION AND TERMINAL SAFETY CONF., 71-82, (PROC. OF)
BOSTON, MASS., JUN 13-4, 1972

OTHER INFORMATION -

0012 PAGES, 0003 FIGURES, 0001 TABLES, 0005 REFERENCES

INSULATED STORAGE TANK WITH INSULATION RESTRAINED AGAINST SETTLING BECAUSE OF METAL CONTRACTION

by

LANGE,K.W.

02/02/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

DISCLOSED IS AN IMPROVED INSULATED TANK HAVING A PART THEREOF WHICH IS DOUBLE WALLED. THE DOUBLE-WALLED PORTION, WHICH MAY BE CYLINDRICAL, SPHERICAL OR SOME OTHER SHAPE, CONTAINS FREE-FLOWING INSULATING MATERIAL AND A RESILIENT INSULATING BLANKET WHICH HAS BEEN COMPRESSED BY ACTIVE PRESSURE SUBSTANTIALLY ABOVE THE LATERAL PASSIVE PRESSURE CAUSED BY THE FREE-FLOWING, USUALLY GRANULAR, INSULATION. WHEN THE INNER WALL OF THE TANK CONTRACTS DURING LOW-TEMPERATURE USE, SUCH AS IN THE STORAGE OF A CRYOGENIC LIQUID, THE BLANKET EXPANDS SUFFICIENTLY FAR AND WITH ENOUGH PRESSURE TO OCCUPY THE INCREASED INSULATING SPACE WITHOUT SETTLING OF THE FREE-FLOWING INSULATION.

-PERTINENT FIGURES-

FIG.1 VERTICAL SECTIONAL VIEW THROUGH AN INSULATED TANK SHOWING ONE EMBODIMENT OF THE INVENTION//FIG.3 VERTICAL SECTIONAL VIEW OF AN INSULATED TANK SHOWING A WINDING AROUND THE INSULATING BLANKET TO COMRESS THE SAME

-BIBLIOGRAPHY-

BIAIS, U S PATENT NO. 3,118,194 (JAN 1964)//WISSMILLER, U S PATENT NO. 3,147,878 (SEP 1964)//HERRENSCHMIDT, U S PATENT NO. 3,273,740 (SEP 1966)// AUSTRALIA, PATENT NO. 234,484 (JUL 1961)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.
REPORT NUMBER -
U S PATENT NO. 3,559,835
OTHER INFORMATION -
0006 PAGES, 0006 FIGURES, 0000 TABLES, 0004 REFERENCES

key 21150

EVALUATION OF LIQUID METHANE STORAGE AND TRANSFER PROBLEMS IN SUPERSONIC AIRCRAFT FINAL REPORT, AUGUST 6, 1971

by

MCGREW,J.L.
BUSKIRK,D L.
BRADY,H.F.
LEEDS,M.W.

08/06/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THE OBJECTIVE OF THE REPORTED PROGRAM WAS TO EVALUATE THE PROBLEMS INVOLVED IN USING LIQUID METHANE IN A SUPERSONIC CRUISE-TYPE AIRCRAFT. THE ANALYSES INCLUDED PRESSURIZATION AND FUEL TRANSFER IN SYSTEMS USING LIQUID METHANE IN A SATURATED STATE, IN THE SUBCOOLED STATE, OR PARTLY AS A SATURATED LIQUID AND PARTLY AS A SUBCOOLED LIQUID. THE PROGRAM INCLUDED DESIGNING AND FABRICATING A TEST RIG, CONDUCTING 49 TESTS, AND REDUCING AND ANALYZING SOME 100 CHANNELS OF DATA. THREE SEPARATE LOW-PRESSURE TANK CONFIGURATIONS AND ONE HIGH-PRESSURE TANK WERE TESTED. THE TESTS DEMONSTRATED THAT SUBCOOLED METHANE CAN BE LOADED AND HELD FOR REASONABLE LENGTHS OF TIME UNDER SIMULATED AIRCRAFT CONDITIONS USING METHANE VAPORS TO MAINTAIN THE PRESSURIZATION.

-SOURCE INFORMATION-

CORPORATE SOURCE -
MARTIN MARIETTA CORP., DENVER, COLO.
REPORT NUMBER -
N71-34648//NASA-CR-72952
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO
CONTRACT NUMBER -
CONTRACT NAS3-12411
OTHER INFORMATION -
0264 PAGES, 0174 FIGURES, 0009 TABLES, 0000 REFERENCES

keys 20161 through 20164

DEVELOPMENT OF LNG PIPELINE TECHNOLOGY

by

DIMENTBERG, M.

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

BECAUSE LNG PIPELINES WILL HAVE TO BE OPERATED AT CRYOGENIC TEMPERATURES, THE SUITABILITY OF MATERIALS, DESIGN CONCEPTS AND TECHNIQUES ARE FACTORS OF MAJOR IMPORTANCE. ALTHOUGH LOW TEMPERATURE OPERATIONS INTRODUCE ADDITIONAL PROBLEMS, THERE ARE MANY ADVANTAGES OF LNG TRANSMISSION. THIS ARTICLE DISCUSSES MANY FACETS OF LONG DISTANCE TRANSFER OF NATURAL GAS IN THE LIQUID STATE-DWELLING AT SOME LENGTH ON PIPING DESIGN AND OPERATING TEMPERATURES, CRACK INITIATION AND PROPAGATION, AND OPERATING CONSIDERATIONS.

-PERTINENT FIGURES-

FIG.1 REDUCTION OF PRESSURE IN FLUIDS FOLLOWING CRACK INITIATION IN PRESSURE VESSEL DURING EARLY STAGE OF CRACK FORMATION, PAGE 33

-BIBLIOGRAPHY-

DIMENTBERG,M., LNG VIA PIPELINE. CRYOGENIC ENGINEERING NEWS, MARCH 1968// DUFFY,A.R. AND DAINORA,J., CONSIDERATIONS FOR LNG PIPE MATERIAL SELECTION, PROCEEDINGS FIRST INTERNATIONAL CONFERENCE ON LNG - CHICAGO, APR 7-12, 1968 //IVANTSOV,O.M., PROBLEMS OF LNG TRANSMISSION PIPELINES CONSTRUCTION, PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON LIQUEFIED NATURAL GAS, LONDON, MARCH 1969

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CRYOG. IND. GASES VOL 6, NO. 5, 29-30 & 32-6 (SEP/OCT 1971)
OTHER INFORMATION -
0007 PAGES, 0003 FIGURES, 0000 TABLES, 0004 REFERENCES

HASSI R MEL ALGERIAN OWNED LNG SHIP

-ABSTRACT-

THE SUBJECT OF THIS ARTICLE IS THE 40,000 CUBIC METER LNG CARGO CARRIER HASSI R MEL WHICH WAS BUILT TO TRANSPORT LNG FROM SKIKDA, ALGERIA TO FOS-SUR-MER, FRANCE. DESIGN AND CONSTRUCTION DETAILS OF THE SHIP ARE PRESENTED.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
SHIPP. WORLD SHIPBUILD. VOL 165, NO. 3869, 571-4 (MAY 1972)
OTHER INFORMATION -
0006 PAGES, 0006 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20170 through 20173

HOW HOPKINTON LNG PLANT WAS MODIFIED

by

GRIFFITH, M. P.
SORENSEN, J. C.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IN 1967 AN LNG PEAK-SHAVING PLANT WAS COMPLETED AT HOPKINTON, MASS. UNFORTUNATELY, IT COULD NOT BE PLACED IN COMMERCIAL OPERATION DUE TO DIFFICULTIES WITH THE INGROUND STORAGE CONTAINERS. THE PLANT WAS LATER PURCHASED BY HOPKINTON LNG CORP., THE INGROUND STORAGE ABANDONED AND REPLACED BY TWO ABOVEGROUND TANKS OF THE MORE CONVENTIONAL DOUBLE-WALL, PERLITE-INSULATED, 9 PERCENT NICKEL STEEL DESIGN. THIS ARTICLE DESCRIBES THE VARIOUS MODIFICATIONS MADE TO THE ORIGINAL PLANT PRIOR TO PUTTING IT IN SERVICE IN 1971.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NEGEA SERVICE CORP., CAMBRIDGE, MASS.//AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 7, 68 & 71-3 (JUN 1972)
OTHER INFORMATION -
0004 PAGES, 0007 FIGURES, 0000 TABLES, 0000 REFERENCES

CALIFORNIA REGULATIONS FOR LNG AUTO INSTALLATIONS AN EDITORIAL STAFF SUMMARY

-ABSTRACT-

THE GROWING USE ON PUBLIC ROADS OF VEHICLES CONVERTED TO THE USE OF LNG AS A MOTOR FUEL HAS RESULTED IN SOME APPREHENSION ABOUT THE SAFETY OF THE INSTALLATIONS IN THE VEHICLES. APPROPRIATE AUTHORITIES ARE DEVELOPING REGULATIONS FOR SUCH INSTALLATIONS - ONE OF THE FIRST BEING THE CALIFORNIA HIGHWAY PATROL. THE CALIFORNIA RULES PROBABLY WILL BE THE MODEL WHICH OTHER STATES WILL FOLLOW. EXCERPTS AND CONDENSATIONS OF THE NEW REGULATIONS ARE PUBLISHED IN THIS ARTICLE.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CRYOG. TECHNOL. VOL 8, NO. 4, 132-4 (JUL/AUG 1972)
OTHER INFORMATION -
0003 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 20176

URETHANE FOAM INSULATES BRUNEI PIPELINE

-ABSTRACT-

THIS ARTICLE DESCRIBES THE BRUNEI LNG SHIP-LOADING SYSTEM WHICH UTILIZES 6.2 MILES OF STAINLESS STEEL PIPE, FACTORY PRE-INSULATED WITH POLYURETHANE FOAM APPLIED BY A TECHNOLOGY DEVELOPED SPECIFICALLY FOR THE APPLICATION. PHOTOGRAPHS OF THE MANUFACTURING PROCEDURES AND FINISHED PRODUCT ARE INCLUDED.

-PERTINENT FIGURES-

FIG.1 URETHANE FOAM IS BEING SPRAYED ONTO SECTIONS OF PIPE, PAGE 28//FIG.2 END OF A FOAMED PIPE SECTION BEFORE THE OUTER COVERING IS APPLIED, PAGE 28 //FIG.3 FIELD ANCHOR ASSEMBLY, SHOWING FABRICATED FIELD CLOSURE HALF-SECTIONS, PAGE 29//FIG.4 PRE-FABRICATED EXPANSION JOINTS WITH URETHANE FOAM AND GLASS REINFORCED EPOXY VAPOR BARRIER APPLIED, PAGE 29

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CRYOG. IND. GASES VOL 7, NO. 4, 27-9 (JUL/AUG 1972)
OTHER INFORMATION -
0003 PAGES, 0005 FIGURES, 0000 TABLES, 0000 REFERENCES

DOUBLE BARRIER KELLGAZ TANK USES CONCRETE, FLEXIBLE MEMBRANE

-ABSTRACT-

THIS ARTICLE BRIEFLY DESCRIBES THE KELLGAZ LNG STORAGE CONCEPT - A PRESTRESSED CONCRETE TANK WITH INTERNAL LOAD-BEARING INSULATION AND A FLEXIBLE WAFFLED STAINLESS STEEL MEMBRANE LINER. ADVANTAGES OF SUCH CONSTRUCTION ARE ENUMERATED.

-PERTINENT FIGURES-

FIG.1 ARTISTS CONCEPT OF TWO KELLGAZ-CONCEPT LNG STORAGE TANKS AT IMPORT TERMINAL, PAGE 69//FIG.2 CROSS-SECTION OF KELLGAZ TANK, PAGE 69//FIG.3 CORNER DETAIL OF KELLGAZ TANK, PAGE 69//FIG.4 CUTAWAY VIEW OF THE KELLGAZ LNG STORAGE TANK, PAGE 72//FIG.5 STAINLESS STEEL, FLEXIBLE MEMBRANE LIQUID CONTAINER HAS LOW STRESS LEVELS WHEN IN SERVICE TO MINIMIZE RISK OF CRACKING, PAGE 72

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 11, 69 & 72 (SEP 1972)
OTHER INFORMATION -
0002 PAGES, 0005 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20179 through 20180

CONCRETE FLOATING STORAGE FOR LNG

by

ANDRIER, B.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

PRESENTLY, LARGE CAPACITY FLOATING STORAGE VESSELS FOR CRUDE OIL ARE BEING UTILIZED AS RECEIVING TERMINALS FOR SUPERTANKERS AND SEVERAL PROJECTS ARE UNDERWAY USING THE ROTATING MOORING STORAGE SYSTEM (RMS). THIS CONCEPT OF A FLOATING-DOCK STORAGE CAN ALSO BE USEFULLY APPLIED FOR LNG AT EITHER THE RECEIVING END OF A MARITIME TRAFFIC OR AT THE SHIPPING END. DESCRIBED IN THIS ARTICLE IS SUCH A SYSTEM - A FLOATING BARGE WITH A PRESTRESSED CONCRETE DOUBLE HULL SURROUNDED BY PROTECTIVE COMPARTMENTS USED AS BALLASTS.

-PERTINENT FIGURES-

FIG.1 SECTION OF ROTATING MOORING STORAGE SYSTEM SHOWING THE CONSTRUCTION DETAILS OF THE PRESTRESSED CONCRETE DOUBLE-HULL VESSEL AND INSULATING LINING, PAGE 75

-SOURCE INFORMATION-

CORPORATE SOURCE -
ENTREPOSE GTM POUR LES TRAVAUX PETROLIERS MARITIMES, PARIS, FRANCE
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 11, 75 (SEP 1972)
OTHER INFORMATION -
0001 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20181 through 20182

LNG IMPORTS. PLANNING AIDS

by

BOLAN, R.
MARKBREITER, S.
WEISS, I.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE BRIEFLY DISCUSSES DESIGN CONSIDERATIONS FOR LNG IMPORT TERMINALS, INCLUDING THE FOLLOWING, 1. DISPOSAL OF VAPORS DISPLACED IN THE STORAGE SYSTEM DURING THE FILLING OF THE STORAGE TANKS. 2. DESIGN OF STORAGE TANK VAPOR HANDLING SYSTEM FOR DISPOSAL OF NORMAL STORAGE TANK BOILOFF VAPORS GENERATED DUE TO HEAT LEAK. 3. HANDLING OF VAPORS RESULTING FROM OTHER CAUSES. 4. LIQUID HANDLING SYSTEMS FOR THE TRANSFER OF THE STORED LIQUID TO EITHER BARGES, TRAILERS, OR TO THE PRODUCT DELIVERY PUMPS. 5. SENDOUT SYSTEMS INCLUDING LNG PUMPS AND LNG VAPORIZATION EQUIPMENT. 6. MEASUREMENT SYSTEMS FOR RECEIVING AND SENDOUT PURPOSES. 7. SAFETY FEATURES.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CRYOG. IND. GASES VOL 7, NO. 5, 16-7 & 19 & 21-2 (SEP/OCT 1972)
OTHER INFORMATION -
0005 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

key 20183

VITAL LINK. LNG MARINE ARM

by

WHEELER, G.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DESCRIBES THE DESIGN AND USE OF LNG MARINE LOADING/UNLOADING ARMS. INCLUDED ARE DISCUSSIONS OF THE SEAL AND BEARING ARRANGEMENTS, MATERIALS OPTIMIZATION AND SELECTION, PERMISSIBLE FLOW VELOCITIES AND GENERAL CONDITIONS OF USE. THE IMPORTANCE OF THE MARINE ARM LIES IN THE FACT THAT IT IS A CRUCIAL LINK BETWEEN THE LNG TANKER AND THE LNG TERMINAL.

-PERTINENT FIGURES-

FIG.1 LNG MARINE ARM BEARING AND SEAL ARRANGEMENT, PAGE 33//FIG.2 LNG MARINE ARM BEARING AND SEAL ARRANGEMENT, PAGE 33

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CRYOG. IND. GASES VOL 7, NO. 5, 31 & 33-4 (SEP/OCT 1972)
OTHER INFORMATION -
0003 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20184 through 20186

SIX-MILE CRYOGENIC SYSTEM SERVES OFFSHORE BRUNEI LOADING PLATFORM

by

DEASON, D.

03/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DESCRIBES THE LONGEST CRYOGENIC PIPELINE IN EXISTENCE - TWIN 18 INCH LINES EXTENDING 2 1/2 MILES OVER WATER FROM AN INLAND LNG PLANT AT BRUNEI, BORNEO TO AN OFFSHORE LNG TANKER LOADING FACILITY. COMBINED TOTAL LINE LENGTH IS 6 MILES.

-PERTINENT FIGURES-

FIG.1 DIAGRAM OF THE BRUNEI LNG SHIP LOADING SYSTEM, PAGE 55//FIG.2 DETAILS OF THE EXPANSION JOINT AND VIEW OF ONE OF THE UNITS INSTALLED IN THE SYSTEM, PAGE 56//FIG.3 INSULATION OF ALL LINE SECTIONS HANDLING LNG WAS APPLIED AS THREE LAYERS OF SPRAYED POLYURETHANE FOAM WITH A FIBER GLASS REINFORCED EPOXY COVERING WHICH SERVES AS MECHANICAL PROTECTION AND AS A WATER VAPOR BARRIER, PAGE 56//FIG.4 ON THE TRESTLE, THE PIPE LINES ARE ANCHORED AT 120-FOOT INTERVALS, PAGE 57//FIG.5 DETAIL OF THE GRE INNER SLEEVES AT THE CONE ENDS OF FIELD JOINTS, PAGE 57

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
PIPE LINE IND. VOL 38, NO. 3, 55-7 (MAR 1973)
OTHER INFORMATION -
0003 PAGES, 0005 FIGURES, 0000 TABLES, 0000 REFERENCES

PREVENT LNG ROLLOVER

by

DRAKE, E. M.
GEIST, J. M.
SMITH, K. A.

03/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

WHEN LNG IS ADDED TO A STORAGE TANK PARTIALLY FILLED WITH LNG OF A DIFFERENT COMPOSITION, LARGE, UNEXPECTED AND SUDDEN RELEASES OF VAPOR, COMMONLY REFERRED TO AS ROLLOVER, MAY TAKE PLACE. NO DAMAGE OCCURRED IN ANY OBSERVED INCIDENT OF ROLLOVER BUT THE MAGNITUDE AND RATE OF VAPOR RELEASE WERE GREAT ENOUGH TO CAUSE CONCEREN. CONSEQUENTLY, STUDIES HAVE BEEN UNDERTAKEN TO DEVELOP UNDERSTANDING OF BASIC MECHANISMS INVOLVED, TO PREDICT WHEN ROLLOVERS MAY OCCUR AND TO EVALUATE EFFECTIVENESS OF A NUMBER OF POSSIBLE PREVENTIVE MEASURES. SUCH MEASURES INCLUDE MIXING DURING FILLING WHICH MAY REQUIRE USE OF BOTH TOP AND BOTTOM FILL DEPENDING ON WHETHER THE CARGO IS MORE OR LESS DENSE THAN THE HEEL. OTHER SOLUTIONS INCLUDE LIMITING VARIATION IN LNG COMPOSITION AND LOWERING TANK SET POINT PRESSURE. DIFFERENT ACTIONS ARE APPROPRIATE FOR DIFFERENT INSTALLATIONS. SELECTION OF THE APPROPRIATE SOLUTION REQUIRES AN UNDERSTANDING OF THE SITUATIONS THAT LEAD TO ROLLOVER CAUSED BY DENSITY DIFFERENCES IN LNG - THE SUBJECT OF THIS PAPER.

-PERTINENT FIGURES-

FIG.1 LNG DENSITY AT ONE ATMOSPHERE AS A FUNCTION OF COMPOSITION (METHANE, ETHANE, PROPANE MIXTURES WITH 2 PERCENT OR LESS NITROGEN), PAGE 87//FIG.2 TYPICAL CONVECTIVE CIRCULATION IN LNG STORAGE TANK, PAGE 88//FIG.3 CONVECTIVE CIRCULATIONS FOR A DENSE LNG LAYER UNDER A LIGHT LNG LAYER, PAGE 88

-BIBLIOGRAPHY-

HASHEMI,H.T. AND WESSON,H.R., CUT LNG STORAGE COSTS, HYDROCARBON PROCESSING, 117-120 (AUG 1971)//VAN GELDER,L.R. AND LAFAVE,I.V., LNG TANK DYNAMICS, PRESENTED AT LNG 3 CONFERENCE, WASHINGTON, D. C. (SEP 1972)// SARSTEN,J.A., LNG OPERATING EXPERIENCES AT LA SPEZIA, ITALY, PRESENTED AT AGA DISTRIBUTION CONFERENCE, ATLANTA, GA. (MAY 8-10, 1972)// CHATTERJEE,N. AND GEIST,J.M., THE EFFECTS OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS, PRESENTED AT AGA

DISTRIBUTION CONFERENCE, ATLANTA, GA. (MAY 8-10, 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.//AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.//MASSACHUSETTS INST. OF TECH., CAMBRIDGE
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 52, NO. 3, 87-90 (MAR 1973)
OTHER INFORMATION -
0004 PAGES, 0003 FIGURES, 0000 TABLES, 0011 REFERENCES

keys 20224 through 20229

LNG IMPORT TERMINAL. DESIGN CONSIDERATIONS

by

DUCKHAM, H. E.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DESCRIBES THE MANY PROCESS AND MECHANICAL PARAMETERS INVOLVED IN THE DESIGN OF AN LNG IMPORT TERMINAL. INCLUDED ARE DISCUSSIONS ON FACILITIES LOCATION, TRANSFER LINES, INSULATION, STORAGE TANKS, VAPOR HANDLING SYSTEMS AND LNG VAPORIZERS.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CRYOG. IND. GASES VOL 7, NO. 5, 41 & 43 & 45-8 (SEP/OCT 1972)
OTHER INFORMATION -
0006 PAGES, 0006 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20190 through 20193

HAZARDS OF SPILLAGE OF LNG INTO WATER FINAL REPORT JANUARY 15, 1971 - JANUARY 14, 1972

by

BIORDI, J.
BURGESS, D.
MURPHY, J.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Incremental	Good/Excel.

-ABSTRACT-

THE PROGRAM REPORTED HERE WAS A FOLLOW-ON TO AN EARLIER (1969) STUDY FOR THE COAST GUARD IN WHICH THE SPILLAGE OF LNG INTO WATER PRODUCED UNEXPECTED VAPOR EXPLOSIONS. THE TWO MAIN OBJECTIVES OF THE PRESENT STUDY WERE TO ASSESS THE HAZARDS OF VAPOR EXPLOSIONS, AND TO REPEAT ON LARGER SCALE THE EARLIER OBSERVATIONS OF ATMOSPHERIC DISPERSION OF THE NATURAL GAS DOWNWIND OF A SPILL. APPROXIMATELY 12,000 GALLONS OF LNG WERE USED IN THE VARIOUS TESTS, THIS LNG CAME FROM TWO DOMESTIC SOURCES. ONE IN WHICH HEAVY HYDROCARBONS WERE PRESENT IN VERY LOW CONCENTRATION AND WHICH VAPORIZED QUIETLY, ONE IN WHICH THE RATIO ETHANE/HEAVIER HYDROCARBONS WAS ABOUT 10/1 AND WHICH PROVIDED NUMEROUS DELAYED VAPOR EXPLOSIONS. NO EXPLOSION WAS OBTAINED WHICH DUPLICATED THE 1969 EXPERIENCE. THE PROGRAM DID NOT REVEAL THE MECHANISM OF VAPOR EXPLOSIONS BUT DID SHOW THAT EXPLOSIONS UNDER VARIOUS EXPERIMENTAL CONDITIONS WOULD NOT IGNITE THE FLAMMABLE VAPOR CLOUD AND THAT THE ENERGY RELEASE IS VERY MODEST RELATIVE TO CHEMICAL EXPLOSIONS.

-PERTINENT FIGURES-

TAB.8 WEATHERING OF LNG (SOURCE 2) IN 300-GALLON STORAGE TRAILER (VOLUME PERCENT), PAGE 23//TAB.9 WEATHERING OF LNG (SOURCE 2) IN 6,000-GALLON STORAGE TRAILER, PAGE 25//TAB.14 CALCULATED DISTANCES TO END OF FLAMMABLE ZONE WITH STEADY RELEASE RATE OF LNG, PAGE 42//TAB.15 CALCULATED DISTANCES TO END OF FLAMMABLE ZONE (FOLLOWING RELEASE OF 25000 M(3) LNG), PAGE 44

-BIBLIOGRAPHY-

BURGESS,D., MURPHY,J.N., ZABETAKIS,M.G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, AD 705078 (FEB 1970)//ENGEL,T. AND HARTMAN,D.E., LNG SPILLAGE ON WATER II FINAL RPT ON RAPID PHASE TRANSFORMATIONS, TECHNICAL PROGRESS RPT NO. 1-72, SHELL PIPE LINE CORP, HOUSTON, TX (FEB 1972)// NAKANISHI,E. AND REID,R.C., LIQUID NATURAL GAS - WATER REACTIONS, CHEM. ENG. PROG. VOL 67, 36-41

(1971)//WITTE,L.C. AND COX,J.E., NONCHEMICAL EXPLOSIVE INTERACTION OF LNG AND WATER. PAPER PRESENTED AT ASME WINTER ANN. MTG., WASHINGTON, D.C., NOV 28-DEC 2, 1971//KATZ,D.L. AND SLIEPCEVICH,C.M., LNG/WATER EXPLOSIONS, HYDROCARBON PROCESS., 240-4 (NOV 1971)//BURGESS,D. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LNG. R.I. 6099 (1962)

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
REPORT NUMBER -
PMSRC 4177//AD-754498
SPONSOR -
COAST GUARD, WASHINGTON, D.C.
CONTRACT NUMBER -
CONTRACT MIPR NO. Z-70099-9-12395
OTHER INFORMATION -
0091 PAGES, 0030 FIGURES, 0015 TABLES, 0039 REFERENCES

keys 20194 through 20199

THE LNG PLANT DESIGN ENGINEER

by

FARLEY, M.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE, THROUGH INTERVIEWS WITH SIX INDIVIDUALS INVOLVED IN LNG PLANT DESIGNING ACTIVITIES, PROVIDES A BRIEF OVERVIEW OF SOME OF THE PROBLEMS THEY HAVE HAD TO COPE WITH ON VARIOUS PROJECTS. THE DISCUSSIONS ARE VERY INFORMAL AND AT TIMES QUITE CANDID.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
LNG/CRYOGENICS VOL 1, NO. 1, 25-7 (FEB/MAR 1973)
OTHER INFORMATION -
0003 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 20203 through 20205

NATURAL GAS IS A BEAUTIFUL THING

by

WILSON, R.

09/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DISCUSSES SOME OF THE POTENTIAL HAZARDS IN THE USE OF NATURAL GAS, PARTICULARLY THE IMPORTATION OF LIQUEFIED NATURAL GAS (LNG), AND CALLS FOR ADDITIONAL RESEARCH AND SAFETY ANALYSES IN THE AREAS OF EXISTING UNCERTAINTY. THE AUTHOR IS CLEARLY CRITICAL OF VARIOUS FEDERAL AND STATE REGULATOR AGENCIES - CITING NEGLECT AND INADEQUATE STANDARDS AMONG OTHER THINGS. POOR UNDERSTANDING OF THE ISSUES INVOLVED BY LOCAL AUTHORITIES IS ALSO MENTIONED AS A PROBLEM. CERTAIN ASPECTS AND IMPLICATIONS OF THIS PAPER ARE CONTROVERSIAL AND PERHAPS OVERLY SENSATIONAL - HOWEVER, IT DOES MAKE INTERESTING READING.

-BIBLIOGRAPHY-

NATIONAL FIRE PROTECTION ASSOCIATION, GAS EXPLOSION AND FIRE, REPORT UNF-7 (BOSTON. NFPA, 1944)//BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., HAZARDS ASSOCIATED WITH SPILLAGE OF LNG ON WATER, REPORT 7448 (WASHINGTON, D.C., U.S. BUREAU OF MINES, 1970)//NAKANISHI,E. AND REID,R.C., LNG-WATER REACTIONS, CHEM. ENG. PROGRESS, 67, 36 (1971)//KATZ,D.J. AND SLIEPCEVICH,C.M., HYDROCARBON PROCESSING, 50, 240 (1971), AND ENGER,T. AND HARTMEN,E.E., MECHANICS OF THE LNG WATER REACTION, AMERICAN GAS ASSOCIATION CONFERENCE, ATLANTA, GA., 1972//CATTERJEE,N. AND GEIST,J.M., THE EFFECT OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS (PAPER PRESENTED TO AMERICAN GAS ASSOCIATION CONFERENCE, ATLANTA, GA., 1972)//NATIONAL ACADEMY OF SCIENCES, PROCEEDINGS OF CONFERENCE ON LNG IMPORTATION AND TERMINAL SAFETY, BOSTON, JUNE 1972 (WASHINGTON, D.C., THE ACADEMY, 1972), AND NATIONAL BUREAU OF STANDARDS, LIQUEFIED NATURAL GAS, (BOULDER, COLO., THE BUREAU, CRYOGENIC DATA CENTER). THE LATTER IS A LITERATURE SURVEY WHICH IS ISSUED QUARTERLY.

-SOURCE INFORMATION-

CORPORATE SOURCE -
    HARVARD UNIV., BOSTON, MASS.
JOURNAL PROCEEDINGS -
    SCI. PUBLIC AFFAIRS VOL 29, NO. 7, 35-40 (SEP 1973)

keys 20206 through 20210

QUERY INTO STATEN ISLAND LNG TANK FIRE CONTINUES

by

FOWLER, D. P.

09/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DESCRIBES BRIEFLY THE DESIGN OF THE TEXAS EASTERN STATEN ISLAND LNG FACILITY AND THE INVESTIGATIONS INTO THE CAUSE OF FIRE THAT BROKE OUT FEBRUARY 10, 1973 IN THE 600,000 BARREL STORAGE TANK KILLING 40 MEN. PRELIMINARY FINDINGS OF A FEDERAL POWER COMMISSION STAFF REPORT ARE DISCUSSED, CONCLUDING THAT THE EXACT MECHANISM OF FAILURE IS NOT APPARENT.

-PERTINENT FIGURES-

FIG.1 STATEN ISLAND PLANT SOON AFTER CONSTRUCTION OF THE 2-BNCF LNG STORAGE TANK, PAGE 53//FIG.2 CROSS-SECTION VIEW OF THE LNG STORAGE TANK, PAGE 54

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
GAS VOL 49, NO. 9, 52-5 (SEP 1973)
OTHER INFORMATION -
0004 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

key 20211

METHOD FOR ODORIZING CRYOGENIC LIQUIDS

by

KLASS, D. L.
LANDAHL, C. D.

09/25/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

A METHOD IS DISCLOSED FOR ODORIZING CRYOGENIC LIQUIDS SUCH AS LIQUEFIED NATURAL GAS WITH SUFFICIENT QUANTITIES OF DETECTABLE SULFUR CONTAINING ODORANTS BY FIRST DISSOLVING THE ODORANT IN A LIQUEFIED CARRIER MISCIBLE WITH THE CRYOGENIC LIQUID AT CONCENTRATION LEVELS NOT ATTAINABLE IN THE CRYOGENIC LIQUID WITHOUT THE CARRIER. THE LIQUEFIED CARRIER WITH ODORANT IS THEN COMBINED WITH THE CRYOGENIC LIQUID TO PROVIDE THE DISSOLVED ODORANT IN THE MIXTURE AT THE DESIRED DETECTABLE LEVELS UPON VAPORIZATION OF THE CRYOGENIC LIQUID.

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
REPORT NUMBER -
U.S. PATENT NO. 3,761,232
OTHER INFORMATION -
0003 PAGES, 0000 FIGURES, 0000 TABLES, 0004 REFERENCES

keys 20212 through 20216

GLENMAVIS CRYOGENIC PLANT COMMISSIONED

by

EGAN, P. C.
TOOLEY, M. R.

08/25/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DESCRIBES THE COMMISSIONING OF THE BRITISH GAS CORPORATIONS LNG PEAK-SHAVING PLANT IN GLENMAVIS, SCOTLAND. PROBLEMS EXPERIENCED DURING THE PERIOD OF THIS ACTIVITY ARE DETAILED.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BRITISH GAS CORP., ENGLAND
JOURNAL PROCEEDINGS -
GAS WORLD VOL 178, NO. 4644, 133-7 (AUG 1973)
OTHER INFORMATION -
0005 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

key 20218

CRYOGENIC LIQUID SAMPLING AND SAFETY

by

BERNSTEIN, J. T.

10/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

DIFFERENT TECHNIQUES OF SAMPLING CRYOGENIC LIQUIDS ARE DISCUSSED, WITH EMPHASIS ON AVOIDING SAMPLE CONTAMINATION AND ENSURING SAFE HANDLING. METHODS OF AVOIDING COMPOSITION CHANGES ARE ALSO PRESENTED.

-PERTINENT FIGURES-

FIG.1 LIQUID SAMPLE LINE, PAGE 600//FIG.2 INSTANTANEOUS VAPORIZER, VAPORIZING COIL, PAGE 601//FIG.3 CRYOGENIC LIQUID BATCH SAMPLER, PAGE 601// FIG.4 DEWAR WITH COVER, PAGE 601

-BIBLIOGRAPHY-

PRECAUTIONS AND SAFE PRACTICES - LIQUEFIED ATMOSPHERIC GASES, UNION CARBIDE CORPORATION, CRYOGENIC PRODUCTS. FORM 9888 (ALSO FORM 9914, LIQUID HYDROGEN)//CRYOGENIC SAFETY, AIR PRODUCTS INC. (1960)//PRECAUTIONS FOR THE SAFE HANDLING AND STORAGE OF LIQUID OXYGEN AND NITROGEN, AIRCO INC. PUBLICATION AEO 885A//MCCAMY,C.S., IND. ENG. CHEM. VOL 49, NO. 9 (SEP 1957)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CRYOGENIC CONSULTING SERVICE, WESTPORT, CONN.
JOURNAL PROCEEDINGS -
CRYOGENICS VOL 13, NO. 10, 600-2 (OCT 1973)
OTHER INFORMATION -
0003 PAGES, 0004 FIGURES, 0000 TABLES, 0004 REFERENCES

keys 20220 through 20223

LNG MARINE CARRIER CONSTRUCTION

by

HOWARD, J. L.

07/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE AUTHOR DESCRIBES THE SEVERAL CONCEPTS AROUND WHICH THE EXISTING MARINE LNG CONTAINMENT DESIGNS ARE FORMULATED. THE KVAERNER-MOSS SPHERICAL CONTAINMENT SYSTEM WITHOUT SECONDARY BARRIER IS DISCUSSED IN SOME DETAIL. THE DESIGN ANALYSIS OF THAT SYSTEM IS PRESENTED IN A STEP-BY-STEP FASHION AS ACTUALLY PERFORMED, ALONG WITH DESCRIPTIONS OF TANK MATERIALS RESEARCH AND STRUCTURAL EXPERIMENTS WHICH SUPPLEMENT THE ANALYTICAL WORK. THE FABRICATION SEQUENCE OF THE SPHERES IS DISCUSSED, AND THE WELDING PROCEDURES USED FOR BOTH ALUMINUM AND 9 PERCENT NICKEL STEEL ARE INCLUDED.

-PERTINENT FIGURES-

FIG.1 KVAERNER-MOSS SELF-SUPPORTING LNG TANK, PAGE 282//FIG.2 SMALL-LEAK PROTECTION SYSTEM ARRANGEMENT, PAGE 283//FIG.8 TANK ASSEMBLY, PAGE 289// TAB.1 KVAERNER-MOSS LNG SHIP PARTICULARS, PAGE 283

-BIBLIOGRAPHY-

TENGE, PER, AND SOLLI, ODD, 9 PERCENT NICKEL STEEL IN LARGE SPHERICAL TANKS FOR MOSS-ROSENBERG 87,600 M3 LNG-CARRIER. A FRACTURE MECHANICAL APPROACH TO TESTING AND DESIGN, DEPARTMENT OF MATERIALS ENGINEERING, RESEARCH, AND INSPECTION, DET NORSKE VERITAS, OSLO, NORWAY//KVAMSDAL, RAMSTAD, BOGNAES, AND FRANK, THE DESIGN OF AN 88,000 M3 LNG CARRIER WITH SPHERICAL CARGO TANKS AND NO SECONDARY BARRIER, PAPER PRESENTED AT SECOND INTERNATIONAL CONFERENCE AND EXHIBITION ON LNG, OCT 1970

-SOURCE INFORMATION-

CORPORATE SOURCE -
KVAERNER-MOSS, INC., NEW YORK
JOURNAL PROCEEDINGS -
MAR. TECHNOL. VOL 9, NO. 3, 281-91 (JUL 1972) (PRES. AT THE AMERICAN WELDING SOCIETY AND THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS PHILADELPHIA SECTIONS JOINT MEETING,

COMPUTATION OF THE MAXIMUM QUANTITY OF GAS WITHIN THE EXPLOSIVE REGION DURING THE DIFFUSION OF A METHANE GAS CLOUD IN THE ATMOSPHERE

by

VAN BUIJTENEN, C. J. P.

10/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

AS PART OF AN INVESTIGATION INTO THE EXPLOSION HAZARD OF A METHANE GAS CLOUD THE MAXIMUM QUANTITY OF GAS WAS COMPUTED THAT IS PRESENT IN THE EXPLOSIVE REGION (5-15 PERCENT, V/V) DURING DIFFUSION IN THE ATMOSPHERE. FOR THESE COMPUTATIONS USE WAS MADE OF MODELS WITH GAUSSIAN CONCENTRATION DISTRIBUTION AND THE DIFFUSION CONSTANTS ACCORDING TO PASQUILL. FOR AN INSTANTANEOUS CLOUD THE MAXIMUM QUANTITY OF METHANE IN THE EXPLOSIVE REGION WAS FOUND TO BE APPPOXIMATELY 50 PERCENT. THIS MAXIMUM IS INDEPENDENT OF THE SOURCE STRENGTH AND THE WEATHER CONDITIONS. FOR A CONTINUOUS SOURCE THE QUANTITY OF METHANE IN THE EXPLOSIVE REGION WAS FOUND TO BE PROPORTIONAL TO THE SOURCE STRENGTH RAISED TO A CERTAIN POWER.

-BIBLIOGRAPHY-

1. BOYLE, G. J., KNEEBONE, A., LABORATORY INVESTIGATIONS INTO THE CHARACTERISTICS OF LNG SPILLS IN WATER. EVAPORATION, SPREADING AND VAPOUR DISPERSION. SHELL RESEARCH LTD, THORNTON RESEARCH CENTER, REPORT TO A.P. I., MARCH 1973// 2. BRYANT, P. M., METHODS OF ESTIMATION OF THE DISPERSION OF WINDBORNE MATERIAL AND DATA TO ASSIST IN THEIR APPLICATION. AHSB (RP) R42, AUTHORITY HEALTH & SAFETY BRANCH U.K.A.E.A., LONDON, 1964// 3. ESSO RESEARCH AND ENGINEERING COMP. SPILLS OF LNG ON WATER - VAPORIZATION AND DOWNWIND DRIFT OF COMBUSTIBLE MIXTURES. REPORT NO. EE61E-72, SPONSORED BY A.P. I., MAY 1972//4. PASQUILL, F., ATMOSPHERIC DIFFUSION. D. VAN NOSTRAND, LONDON, 1962//5. SUTTON, O. G., MICROMETEOROLOGY. MCGRAW HILL PUBLISHING COMPANY LTD, LONDON, 1953//6. ULDEN, A. P. VAN, ON THE SPREADING OF A HEAVY GAS RELEASED NEAR THE GROUND. FIRST INTERN. LOSS PREVENTION SYMPOSIUM, 28-30 MAY 1974, DELFT, THE NETHERLANDS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
TOEGEPAST NATUURWETENSHAPPELIJK ONDERZOEK, RIJSWIJK

(NETHERLANDS)
REPORT NUMBER -
REP. 1974-20
SPONSOR -
TOEGEPAST NATUURWETENSHAPPELIJK ORDERZOEK, RIJSWIJK (NETHERLANDS)
OTHER INFORMATION -
0035 PAGES, 0011 FIGURES, 0000 TABLES, 0009 REFERENCES

keys 20233 through 20238

PROCESS TECHNIQUES AND HARDWARE USES OUTLINED FOR LNG REGASIFICATION

by

DURR, C. A.

05/13/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

SEVERAL DIFFERENT PROCESSES AND TYPES AND ARRANGEMENTS OF EQUIPMENT CAN BE ADAPTED FOR LNG RECEIVING TERMINALS. NORMALLY IT IS NECESSARY TO MAKE SEVERAL OPTIMIZATION STUDIES ON BOTH PROCESS AND EQUIPMENT TO ARRIVE AT THE BEST SOLUTION FOR INDIVIDUAL TERMINALS. IN EACH CASE, A STUDY OF THE ADVANTAGES AND DISADVANTAGES OF A PARTICULAR SYSTEM, IN THE CONTEXT OF THE JOB TO BE DONE, WILL BE NECESSARY TO SELECT THE OPTIMUM DESIGN. THERE ARE MANY POSSIBLE VARIATIONS IN EXACTLY HOW THE TERMINAL IS PUT TOGETHER, AND EACH INDIVIDUAL SYSTEM IS EXAMINED SEPARATELY IN THIS PAPER. THE SYSTEMS ARE. UNLOADING, STORAGE, VAPOR HANDLING, SENDOUT PUMPS, VAPORIZERS, POWER GENERATION, NITROGEN SYSTEM, HEAT RECOVERY.

-PERTINENT FIGURES-

TAB.1 DESIGN PARAMETERS, PAGE 56//FIG.1 LNG-RECEIVING TERMINAL, PAGE 60// FIG.2 LNG-UNLOADING SYSTEM, PAGE 62//FIG.3 LNG RECIRCULATION, PAGE 63// FIG.4 VAPOR-HANDLING SYSTEM, PAGE 64//FIG.5 VAPOR FLOW RATES VERSUS LNG UNLOADING RATE, PAGE 65

-SOURCE INFORMATION-

CORPORATE SOURCE -
KELLOGG (M.W.) CO., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
OIL GAS J. VOL 72, NO. 19, 56 & 60-6 (MAY 1974) (PRES. AT LNG EQUIPMENT MARKET SYMP., HOUSTON, TEX., FEB 26-8 (1974)
OTHER INFORMATION -
0008 PAGES, 0005 FIGURES, 0001 TABLES, 0000 REFERENCES

keys 20244 through 20245

NOW--A PRACTICAL METHOD FOR ODORIZING LNG

by

MULLINER, D. K.

06/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DESCRIBES THE EXPERIENCE GAINED THROUGH LABORATORY AND FIELD DEVELOPMENT AND EVALUATION TESTS OF EQUIPMENT DESIGNED TO ODORIZE LIQUEFIED NATURAL GAS - NOW A PRACTICAL REALITY. A SOLUTION OF TETRAHYDROTHIOPHENE (ODORANT) IS PROPANE, WITH A FREEZING POINT OF -300 DEGREES F AT AMBIENT PRESSURE, WAS FOUND TO BE THE MOST SUITABLE BECAUSE (IN ADDITION TO ITS LOW FREEZING POINT). 1) ITS ODOR IS SIMILAR TO PIPELINE GAS, 2) THE ODORANT DOES NOT LINGER LONG AFTER THE GAS IS GONE, 3) IT IS CHEMICALLY STABLE, 4) IT LEAVES NO RESIDUE. AUTOMATIC CONTROL EQUIPMENT WAS DEVELOPED TO INJECT THE ODORANT INTO FLOWING LNG FOR PROPER MIXING.

-SOURCE INFORMATION-

CORPORATE SOURCE -
SAN DIEGO GAS AND ELECTRIC CO., CALIF.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 201, NO. 7, 78 & 81 & 84 (JUN 1974)
OTHER INFORMATION -
0003 PAGES, 0000 FIGURES, 0001 TABLES, 0000 REFERENCES

keys 20249 through 20253

INNOVATIONS WILL MARK LNG-RECEIVING TERMINAL

by

BERGMAN, R. A.
CRAWFORD, D. B.

08/05/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE PROVIDES THE DESIGN CRITERIA AND NARRATIVE DESCRIPTION OF THE COLUMBIA-CONSOLIDATED COVE POINT, MARYLAND LNG RECEIVING TERMINAL WHICH IS NOW UNDER CONSTRUCTION. AN UNUSUAL FEATURE INCORPORATED AT THIS PARTICULAR INSTALLATION IS THE USE OF AN UNDERWATER TUNNEL IN PLACE OF AN ABOVE-WATER PIER TO CARRY THE SHIPS UNLOADING LINES FROM BERTHS APPROXIMATELY ONE MILE OFFSHORE TO THE STORAGE TANKS AND SENDOUT FACILITIES. FEATURES OF THE TUNNEL ARE PROVIDED.

-PERTINENT FIGURES-

FIG.2 PROCESS FLOW DIAGRAM FOR THE COLUMBIA-CONSOLIDATED COVE POINT, MD. LNG RECEIVING TERMINAL, PAGE 59//FIG.3 VALVE-CLOSURE DYNAMIC RESPONSE FOR A 32 INCH LNG LINE AT A FLOW RATE OF 52,500 GPM, PAGE 61

-SOURCE INFORMATION-

CORPORATE SOURCE -
KELLOGG (M.W.) CO., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
OIL GAS J. VOL 72, NO. 31, 57-61 (AUG 1974)
OTHER INFORMATION -
0005 PAGES, 0003 FIGURES, 0001 TABLES, 0000 REFERENCES

keys 20296 through 20305

THE INFLUENCE OF ACCIDENTS IN THE CONTINUING DEVELOPMENT OF CRYOGENIC PROCEDURES

by

REIDER, R.

00/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS IS A REVIEW OF MAJOR AND TYPICAL MINOR MISADVENTURES INVOLVING CRYOGENIC FLUIDS. THE NATURE AND CONSEQUENCES OF INCIDENTS ARE DESCRIBED AND EXTRAPOLATED TO POTENTIAL INCIDENTS INVOLVING LARGER QUANTITIES OR ALTERNATE CIRCUMSTANCES. METHANE, OXYGEN AND HYDROGEN HAVE BEEN INVOLVED IN MAJOR EPISODES. LIQUEFIED AIR, INERT ATMOSPHERIC GASES AND HELIUM HAVE ALSO BEEN INVOLVED IN MISHAPS IN COMMERCIAL AND LABORATORY PRACTICE. THE DEVELOPMENT OF RATIONAL OPERATIONAL PROCEDURES CAN BE PROPERLY INFLUENCED BY A KNOWLEDGE OF ACCIDENTS. THIS REQUIRES ACCURATE INFORMATION ON ACCIDENTS TO BE MADE PUBLIC AS PROMPTLY AS THE FACTS PERMIT.

-BIBLIOGRAPHY-

BARNES,G.E., BRAIDECH,M.M. AND DONALDSON,K.H., REPORT OF THE TECHNICAL CONSULTANTS BOARD OF INQUIRY FOR THE EAST OHIO GAS COMPANY FIRE, CLEVELAND, OHIO (JULY, 1945) - FROM THE PRIVATE COLLECTION OF MATHEW M. BRAIDECH// REPORT ON THE EAST OHIO GAS COMPANY EXPLOSION AND CONFLAGRATION, CLEVELAND, OHIO, BY THE NATIONAL BOARD OF FIRE UNDERWRITERS, NEW YORK, AND THE OHIO INSPECTION BUREAU, COLUMBUS, OHIO (OCT 20, 1945)//LANG,A., CAUSES OF THE EXPLOSION OF AN AIR FRACTIONATION PLANT AND THE LESSONS LEARNED FROM THE ACCIDENT, GESELLSCHAFT FUER LINDES EISMASCHINEN AG, WIESBADEN (1961)// BOLLEN, SAFETY IN AIR AND AMMONIA PLANT, V2, P6-S, AMERICAN INSTITUTE OF CHEMICAL ENGINEERS (1960)//REPORT ON THE INVESTIGATION OF EXPLOSION AND FIRE-EXPERIMENTAL HALL-CAMBRIDGE ELECTRON ACCELERATOR, CAMBRIDGE, MASSACHUSETTS (JULY 5, 1965), UNITED STATE ATOMIC ENERGY COMMISSION, TID-22594 (FEB 1966)//STANDARD FOR STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS AT UTILITY GAS PLANTS, NATIONAL FIRE PROTECTION ASSOCIATION, NFPA NO. 59-A, BOSTON, MASS (1967)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LOS ALAMOS SCIENTIFIC LAB., N.MEX.

keys 20346 through 20348

INSULATION SYSTEMS FOR LIQUID METHANE FUEL TANKS FOR SUPERSONIC CRUISE AIRCRAFT FINAL REPORT, JUNE 1972

by

BRADY, H. F.
DEL DUCA, D.

06/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Incremental	Acceptable

-ABSTRACT-

TWO INSULATION SYSTEMS FOR TANKS CONTAINING LIQUID METHANE IN SUPERSONIC CRUISE-TYPE AIRCRAFT WERE DESIGNED AND TESTED AFTER AN EXTENSIVE MATERIALS INVESTIGATION. ONE SYSTEM IS AN EXTERNAL INSULATION AND THE OTHER IS AN INTERNAL WET-TYPE INSULATION SYSTEM. TANK VOLUME WAS MAXIMIZED BY MAKING THE TANK SHAPE APPROACH A RECTANGULAR PARALLELOPIPED. ONE TANK WAS DESIGNED TO USE THE EXTERNAL INSULATION AND THE OTHER TANK TO USE THE INTERNAL INSULATION. PERFORMANCE OF THE EXTERNAL INSULATION SYSTEM WAS EVALUATED ON A FULL-SCALE TANK UNDER THE TEMPERATURE ENVIRONMENT OF -320 DEGREES F TO 700 DEGREES F (-196 DEGREES C TO 371 DEGREES C) AND AMBIENT PRESSURES OF GROUND-LEVEL ATMOSPHERIC TO 1 PSIA (6.895 N/M(2)). PROBLEMS WITH INSTALLING THE INTERNAL INSULATION ON THE TEST TANK PREVENTED FULL-SCALE EVALUATION OF PERFORMANCE, HOWEVER, SMALL-SCALE TESTING VERIFIED THERMAL CONDUCTIVITY, TEMPERATURE CAPABILITY, AND INSTALLED DENSITY.

-PERTINENT FIGURES-

TAB.1 INTERNAL INSULATION CALORIMETER TESTS, PAGE 23//TAB.3 WATER ABSORPTION IN CERAFELT INSULATION, PAGE 40//TAB.9 SUMMARY OF TWO BASELINE TESTS, PAGE 88//TAB.10 PRESSURE CYCLES 1 THROUGH 10, PAGE 139//TAB.11 PRESSURE CYCLES 11 THROUGH 20, PAGE 139//TAB.12 CYCLE 6 PRESSURE AND TEMPERATURE DATA, PAGE 141

-SOURCE INFORMATION-

CORPORATE SOURCE -
MARTIN MARIETTA CORP., DENVER, COLO.
REPORT NUMBER -
N72-26545//NASA-CR-120930//MCR-72-42
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO
CONTRACT NUMBER -
CONTRACT NAS3-12425

keys 20415 through 20421

CONSIDERATIONS FOR THE SAFETY OF LNG STORAGE TERMINALS

by

STONE, L. K.

11/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

LOCATION OF AN LNG STORAGE TERMINAL AT THREE TYPES OF SITES IS DISCUSSED. GENERAL SITE REQUIREMENTS FOR AN LNG STORAGE TERMINAL ARE CONSIDERED. AN ASSESSMENT OF TYPICAL LNG SPILLS IS PRESENTED. HAZARDS ASSOCIATED WITH ACCIDENTAL LNG SPILLS ARE DISCUSSED. AN ESTIMATE OF THE LOWER FLAMMABLE LIMIT OF THE VAPOR CLOUD IS DESCRIBED FOR THE CASES WHICH WERE STUDIED. ENGINEERING FEATURES TO ENHANCE SAFETY ARE PRESENTED. ACCIDENTS ARE CLASSIFIED BY THE VOLUME OF LNG SPILLED TO THE ENVIRONMENT. A TYPICAL CASE FOR EACH CLASS OF SPILL IS ALSO DESCRIBED. ENGINEERING FEATURES WHICH COULD MITIGATE THE ADVERSE IMPACTS OF A FLAMMABLE CLOUD, AND OTHER SPECIAL CONSIDERATIONS FOR THE PROTECTION OF PUBLIC SAFETY ARE DISCUSSED. RISK ASSESSMENT IS DISCUSSED. A SEVERITY INDEX AND A RISK INDEX ARE DESCRIBED. WHILE THE CONSEQUENCES OF AN ACTUAL SPILL MAY BE SEVERE, SUCH SPILLS ARE CONSIDERED NOT LIKELY TO OCCUR.

-PERTINENT FIGURES-

TAB.1 RESULTS OF HEAD-LOSS TYPE SPILL, PAGE 3//TAB.2 TWO MAJOR U.S. CODES APPLICABLE TO LNG FACILITIES, PAGE 5//TAB.3 AFFECTED DISTANCE AND DEGREES OF RISK ASSOCIATED WITH LNG SPILLS DURING UNLOADING WIND 5-10 MPH, STABLE CONDITIONS, PAGE 6

-BIBLIOGRAPHY-

HAZARDS OF SPILLAGE OF LNG INTO WATER, PMSRC REPORT 4177, U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF MINES, SEP 1972//FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT STATEN ISLAND, U. S. FEDERAL POWER COMMISSION, NEW YORK, JULY 1974//SMITH,K.A., ET AL., MIXING AND ROLLOVER IN LNG STORAGE TANKS, CRYOGENIC ENGINEERING CONFERENCE, ATLANTA, GEORGIA, AUG 1973//CLAPP,M.D., AND LITZINGER,L.F., MARINE TERMINALS FOR LPC, ETHYLENE AND LNG, 68TH NATIONAL MEETING, AICHE//WESSON,H.R., WALKER,J.R. AND BROWN,L.E., CONTROL OF LNG SPILL FIRES ON LAND, CRYOGENIC ENGINEERING CONFERENCE, ATLANTA, GA., AUG 1973//A METHODOLOGICAL PROCEDURES FOR RISK ANALYSIS OF LIQUEFIED NATURAL GAS, PREPARED FOR THE COUNCIL ON ENVIRONMENTAL

QUALITY, ECOSYSTEMS, INCORPORATED, APRIL 1974

-SOURCE INFORMATION-

CORPORATE SOURCE -
INTERIOR DEPT., WASHINGTON, D.C.
JOURNAL PROCEEDINGS -
ASME WINTER ANNUAL MEETING, (PRES. AT) NEW YORK, NOV 17-22, 1974. PAPER NO. 74-WA/PID-13
OTHER INFORMATION -
0007 PAGES, 0000 FIGURES, 0003 TABLES, 0014 REFERENCES

keys 20422 through 20423

SAFETY AT AN LNG PEAKSHAVING FACILITY

by

SCHULZ, F. P.

11/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

DESIGN AND OPERATION OF THE MANY SAFETY RELATED ASPECTS OF LONG ISLAND LIGHTING COMPANYS HOLBROOK LNG (LIQUEFIED NATURAL GAS) PLANT IS DESCRIBED. SUCH FEATURES RANGE FROM THE COMMON EQUIPMENT, SUCH AS GAS LEAK DETECTION, FIRE DETECTION AND EMERGENCY SHUTDOWN SYSTEMS, TO THE MORE SOPHISTICATED AUTOMATIC DRY POWDER AND LNG VAPOR DISPERSION SYSTEMS. CONFORMANCE TO THE VARIOUS APPLICABLE CODES AND STANDARDS IS EXPLAINED AND THE DEVELOPMENT OF PLANT SYSTEMS ASSOCIATED WITH PERSONNEL AND EQUIPMENT SAFETY THAT EXCEED THE REQUIREMENTS OF THESE CODES IS ALSO DETAILED.

-BIBLIOGRAPHY-

NATIONAL FIRE PROTECTION ASSOCIATION INTERNATIONAL, STANDARD FOR STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS AT UTILITY GAS PLANTS, NFPA NO. 59A (1967)//NEW YORK STATE PUBLIC SERVICE COMMISSION, 16 NYCRR PART 259 LIQUEFIED NATURAL GAS, SECTIONS 259.9 (A) AND 259.4 (A) (I), (1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LONG ISLAND LIGHTING CO., HICKSVILLE, N.Y.
JOURNAL PROCEEDINGS -
ASME WINTER ANNUAL MEETING, (PRES. AT) NEW YORK, NOV 17-22, 1974. PAPER NO. 74-WA/PID-10
OTHER INFORMATION -
0005 PAGES, 0001 FIGURES, 0000 TABLES, 0002 REFERENCES

keys 20429 through 20430

AMERICAN GAS ASSOCIATION GAS MEASUREMENT MANUAL LNG INSTRUMENTATION, DRAFT COPY

-ABSTRACT-

THIS PAPER DESCRIBES THE REQUIREMENT FOR HIGHLY ACCURATE LIQUID LEVEL MEASUREMENTS IN THE CARGO TANKS OF LARGE MARINE LNG CARRIERS. THE ACCURACY IS REQUIRED FOR BOTH CARGO HANDLING AND CUSTODY TRANSFER. REQUIREMENTS FOR THE INSTRUMENTATION INCLUDE MEASUREMENT FROM THE TANK BOTTOM, DIVISION OF THE SENSING REGION INTO PARTS (TO INCREASE ACCURACY), NO MOVING PARTS AND NO GAS FLOWS. THE MEASURING SYSTEM SATISFYING THESE REQUIREMENTS CONSISTS OF A LONG TUBULAR SENSOR, CONSISTING OF A SERIES OF CAPACITANCE SENSORS ALL OF THE SAME LENGTH. LEVEL IS MEASURED BY DETERMINING THE NUMBER OF SUBMERGED SEGMENTS PLUS THE IMMERSED PART OF THE SENSOR AT THE LIQUID SURFACE. THE FRACTIONAL IMMERSION OF THE SENSOR AT THE LIQUID SURFACE IS MEASURED BY THE RATIO OF ITS CAPACITANCE TO THAT OF THE FULLY IMMERSED SEGMENT BELOW IT. HIGH AND LOW LEVEL ALARMS CAN BE ATTACHED TO THE SENSING SYSTEM. AN EMERGENCY SYSTEM, EITHER A BUBBLER TUBE OR A MANUALLY-OPERATED FLOAT GAGE, CAN BE PROVIDED IN CASE THE MAIN SYSTEM BREAKS DOWN.

-BIBLIOGRAPHY-

DIGITAL CAPACITANCE SYSTEM FOR MASS, VOLUME, AND LEVEL MEASUREMENTS OF LIQUID PROPELLANTS, AIAA JOURNAL VOL 1, NO. 11, PAGES 2590-2596 (NOV 1963)

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
OTHER INFORMATION -
0009 PAGES, 0000 FIGURES, 0000 TABLES, 0001 REFERENCES

keys 20431 through 20436

LIQUEFIED NATURAL GAS

by

LOM, W. L.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Good/Excel.

-ABSTRACT-

THIS BOOK SUMMARIZES RECENT DEVELOPMENTS IN THE GENERAL AREA OF NATURAL GAS LIQUEFACTION AND USE. TREATMENT IS TECHNICAL RATHER THAN THEORETICAL AND THERMODYNAMICS, ECONOMIC EVALUATIONS AND STATISTICAL DATA ARE RELEGATED TO THE APPENDICES. THE MAIN PART OF THE REVIEW CONSISTS OF AN INTRODUCTION DEALING WITH THE HISTORICAL DEVELOPMENT OF CRYOGENICS AND GAS LIQUEFACTION AND THEIR APPLICATION IN THE GAS INDUSTRY. IT CONTINUES WITH AN ANALYSIS OF NATURAL GAS SUPPLY AND DEMAND AND DISCUSSES THE EFFECT LNG WILL EXERT ON THE BALANCE. NEXT FOLLOWS A STUDY OF NATURAL GAS LIQUEFACTION METHODS AND EQUIPMENT. IN SUBSEQUENT SECTIONS METHODS AND MATERIALS OF CONSTRUCTION FOR LNG CARRIERS, FOR STORAGE TANKS AND FOR RE-GASIFICATION EQUIPMENT, RESPECTIVELY, ARE REVIEWED WITH SPECIAL ATTENTION PAID TO LOW TEMPERATURE INSULATION AND TO THE EFFECTS OF CRYOGENIC CONDITIONS ON THE STRUCTURAL STRENGTH OF MATERIALS OF CONSTRUCTION. ANOTHER SECTION DEALS WITH ACTUAL AND POTENTIAL USES OF LNG AS A FUEL AND/OR REFRIGERANT, FOLLOWED BY A DISCUSSION ON THE SAFETY OF LNG INSTALLATIONS AND POTENTIAL HAZARDS WHICH COULD ARISE DUE TO ITS LOW TEMPERATURE AND FLAMMABILITY. A CONCLUDING SECTION ASSESSES DEVELOPMENTS OF A TECHNOLOGICAL NATURE WHICH ARE EXPECTED TO MAKE THEIR IMPACT IN THE NOT TOO DISTANT FUTURE.

-SOURCE INFORMATION-

CORPORATE SOURCE -
    ESSO DEVELOPMENT CO., LTD., ABINGDON, ENGLAND
PUBLISHER -
    JOHN WILEY AND SONS, INC., NEW YORK
OTHER INFORMATION -
    0185 PAGES, 0021 FIGURES, 0034 TABLES, 0224 REFERENCES

key 20471

FUEL ENERGY SYSTEMS. CONVERSION AND TRANSPORT EFFICIENCIES

by

UHL, A. E.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE DOMINANT SOURCES OF ENERGY TODAY ARE FUELS-GASEOUS, LIQUID, AND SOLID - WHICH, PRIOR TO BEING CONVERTED TO HEAT OR ELECTRIC ENERGY, WITH THEIR INHERENT CONVERSION INEFFICIENCIES, ARE THEMSELVES SUBJECT TO ATTRITION IN ENERGY CONTENT DUE TO TRANSPORTATION AND ALSO OFTEN DUE TO CONVERSION OF FORM AMONG THEMSELVES. THE TRANSPORT TECHNOLOGY IS ESSENTIAL TO THE CONVERSION OF AN ENERGY RESOURCE INTO FUEL SUPPLY. IN MANY CASES, CONVERSION OF THE ORIGINAL FUEL FORM INTO ANOTHER FORM IS EITHER NECESSARY OR INHERENT IN THE EXISTING FUEL ENERGY SUPPLY CHAIN. THE EFFICIENCY OF VARIOUS EXISTING FUEL-TRANSPORT COMBINATIONS IS ANALYZED ON THE BASIS OF SYSTEMS OPTIMIZED IN ACCORDANCE WITH CONVENTIONAL ECONOMIC RESTRAINTS. THIS EFFICIENCY IS INDICATED IN TERMS OF FUEL ENERGY UNITS CONSUMED PER TON-MILE OF FUEL TRANSPORTED FOR THE DOMINANT FUEL TYPES, TRANSPORT METHODS, AND BATCH QUANTITIES. IN ADDITION, CONVERSION, INTERFACING, AND STORAGE EFFECTS ARE CONSIDERED. THE CONTEXT OF FUELS TRANSPORTATION ENCOMPASSES THE GLOBAL MOVEMENT OF ALL FUELS BY ALL MEANS WHICH IN COMBINATION CONSTITUTE A DISCERNABLE PERCENTAGE OF FUEL TRANSPORT ACTIVITY.

-PERTINENT FIGURES-

TAB.3 TRANSPORTATION OPTIONS FOR VARIOUS FUELS, PAGE 580//FIG.3 RELATIVE EFFICIENCY OF FREIGHT-CARGO TRANSPORTATION METHODS, PAGE 583//TAB.10 FUEL TRANSPORT ECONOMICS, PAGE 584//TAB.11 FUEL-TO-ELECTRICITY SYSTEM EFFICIENCIES, PAGE 585//FIG.4 OVERALL EFFICIENCY OF ENERGY SUPPLY SYSTEMS, PAGE 586

-BIBLIOGRAPHY-

MITRIC, SLOBODAN, TRANSPORTATION AND THE CONSUMPTION OF ENERGY, ADDRESS TO TRANSPORTATION SCIENCE SEMINAR, UNIVERSITY OF CALIFORNIA BERKELEY, (9 FEB 1973)//ROBB,J.E., TRANSPORTATION OF ENERGY, (DIVISION FIVE POSITION PAPER), PROCEEDINGS, NINTH WORLD ENERGY CONFERENCE, (1973)// UHL,A.E., FUELS TRANSPORT AND THE POTENTIAL FOR ENERGY CONSERVATION, COMMITTEE FOR THE CONSERVATION OF ENERGY, FEDERAL POWER COMMISSION, WASHINGTON, D.C. (1973)

-SOURCE INFORMATION-

CORPORATE SOURCE -
BECHTEL CORP., SAN FRANCISCO, CALIF.
JOURNAL PROCEEDINGS -
INTERSOCIETY ENERGY CONVERSION ENGINEERING CONF., 9TH, 578-87
(PROC. OF) SAN FRANCISCO, CALIF., AUG 26-30, 1974
PUBLISHER -
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK
OTHER INFORMATION -
0010 PAGES, 0004 FIGURES, 0011 TABLES, 0008 REFERENCES

key 20473

HYDROGEN-RICH AUTOMOTIVE FUELS. FUTURE COST AND SUPPLY PROJECTIONS

by

HOFFMAN, G. A.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE LONG-RANGE OUTLOOK IS FOR SHARP INCREASES IN AUTOMOTIVE FUEL PRICES, PARTICULARLY IN RELATION TO DIMINISHING FOSSIL (OIL, COAL) RESOURCES. THE FUTURE COSTS OF CARBON-RICH FUELS ARE PREDICTED TO BE FOUR TIMES CURRENT PRICES BY 1990 OR EARLIER WHEN THEY WILL BEGIN TO BE SUPPLANTED BY HYDROGEN-RICH FUELS, SUCH AS PROPANE AND METHANE. ABOUT 50 YEARS HENCE, HYDROGEN-RICH FUEL COSTS WILL HAVE ESCALATED TEN- TO TWENTYFOLD, AT WHICH TIME CRYOGENIC HYDROGEN OR METHANE WILL BECOME THE MOST ECONOMIC FUEL FOR TRANSPORTATION VEHICLES.

-PERTINENT FIGURES-

TAB.2 CURRENT PRICE ESTIMATES OF CARBON-RICH AUTOMOTIVE FUELS FOR HEAT ENGINES, PAGE 937//TAB.3 CURRENT PRICE ESTIMATES OF HYDROGEN-RICH AUTOMOTIVE FUELS AND ELECTRICITY, PAGE 938//FIG.5 THE FUTURE COSTS OF FUELS AND AUTOMOTIVE ENERGY IN AN AMPLE SCENARIO, PAGE 939//FIG.6 FUTURE COSTS OF HYDROGEN-RICH AUTOMOTIVE FUELS, PAGE 939//FIG.7 COST OF FOSSIL, SYNTHETIC, AND ELECTROLYTIC AUTOMOTIVE FUELS, PAGE 939//TAB.4 STORAGE PROPERTIES OF HYDROGEN-RICH AUTOMOTIVE FUELS, PAGE 940

-BIBLIOGRAPHY-

GREGORY,D P., THE HYDROGEN ECONOMY, SCIENTIFIC AMERICAN VOL 228,
GREGORY,D P., THE HYDROGEN ECONOMY, SCIENTIFIC AMERICAN VOL 228,
NO. 1, JAN 1973, PP 13-21//HOFFMAN,G.A., THE AUTOMOTIVE ENERGY CRISIS AND THE DESIGN OF THE HYDROGEN BUS, PROCEEDINGS OF THE AIAA LOS ANGELES TRANSPORTATION SYMPOSIUM, @ OCT 1973//BOCKRIS,J.OM., A HYDROGEN ECONOMY, SCIENCE VOL 176, NO. 4041, JUNE 23, 1972, P 1323//WINSCHE,W.E., HOFFMAN,K.C. AND SALZANO,F.J., HYDROGEN. ITS FUTURE ROLE IN THE NATIONS ENERGY ECONOMY, SCIENCE VOL 180, NO. 4093, JUNE 29, 1973, PP 1325-1332// MANNE,A.S. AND MARCHETTI,C., HYDROGEN. MECHANISMS AND STRATEGIES OF MARKET PENETRATION, INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS, LAXENBURG, AUSTRIA. 1974

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES
JOURNAL PROCEEDINGS -
INTERSOCIETY ENERGY CONVERSION ENGINEERING CONF., 9TH, 934-40
(PROC. OF) SAN FRANCISCO, CALIF., AUG 26-30, 1974
PUBLISHER -
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, NEW YORK
OTHER INFORMATION -
0007 PAGES, 0008 FIGURES, 0004 TABLES, 0009 REFERENCES

keys 20495 through 20497

LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK. SUMMARY

by

ALLAN, D. S.
ATALLAH, S.
DRAKE, E. M.
RAUSCH, A. H.
SARKES, L. A.

07/01/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	Summary	Good/Excel.

-ABSTRACT-

THE LNG SAFETY PROGRAM, PHASE II, CONSEQUENCES OF LNG SPILLS ON LAND WAS AN EXPERIMENTAL AND ANALYTICAL PROGRAM CARRIED OUT FOR THE AMERICAN GAS ASSOCIATION. THE OBJECTIVES OF THE PHASE II PROGRAM INCLUDED DEVELOPMENT OF METHODS OF PREDICTING THE HAZARDOUS ZONES FOR LARGE LNG SPILLS AND OBTAINING DATA ON METHODS OF REDUCTION OF THE HAZARDOUS ZONES. THE PRINCIPAL HAZARDS WERE CONSIDERED TO BE DOWNWIND TRAVEL OF FLAMMABLE MIXTURES AND RADIATION FROM LNG FIRES. THE PROGRAM INVOLVED EXPERIMENTAL SPILLS INTO DIKES UP TO 80 FEET IN DIAMETER. FOUR TYPES OF EXPERIMENTS WERE CONDUCTED, MEASUREMENTS OF DISPERSION OF THE VAPOR CLOUD, MEASUREMENTS OF RADIATION EFFECTS FROM FIRES, OBSERVATIONS OF CONTROL OF DISPERSION, AND OBSERVATIONS OF CONTROL AND EXTINGUISHMENT OF FIRES. SOME 42 SPILLS WERE MADE INTO CIRCULAR DIKES UP TO 80 FEET IN DIAMETER AT THE TRW CAPISTRANO TEST SITE FOR DISPERSION AND RADIATION EXPERIMENTS. CONTROL AND EXTINGUISHMENT EXPERIMENTS WERE CONDUCTED ON THE SITE OF THE ANSUL COMPANY AT MARINETTE, WISCONSIN, IN DIKES 20 FEET BY 20 FEET AND 30 FEET BY 40 FEET, SOME PRELIMINARY CONTROL EXPERIMENTS WERE DONE WITH 5-FOOT AND 10-FOOT-DIAMETER DIKES AT THE PHILADELPHIA GAS WORKS. THIS PROGRAM HAS BEEN CARRIED OUT BY A RESEARCH TEAM CONSISTING OF PERSONNEL FROM THE AMERICAN GAS ASSOCIATION (AGA), BATTELLE COLUMBUS LABORATORIES (BCL), TRW SYSTEMS, INC. (TRW), ARTHUR D. LITTLE, INC. (ADL), UNIVERSITY ENGINEERS (UE), AND PROFESSORS ROBERT O. PARKER OF POLYTECHNIC INSTITUTE OF NEW YORK AND ROBERT C. REID OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY. THIS TEAM WAS ASSISTED AND GUIDED BY TWO PANELS, INCLUDING REPRESENTATIVES OF THE LNG INDUSTRY AND EXPERTS IN CRYOGENICS. THE RESULTS AND CONCLUSIONS OF THE PROGRAM ARE SUMMARIZED IN SECTION A OF THE INTERIM REPORT ON PHASE II WORK COVERED HERE.

-PERTINENT FIGURES-

FIG.A-5 PREDICTED DOWNWIND EXTENT OF FLAMMABLE PLUME (LFL) FOR CONDITIONS INDICATED, PAGE A-11//FIG.A-10 RADIANT FLUX ON TARGET

ORIENTED FOR MAXIMUM INTENSITY--NO WIND, PAGE A-20//FIG.A-11 EFFECT OF WIND ON RADIANT FLUX ON TARGET ORIENTED FOR MAXIMUM INTENSITY, PAGE A-21

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.//LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK, SECT. A, A-1 - A-25 (JUL 1974)
PUBLISHER -
BATTELLE COLUMBUS LABS., OHIO
OTHER INFORMATION -
0025 PAGES, 0011 FIGURES, 0002 TABLES, 0000 REFERENCES

keys 20498 through 20500

LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK. DISPERSION AND RADIATION EXPERIMENTS

by

DUFFY, A. R.
GIDEON, D. N.
PUTNAM, A. A.

07/01/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE LNG SAFETY PROGRAM, PHASE II, CONSEQUENCES OF LNG SPILLS ON LAND CALLED FOR TWO SERIES OF EXPERIMENTS--SOME 30 DISPERSION EXPERIMENTS AND 12 RADIATION EXPERIMENTS--TO BE CONDUCTED BY SPILLING LNG INTO DIKES AND MEASURING THE DOWNWIND CONCENTRATIONS IN THE DISPERSION EXPERIMENTS AND THE RADIATION CHARACTERISTICS IN FIRE EXPERIMENTS. THE OBJECTIVES OF THE PROJECT AND THE EXPERIMENTAL PLAN IMPLIED CERTAIN REQUIREMENTS FOR THE SITE AND FOR THE INSTRUMENTATION, WHICH ARE DESCRIBED IN SECTION B OF THE INTERIM REPORT ON PHASE II WORK COVERED HERE. ALSO DESCRIBED IS THE EMPIRICAL CORRELATION FOR DOWNWIND DISTANCES VERSUS PEAK METHANE CONCENTRATIONS RESULTING FROM THE FLASH OF VAPOR WHEN LNG FIRST COVERS THE WARM SOIL - OBTAINED FROM ANALYSIS OF THE GAS SENSOR DATA.

-PERTINENT FIGURES-

TAB.C-15 LNG FIRE DATA, PAGE C-47//FIG.C-18 COMPARISON OF DISPERSION MODELS PREDICTIONS OF METHANE CONCENTRATIONS WITH CORRELATION OF CAPISTRANO GAS SENSOR DATA, PAGE C-66//FIG.C-22 RADIANT FLUX ON TARGET ORIENTED FOR MAXIMUM INTENSITY--NO WIND, PAGE C-78//FIG.C-23 EFFECT OF WIND ON RADIANT FLUX ON TARGET ORIENTED FOR MAXIMUM INTENSITY, PAGE C-80

-BIBLIOGRAPHY-

THERMAL RADIATION AND OVERPRESSURES FROM INSTANTANEOUS LNG RELEASE INTO THE ATMOSPHERE--PHASE II, APPENDIX, A. AN EXPERIMENTAL INVESTIGATION OF THE ATMOSPHERIC DIFFUSION AND IGNITION OF BOIL-OFF VAPORS ASSOCIATED WITH A SPILLAGE OF LIQUEFIED NATURAL GAS, TRW SYSTEMS, INC., REPORT TO A.G.A. (MAY 1969)//MAY,W.G. AND MCQUEEN,W., RADIATION FROM LARGE LIQUEFIED NATURAL GAS FIRES, COMBUSTION SCIENCE AND TECHNOLOGY, VOL 7, 51-6 (1973)//ATALLAH,S. AND ALLAN,D.S., SAFE SEPARATION DISTANCES FROM LIQUID FUEL FIRES, FIRE TECHNOLOGY, VOL 7, 47-56 (1971)

-SOURCE INFORMATION-

CORPORATE SOURCE -
BATTELLE COLUMBUS LABS., OHIO
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK, SECT. C, C-1 - C-82 (JUL 1974)
PUBLISHER -
BATTELLE COLUMBUS LABS., OHIO
OTHER INFORMATION -
0082 PAGES, 0023 FIGURES, 0016 TABLES, 0026 REFERENCES

keys 20501 through 20504

LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK. ANALYSIS OF VAPOR DISPERSION EXPERIMENTS

by

DRAKE, E. M.
HARRIS, S. H.
REID, R. C.

07/01/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE OVERALL OBJECTIVE OF THE VAPOR DISPERSION SPILL TESTS CONDUCTED IN THIS PROGRAM WAS TO PROVIDE LARGE SCALE EXPERIMENTAL DATA WHICH COULD BE USED TO VERIFY OR IMPROVE EXISTING LNG VAPOR DISPERSION MODELS. PRIOR TO THIS PROGRAM, SUCH MODELS HAD BEEN DEVELOPED USING GENERAL MODELS OF ATMOSPHERIC DISPERSION DEVELOPED FOR VARIOUS OTHER POLLUTANTS AND HAD BEEN CHECKED AGAINST A LIMITED NUMBER OF SMALL SCALE SPILL TESTS. IN THIS PROGRAM, EXPERIMENTAL SPILLS INTO AN 80-FT DIAMETER DIKE INCREASED ACTUAL SPILL DIMENSIONS BY ABOUT AN ORDER OF MAGNITUDE OVER MOST PREVIOUS TESTS. CONFIRMATION OF MODELS ON THIS SCALE ADDS CONFIDENCE IN USING MODELS FOR FULL SCALE FACILITY PREDICTIONS. AN EQUALLY IMPORTANT OBJECTIVE WAS TO LEARN MORE ABOUT THE NATURE OF THE VAPOR DISPERSION HAZARD AND TO DEVELOP METHODS FOR MINIMIZING OR ELIMINATING THE COMBUSTIBLE VAPOR CLOUD PROBLEMS ASSOCIATED WITH ACCIDENTAL SPILLS THAT COULD OCCUR IN THE LNG INDUSTRYS OPERATIONS. A PREDICTIVE MODEL DEVELOPED AT A. D. LITTLE, INC. AND USED IN INTERPRETING TEST DATA IS DESCRIBED IN SECTION D OF THE INTERIM REPORT ON PHASE II WORK COVERED HERE, ALONG WITH A DETAILED PROGRAM LISTING AND A USERS MANUAL.

-PERTINENT FIGURES-

FIG.D-29 SOIL HEAT TRANSFER TERMS, PAGE D-82//FIG.D-37 EFFECT OF TIME ON VAPOR FLOW RATE OVER LEE EDGE, PAGE D-97

-BIBLIOGRAPHY-

PARKER,R.O., A STUDY OF DOWNWIND VAPOR TRAVEL FROM LNG SPILLS, A. GAS ASSOC., DISTRIBUTION CONF., SEATTLE, WASHINGTON (MAY 25-8, 1970)// BURGESS,D. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, U.S. DEPT. INTERIOR, BUR. MINES REPORT 6099 (1962)//BOYLE,G.J. AND KNEEBOEN,A., LABORATORY INVESTIGATION INTO THE CHARACTERISTICS OF LNG SPILLS ON WATER. EVAPORATION, SPREADING, AND VAPOR DISPERSION, SHELL RESEARCH LTD.,

REPORT TO API (MAY 1973)//MAY,W.G., MCQUEEN,W. AND WHIPP,R.H., LNG SPILLS ON WATER, PAPER PRESENTED AT THE DIVISION OF REFINING, AMERICAN PETROLEUM INST., PHILADELPHIA, PENN. (MAY 1973)//BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED NATURAL GAS IN WATER, BUREAU OF MINES, R.I. 7448 (1970)//BURGESS,D.S., BIORDI,J. AND MURPHY,J.N., HAZARDS OF SPILLAGE OF LNG INTO WATER, BUREAU OF MINES, MIPR NO. Z-70099-9-12395 (1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.//MASSACHUSETTS INST. OF TECH., CAMBRIDGE
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK, SECT. D, D-1 - 2-15 (JUL 1974)
PUBLISHER -
BATTELLE COLUMBUS LABS., OHIO
OTHER INFORMATION -
0161 PAGES, 0061 FIGURES, 0016 TABLES, 0068 REFERENCES

keys 20505 through 20506

LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK. VAPOR DISPERSIONS FROM LNG SPILLS

by

WELKER, J. R.

07/01/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

SECTION E OF THE INTERIM REPORT ON PHASE II WORK SUMMARIZES THE ANALYSIS BY UNIVERSITY ENGINEERS OF THE FIELD MEASUREMENTS ON ATMOSPHERIC VAPOR DISPERSION FROM LNG SPILLS ON LAND. INITIALLY IT WAS ANTICIPATED THAT RIGOROUS MATHEMATICAL MODELS WOULD BE NEEDED TO ANALYZE AND CORRELATE THE DATA. HOWEVER, A PRELIMINARY EVALUATION OF THE MEASUREMENTS INDICATED THAT THE MORE SOPHISTICATED ANALYSES COULD BE USED TO FORM THE BASES FOR SIMPLIFIED TECHNIQUES WHICH WOULD BE ADEQUATE FOR THE PURPOSES INTENDED. THESE SIMPLIFIED TECHNIQUES ENABLE SHORT-CUT CALCULATIONAL PROCEDURES FOR PREDICTING VAPOR DISPERSION. NOTHING MORE THAN A SLIDE RULE AND ACCESS TO FUNCTIONS READILY AVAILABLE IN THE LITERATURE ARE REQUIRED AND THE RESULTS ARE ADEQUATE FOR MOST ENGINEERING APPLICATIONS. THIS U.E. PROCEDURE SHOULD BE USEFUL IN MAKING PRELIMINARY STUDIES FOR A SITE TO DETERMINE THE EFFECTS OF VARIATIONS IN SITE GEOMETRY, ATMOSPHERIC PARAMETERS, AND SOIL PROPERTIES. IT IS LIMITED BY THE ASSUMPTION OF INSTANTANEOUS LNG COVERAGE OF THE DIKE FLOOR, AND TAKES NO CREDIT FOR VAPOR HOLDUP IN THE DIKE, HENCE, THE BENEFITS OF VAPOR STORAGE OR SLOPING FLOORS ARE NOT COVERED IN THIS SIMPLE MODEL.

-PERTINENT FIGURES-

FIG.E-41 CALCULATED EVAPORATION RATE FOR AN LNG SPILL ON AVERAGE SOIL, PAGE E-53//FIG.E-44 GROUND LEVEL METHANE CONCENTRATIONS DOWNWIND OF A 200-FOOT LNG SPILL, NEUTRAL ATMOSPHERE, 5 MPH WIND, PAGE E-58//FIG.E-45 CONCENTRATION PROFILES FOLLOWING AN LNG SPILL, PAGE E-60//FIG.E-46 CONCENTRATION CHANGES VARIOUS DISTANCES DOWNWIND OF AN LNG SPILL, PAGE E-61//FIG.E-47 EFFECT OF WIND SPEED ON CONCENTRATION PROFILES, PAGE E-62// FIG.E-48 EFFECT OF EVAPORATION RATE ON CONCENTRATION PROFILES, PAGE E-63

-BIBLIOGRAPHY-

BROWN,L.E. AND COLVER,C.P., NUCLEATE AND FILM BOILING HEAT TRANSFER TO LIQUEFIED NATURAL GAS, ADVANCES IN CRYOGENIC ENGINEERING, VOL 13, 647 (1968)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK, SECT. E, E-1 - E-65 (JUL 1974)
PUBLISHER -
BATTELLE COLUMBUS LABS., OHIO
OTHER INFORMATION -
0065 PAGES, 0049 FIGURES, 0001 TABLES, 0008 REFERENCES

key 20507

LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK. RADIANT HEATING FROM LNG FIRES

by

WELKER, J. R.

07/01/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

SECTION F OF THE INTERIM REPORT ON PHASE II WORK SUMMARIZES THE ANALYSIS BY UNIVERSITY ENGINEERS OF THE FIELD MEASUREMENTS ON RADIANT HEAT FLUXES FROM LNG FIRES. ALTHOUGH MOST OF THE FIELD TESTS WERE PERFORMED AT THE TRW CAPISTRANO TEST SITE, DATA OBTAINED IN THIS PROGRAM BY UNIVERSITY ENGINEERS AT THE ANSUL FACILITIES IN MARINETTE, WISCONSIN, ARE INCLUDED TO SUBSTANTIATE THE RADIANT HEAT FLUX CALCULATIONS. AGAIN, AS WITH THE DISPERSION ANALYSIS, IT HAS BEEN FOUND THAT SIMPLIFIED CALCULATIONAL TECHNIQUES ARE ADEQUATE FOR THE PURPOSES INTENDED. HEAT TRANSFER FROM A FIRE TO AN OBJECT OCCURS BY RADIATION AND CONVECTION. IF THE OBJECT IS WITHIN THE FLAME OR THE HOT GAS PLUME, RADIATION IS THE DOMINANT MECHANISM. IF THE OBJECT IS OUTSIDE THIS ENVELOPE, THEN THE HEAT TRANSFER IS BY RADIATION ALONE. ONLY THE LATTER CASE WAS CONSIDERED IN THIS STUDY. ESSENTIALLY, TWO ANALYTICAL METHODS ARE AVAILABLE FOR PREDICTING RADIANT HEAT TRANSFER FROM FLAMES. SINCE EACH OF THEM SUFFERS FROM DEFICIENCIES, CERTAIN COMPROMISES HAVE TO BE MADE IN THE ANALYSIS.

-PERTINENT FIGURES-

FIG.F-3 COMPARISON OF MEASURED AND PREDICTED FLAME ANGLES FOR 6-FOOT, 20-FOOT, AND 80-FOOT LNG FIRES, PAGE F-11//FIG.F-7 NON-PILOTED IGNITION TIME OF DRY REDWOOD EXPOSED TO FLAME RADIATION, PAGE F-21//FIG.F-8 FLAME ANGLE FOR A 200 FOOT LNG FIRE, PAGE F-23//FIG.F-9 CALCULATED RADIANT FLUXES FOR A 200 FOOT LNG FIRE, PAGE F-24

-BIBLIOGRAPHY-

THOMAS,P.H., THE SIZE OF FLAMES FROM NATURAL FIRES, NINTH INTERNATIONAL SYMPOSIUM ON COMBUSTION, ACADEMIS PRESS, NEW YORK (1963)//WELKER,J.R. AND SLIEPCEVICH,C.M., SUSCEPTIBILITY OF POTENTIAL TARGET COMPONENTS TO DEFEAT BY THERMAL ACTION, UNIVERSITY OF OKLAHOMA RESEARCH INST. REPORT NO. OURI-1578-FR, NORMAN, OKLA. (1970)//REIN,R.G., SLIEPCEVICH,C.M. AND WELKER,J.R., RADIATION VIEW FACTORS FOR TILTED CYLINDERS, J. FIRE AND

FLAMMABILITY, VOL 1, 140 (1970)//HOWELL,J.R. AND SEIGEL,R., THERMAL RADIATION HEAT TRANSFER, VOL II, NASA SP-164, WASHINGTON, D.C. (1969)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK, SECT. F, F-1 - F-25 (JUL 1974)
PUBLISHER -
BATTELLE COLUMBUS LABS., OHIO
OTHER INFORMATION -
0025 PAGES, 0009 FIGURES, 0004 TABLES, 0007 REFERENCES

key 20508

LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK. RADIATION FROM LNG FIRES

by

ATALLAH, S.
RAJ, P. P. K.

07/01/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

EARLY IN PROCESS OF CONCEPTUAL DESIGN AND SITING OF LNG PROCESSING AND STORAGE FACILITIES, IT IS IMPORTANT TO ESTIMATE SAFE SEPARATION DISTANCES FROM POTENTIAL LNG SPILL FIRES. TO ACHIEVE THIS ONE NEEDS TO IDENTIFY POTENTIAL CAUSES OF SPILLS, DETERMINE THEIR LIKELY LOCATIONS AND SIZES AND THEN ESTIMATE, USING AN APPROPRIATE THERMAL RADIATION MODEL, THE INTENSITY OF RADIATION AT VARIOUS DISTANCES FROM THESE LOCATIONS. DEPENDING ON THE RESULTS, APPROPRIATE ADJUSTMENTS MAY HAVE TO BE MADE IN THE PLANT LAYOUT TO PREVENT OR MINIMIZE INJURY TO LIFE AND PROPERTY. WHERE THIS IS IMPOSSIBLE TO ACHIEVE, FIRE PROTECTION SYSTEMS ARE SELECTED TO REDUCE THE POTENTIAL HAZARD TO ACCEPTABLE LEVELS. THE OBJECTIVE OF THE PRESENT STUDY WAS TO SELECT AND MODIFY IF NECESSARY AN ANALYTICAL MODEL THAT CAN BE USED TO PREDICT THE THERMAL RADIATION HAZARD FROM LNG FIRES ON LAND. THE SELECTION WAS TO BE BASED ON THE ADEQUACY OF THE MODEL TO CORRELATE EXPERIMENTAL DATA DEVELOPED DURING SEVEN 6-FOOT, SIX 20-FOOT, AND ONE 80-FOOT LNG SPILL FIRES CONDUCTED UNDER THIS PROGRAM AS WELL AS OTHER EXPERIMENTAL DATA DEVELOPED BY OTHERS. A COMPUTER PROGRAM WAS ALSO TO BE PROVIDED WITH ADEQUATE INSTRUCTIONS FOR ITS USE. THIS REPORT (SECTION G OF THE INTERIM REPORT ON PHASE II WORK) BEGINS WITH A REVIEW OF EXPERIMENTAL STUDIES CONDUCTED BY OTHERS. THE EXPERIMENTAL DATA DEVELOPED UNDER THIS PROGRAM ARE THEN PRESENTED AND ANALYZED. A MODEL IS FINALLY PRESENTED AND ITS PREDICTIONS COMPARED WITH EXPERIMENTAL DATA. A COMPUTERIZED VERSION OF THE MODEL IS ALSO PROVIDED.

-PERTINENT FIGURES-

FIG.G-9 FLAME SURFACE HEAT FLUX VERSUS DIKE DIAMETER, PAGE G-35//TAB.G-11 PERCENT ENERGY RADIATED, PAGE G-39

-BIBLIOGRAPHY-

ARTHUS D. LITTLE, INC., A REPORT ON LNG SAFETY RESEARCH - VOLUME II, AGA PROJECT 1 U-2-1 PREPARED FOR AMERICAN GAS ASSOCIATION, AGA

PROJECT 1 U-2-1, (1971)//BURGESS,D. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, BUREAU OF MINES REPORT NO. 6099, U.S. DEPT. OF INTERIOR (1962)//LNG VAPOR DISPERSION AND FIRE TESTS, A JOINT EFFORT SPONSORED BY THE PHILADELPHIA GAS WORKS, WALTER R. KIDDE CO., AMERICAN GAS ASSOCIATION, REPORT BY UNIVERSITY ENGINEERS, INC., NORMAN, OKLAHOMA (DEC 1971)//UNIVERSITY ENGINEERS, INC., RADIANT HEATING FROM LNG FIRES, REPORT TO BATTELLE COLUMBUS LABORATORIES UNDER THIS AGA PROGRAM (AUG 1973). (SECTION F OF THIS REPORT)//MAY,W.B. AND MCQUEEN,W., RADIATION FROM LARGE LNG FIRES, COMBUSTION SCIENCE AND TECHNOLOGY, 7(2), 51-56 (1973)//WELKER,J.R., WESSON,H.R., SLIEPCEVICH,C.M., LNG SPILLS - TO BURN OR NOT TO BURN, PAPER PRESENTED AT THE DISTRIBUTION CONFERENCE, OPERATING SECTION, AMERICAN GAS ASSOCIATION, PHILADELPHIA, PA., MAY 12-15, 1969

-SOURCE INFORMATION-

CORPORATE SOURCE -
    LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
JOURNAL PROCEEDINGS -
    LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK, SECT. G, G-1 - A-11, (JUL 1974)
PUBLISHER -
    BATTELLE COLUMBUS LABS., OHIO
OTHER INFORMATION -
    0069 PAGES, 0012 FIGURES, 0011 TABLES, 0020 REFERENCES

key 20509

LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK. FIRE CONTROL AND VAPOR SUPPRESSION

by

WESSON, H. R.

07/01/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

SECTION I OF THE INTERIUM REPORT ON PHASE II WORK COVERS EXPERIMENTS WHICH WERE DESIGNED TO EVALUATE MODERN MATERIALS AND TECHNIQUES OF FIRE CONTROL AND TO DETERMINE THE EFFECTIVENESS OF HIGH-EXPANSION FOAMS IN SUPPRESSING VAPOR GENERATION AND DISPERSION. ANALYSES OF ASSUMED MAXIMUM LNG FIRE CONDITIONS IN AN LNG PLANT USUALLY INDICATE SEVERE RADIANT HEATING EFFECTS ON BOTH PLANT AND SURROUNDING FACILITIES. TO ALLEVIATE THESE POTENTIALLY ADVERSE RADIANT HEATING EFFECTS, IT IS USUALLY NECESSARY TO PROVIDE RATHER EXTENSIVE AND EXPANSIVE EXPOSURE CONTROL PROVISIONS (NORMALLY DIRECT CONTACT WATER SPRAY SYSTEMS) OR TO PROVIDE FOR DIRECT CONTROL OF THE LNG FIRE. TO DATE IN THIS COUNTRY MOST LNG PLANTS THAT HAVE CONSIDERED LARGE SPILL FIRE CONDITIONS HAVE UTILIZED THE WATER SPRAY OR WATER CURTAIN APPROACH. HOWEVER, SEVERAL LNG FACILITIES IN OTHER COUNTRIES (JAPAN, FRANCE, AND CANADA) ARE EQUIPPED TO CONTROL LNG FIRES DIRECTLY WITH HIGH EXPANSION FOAM SYSTEMS. THE TEST REPORTS CURRENTLY AVAILABLE FROM THESE INSTALLATIONS ON THE CONTROL OF LNG FIRES WITH HIGH EXPANSION FOAM SYSTEMS GIVE ONLY QUALITATIVE RESULTS. THE AMERICAN GAS ASSOCIATION, THEREFORE, SPONSORED A JOINT INDUSTRY TEST PROGRAM ON REALISTIC LNG POOL FIRES TO EVALUATE THE FACTORS IN CONTROLLING LNG FIRES WITH AVAILABLE HIGH EXPANSION FOAM EQUIPMENT AND FOAM CONCENTRATES. THE EXPERIMENTAL PROGRAM ALSO INCLUDED AN EXTENSIVE EVALUATION OF THE DRY CHEMICAL FIRE EXTINGUISHING REQUIREMENTS FOR THE SIZES OF LNG SPILL FIRES THAT MAY OCCUR WITH RELATIVELY NORMAL MALFUNCTIONS IN LNG PLANT OPERATIONS. SPECIFIC OBJECTIVES OF THIS EXPERIMENTAL PROGRAM WERE. 1. TO EVALUATE THE EFFECTIVENESS OF COMMERCIALLY AVAILABLE DRY CHEMICAL AGENTS IN EXTINGUISHING LNG POOL FIRES AND TO DETERMINE MINIMUM APPLICATION RATES, 2. TO DETERMINE THE EFFECTS OF EXPANSION RATIOS AND OF APPLICATION RATES OF HIGH EXPANSION FOAMS IN CONTROLLING LNG FIRES, 3. TO OBSERVE THE REDUCTION IN EXTERNAL RADIATION FROM LNG FIRES BY WATER SPRAYS BETWEEN THE FIRE AND POSSIBLE TARGETS, AND ALSO BY HIGH EXPANSION FOAMS ON THE BURNING LNG POOL, 4. TO MEASURE THE VAPOR SUPPRESSION PRODUCED BY A HIGH EXPANSION FOAM BLANKET ON A NONBURNING LNG POOL.

-PERTINENT FIGURES-

FIG.I-1 EFFECTS OF FOAM APPLICATION RATE ON LNG FIRE CONTROL TIME, PAGE I-5//FIG.I-2 EFFECTS OF FOAM EXPANSION RATIO ON EXTERNAL RADIATION HEAT FLUX LEVELS, PAGE I-6//FIG.I-3 CORRELATION OF THE HIGH EXPANSION FOAM CONTROL TIMES, PAGE I-7//TAB.I-1 COMPARISON OF DRY CHEMICAL AGENT THRESHOLD LIMITS FOR THE EXTINGUISHMENT OF EXPOSED LNG POOL FIRES WITH A TOTAL LNG EVAPORATION RATE OF NOT MORE THAN 0.5 INCH PER MINUTE, PAGE I-16 //TAB.I-2 COST EFFECTIVENESS COMPARISON OF THE DIFFERENT DRY CHEMICAL AGENTS USED IN VARIOUS SIZE DRY CHEMICAL EQUIPMENT AND APPLIED BY VARIOUS METHODS, PAGE I-17

-BIBLIOGRAPHY-

LNG VAPOR DISPERSION AND FIRE TESTS, FINAL REPORT TO AMERICAN GAS ASSOC. BY UNIVERSITY ENGINEERS, INC., 1215 WESTHEIMER DRIVE, NORMAN, OKLA. (DEC 1971)//LNG FIRE CONTROL, FIRE EXTINGUISHMENT, AND VAPOR DISPERSION TESTS, FINAL REPORT TO AMERICAN GAS ASSOC. BY UNIVERSITY ENGINEERS, INC., 1215 WESTHEIMER DRIVE, NORMAN, OKLA. (JUL 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK, SECT. I, I-1 - I-21 (JUL 1974)
PUBLISHER -
BATTELLE COLUMBUS LABS., OHIO
OTHER INFORMATION -
0021 PAGES, 0008 FIGURES, 0002 TABLES, 0003 REFERENCES

keys 20510 through 20511

LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK. A VAPOR DISPERSION DATA CORRELATION COMPARED TO A VAPOR DISPERSION MODEL

by

PARKER, R. O.

07/01/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE PURPOSE OF SECTION J OF THE INTERIM REPORT ON PHASE II WORK IS TO COMPARE THE BATTELLE CORRELATION OF THE EXPERIMENTAL VAPOR DISPERSION DATA WITH VALUES COMPUTED FROM A MODEL THAT WAS DEVELOPED FROM CONSIDERATIONS ENTIRELY APART FROM AND PRIOR TO THE TESTS OF THIS PROGRAM. SINCE THE CALCULATED VALUES AND THE CORRELATION AGREE REASONABLY WELL, CALCULATIONS OF VAPOR DISPERSION FOR CONTAINMENT SYSTEMS HAVING DIFFERENT GEOMETRIES, BOIL-OFF RATES, AND WEATHER CONDITIONS CAN BE UNDERTAKEN WITH AN EXPECTATION OF REASONABLE ACCURACY. THE MODEL USED HERE IS AN AREA SOURCE MODEL WHICH PERMITS DILUTION OVER THE AREA SOURCE. ITS DEVELOPMENT WAS DESCRIBED IN 1970 AND IT HAS UNDERGONE SOME MODIFICATION SINCE THAT TIME.

-PERTINENT FIGURES-

FIG.J-1 EXTENT OF PEAK FLAMMABLE PLUME, PAGE J-3//FIG.J-2 EXTENT OF PEAK FLAMMABLE PLUME, PAGE J-5

-BIBLIOGRAPHY-

PARKER,R.O., A STUDY OF DOWNWIND VAPOR TRAVEL FROM LNG SPILLS, AMERICAN GAS ASSOC., DISTRIBUTION CONF., SEATTLE, WASHINGTON (MAY 25-28, 1970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
POLYTECHNIC INST. OF BROOKLYN, N.Y.
JOURNAL PROCEEDINGS -
LNG SAFETY PROGRAM INTERIM REPORT ON PHASE II WORK, SECT. J, J-1 - J-6 (JUL 1974)
PUBLISHER -
BATTELLE COLUMBUS LABS., OHIO
OTHER INFORMATION -

keys 21081 through 21085

NEW CRYOGENIC STORAGE SYSTEMS

by

NELSON, A.H.

10/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

A SERIES OF CONTROLLED EXPERIMENTS TO MORE ACCURATELY DEFINE THE ACTUAL BEHAVIOR CHARACTERISTICS OF PERLITE IN COLD SERVICE WERE CONDUCTED BY THE PITTSBURGH-DES MOINES STEEL CO. ONE TEST DETERMINED ON AN ACCELERATED BASIS WHETHER THE INNER CYLINDRICAL SHELL OF A SMALL DOUBLE-WALL, PERLITE INSULATED CRYOGENIC STORAGE TANK COULD BUCKLE DURING THERMAL WARM-UP OF THE TANK DUE TO PERLITE COMPACTION AND CONSOLIDATION CAUSED BY THE TANKS THERMAL AND STRESS MOVEMENTS. THE INNER SHELL WAS THERMALLY CYCLED BETWEEN LIQUID NITROGEN TEMPERATURE AND AMBIENT AIR TEMPERATURE. EACH THERMAL CYCLE PRODUCED A RADIAL MOVEMENT OF THE INNER SHELL OF 0.112 IN. RESULTING IN A VOLUMETRIC DISPLACEMENT OF 3.7 PERCENT OF THE ANNULAR VOLUME OF PERLITE. AFTER 7 CYCLES THE SHELL BUCKLED. A TEST WAS THEN CONDUCTED ON A LARGER (60 FT DIAMETER BY 24 FT HIGH) TANK WITH AN 18-IN. ANNULAR SPACE FOR THE PERLITE. JACKET TENSIONING CYCLES WERE PERFORMED. RESULTS SHOWED THAT, 1) THE WORKING (TEMPERATURE VARIATIONS) OF THE OUTER JACKET IS A MAJOR FACTOR IN THE CONSOLIDATION OF PERLITE IN AN ANNULAR INSULATION SPACE OF A DOUBLE-WALL TANK, 2) IF SUCH A TANK IS TAKEN OUT OF COLD SERVICE, THE BUILDUP OF EXTERNAL PRESSURE ON THE INNER TANK AS IT EXPANDS INTO THE BED OF PERLITE CAN BE CONSIDERABLE. TWO NEW SHELL INSULATION SYSTEMS WERE CONSEQUENTLY DEVELOPED TO ELIMINATE THESE PROBLEMS, ONE, A SHELL INSULATION SYSTEM COMPOSED ENTIRELY OF GLASS FIBER PLACED IN SUCH A MANNER THAT IT IS HELD IN PLACE BY FRICTION FROM RESIDUAL RADIAL COMPRESSION IN THE GLASS FIBER OBTAINED BY USING TIGHTLY COMPRESSED BUNDLES AND THE OTHER, A SYSTEM COMPOSED OF GLASS FIBER IN CONJUNCTION WITH PERLITE. ONE GLASS FIBER LAYER IS INSTALLED ADJACENT TO THE JACKET WALL WHICH PREVENTS PERLITE CONSOLIDATION FROM THE WORKING OF THE JACKET AND ANOTHER ADJACENT TO THE INNER VESSEL WALL WHICH PREVENTS PERLITE CONSOLIDATION FROM MOVEMENTS OF THE INNER SHELL. DETAILS OF THE USE OF GLASS FIBER SHELL INSULATION SYSTEM IN THE LA SPEZIA TWO 315,000 BBL LNG STORAGE VESSELS ARE GIVEN.

-PERTINENT FIGURES-

TAB.1 RESULTS OF FIRST BUCKLING CYCLE ON 60-FOOT-DIAMETER DOUBLE-WALL TANK, PAGE 23//FIG.1 DOUBLE-WALL CRYOGENIC TANK MODEL USED FOR ACCELERATED BUCKLING TEST, PAGE 22//FIG.3 THE 315,000

BARREL LNG STORAGE VESSELS UNDER CONSTRUCTION AT LA SPEIZA, ITALY, PAGE 24//FIG.4 NEW DEVELOPMENT IN SHELL INSULATION SYSTEMS USING A UNIQUE COMBINATION OF GLASS FIBER AND PERLITE, PAGE 25//FIG.6 RESULTS OF THERMAL CONDUCTIVITY TESTS ON 6 MICRON GLASS FIBER INSULATION, PAGE 27

-SOURCE INFORMATION-

CORPORATE SOURCE -
PITTSBURGH-DES MOINES STEEL CO., PITTSBURGH, PA.
JOURNAL PROCEEDINGS -
PIPE LINE IND. VOL 29, 75-80 (OCT 1968)
OTHER INFORMATION -
0006 PAGES, 0006 FIGURES, 0001 TABLES, 0000 REFERENCES

keys 20144 through 20149

NEW DEVELOPMENTS IN ABOVE GROUND METAL LNG CONTAINERS PART II

by

HANKE, C. C.

00/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS IS PART 2 OF A TWO PART ARTICLE ON NEW (IN 1969) DEVELOPMENTS IN ABOVE GROUND METAL LNG STORAGE TANKS. DISCUSSED HERE IS THE PROBLEM OF PERLITE COMPACTION - IT FLOWS INTO THE INSULATING ANNULUS VOID SPACE CREATED DURING TANK COOLDOWN AND COMPACTS, CREATING EXCESSIVE PRESSURES AND LOADING ON THE TANK SHELLS DURING WARMUP - AS WELL AS ITS REMEDY WHICH HAS PROVEN EFFECTIVE IN ACTUAL PRACTICE. THE SOLUTION LIES IN THE INSTALLATION OF A RESILIENT FIBERGLASS BLANKET, INSTALLED ON THE OUTER SURFACE OF THE INNER TANK SHELL, WHICH ACTS AS A SPRING TAKING WALL MOVEMENT IN RESILIENCY RATHER THAN LEAVING VOIDS THAT PERLITE WOULD FILL.

-PERTINENT FIGURES-

FIG.3 MOVEMENTS TO BE CONSIDERED WHEN DESIGNING A DOUBLE WALL LNG TANK, PAGE 214//FIG.4 A 45,000 GALLON CAPACITY HORIZONTAL LIQUID HYDROGEN DEWAR, PAGE 214

-BIBLIOGRAPHY-

WISSMILLER,I.L. AND CLAPP,M.B., CHICAGO BRIDGE AND IRON COMPANY, LIQUEFIED NATURAL GAS STORAGE IN ABOVE GROUND TANKS, AMERICAN GAS ASSOCIATION PRODUCTION CONFERENCE, BOSTON, MASS., JUNE, 1962//PETSINGER,R.E., UNITED STATES STEEL CORP., HANKE,C.C.,JR., CHICAGO BRIDGE AND IRON COMPANY, DESIGN OF 9 PERCENT NICKEL STEEL LNG STORAGE TANKS, ASME PETROLEUM MECHANICAL ENGINEERING CONFERENCE, HOUSTON, TEXAS, SEP 1965//HANKE,C.C., CHICAGO BRIDGE AND IRON COMPANY, ABOVEGROUND STORAGE OF LNG IS SAFE AND PRACTICAL, THE OIL AND GAS JOURNAL, FEB 1966//WISSMILLER,I.L., CHICAGO BRIDGE AND IRON COMPANY, ABOVEGROUND STORAGE TANKS FOR LIQUEFIED NATURAL GAS, WINTER ANNUAL MEETING ASME, NOV 1966//BRUNT,W.R., HORTON STEEL WORKS, LTD. AND CLAPP,M.B., CHICAGO BRIDGE AND IRON COMPANY, DESIGN OF ETHYLENE AND LNG LIQUEFACTION AND STORAGE FACILITIES, 50TH CONFERENCE AND EXHIBITION OF THE CHEMICAL INSTITUTE OF CANADA, TORONTO, JUNE 1967//LUSK,D.T., CHICAGO BRIDGE AND IRON COMPANY AND DORNEY,D.C., CHICAGO BRIDGE LTD., ADVANCEMENTS IN CONSTRUCTION AND PERFORMANCE OF ABOVEGROUND

STORAGE TANKS FOR LNG, 12TH INTERNATIONAL CONGRESS OF REFRIGERATION, MADRID, SPAIN, SEP 1967

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.
JOURNAL PROCEEDINGS -
CRYOG. TECHNOL. VOL 5, NO. 5, 213-5 (SEP/OCT 1969) (PRES. AT THE AMERICAN GAS ASSOCIATION DISTRIBUTION CONF.)
OTHER INFORMATION -
0003 PAGES, 0007 FIGURES, 0000 TABLES, 0021 REFERENCES

keys 21214 through 21215

GROUND SUPPORT EQUIPMENT, LOW POLLUTANT FUELS FINAL REPORT

by

WEIKEL,T.D.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

ALTERNATE FUELS, WITH AN EMPHASIS ON LIQUEFIED NATURAL GAS, WERE REVIEWED FOR FEASIBILITY OF USE IN AIRCRAFT GROUND SUPPORT EQUIPMENT TO REDUCE AIR POLLUTION. ELECTRICITY, STEAM, AND WANKEL ENGINES WERE ALSO INVESTIGATED. A LITERATURE SURVEY, ATTENDANCE AT CONFERENCES, AND PERSONAL INTERVIEWS LEAD TO THE CONCLUSION THAT THE MOST PRACTICAL SYSTEM IS THE USE OF LIQUEFIED PETROLEUM GAS AND CATALYTIC CONVERTERS ON PRESENT GASOLINE ENGINE SUPPORT EQUIPMENT. NO USEFUL POLLUTION REDUCTION METHODS WERE FOUND FOR DIESELS.

-PERTINENT FIGURES-

FIG.1 POSSIBLE POSITIVE VENT GAS DISPOSAL SYSTEM, PAGE 9//FIG.2 FIRST GENERATION LNG DISTRIBUTION SYSTEM, PAGE 13

-BIBLIOGRAPHY-

NAVAIR 06-03-501 OF 1 MARCH 1971, TECHNICAL MANUAL OF OXYGEN/NITROGEN CRYOGENIC SYSTEMS, PP2-8//PETSINGER,R.E., LNG ON THE MOVE, GAS MAGAZINE, (DEC 1967)//BARRON,R., CRYOGENIC SYSTEMS, MCGRAW-HILL BOOK CO., NEW YORK, PP256 (1966)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NAVAL AIR ENGINEERING CENTER, PHILADELPHIA, PA.
REPORT NUMBER -
NAEC-GSED-59//AD-755151
OTHER INFORMATION -
0032 PAGES, 0004 FIGURES, 0003 TABLES, 0013 REFERENCES

EXPLOSIVE INTERACTION OF LIQUEFIED NATURAL GAS AND ORGANIC LIQUIDS

by

YANG,K.

05/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

WHEN LIQUEFIED NATURAL GAS (LNG) IS SPILLED ONTO WATER, A VIOLENT EXPLOSION MAY OCCUR, CAUSED BY THE SUDDEN RELEASE OF ENERGY STORED IN A SUPERHEATED, METASTABLE LNG PHASE. IT IS THEREFORE TERMED A SUPERHEAT-LIMIT EXPLOSION (SLE). A SLE DOES NOT CONTAIN FLAMES, BUT IS VERY NOISY. ACCORDING TO ONE THEORETICS ESTIMATE, THE EXPLOSION WHICH CAN OCCUR WHEN LNG IS SPILLED ONTO WATER IS EQUIVALENT TO 1/50 TO 1/17 THE EXPLOSION OF A SIMILAR MASS OF TNT. BECAUSE THE LNG WOULD BE SPREAD OVER A MUCH BIGGER AREA, HOWEVER, THE FORCE PER UNIT AREA FROM SUCH AN EXPLOSION WOULD APPARENTLY NOT BE LARGE. SLE ON WATER HAS BEEN SHOWN TO OCCUR ONLY WHEN THE LNG CONTAINS ABNORMALLY HIGH AMOUNTS OF HEAVIER HYDROCARBONS (IS LESS THAN OR EQUAL TO 50 MOL PERCENT). DISCUSSED HERE ARE EXPLOSIONS THAT OCCUR WHEN LNG IS POURED ONTO VARIOUS ORGANIC LIQUIDS. OCCURRENCES OF SLE ON N-PENTANE HAVE BEEN MENTIONED BEFORE, BUT FOR OTHER ORGANIC LIQUIDS THERE IS NO PUBLISHED INFORMATION. BY SHARP CONTRAST WITH WATER, WHERE A HIGH CONCENTRATION OF HEAVY HYDROCARBONS IN LNG IS NEEDED TO CAUSE SLE, EXPLOSIONS ON SOME ORGANIC COMPOUNDS OCCUR EVEN IF LNG HAS ITS USUAL COMPOSITION, LESS THAN 10 PERCENT HEAVY COMPONENTS AND MORE THAN 90 PERCENT METHANE. THE NATURE OF THE COMPOUNDS WHICH CAUSE THE LNG EXPLOSIONS GIVES USEFUL INFORMATION ON THE SLE MECHANISM.

-PERTINENT FIGURES-

FIG.1 BOILING HEAT TRANSFER MECHANISM, PAGE 221

-BIBLIOGRAPHY-

BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., U.S. DEPT. OF INTERIOR, BUREAU OF MINES REPORT, S-4105 (FEB 1970)//KATZ,D.L., CHEM. ENG. PROG., VOL 68, 68 (1972)//KATZ,D.L. AND SLIEPCEVICH,C.M., HYDROCARB. PROC. PETROL. REFIN., 240 (NOV 1971)//ANDERSON,R.P. AND ARMSTRONG,D.R., PROC. THIRD LNG CONFERENCE, WASHINGTON,D.C. (1972)//NAKANISHI,E. AND REID,R.C., LNG-WATER INTERACTIONS, MIT, DEPT. OF CHEMICAL ENGINEERING (JUN 1971)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CONTINENTAL OIL CO., PONCA CITY, OKLA.
JOURNAL PROCEEDINGS -
NATURE (LONDON) VOL 243, NO. 5404, 221-2 (MAY 1973)
OTHER INFORMATION -
0002 PAGES, 0001 FIGURES, 0000 TABLES, 0005 REFERENCES

key 21162

MECHANISM FOR VAPOUR EXPLOSIONS

by

BUCHANAN,D.J.
DULLFORCE,T.A.

09/07/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IT IS WELL KNOWN THAT WHEN A HOT LIQUID COMES INTO CONTACT WITH A COLD VAPORIZABLE LIQUID AN EXPLOSION OF CONSIDERABLE VIOLENCE MAY OCCUR. THIS TYPE OF EXPLOSION IS CALLED ALTERNATIVELY A VAPOUR EXPLOSION, A THERMAL INTERACTION OR FUEL-COOLANT INTERACTION (FCI), THE HOT LIQUID BEING THE FUEL AND THE COLD LIQUID THE COOLANT. THESE INTERACTIONS ARE NOT THE RESULT OF CHEMICAL CHANGE, THE ENERGY SOURCE IS THE EXCESS HEAT IN THE FUEL. FUEL-COOLANT INTERACTIONS HAVE BEEN OBSERVED BETWEEN MOLTEN TIN, INDIUM, STEEL, ALUMINIUM AND COLD WATER, IN THE NUCLEAR FIELD BETWEEN MOLTEN URANIUM DIOXIDE (THE FUEL) AND LIQUID SODIUM (THE COOLANT), AND IN THE CHEMICAL INDUSTRY BETWEEN LIQUEFIED NATURAL GAS, LNG (THE COOLANT) AND WATER (THE FUEL). SEVERAL AUTHORS HAVE RECENTLY DISCUSSED A MODEL FOR THE LNG-WATER INTERACTIONS BASED ON THE THEORY OF HOMOGENEOUS NUCLEATION. IT IS PROPOSED THAT THE WATER HEATS THE LNG TO THE SUPERHEATED, METASTABLE STATE. THE VIOLENT EXPLOSIONS OCCUR WHEN THE LNG REACHES THE HOMOGENEOUS NUCLEATION TEMPERATURE AND SUDDEN VAPORIZATION OCCURS. SUCH A SCHEME CANNOT, HOWEVER, COMPLETELY ACCOUNT FOR ALL FCIS. BECAUSE OF THE LIMITATIONS OF THE SUPERHEATING MODEL, AN ALTERNATIVE MECHANISM IS PROPOSED IN THIS PAPER, AND SOME EXPERIMENTAL EVIDENCE IS INDICATED WHICH SUPPORTS THE MODEL.

-BIBLIOGRAPHY-

MARGOLIS,S.V. AND KRINSLEY,D.H., NAUTRE, VOL 245, 30 (1973)//KRINSLEY,D.H. AND DOORNKAMP,J., ATLAS OF QUARTZ SAND GRAIN SURFACE TEXTURES, (CAMBRIDGE UNIV. PRESS, IN THE PRESS)//BROWN,J.E., THESIS, UNIV. MANCHESTER (1973)// KRINSLEY,D.H. AND MARGOLIS,S., TRANS. N.Y. ACAD. SCI., SER. II, VOL 31, 457 (1969)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNITED KINGDOM ATOMIC ENERGY AUTHORITY, CULHAM, ENGLAND
JOURNAL PROCEEDINGS - NATURE (LONDON) VOL 245, NO. 5419, 32-4

key 21168

UNUSUAL FIRE HAZARD OF LNG TANKER SPILLS

by

FAY,J.A.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE SPREADING AND EVAPORATION RATES OF LIQUEFIED NATURAL GAS SPILLED ON WATER ARE ESTIMATED THEORETICALLY. ACCORDING TO THE CALCULATIONS, SUBSEQUENT GRAVITATIONAL SPREAD AND HEATING OF THE VAPOR EVOLVED FROM THE SPILL GENERATES A PANCAKE-SHAPED CLOUD IN 15 MINUTES OR LESS. THE AUTHOR MAKES AN ANALOGY BETWEEN THE BURNING OF THE DIRIGIBLE HINDENBURG IN 1937 AND THE BURNING OF A FULL CARGO OF AN LNG SUPERTANKER, STATING THAT THAT WOULD BE THE EQUIVALENT OF 100 HINDENBURGS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
MASSACHUSETTS INST. OF TECH., CAMBRIDGE
JOURNAL PROCEEDINGS -
COMBUST. SCI. TECHNOL. VOL 7, NO. 2, 47-9 (1973)
OTHER INFORMATION -
0003 PAGES, 0000 FIGURES, 0001 TABLES, 0006 REFERENCES

keys 21173 through 21175

LNG PLANT EXPLOSION

-ABSTRACT-

ON JANUARY 27, 1972, A NATURAL GAS EXPLOSION SEVERELY DAMAGED THE CONTROL ROOM OF THE LNG LIQUEFACTION AND PEAK-SHAVING PLANT OF GAZ METROPOLITAIN IN MONTREAL EAST, QUEBEC. FIVE MEN IN THE CONTROL ROOM SUFFERED MINOR INJURIES. THE DAMAGE WAS ESTIMATED AT $107,000. THE SEQUENCE OF EVENTS LEADING UP TO THE EXPLOSION IS DISCUSSED IN THIS BRIEF ARTICLE, AS WELL AS REMEDIAL MEASURES INCORPORATED AFTERWARDS. THE PROBLEM OCCURRED AS A RESULT OF INADVERTENTLY LEAVING SEVERAL SHUTOFF VALVES OPEN AFTER A DERIVING CYCLE, PERMITTING NATURAL GAS TO INFILTRATE PNEUMATICALLY OPERATED INSTRUMENTATION LINES GOING INTO THE CONTROL ROOM.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
FIRE J. VOL 66, NO. 4, 38-9 (JUL 1972)
OTHER INFORMATION -
0002 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21177 through 21179

PURGING LNG TANKS WITH NITROGEN

-ABSTRACT-

A 45,000 BARREL LNG STORAGE TANK AT ELIZABETHTOWN GAS COMPANY WAS PURGED OF AIR AND WATER VAPOR AND COOLED TO -260 DEGREES F IN 35 HOURS TO READY IT FOR A LOAD OF LNG. NORMAL PURGING TIME FOR A TANK THIS SIZE IS ONE WEEK. NITROGEN CONSUMPTION USING BANKED CYLINDERS IS USUALLY 2 1/2 TIMES TANK VOLUME, THE PROCESS USED HERE REQUIRED APPROXIMATELY 1 TANK VOLUME FOR THE PURGE - REPRESENTING SIGNIFICANT COST AND TIME SAVING TO THE OWNER. BOTH PURGING AND COOLDOWN OPERATIONS ARE DESCRIBED IN THIS SHORT ARTICLE.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
GAS VOL 49, NO. 2, 48-9 (FEB 1973)
OTHER INFORMATION -
0002 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21180

FRICTION AND WEAR OF SELECTED METALS AND OF CARBONS IN LIQUID NATURAL GAS

by

WISANDER,D.W.

12/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Incremental	Good/Excel.

-ABSTRACT-

FRICTION AND WEAR EXPERIMENTS WERE CONDUCTED WITH HEMISPHERICALLY TIPPED (4.76-MM RADIUS) RIDER SPECIMENS IN SLIDING CONTACT WITH A ROTATING DISK SUBMERGED IN LIQUID NATURAL GAS (LNG). THE PROGRAM INCLUDED METAL COMBINATIONS AND CARBON-METAL COMBINATIONS. THESE EXPERIMENTS REVEALED THAT THE METAL COMBINATIONS WERE NOT LUBRICATED BY THE LNG. CARBONS HAD MUCH LOWER WEAR IN LNG THAN IN LIQUID HYDROGEN OR IN LIQUID NITROGEN. (WEAR OF CARBON IN LIQUID HYDROGEN WAS 100 TIMES THAT IN LNG.) THE FRICTION COEFFICIENTS OBTAINED IN LNG (0.6 FOR METAL-METAL AND 0.2 FOR CARBON-METAL) ARE SIMILAR TO THOSE OBTAINED IN LIQUID HYDROGEN.

-PERTINENT FIGURES-

FIG.2 METAL COMBINATIONS SLIDING IN LIQUID NATURAL GAS, PAGE 6//FIG.4 CARBON SLIDING AGAINST STEEL IN LIQUID NATURAL GAS, PAGE 9

-BIBLIOGRAPHY-

EISENBERG,J.D. AND CHAMBELLAN,R.E., TANKAGE SYSTEMS FOR A METHANE FUELED SUPERSONIC TRANSPORT, PAPER 68-196, AIAA, (FEB 1968)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO
REPORT NUMBER -
N72-15459//NASA-TND-6613
OTHER INFORMATION -
0014 PAGES, 0004 FIGURES, 0002 TABLES, 0012 REFERENCES

keys 21181 through 21182

WELDED TANKS FOR LIQUEFIED GASES

by

RILEY,G.E.
PLATE,C.A.

02/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

DESIGN APPROACHES, CHOICE OF MATERIALS, AND WELDING PROCEDURES FOR ABOVE-GROUND WELDED LPG AND LNG STORAGE TANKS ARE REVIEWED, AND COMPARISON IS MADE BETWEEN THE REQUIREMENTS OF API 620 AND BS 4741 STANDARDS. PARTICULAR EMPHASIS IS GIVEN TO STORAGE VOLUME LIMITATION FOR PROPANE TANKS DESIGNED TO BS 4741.

-PERTINENT FIGURES-

FIG. 1 SKETCH OF DOUBLE-WALL LNG TANK, PAGE 52

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
METAL CONSTR. BRIT. WELD. J. VOL 6, NO. 2, 52-5 (FEB 1974)
OTHER INFORMATION -
0004 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21183 through 21188

LNG CARRIERS. THE CURRENT STATE OF THE ART

by

THOMAS,W.D.
SCHWENDTNER,A.H.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Good/Excel.

-ABSTRACT-

THIS PAPER DISCUSSES IN VERY BROAD TERMS SOME OF THE TECHNICAL AND OPERATIONAL ASPECTS OF LNG SHIPS, IN WHICH THERE HAS RECENTLY BEEN A GREAT AMOUNT OF INTEREST. A SHORT HISTORY OF THIS TYPE OF VESSEL IS GIVEN, AS ARE CONCISE DESCRIPTIONS OF ALL THE PROPRIETARY DESIGNS WHICH HAVE BEEN CONSTRUCTED OR ARE PRESENTLY BEING OFFERED. THE OPERATIONS WHICH FORM THE BASIS FOR LNG SHIP OPERATION ARE DISCUSSED, AND SOME OF THE FEATURES OF CARGO HANDLING EQUIPMENT AND INSTRUMENTATION, WITH PARTICULAR EMPHASIS ON CARGO MEASUREMENT, ARE OUTLINED BRIEFLY. A SECTION IS INCLUDED WHICH COMPARES THE REQUIREMENTS OF THE CLASSIFICATION SOCIETIES AND REGULATORY BODIES WHICH HAVE DEVELOPED RULES FOR THE CONSTRUCTION OF LNG SHIPS. THE SELECTION OF CONTAINMENT SYSTEMS IS DISCUSSED IN A SECTION WHEREIN THE ADVANTAGES AND DISADVANTAGES OF THE VARIOUS TYPES OF TANK AND INSULATION SYSTEMS ARE COMMENTED UPON. OTHER SECTIONS ARE DEVOTED TO THE OPERATING EXPERIENCE OF SHIPS BUILT TO DATE, POWER PLANT SELECTION, ECONOMICS AND PRINCIPAL SHIP CHARACTERISTICS, AND SOME OF THE POLLUTION AND SAFETY PROBLEMS THAT HAVE BEEN ENCOUNTERED. THE PAPER IS NOT INTENDED TO BE A DESIGN MANUAL FOR THE LNG SHIP, NOR DOES IT DELVE EXHAUSTIVELY INTO THE MANY TECHNICAL AND COMMERCIAL DETAILS THAT ABOUND IN THIS TYPE OF SHIP. A SELECTED BIBLIOGRAPHY IS INCLUDED TO ALLOW THE READER TO SECURE A FULLER BACKGROUND IN THE TECHNOLOGY INVOLVED IN THIS SOPHISTICATED, SPECIALIZED SHIP.

-PERTINENT FIGURES-

TAB.3 PARTICULARS OF LNG SHIPS IN SERVICE AND ON ORDER, PAGE A41-4//FIG.12 INSULATION DETAIL OF CONCH OCEAN MEMBRANE TANK DESIGN, PAGE A12//FIG.14 ESSO BREGA - INSULATION DETAIL, PAGE A13//FIG.16 INSULATION DETAIL OF GAS TRANSPORT MEMBRANE TANK DESIGN, PAGE A13//FIG.17 TYPICAL SECTION OF KVAERNER-MOSS SPHERICAL TANK DESIGN, PAGE A14//FIG.26 PROFILES OF TYPICAL LNG SHIPS (CARGO TANKS ARE SHOWN CROSS-HATCHED), PAGE A39

-BIBLIOGRAPHY-

FFOOKS,R.C. AND JACKSON,R.G., THE TECHNICAL AND COMMERCIAL DEVELOPMENT OF LIQUEFIED NATURAL GAS TANKERS, SECOND INTERNATIONAL CONFERENCE AND EXHIBITION ON LNG, PARIS (1970)//FILSTEAD,C.G. AND BANISTER,M., LOW-TEMPERATURE, LIQUEFIED GAS TRANSPORTATION, TRANS. SNAME, VOL 69, 338-65 (1961)//TENTATIVE GUIDE FOR THE REVIEW OF LIQUEFIED FLAMMABLE GAS CARRIERS, U.S. COAST GUARD (APR 1971)//ATKINSON,F.H., A CLASSIFICATION SOCIETIES APPROACH TO VESSELS DESIGNED FOR THE CARRIAGE OF LIQUEFIED GASES, SECOND INTERNATIONAL CONFERENCE AND EXHIBITION ON LNG, PARIS (1970)//LIQUID NATURAL GAS - CHARACTERISTICS AND BURNING BEHAVIOR, CONCH METHANE SERVICES, LTD. (1962)//BURGESS,D.S., ET AL., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES (FEB 1970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
HENRY (J.J.) CO., INC., NEW YORK
JOURNAL PROCEEDINGS -
SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS ANNUAL MEETING, (PRES. AT) NEW YORK, NOV 11-2, 1971
OTHER INFORMATION -
0046 PAGES, 0002 FIGURES, 6003 TABLES, 0049 REFERENCES

keys 21207 through 21208

SAFETY OF THE SEA TRANSPORTATION OF LNG

by

MASSAC,G.

02/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IN THIS ARTICLE DISCUSSING SAFETY ASPECTS AND RISK PROBABILITY IN THE SEA TRANSPORTATION OF LNG, THE AUTHOR CONCLUDES. 1) THE SEA TRANSPORATION OF LNG INVOLVES, IN ITSELF, LESS RISK THAN THAT OF CARRYING OIL IN CONVENTIONAL TANKERS, 2) COMPARED WITH LPG TANKERS, METHANE CARRIERS ARE NOT SIGNIFICANTLY DIFFERENT FROM THE RISK ASPECT, 3) THE DESIGN IS SUCH THAT DAMAGE RESULTING FROM THE TYPE OF COLLISION MOST FREQUENT IS UNLIKELY TO CAUSE RUPTURE OF THE CARGO CONTAINMENT SYSTEM. IF THE CONTAINMENT SYSTEM IS RUPTURED, FROM PRESENT STATE OF KNOWLEDGE IT IS BELIEVED THAT THE FREE EXPLOSION RISK IS LESS THAN WITH A TANKER CARRYING LIQUID HYDROCARBONS DUE TO THE VAPORIZATION AND SPREADING CHARACTERISTICS, 4) THERE ARE NO GROUNDS FOR BELIEVING THE STATEMENT THAT EXPLOSION WOULD AUTOMATICALLY FOLLOW COLLISION INVOLVING A METHANE TANKER.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
TANKER BULK CARRIER VOL 18, NO. 10, 14 + 16 (FEB 1972)
OTHER INFORMATION -
0002 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 19748 through 19750

AN INTRODUCTION TO THE MARINE TRANSPORTATION OF BULK LNG AND THE DESIGN OF LNG CARRIERS

by

WILSON, J. J.

03/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE SPECIAL PROBLEMS CONNECTED WITH BUILDING SHIPS TO CARRY LIQUEFIED NATURAL GAS ARE SUMMARIZED AND THE DIFFERENT DESIGNS OF SHIPS PRESENTLY IN USE ARE DISCUSSED. OTHER PROBLEMS CONCERNED WITH MARINE TRANSPORT OF LNG SUCH AS HANDLING, PUMPING SYSTEMS, AND DEALING WITH BOIL-OFF GASES ARE ALSO CONSIDERED.

-PERTINENT FIGURES-

FIG.1 BRIDGESTONE SEMI-INDEPENDENT TANK SYSTEM//FIG.2 TECHNIGAZ CONCH OCEAN MEMBRANE TANK SYSTEM//FIG.3 TYPICAL SECTION OF GAZ TRANSPORT MEMBRANE TANK DESIGN//FIG.4 MOSS ROSENBERG SYSTEM AND SKIRT ATTACHMENT TO SPHERICAL TANK

-SOURCE INFORMATION-

CORPORATE SOURCE -
LLOYDS REGISTER OF SHIPPING, LONDON, ENGLAND
JOURNAL PROCEEDINGS -
CRYOGENICS VOL 14, NO. 3, 115-20 (MAR 1974)
OTHER INFORMATION -
0006 PAGES, 0004 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21216 through 21217

PRELIMINARY OPERATING RESULTS OF AXIAL TURBO-COMPRESSORS AT SKIKDA

by

GUGUEN,B.
CHERIFI,M.S.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE TURBO-COMPRESSOR SYSTEM AT SKIKDA, ALGERIA, RATED AT 73.5 MW, CONSISTS OF A SINGLE TURBINE DRIVING HIGH-PRESSURE AND LOW-PRESSURE COMPRESSORS, WITH 77 PERCENT OF ITS POWER SUPPLIED TO THE HIGH-PRESSURE COMPRESSOR AND 23 PERCENT TO THE LOW-PRESSURE COMPRESSOR. THE TURBINE IS CONTROLLED BY CHANGING ITS SPEED IN RESPONSE TO THE REQUIREMENTS OF THE LOW-PRESSURE COMPRESSOR. PRIOR TO INSTALLATION, THE TURBO-COMPRESSOR UNIT WAS TESTED WITH AIR, NATURAL GAS, AND REFRIGERANT GAS TO CHECK THE EFFECTS OF MOLECULAR WEIGHTS AND OTHER PARAMETERS ON THE OPERATING CHARACTERISTICS. OPERATING PROBLEMS EXPERIENCED INCLUDED RUPTURE OF THE INJECTION NOZZLE, CAUSING BREAKING OF THE FIRST-STAGE BLADING, DEFORMATION OF THE TURBINE CASING, LEAKS AT THE HORIZONTAL JOINTS, VALVE BLOCKAGE IN THE INTERMEDIATE RECYCLING STAGE, AUTOMATIC START-UP CONTROL, BLADE DAMAGES, RUPTURE OF THE VALVE SYSTEM IN THE COLD RECYCLE STAGE, AND VIBRATIONS AND OIL LEAKS. MOST OF THE DIFFICULTIES WERE SOLVED BY REDUCING THE OPERATING SPEED FROM 3240-3940 RPM TO 3300-3450 RPM, MODIFYING THE EQUIPMENT DESIGN, AND CHANGING MATERIALS OF CONSTRUCTION AND OPERATING CONDITIONS. HOWEVER, THE BRIEF OPERATING EXPERIENCE ACCUMULATED TO DATE AND THE INCOMPLETE TESTING OF THESE MODIFICATIONS PREVENT FINAL RECOMMENDATIONS CONCERNING THE FEASIBILITY OF THE APPLICATION OF TURBO-COMPRESSORS IN THE LIQUEFACTION OF NATURAL GAS USING A MIXED-REFRIGERANT PROCESS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
SONATRACH, SKIKDA, ALGERIA
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 4TH, (PROC. OF, SESSION III) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 8
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0011 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21218 through 21221

LNG PEAKSHAVING PLANT OPERATING EXPERIENCE

by

SIPPLE,P.A.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

AIR PRODUCTS HAD EXPERIENCED A CUMMULATIVE TOTAL OF FIFTEEN YEARS OPERATING EXPERIENCE WITH LNG PEAKSHAVING FACILITIES AT THE TIME THIS PAPER WAS WRITTEN. THE THREE FACILITIES OWNED AND/OR OPERATED BY AIR PRODUCTS REPRESENTED 15 PERCENT OF THE TOTAL LNG LIQUEFACTION CAPACITY OPERATIONAL IN THE UNITED STATES IN 1974. A CENTRALIZED, SYSTEMATIC APPROACH TO OPERATIONS MANAGEMENT IS CREDITED WITH THE RELIABLE AND SAFE PERFORMANCE OF THESE FACILITIES. A COMPUTER CO-ORDINATED CONTROL PROGRAM IS USED TO PROVIDE PREVENTIVE MAINTENANCE TASK IDENTIFICATION, COMPLIANCE REPORTING AND FEEDBACK DATA ACCUMULATION. THE USE OF THIS PROGRAM ON A MULTI-PLANT SYSTEM PROVIDES FOR EFFECTIVE COMMUNICATION WITH REGARD TO PROCEDURES AND OTHER IMPORTANT FACTORS WHICH HAVE A DIRECT AND IMMEDIATE IMPACT ON PLANT PERFORMANCE. SAFETY INSPECTIONS AND TEST ACTIVITIES ARE INCLUDED IN THE COMPUTERIZED CONTROL PROGRAM. THE TASK IDENTIFICATION, COMPLIANCE REPORTING, UNIFORMITY OF APPLICATION AND DATA ACCUMULATION ASPECTS OF THE CENTRALIZED CONTROL PROGRAM ARE ALL BROUGHT TO BEAR ON SAFETY ASPECTS OF PLANT OPERATION, THUS INCREASING THE EFFECTIVENESS OF LOSS PREVENTION ACTIVITIES. THE OPERATING PHILOSOPHY AND TECHNIQUES DISCUSSED ARE APPLIED BY AIR PRODUCTS NOT ONLY IN LNG PEAKSHAVING BUT IN SUPPORT OF ALL OF ITS OPERATING FACILITIES ON A WORLD-WIDE BASIS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 4TH, (PROC. OF, SESSION IV) ALGIERS, ALGERIA, JUN 24-7, 1974. PAPER 5
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0014 PAGES, 0006 FIGURES, 0003 TABLES, 0000 REFERENCES

keys 21224 through 21231

LIQUEFIED PETROLEUM GASES. A GUIDE TO PROPERTIES, APPLICATIONS AND USAGE OF PROPANE AND BUTANE

by

WILLIAMS,A.F.
LOM,W.L.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE INTENTION OF THIS BOOK IS TO PRESENT IN ONE PUBLICATION ALL AVAILABLE PRACTICAL INFORMATION ON LPG. THE GROWTH OF LPG AS A FUEL AND A CHEMICAL FEEDSTOCK HAS EMPHASIZED THE NEED FOR A SINGLE SPECIALIST PUBLICATION DEALING WITH THE PRODUCT. CHAPTERS INDEXED FOR ASRDI ARE CHAPTER 2, MANUFACTURE OF LPG//CHAPTER 3, COMPOSITION AND CHEMICAL PROPERTIES// CHAPTER 4, PHYSICAL PROPERTIES// CHAPTER 5, QUALITY CONTROL AND ANALYTICAL METHANE//CHAPTER 6, COMBUSTION OF LPG//CHAPTER 7, BURNERS AND ANCILLARY EQUIPMENT//CHAPTER 8, BULK DISTRIBUTION AND HANDLING//CHAPTER 9, LPG CYLINDERS AND ASSOCIATED EQUIPMENT//CHAPTER 11, LPG AS AN AUTOMOTIVE FUEL.

-SOURCE INFORMATION-

CORPORATE SOURCE -
ESSO DEVELOPMENT CO., LTD., ABINGDON, ENGLAND
PUBLISHER -
ELLIS HORWOOD LTD., CHICHESTER, ENGLAND
OTHER INFORMATION -
0416 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 21108 through 21109

CRYOGENIC TANK

by

LARSEN,L.V.

04/27/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

AN INSULTAED TANK FOR STORAGE OF LIQUIDS AT LOW TEMPERATURES. THE TANK HAS AN OUTER SHELL COMPRISING A BOTTOM, SIDEWALLS AND ROOF, AND AN INNER SHELL COMPRISING AT LEAST A BOTTOM AND SIDEWALLS, WITH OR WITHOUT AN INNER ROOF. THE INNER SHELL BOTTOM IS MADE OF METAL SHEET OR PLATE SUSPENDED FROM A PLURALITY OF SPACED-APART SUPPORTS RESTING ON THE BOTTOM OF THE OUTER SHELL. THE SUSPENDED INNER SHELL BOTTOM HAS A PLURALITY OF ELONGATED CORRUGATIONS OF SMOOTHLY UNDULATING CONTOUR WITH THE VALLEYS OF THE CORRUGATIONS BEING BETWEEN THE SUPPORTS, AND A PLURALITY OF CORRUGATIONS CROSSING AND GENERALLY CONFORMING TO THE SMOOTHLY UNDULATING CONTOUR OF SAID ELONGATED CORRUGATIONS. THE CORRUGATIONS ACCOMMODATE THE LIQUID LOAD AND CONTRACTION OF THE SUSPENDED INNER SHELL BOTTOM DURING LOW TEMPERATURE USE OF THE TANK WITHOUT SUBSTANTIAL HORIZONTAL MOVEMENT OF SAID SUSPENDED BOTTOM OR ITS SUPPORTS AND WITHOUT OVERSTRESSING THE METAL SHEET OR PLATE OF WHICH THE INNER SHELL BOTTOM IS MADE. THE TANK ALSO HAS INSULATING MATERIAL BENEATH SAID SUSPENDED INNER SHELL METAL BOTTOM, BETWEEN THE INNER AND OUTER SIDEWALLS OF THE TANK AND BENEATH THE ROOF.

-PERTINENT FIGURES-

FIG.1 VERTICAL PARTIAL SECTIONAL VIEW OF A STORAGE TANK FOR LIQUEFIED GASES OR OTHER LIQUIDS TO BE STORED AT LOW TEMPERATURES//FIG.4 HORIZONTAL SECTIONAL VIEW OF A CYLINDRICAL TANK IN WHICH THE INNER BOTTOM HAS RADIAL CORRUGATIONS AND A PLURALITY OF CIRCULAR SMOOTHLY UNDULATING CORRUGATIONS SPACED OUTWARDLY ABOUT THE AXIS OF THE TANK//FIG.7 ELEVATIONAL END VIEW OF A WOODEN SUPPORT WHICH CAN BE USED FOR SUPPORTING THE INNER SHELL BOTTOM

-BIBLIOGRAPHY-

DELMAR, U S PATENT NO. 2,702,458 (FEB 1955)//BECKMAN, U S PATENT NO. 3,094,071 (JUN 1963)//EDWARDS, U S PATENT NO. 3,220,595 (NOV 1965)// CANADA, PATENT NO. 668,208 (AUG 1963)//FRANCE, PATENT NO. 1,442,256 (MAY 1966)//GREAT BRITAIN, PATENT NO. 1,170,842 (NOV 1969)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.
REPORT NUMBER -
U.S. PATENT NO. 3,576,270
OTHER INFORMATION -
0007 PAGES, 0012 FIGURES, 0000 TABLES, 0009 REFERENCES

keys 21240 through 21241

BOILING OF LIQUEFIED HYDROCARBONS ON WATER

by

JEJE, A.A.
REID, R.C.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

LNG (LIQUEFIED NATURAL GAS) IS SHIPPED AT ESSENTIALLY ATMOSPHERIC PRESSURE IN INSULATED TANKERS AND BARGES. SHOULD AN ACCIDENTAL SPILL OCCUR ON WATER, RAPID VAPORIZATION RESULTS. TO ESTIMATE DOWNWIND VAPOR CONCENTRATIONS, ONE MUST BE ABLE TO DETERMINE THE SOURCE RATE OF VAPOR EVOLUTION AT THE SPILL SITE. A SPILLED CRYOGENIC LIQUID SIMULTANEOUSLY SPREADS AND BOILS. THE PRESENT STUDY DEALS ONLY WITH THE LATTER PHENOMENON. THE CRYOGENS STUDIED WERE LIQUID NITROGEN, METHANE, ETHANE, AND SEVERAL TYPICAL LNG COMPOSITIONS. THE CRYOGENIC LIQUID COMPOSITIONS, INITIAL WATER TEMPERATURE AND QUANTITY SPILLED PER UNIT AREA WERE THE PRIMARY VARIABLES STUDIED. BOILING RATES WERE MEASURED BY EMPLOYING A LOAD CELL TO MONITOR THE RESIDUAL MASS OF LIQUID CRYOGEN. TEMPERATURES WERE ALSO MEASURED CONTINUOUSLY IN BOTH THE VAPOR AND THE WATER. INITIAL BOILING FLUXES FOR LIQUID NITROGEN RANGED FROM ABOUT 8,000 TO 11,000 BTU/HR-FT(2) AND DECREASED SLOWLY WITH TIME. FOR PURE METHANE (99.98), THE INITIAL FLUXES WERE IN A SIMILAR RANGE, BUT THEY INCREASED SLIGHTLY WITH TIME. WHEN EVEN TRACE AMOUNTS (E.G., 0.1 - 0.2 PERCENT) OF HEAVIER ALKANE HYDROCARBONS WERE PRESENT IN METHANE, SIGNIFICANT INCREASES IN THE BOILING FLUX WERE NOTED. WITH A LEAN LNG (98.2 PERCENT CH(4)) THE BOILING FLUX WAS ALMOST TWO TIMES THAT NOTED FOR PURE METHANE, AND THE RATE OF INCREASE OF THE FLUX WAS QUITE PRONOUNCED WITH TIME. VERY HIGH BOILING FLUXES WERE ALSO NOTED FOR LIQUID ETHANE SPILLS. A NUMBER OF PHOTOGRAPHS WERE TAKEN OF THE WATER-CRYOGEN INTERFACES DURING BOILING. THE PHOTOGRAPHS ALLOWED MEASUREMENT OF THE AVERAGE VAPOR BUBBLE SIZE AND TO EVALUATE THE EXTENT AND RATE OF ICE FORMATION AT THE SURFACE. NO SATISFACTORY THEORY HAS YET BEEN FORMULATED TO EXPLAIN ALL THE RESULTS OBSERVED. LIQUEFIED NITROGEN AND METHANE APPARENTLY EVAPORATE IN STABLE FILM BOILING WITH NO SIGNIFICANT ICE FORMATION AT THE INTERFACE. IN PURE ETHANE RUNS, ICE FORMED QUICKLY AND BOTH FILM AND NUCLEATE BOILING RESULTED. FOR LNG MIXTURES, SIGNIFICANT FOAMING RESULTED AND IT IS ALSO SUSPECTED THAT ICE IS RAPIDLY FORMED AND REMELTED BY EDDY CIRCULATION IN THE UPPER LAYER OF WATER.

-PERTINENT FIGURES-

FIG.6 HEAT FLUXES BETWEEN WATER AND BOILING METHANE (99.98 PERCENT), PAGE 17//FIG.7 HEAT FLUXES BETWEEN WATER AND BOILING METHANE-ETHANE BINARY MIXTURES, PAGE 18//FIG.8 HEAT FLUXES BETWEEN WATER AND BOILING METHANE-PROPANE BINARY MIXTURES, PAGE 19//FIG.9 HEAT FLUXES BETWEEN WATER AND BOILING METHANE-N-BUTANE BINARY MIXTURES, PAGE 20//FIG.10 HEAT FLUXES BETWEEN WATER AND BOILING LNG, PAGE 21

-BIBLIOGRAPHY-

BOYLE,G.J. AND KNEEBONE,A., LABORATORY INVESTIGATIONS INTO THE CHARACTERISTICS OF LNG SPILLS ON WATER. EVAPORATION, SPREADING, AND VAPOR DISPERSION, SHELL RESEARCH LIMITED, THORNTON RESEARCH CENTER, CHESTER, ENGLAND, MAR 1973//BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, U.S. BUREAU OF MINES, FEB 1970// BURGESS,D.S., BIORDI,J. AND MURPHY,J., HAZARDS OF SPILLAGE OF LNG INTO WATER, U.S. BUREAU OF MINES, SEP 1972//JEJE,A.A., TRANSIENT POOL BOILING OF CRYOGENIC LIQUIDS ON WATER, PH.D. THESIS, CHEM. ENG. DEPT., M.I.T. (1974)//MAY,W.G., MCQUEEN,W. AND WHIPP,R.H., DISPERSION OF LNG SPILLS, HYDRO. PROC. VOL 105, MAY 1973)//NAKANISHI,E. AND REID,R.C., LIQUID NATURAL GAS-WATER REACTIONS, CHEM. ENG. PROG. VOL 67, 36-41 (1971)

-SOURCE INFORMATION-

CORPORATE SOURCE -
MASSACHUSETTS INST. OF TECH., CAMBRIDGE
JOURNAL PROCEEDINGS -
NATURAL GAS RESEARCH AND TECHNOLOGY CONF., 3RD, (PROC. OF, SESSION VI) DALLAS, TEX., MAR 6-8, 1974. PAPER NO. 1
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0021 PAGES, 0010 FIGURES, 0000 TABLES, 0014 REFERENCES

keys 21242 through 21244

THERMAL RADIATION FROM LNG FIRES AND LNG FIRE SUPPRESSION

by

BROWN,L.E.
WESSON,H.R.
WELKER,J.R.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IF A VAPOR CLOUD FROM AN LNG SPILL IS IGNITED, THE FIRE WILL BURN BACK TO THE LIQUID POOL, CONSUMING THE VAPOR CLOUD AS IT BURNS. THE FIRE IN THE VAPOR CLOUD WILL BE RELATIVELY SHORT IN DURATION, BUT WILL PRODUCE SUFFICIENT HEAT FOR LONG ENOUGH TIMES TO IGNITE THIN MATERIALS AND BURN PERSONNEL. IF IGNITION OCCURS SOON AFTER THE SPILL, THE CLOUD MAY NOT DRIFT BEYOND THE IMMEDIATE PLANT AREA. IN EITHER CASE, IF A SUBSTANTIAL AMOUNT OF LNG IS SPILLED AND FIRE OCCURS, THE FIRE CAN EASILY DAMAGE EQUIPMENT AND FACILITIES IN OR NEAR THE PLANT AREA. THERE ARE TWO GENERAL APPROACHES THAT CAN BE USED TO PROTECT SURROUNDING FACILITIES FROM DAMAGE OR DESTRUCTION. SUFFICIENT COOLING CAN BE PROVIDED TO PREVENT DAMAGE OR THE FIRE CAN BE CONTROLLED OR EXTINGUISHED. IF PROTECTION TO SURROUNDING FACILITIES IS TO BE BY COOLING, THE HEAT LOAD AT THOSE AREAS MUST BE KNOWN. IF CONTROL OR EXTINGUISHMENT IS CHOSEN, PROPER FIRE PROTECTION SYSTEMS MUST BE DESIGNED. A BRIEF, SIMPLIFIED DISCUSSION SHOWS HOW EITHER MAY BE HANDLED.

-PERTINENT FIGURES-

FIG.2 MEASURED AND PREDICTED FLAME ANGLES FOR LNG FIRES, PAGE 8//FIG.3 SURFACE FLUXES FOR LNG FIRES, PAGE 9//FIG.5 RADIANT FLUXES FROM A 100-FT. LNG FIRE UNDER CALM CONDITIONS, PAGE 11//FIG.6 MAXIMUM RADIANT FLUXES DOWNWIND FROM A 100-FT. LNG FIRE, PAGE 12//FIG * EXTINGUISHING TIMES FOR DRY CHEMICALS APPLIED TO STEADY STATE LNG FIRES UNDER IDEAL CONDITIONS, PAGE 14//FIG.11 REDUCTION IN EXTERNAL RADIANT HEAT FLUXES USING HIGH EXPANSION FOAM, PAGE 17

-BIBLIOGRAPHY-

AMERICAN GAS ASSOCIATION PROJECT IS-3-1, PHASE II, CONSEQUENCES OF LNG SPILLS ON LAND, FINAL REPORT (1974)//REIN,R.G., SLIEPCEVICH,C.M., AND WELKER,J.R., RADIATION VIEW FACTORS FOR TILTED CYLINDERS, J. FIRE AND FLAMMABILITY VOL 1, 140 ((6))//THOMAS,P.H., THE SIZE OF FLAMES FROM NATURAL FIRES, NINTH

INTERNATIONAL SYMPOSIUM ON COMBUSTION, ACADEMIC PRESS, NEW YORK (1963)//WELKER,J.R. AND SLIEPCEVICH,C.M., SUSCEPTIBILITY OF POTENTIAL TARGET COMPONENTS TO DEFEAT BY THERMAL ACTION, UNIVERSITY OF OKLAHOMA RESEARCH INSTITUTE REPORT NO. OURI-1578-FR, NORMAN, OKLAHOMA (1970)//WESSON,H.R., WELKER,J.R., BROWN,L.E. AND SLIEPCEVICH,C.M., FIGHT LNG FIRES WITH FOAM. HYDROCARBON PROCESSING VOL 52, 165 (OCT 1973)// WESSON,H.R., WELKER,J.R., BROWN,L.E. AND SLIEPCEVICH,C.M., FIGHT LNG FIRES WITH DRY CHEMICALS, HYDROCARBON PROCESSING VOL 52, 234 (NOV 1973)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
NATURAL GAS RESEARCH AND TECHNOLOGY CONF., 3RD, (PROC. OF, SESSION VI) DALLAS, TEX., MAR 6-8, 1974. PAPER NO. 2
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0017 PAGES, 0011 FIGURES, 0001 TABLES, 0006 REFERENCES

keys 21245 through 21246

LNG DIKE DESIGN

by

PARKER,R.O.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

CONTAINMENT DESIGN FOR LNG SPILLS IS TREATED IN THIS PAPER. BASIC, BUT NOT ESSENTIAL TC THE TREATMENT, IS RECOGNITION THAT A FINITE TIME PERIOD IS REQUIRED FOR A LARGE AMOUNT OF LIQUID TO BE SPILLED. THIS AND THE FACT THAT VAPOR GENERATION RATES DECAY WITH TIME LEAD TO A RATIONAL DESIGN PROCEDURE. A GENERAL METHOD IS OUTLINED. DESIGN VARIATIONS ARE SUGGESTED. A FLOW CHART OF AN EXISTING COMPUTER PROGRAM FOR INSTANTANEOUS SPILL IS INCLUDED IN THE PAPER.

-PERTINENT FIGURES-

FIG.1 COMPUTER PROGRAM FLOW CHART - LNG VAPOR DISPERSION SUBROUTINE, PAGE 5

-SOURCE INFORMATION-

CORPORATE SOURCE -
POLYTECHNIC INST. OF NEW YORK, BROOKLYN
JOURNAL PROCEEDINGS -
NATURAL GAS RESEARCH AND TECHNOLOGY CONF., 3RD, (PROC. OF, SESSION VI) DALLAS, TEX., MAR 6-8, 1974. PAPER NO. 3
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0006 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

key 21247

CONVECTION PATTERNS IN STRATIFIED LNG TANKS - CELLS DUE TO LATERAL HEATING

by

GRIFFIS,K.A.
SMITH,K.A.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

ROLL-OVER IN LNG TANKS HAS BEEN ASCRIBED TO THE RAPID MIXING OF STRATIFIED LAYERS WHICH HAD RESULTED FROM THE ADDITION OF LNG OF A CERTAIN DENSITY TO A TANK WHICH WAS ALREADY PARTIALLY FILLED WITH A LNG OF A DIFFERENT DENSITY. CAREFUL FILL NOZZLE DESIGN CAN DO MUCH TO ACHIEVE MIXING DURING THE FILLING PROCESS, BUT A RESIDUAL CONCENTRATION (AND THUS DENSITY) GRADIENT ALWAYS REMAINS. TURNER (1968) HAS DESCRIBED THE FORMATION OF LAYERS FROM SUCH A GRADIENT AS A RESULT OF BOTTOM HEAT FLUX, OTHERS HAVE STUDIED LAYER FORMATION AS A RESULT OF HEAT TRANSFER FROM AN ISOTHERMAL VERTICAL WALL. THIS PAPER TREATS THE SUBJECT OF LAYER FORMATION DUE TO A UNIFORM LATERAL HEAT FLUX, SUCH AS EXISTS AT AN LNG TANK WALL. EXPERIMENTALLY, A WATER-SUGAR SYSTEM HAS BEEN USED TO MODEL THE METHANE-HIGHER HYDROCARBON SYSTEM OF INTEREST, AS JUSTIFIED BY DIMENSIONAL ANALYSIS. A CONCENTRATION GRADIENT IS ESTABLISHED IN A 30 CM CUBE FOR WHICH ONE SIDE WALL IS OF ALUMINUM WHEREAS ALL OTHERS ARE OF PLEXIGLAS, AND THE EXPERIMENT IS INITIATED BY EXPOSING THE ALUMINUM WALL TO RADIANT HEAT. THIS RESULTS IN HORIZONTAL CONVECTION CELLS WHICH ARE OBSERVED BY DYE TRACER TECHNIQUES AND BY SHADOWGRAPH. PRELIMINARY RESULTS INDICATE THAT CONVECTIVE LAYERS WILL BE RELATIVELY THIN FOR CASES WHICH ARE GERMANE TO LNG STORAGE. FOR COMPUTATIONAL PURPOSES, LAYERS RESULTING FROM SUCH LATERAL HEATING MAY EVEN BE ASSUMED TO BE INFINITELY THIN.

-BIBLIOGRAPHY-

CHATTERJEE,N. AND GEIST,J.M., THE EFFECTS OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS, PIPELINE AND GAS J., VOL 199, 40-5 (1972)//DRAKE,E.M., GEIST,J.M. AND SMITH,K.A., PREVENT LNG ROLL-OVER, HYDROCARBON PROCESSING, VOL 52, 87-90 (MARCH 1973)//SMITH,K.A., LEWIS,J.M., RANDALL,G.A. AND MELDON,J.H., PREVENTION OF ROLL-OVER BY MIXING DURING THE FILLING OF LNG STORAGE TANKS, TO APPEAR IN ADVANCES IN CRYOGENIC ENGINEERING (1974)

-SOURCE INFORMATION-

CORPORATE SOURCE -
MASSACHUSETTS INST. OF TECH., CAMBRIDGE
JOURNAL PROCEEDINGS -
NATURAL GAS RESEARCH AND TECHNOLOGY CONF., 3RD, (PROC. OF, SESSION VI) DALLAS, TEX., MAR 6-8, 1974. PAPER NO. 4
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0013 PAGES, 0003 FIGURES, 0000 TABLES, 0012 REFERENCES

key 19586

THERMAL RADIATION FROM STORED LNG RELEASE

by

CARPENTER, H. J.
MORIZUMI, S. J.
PETERSON, J. B.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE AMERICAN GAS ASSOCIATION CONTRACTED WITH TRW SYSTEMS TO STUDY THE ENVIRONMENT ASSOCIATED WITH A MASSIVE FAILURE OF A LIQUID NATURAL GAS (LNG) STORAGE FACILITY. TWO ENVIRONMENTAL PHENOMENA WERE STUDIED. RADIATION FROM A LARGE FIRE AND OVERPRESSURE FROM AN EXPLOSION. THE MORE PROBABLE OF THE TWO ENVIRONMENTS, FIRE, IS DISCUSSED HERE. RADIATION IS EXPECTED TO BE THE DOMINANT ENERGY RELEASE MECHANISM OF A FIRE. A NUMBER OF CONSIDERATIONS ARE IMPORTANT FOR LARGE FIRES (DIMENSIONS OF HUNDREDS OF FEET) WHICH ARE INCONSEQUENTIAL FOR SMALL FIRES. THESE INCLUDE ABSORPTION OF RADIATION WITHIN THE FLAME, RADIATION CONTROL OF THE LNG BOILOFF RATE, CIRCULATION OF THE SURROUNDING ATMOSPHERE, AND THE EFFECT ON THE CHEMICAL KINETICS OF THE LARGER RESIDENCE TIME IN THE LARGE FIRE. THESE EFFECTS CAN MAKE A LARGE FIRE QUALITATIVELY DIFFERENT FROM A SMALL FIRE. THEREFORE, IT IS IMPROPER TO SIMPLY SCALE SMALL FIRES. INSTEAD, A THEORETICAL MODEL IS DISCUSSED WHICH INCLUDES EFFECTS WHICH ARE NOT IMPORTANT FOR SMALL FIRES. THE MODEL IS DIVIDED INTO TWO COUPLED PARTS - A FLUID MODEL WHICH DESCRIBES THE THERMODYNAMIC AND FLOW PROPERTIES IN THE FLAME AS A FUNCTION OF POSITION, AND A RADIATION MODEL. A SUPPLEMENTARY RADIATION MODEL CALCULATES RADIATION, INHERENTLY THREE-DIMENSIONAL, TO EXTERNAL REGIONS. THE FLUID MODEL INCORPORATES A THERMOCHEMICAL MODEL FOR DESCRIBING THE CHEMICAL CONSTITUENTS AND THEIR THERMODYNAMIC STATES. THESE MODELS ARE DESCRIBED AND THE MOST IMPORTANT EQUATIONS ARE GIVEN.

-PERTINENT FIGURES-

FIG.1 FLAME SCHEMATIC, PAGE 4

-BIBLIOGRAPHY-

TASK ASPO-24, THERMAL RADIATION FROM SATURN FIREBALL, VOLUME I, TRW SYSTEMS REPORT 2122-6001-T0000, 15 DECEMBER 1965

-SOURCE INFORMATION-

CORPORATE SOURCE -
TRW, INC., REDONDO BEACH, CALIF.
JOURNAL PROCEEDINGS -
LNG INTERNATIONAL CONF., 1ST, (PROC. OF, SESSION NO. 5)
CHICAGO, ILL., APR 7-12, 1968. PAPER 25
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0009 PAGES, 0001 FIGURES, 0001 TABLES, 0004 REFERENCES

keys 19587 through 19590

CONSIDERATIONS FOR LNG PIPE MATERIAL SELECTION

by

DAINORA, J.
DUFFY, A. R.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE OBJECTIVE OF THIS PAPER IS TO DISCUSS SOME CONSIDERATIONS IN ARRIVING AT A MATERIAL SELECTION FOR AN LNG PIPELINE FROM A FRACTURE TOUGHNESS VIEWPOINT. ALTHOUGH THERE ARE OTHER CONSIDERATIONS THAT MUST BE TAKEN INTO ACCOUNT IN THE SELECTION OF AN APPROPRIATE PIPE MATERIAL FOR A GIVEN PROJECT--E.G., STRENGTH, WELDABILITY, FABRICABILITY, CONTRACTION COEFFICIENT, ETC.--ONLY FRACTURE TOUGHNESS CONSIDERATIONS WILL BE TREATED IN THE PRESENT PAPER.

-BIBLIOGRAPHY-

ANDERSON,J.H., LIQUEFIED-METHANE PIPELINE. NEXT GAS TRANSMISSION STEP., OIL AND GAS J., VOL 63, 74-80 (1965) FEB 8//DIMENTBERG,M., BETTER ECONOMICS PROMISE EVENTUAL USE OF LNG LINES, OIL AND GAS J., VOL 65, 96-102 (1967) SEP 18//CARBONELL,E., GUERIN,J.Y., AND SOLENTE,P., THE TRANSPORT OF LNG BY PIPE LINES, TECHNICAL AND ECONOMIC ASPECTS, ADVANCES IN CRYOGENIC ENGINEERING, K. D. TIMMERHAUS, EDITOR VOL 12, 452-457. NEW YORK, PLENUM PRESS, 1966//DAINORA,J., DUFFY,A.R., ATTERBURY,T.J., MATERIALS FOR CONSTRUCTION FOR USE IN AN LNG PIPELINE, AMERICAN GAS ASSOCIATION REPORT CATALOGUE NO. 40000, (APRIL, 1968) //DUFFY,A.R. AND DAINORA,J., ENGINEERING STUDIES SHOW POSSIBILITIES FOR LNG PIPE LINE, PIPE LINE INDUSTRY VOL 27, 42-49 (1967) AUGUST. ALSO, LNG PIPELINES APPEAR TECHNICALLY FEASIBLE, OIL AND GAS J. VOL 65, 80-89 (1967) MAY 8

-SOURCE INFORMATION-

CORPORATE SOURCE -
BATTELLE MEMORIAL INST., COLUMBUS, OHIO
JOURNAL PROCEEDINGS -
LNG INTERNATIONAL CONF., 1ST, (PROC. OF, SESSION NO. 6) CHICAGO, ILL., APR 7-12, 1968. PAPER 42
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -

keys 19721 through 19726

DESIGN NEEDS FOR BASE-LOAD LNG STORAGE, REGASIFICATION

by

DINAPOLI, R. N.

10/22/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

MANY BASE-LOAD PROJECTS FOR SUPPLYING LNG TO THE UNITED STATES ARE MOVING FROM THE PLANNING TO THE ENGINEERING PHASE, CONFRONTING DESIGN ENGINEERS WITH THE TASK OF DESIGNING LARGE STORAGE AND REGASIFICATION FACILITIES. THIS ARTICLE DESCRIBES THE GENERAL PROCESSING SEQUENCE FOR AN LNG STORAGE AND REGASIFICATION TERMINAL, DISCUSSING ENGINEERING SYSTEMS AND PROCEDURES UTILIZED IN SUCH A FACILITY.

-PERTINENT FIGURES-

TAB.1 LNG IMPORT TERMINALS ANNOUNCED FOR U.S., PAGE 67//TAB.2 UNLOADING TIME, PRESSURE DROP, PAGE 68//TAB.3 THERMAL CONDUCTIVITY, OVERALL HEAT FLUX, PAGE 69//FIG.1 LNG TERMINAL, REGASIFICATION FACILITY, PAGE 67

-BIBLIOGRAPHY-

VITAL LINK. LNG MARINE ARM, CRYOGENICS AND INDUSTRIAL GASES, SEPTEMBER, OCTOBER 1972//HASHEMI,H.T. AND WESSON,H.R., HYDROCARBON PROCESSING, 50, NO. 8 (1971)//MAHER,J.B. AND VAN GELDER,L.R., LNG TANK DYNAMICS, PAPER NO. 116 PRESENTED AT THIRD INTERNATIONAL CONFERENCE ON LNG, WASHINGTON, D.C., 1972// SMITH,L.R., SUBMERGED LNG PUMPS, PAPER NO. 117 PRESENTED AT THIRD INTERNATIONAL CONFERENCE ON LNG, WASHINGTON, D.C., 1972

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
OIL GAS J. VOL 71, NO. 43, 67-70 (OCT 1973)
OTHER INFORMATION -
0004 PAGES, 0002 FIGURES, 0004 TABLES, 0004 REFERENCES

keys 19604 through 19606

USE OF SUBMERGED ELECTRIC MOTOR DRIVEN PUMPS FOR LIQUEFIED GASES

by

HYLTON, E.
JACKSON, R. G.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

WHEN THE METHANE PIONEER WAS FITTED WITH DEEPWELL PUMPS IN 1958, HIGH SPEED CENTRIFUGAL SUBMERGED ELECTRIC MOTOR DRIVEN PUMPS WERE ALREADY IN SERVICE IN AIRCRAFT FUEL TANKS. ALTHOUGH THE DEEPWELL PUMPS WERE GENERALLY SATISFACTORY, DIFFICULTIES WERE ENCOUNTERED WHICH WERE BELIEVED TO BE DUE TO THE LENGTH OF THE DRIVE SHAFT. THE ELIMINATION OF THE LONG SHAFT, ITS SUPPORT BEARINGS AND THE SHAFT SEAL REMOVES AT ONE STROKE A NUMBER OF SOURCES OF POTENTIAL PUMP FAILURE. ADDITIONALLY, THE SUBMERGED ELECTRIC MOTOR PRINCIPLE ENABLES THE USE OF HIGHER PUMP SPEEDS THAN CAN BE TOLERATED BY LONG SHAFT DRIVES. FOLLOWING CAREFUL CONSIDERATION OF THE ADVANTAGES OF THE TWO TYPES OF PUMP, CONCH DECIDED IN 1959 TO BEGIN A SERIES OF TESTS TO PROVE THE SUITABILITY OF THE SUBMERGED ELECTRIC MOTOR DRIVEN PUMP FOR LNG SERVICE, AND TO PROVIDE SUFFICIENT INFORMATION TO THE CLASSIFICATION SOCIETIES AND REGULATORY BODIES TO OBTAIN THEIR APPROVAL FOR THIS TYPE OF PUMP FOR LIQUEFIED GAS SERVICE. CONCH CHOSE A PUMP MANUFACTURED BY THE J. C. CARTER COMPANY FOR THIS PURPOSE. THIS PAPER DESCRIBES THE VARIOUS STEPS EACH COMPANY HAS MADE OVER THE PAST YEARS IN DEVELOPING THE PUMP, OBTAINING AUTHORITY FOR ITS USE AND PRODUCING DESIGNS TO MEET THE REQUIREMENTS FOUND IN SERVICE.

-PERTINENT FIGURES-

FIG.3 SHIP PUMP-MOTOR UNIT, PAGE 391//FIG.4 REMOVABLE PUMP-MOTOR UNIT, PAGE 392

-SOURCE INFORMATION-

CORPORATE SOURCE -
CARTER (J.C.) CO., COSTA MESA, CALIF.//CONCH METHANE SERVICES LTD., LONDON, ENGLAND

JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 379-93, (PROC. OF) LONDON, ENGLAND, MAR 25-8, 1969

keys 19607 through 19609

DESIGN CONSIDERATIONS FOR LNG STORAGE TANKS CURRENT UNITED STATES PRACTICE

by

BODLEY, R. W.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

ABOVE GROUND, METAL, DOUBLE WALL TANKS ARE CONSIDERED TO BE THE MOST PRACTICAL MEANS FOR STORING LIQUEFIED NATURAL GAS TODAY, PROVIDING BOTH STRUCTURAL RELIABILITY AND PREDICTABILITY OF BOIL-OFF RATES AT ACCEPTABLE COSTS. SIGNIFICANT DIFFERENCES BETWEEN THE DESIGN OF LNG STORAGE TANKS AND OTHER LOW TEMPERATURE TANKS HAVE REQUIRED THE EXTENSION OF EXISTING TECHNOLOGY. THIS PAPER DISCUSSES SOME OF THE IMPORTANT DESIGN CONSIDERATIONS. IT GIVES CURRENT APPROACHES TO AND SOLUTIONS OF DESIGN PROBLEMS IN THE UNITED STATES. AN ATTEMPT IS MADE TO PRESENT PERTINENT TECHNICAL INFORMATION ON THE MAJOR STORAGE COMPONENTS. THE PAPER PLACES EMPHASIS ON THOSE ITEMS NOT READILY FOUND IN CURRENT (1969) LITERATURE AND BY-PASSES THOSE WHICH HAVE ALREADY BEEN WELL COVERED.

-PERTINENT FIGURES-

FIG. 1 DOUBLE WALL LNG TANK - NITROGEN PURGE PRIMARY AND SECONDARY COMPONENTS, PAGE 466//FIG.2 INSULATION SYSTEM FOR TANK BOTTOM, PAGE 467// FIG.3 FREE SPAN GRID ROOF FOR LNG OUTER TANK, 194 FT. DIAMETER, PAGE 468

-BIBLIOGRAPHY-

API STANDARD NO. 620, DESIGN AND CONSTRUCTION OF LARGE, WELDED LOW-PRESSURE STORAGE TANKS, APPENDIX Q, LOW-PRESSURE STORAGE TANKS FOR LIQUEFIED NATURAL GAS//NFPA NO. 59A-T-1966, STANDARD FOR THE STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS AT UTILITY GAS PLANTS//API STANDARD NO. 2510A, DESIGN AND CONSTRUCTION OF LNG INSTALLATIONS AT PETROLEUM TERMINALS, NATURAL GAS PROCESSING PLANTS, REFINERIES, AND OTHER INDUSTRIAL PLANTS//PERLITE INSTITUTE, INC., TECHNICAL DATA SHEET NO. 2-3, EXPANDED PERLITE INSULATION FOR LOW TEMPERATURES IN ATMOSPHERIC SERVICE

-SOURCE INFORMATION-

CORPORATE SOURCE -
GRAVER TANK AND MFG. CO., CHICAGO, ILL.
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 457-68. (PROC. OF)
LONDON, ENGLAND, MAR 25-8, 1969
PUBLISHER -
WILLIAM CLOWES AND SONS LTD., LONDON, ENGLAND
OTHER INFORMATION -
0012 PAGES, 0003 FIGURES, 0000 TABLES, 0004 REFERENCES

key 19610

EVALUATION OF THE FATIGUE STRENGTH OF INTERGRATED TANKS FOR LNG SHIPS

by

BURNS, D. J.
JACKSON, R. G.
KALBFLEISCHU, J. G.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE TREND IN DESIGN OF SHIPS FOR TRANSPORTING LIQUEFIED NATURAL GAS IS TOWARDS THE REPLACEMENT OF SELF-SUPPORTING TANKS BY INTEGRATED TANKS. THE LATTER ARE THIN-METALLIC MEMBRANE TANKS SUPPORTED BY LOAD-BEARING INSULATION FITTED TO THE INSIDE OF THE HULL. THIS PAPER DESCRIBES ONE DESIGN OF INTEGRATED CARGO TANK FOR SHIPBOARD TRANSPORTATION OF LNG, DISCUSSES THE LOADS IMPOSED ON IT AND SHOWS HOW THE RESULT OF CYCLIC PRESSURE FATIGUE TESTS ON PILOT SCALE TANKS HAVE BEEN ANALYSED STATISTICALLY USING THE LIKELIHOOD FUNCTION. THE PAPER ALSO SHOWS HOW THE FATIGUE DATA CAN BE COMBINED WITH THE SEA LOAD SPECTRUM TO PREDICT WHETHER SHIP TANKS WILL HAVE AN ACCEPTABLE FATIGUE STRENGTH.

-PERTINENT FIGURES-

FIG.1 CROSS-SECTION OF INTEGRATED LNG CARGO TANK, PAGE 484

-BIBLIOGRAPHY-

ALLEAUME,J., THE METHAN ETHYLENE TANKER PYTHAGORE, ASSOCIATION TECHNIQUE MARITIME ET AERONAUTIQUE, 1964//ROOKE,D.E. AND FILSTEAD,C.G., THE U.K. LIQUID METHANE TANKERS, PROC. CONF. - PETROLEUM AND THE SEA, MONACO, MAY 1965//FFOOKS,R.C. AND MASSAC,G., LA CONCEPTION ET LA MISE EN POINT D UNE TECHNIQUE DE CUVE MEMBRANE POUR LE TRANSPORT DE GAZ NATUREL LIQUEFIE, ASSOCIATION TECHNIQUE MARITIME ET AERONAUTIQUE, 1968//JACKSON,R.G. AND KOTCHARIAN,M., TESTING AND TECHNOLOGY OF MODELS OF INTEGRATED TANKS FOR LNG CARRIERS

-SOURCE INFORMATION-

CORPORATE SOURCE -
WATERLOO UNIV., ONTARIO//CONCH METHANE SERVICES LTD., LONDON, ENGLAND// ESSEX UNIV., COLCHESTER, ENGLAND

JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 469-86, (PROC. OF)
LONDON, ENGLAND, MAR 25-8, 1969
PUBLISHER -
WILLIAM CLOWES AND SONS LTD., LONDON, ENGLAND
OTHER INFORMATION -
0018 PAGES, 0006 FIGURES, 0002 TABLES, 0015 REFERENCES

keys 19611 through 19612

TRANSPORT, TEMPORARY STORAGE AND VAPORIZATION OF LIQUID NATURAL GAS

by

MAISHMAN, W. G.
POTTER, J. H.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER DEALS WITH THE EXPERIENCE OBTAINED IN TRANSPORTING ALGERIAN NATURAL GAS BY ROAD TANKER AND VAPORIZING INTO NATURAL GAS MAINS FOR THE GAS BOARDS DURING THEIR CONVERSION PROGRAM FROM TOWNS GAS TO NATURAL GAS. THE SUBJECT IS DEALT WITH IN TWO SECTIONS. 1. ROAD TANKERS AND TRANSPORT OF LNG BY ROAD, 2. SITE OPERATIONS.

-PERTINENT FIGURES-

FIG.3 14 TON AND 6 TON LNG TANKER PRESSURE RISE, PAGE 570//FIG.4 PRESSURE RISE IN 14 TON LNG TANKER DURING 5 DAY RUN, PAGE 571

-SOURCE INFORMATION-

CORPORATE SOURCE -
BRITISH OXYGEN CO., LTD., LONDON, ENGLAND
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 560-80, (PROC. OF) LONDON, ENGLAND, MAR 25-8, 1969
PUBLISHER -
WILLIAM CLOWES AND SONS LTD., LONDON, ENGLAND
OTHER INFORMATION -
0021 PAGES, 0013 FIGURES, 0000 TABLES, 0001 REFERENCES

keys 19613 through 19614

THE DESIGN OF OPTIMUM LNG HIGHWAY TANKERS

by

LATHAM, W. N.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

WITH THE RECENT SURGE OF INTEREST IN AND AVAILABILITY OF LNG, A DEMAND HAS ARISEN FOR OPTIMUM DESIGN LNG HIGHWAY TRANSPORT TANKERS. THIS PAPER REVIEWS DESIGN CRITERIA OF CRYOGENIC HIGHWAY SEMITRAILERS IN GENERAL AND OF LNG TRAILERS IN PARTICULAR. SPECIAL EMPHASIS IS GIVEN TO METHODS OF TRAILER UNLOADING AND TO SAFETY. DESIGN AND PERFORMANCE DATA ARE PRESENTED ON THREE 11,650-GALLON TRAILERS DESIGNED AND BUILT SPECIFICALLY FOR LNG SERVICE.

-PERTINENT FIGURES-

FIG.1 TYPIÇAL PIPING SCHEMATIC, PRESSURE UNLOADING TRAILER, PAGE 603//FIG.2 TYPICAL PIPING SCHEMATIC, PUMP UNLOADING TRAILER, PAGE 604

-SOURCE INFORMATION-

CORPORATE SOURCE -
    CRYOGENIC INDUSTRY, PLAISTOW, N.H.
JOURNAL PROCEEDINGS -
    LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 592-606 (PROC. OF)
    LONDON, ENGLAND, MAR 25-8, 1969
PUBLISHER -
    WILLIAM CLOWES AND SONS LTD., LONDON, ENGLAND
OTHER INFORMATION -
    0015 PAGES, 0004 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 19615 through 19617

STANDARDS DEVELOPMENT IN THE UNITED STATES FOR LIQUEFIED NATURAL GAS INSTALLATIONS

by

DYER, A. F.
SOMMER, E. C.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER BRIEFLY REVIEWS THE BASIC REQUIREMENTS OF CURRENT (IN 1969) STANDARDS FOR LNG STORAGE FACILITIES - API2510A DESIGN AND CONSTRUCTION OF LNG INSTALLATIONS AT PETROLEUM TERMINALS, NATURAL GAS PROCESSING PLANTS, REFINERIES, AND OTHER INDUSTRIAL PLANTS AND NFPA 59A LIQUEFIED NATURAL GAS AT UTILITY GAS PLANTS. ALSO, SOME OF THE BACKGROUND AND THINKING THAT WENT INTO THE DEVELOPMENT OF THE REQUIREMENTS OF THESE STANDARDS IS PRESENTED. WHILE THERE ARE SOME DIFFERENCES BETWEEN THESE TWO STANDARDS, IT SHOULD BE RECOGNIZED THAT THEY COVER DIFFERENT TYPES OF INSTALLATIONS. STEPS ARE DISCUSSED TO RECONCILE THE DIFFERENCES BETWEEN THESE TWO STANDARDS WITH THE ULTIMATE GOAL OF DEVELOPING A SINGLE LNG STANDARD.

-SOURCE INFORMATION-

CORPORATE SOURCE -
PHILLIPS PETROLEUM CO., BARTLESVILLE, OKLA.//ESSO RESEARCH AND ENGINEERING CO., FLORHAM PARK, N.J.
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF., 138-47, (PROC. OF) LONDON, ENGLAND, MAR 25-8, 1969
PUBLISHER -
WILLIAM CLOWES AND SONS LTD., LONDON, ENGLAND
OTHER INFORMATION -
0010 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

THE BRITISH CRYOGENICS COUNCIL SAFETY MANUAL A GUIDE TO GOOD PRACTICE

by

TUTTON, R. C.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE BRITISH CRYOGENICS COUNCIL SAFETY MANUAL IS DESCRIBED. THE FIVE SECTIONS, GENERAL SAFETY REQUIREMENTS, AIR SEPARATION PLANTS, LIQUEFIED NATURAL GAS, HYDROGEN SEPARATION PLANTS, AND ETHYLENE AND ETHANE, ARE REVIEWED SEPARATELY. THIS MANUAL IS NOT A CODE. IT IS A GUIDE TO GOOD PRACTICE IN WHICH THE ACCUMULATED KNOWLEDGE AND EXPERIENCE OF THE MAJOR BRITISH COMPANIES OPERATING IN CRYOGENICS (WITH ADDITIONAL HELP FROM A NUMBER OF OVERSEAS COMPANIES) HAVE BEEN POOLED. THIS GUIDE, USED INTELLIGENTLY AND IMAGINATIVELY, WILL ENHANCE THE VIEW THAT THE APPLICATIONS OF LOW-TEMPERATURE TECHNOLOGY ARE NOT ONLY FASCINATING AND WORTHWHILE, BUT ALSO SAFE. THE MANUAL MAY BE OBTAINED FROM THE INSTITUTION OF CHEMICAL ENGINEERS, 16 BELGRAVE SQUARE, LONDON, ENGLAND.

-SOURCE INFORMATION-

CORPORATE SOURCE -
CONCH METHANE SERVICES LTD., LONDON, ENGLAND
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 17, 176-81 (1972) (PAPER F-1)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0006 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 19634 through 19638

CONSIDER SAFETY, RELIABILITY, COST IN SELECTING TYPE OF LNG STORAGE

by

GIBSON, G. H.
WALTERS, W. J.

02/08/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS ARTICLE DISCUSSES ADVANTAGES AND DISADVANTAGES OF THE VARIOUS AVAILABLE METHODS OF LNG STORAGE - ABOVEGROUND DOUBLE-WALLED METAL TANKS, ABOVE OR BELOW GROUND PRESTRESSED CONCRETE TANKS, INGROUND FROZEN EARTH STORAGE, AND CAVERN STORAGE. CONSIDERATION IS GIVEN TO SAFETY, RELIABILITY AND COST IN THE SELECTION PROCESS.

-PERTINENT FIGURES-

FIG.4 VARIATION OF LNG STORAGE TANK BOILOFF RATE WITH INSULATION THICKNESS, PAGE 66

-BIBLIOGRAPHY-

WALTERS,W.J. AND WARD,J.A., FACILITIES FOR IMPORTATION OF LIQUID METHANE INTO CANVEY ISLAND, THE INSTITUTION OF GAS ENGINEER, COMMUNICATION 696// WARD,J.A. AND EGAN,P.C., EXPERIENCE WITH FROZEN STORAGE UNITS FOR LIQUEFIED NATURAL GAS - CANVEY ISLAND UK, LIQUEFIED NATURAL GAS CONFERENCE, LONDON, MARCH 25-28, 1969//WARD,J.A. AND HILDREW,R.G., LATEST DEVELOPMENTS AT CANVEY ISLAND, FIRST INTERNATIONAL CONFERENCE ON LNG, CHICAGO, APRIL 7-12, 1968

-SOURCE INFORMATION-

CORPORATE SOURCE -
GAS COUNCIL, LONDON, ENGLAND
JOURNAL PROCEEDINGS -
OIL GAS J. VOL 69, NO. 6, 65-9 (FEB 1971)
OTHER INFORMATION -
0005 PAGES, 0005 FIGURES, 0000 TABLES, 0004 REFERENCES

keys 19641 through 19644

MARINE TERMINALS FOR LNG, ETHYLENE, AND LPG

by

CLAPP, M. B.
LITZINGER, L. F.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

MARINE TERMINALS FOR LIQUEFIED NATURAL GAS, ETHYLENE, AND LIQUEFIED PETROLEUM GAS SERVED BY OCEAN-GOING VESSELS ARE THE GENERAL SUBJECTS OF THIS PAPER. TERMINALS SERVED EXCLUSIVELY BY INLAND, CANAL, OR RIVER-GOING BARGES WILL BE BRIEFLY DISCUSSED. FOR AT LEAST 15 YEARS REFRIGERATED SHIPMENT OF LIQUIDS OF UP TO 3000 TONS PER BARGE HAVE BEEN COMMON. HOWEVER, DURING THE LAST 10 YEARS SHIPS DESIGNED TO CARRY 10,000 TO 70,000 TONS OF REFRIGERATED LIQUIDS HAVE BEEN BUILT AND PLACED IN SERVICE. TERMINALS SERVING THESE SHIPS ARE UNIQUE IN MANY WAYS. LARGER-CAPACITY PRODUCTION FACILITIES WILL MANDATE BIGGER STORAGE TANKS AND HIGHER-CAPACITY SHIPS. IT APPEARS QUITE CLEAR THAT REFRIGERATED STORAGE AND SHIPPING OF LNG, ETHYLENE, AND LPG WILL BE MORE COMMON AND IN GREATER DEMAND. DIFFERENCES IN PRODUCT STORAGE TEMPERATURES AND COMPOSITIONS REQUIRE CAREFUL CONSIDERATION WHEN DESIGNING REFRIGERATED STORAGE FACILITIES. PARTICULARLY, THE LAND STORAGE FILLING AND PUMPOUT FACILITY MUST INCLUDE IN ITS DESIGN PROPER CONSIDERATION OF THE COOLDOWN REQUIRED FOR THE INFREQUENTLY USED PRODUCT FILL OR PUMPOUT LINES. REFRIGERATION DUTIES FROM SHIP PUMP ENERGY, LINE HEAT LEAK, DISPLACED VAPOR, ETC. MUST BE EVALUATED AND PROPERLY ACCOMMODATED IN THE LAND STORAGE FACILITY WHICH RECEIVES REFRIGERATED PRODUCT.

-PERTINENT FIGURES-

TAB.1 LAND STORAGE COMPARISON FOR 20000 TONS PRODUCT, PAGE 85//TAB.2 EFFECT OF TANK HEIGHT ON COST AND BOIL-OFF, PAGE 89//FIG.7 CONSEQUENCES OF NONUNIFORM SUPPORT OF LOAD-BEARING INSULATION, PAGE 91//FIG.8 RINGWALL FOUNDATION SUPPORT FOR REFRIGERATED STORAGE TANKS, PAGE 91//FIG,9 PILING AND CAP FOUNDATION SUPPORT FOR REFRIGERATED STORAGE TANKS, PAGE 92

-BIBLIOGRAPHY-

BRUNT,W.R. AND CLAPP,M.B., DESIGN OF ETHYLENE AND LNG LIQUEFACTION AND STORAGE FACILITIES, PRESENTED AT 50TH CONFERENCE AND EXHIBITION OF THE CHEMICAL INSTITUTE OF CANADA, TORONTO, CANADA,

JUNE 1967//LUCK,D.T. AND DORNEY,D.C., ADVANCEMENTS IN CONSTRUCTION AND PERFORMANCE OF ABOVEGROUND STORAGE TANKS FOR LNG, PRESENTED AT 12TH INTERNATIONAL CONGRESS OF REFRIGERATION, MADRID, SPAIN, SEP 1967//MARSHALL,H.T. AND JOHNSON,P.C., DESIGN AND CONSTRUCTION OF AN LNG FACILITY, PRESENTED AT 12TH INTERNATIONAL CONGRESS OF REFRIGERATION, MADRID, SPAIN, SEP 1967//NEILL,O.T., HASHEMI,H.T. AND SLIEPCEVICH,C.M., BOIL-OFF RATES AND WALL TEMPERATURES IN ABOVEGROUND LNG STORAGE TANKS, PRESENTED AT 60TH ANNUAL AICHE MEETING, NEW YORK, NOV 1967//HANKE,C.C. AND MARSHALL,H.T., DESIGN AND CONSTRUCTION OF THE BOSTON GAS LNG FACILITY, PRESENTED AT THE FIRST INTERNATIONAL CONFERENCE ON LNG, CHICAGO, ILL., APR 1968//HANKE,C.C., NEW DEVELOPMENTS IN ABOVEGROUND METAL LNG CONTAINERS, PRESENTED AT AMERICAN GAS ASSOCIATION DISTRIBUTION CONFERENCE, MAY 1968

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 17, 84-92 (1972) (PRES. AT AICHE NATIONAL MEETING, 68TH, HOUSTON, TEX., FEB 28-MAR 4, 1971. PAPER B-3)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0009 PAGES, 0009 FIGURES, 0002 TABLES, 0008 REFERENCES

keys 19645 through 19648

FRACTURE BEHAVIOR IN PIPE PRESSURED WITH LNG

by

DUFFY, A. R.
EIBER, R. J.

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER PRESENTS A SUMMARY OF THE FRACTURE BEHAVIOR OF PIPE PRESSURED WITH LIQUEFIED NATURAL GAS AS OBSERVED IN FULL-SCALE EXPERIMENTS CONDUCTED FOR THE PIPELINE RESEARCH COMMITTEE OF THE AMERICAN GAS ASSOCIATION. THE OBJECTIVE OF THE EXPERIMENTS WAS TO INVESTIGATE THE CONDITIONS SURROUNDING THE INITIATION, UNSTABLE PROPAGATION, AND ARREST OF FRACTURES WHEN LNG IS USED AS THE PRESSURING FLUID. ALTOGETHER, 14 EXPERIMENTS ARE REPORTED--9 OF THESE EMPLOYED LNG AS THE PRESSURING MEDIUM, INCLUDING TWO ALUMINUM ALLOY EXPERIMENTS CONDUCTED ON ANOTHER RESEARCH PROGRAM. OF SPECIAL IMPORTANCE AMONG THE DATA OBTAINED IN THIS RESEARCH INVESTIGATION IS THE OBSERVATION THAT A STRESS LEVEL EXISTS BELOW WHICH UNSTABLE FRACTURE PROPAGATION CANNOT BE SUPPORTED IN LIQUID FILLED LNG PIPELINES. THIS CRITICAL STRESS LEVEL CAN BE COMPARED WITH THE STRESS LEVEL AT THE SATURATION PRESSURE OF THE LNG PIPELINE UNDER EXPECTED OPERATING CONDITIONS (THE PIPELINE WOULD DECOMPRESS TO THE SATURATION PRESSURE AT THE ONSET OF FRACTURE) AND PIPE WALL THICKNESS CAN BE ACCORDINGLY CHOSEN TO PREVENT THE POSSIBILITY OF LONG, UNSTABLE FRACTURE PROPAGATION SHOULD ONE UNAVOIDABLY BE INITIATED. THESE EXPERIMENTS SUGGEST THAT IT MAY BE POSSIBLE TO DESIGN SHIP-TO-SHORE LNG TRANSFER LINES, IN-PLANT LNG PIPING, OR OTHER CRYOGENIC PIPELINES WITH A GREATER ASSURANCE OF SAFETY.

-PERTINENT FIGURES-

TAB.1 RESULTS OF LAB TESTS AND FULL-SCALE EXPERIMENTS, PAGE 4//FIG.2 CHARACTERISTIC VAPOR AND SUBCOOLED FLUID DECOMPRESSION, PAGE 10//FIG.3 EXTENT OF PROPAGATION VERSUS STRESS LEVEL AT THE SATURATION-PRESSURE LEVEL FOR PIPE MATERIALS, PAGE 11

-BIBLIOGRAPHY-

FOURTH SYMPOSIUM ON LINE PIPE RESEARCH, AMERICAN GAS ASSOCIATION, 605 THIRD AVENUE, NEW YORK, NEW YORK, CATALOG NO. L30075 (NOVEMBER, 1969) // LAKE,R.L., EIBER,R.J. AND DEMONEY,F.W., BURST TESTS OF PRE-FLAWED WELDED ALUMINUM ALLOY PRESSURE VESSELS AT -220

F, ADVANCES IN CRYOGENIC ENGINEERING, VOL 13 (1967)

-SOURCE INFORMATION-

CORPORATE SOURCE -
BATTELLE MEMORIAL INST., COLUMBUS, OHIO
JOURNAL PROCEEDINGS -
NATURAL GAS RESEARCH AND TECHNOLOGY CONF., (PROC. OF, SESSION II) CHICAGO, ILL., FEB 28-MAR 3, 1971. PAPER 1
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0018 PAGES, 0005 FIGURES, 0001 TABLES, 0012 REFERENCES

keys 19654 through 19658

MARINE TERMINALS FOR LPG, ETHYLENE AND LNG

by

CLAPP, M. B.
LITZINGER, L. F.

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

DIFFERENCES IN PRODUCT STORAGE TEMPERATURES AND COMPOSITIONS REQUIRE CAREFUL CONSIDERATION WHEN DESIGNING REFRIGERATED STORAGE FACILITIES. PARTICULARLY, THE LAND STORAGE FILLING AND PUMPOUT FACILITIES MUST INCLUDE IN THEIR DESIGN PROPER CONSIDERATIONS OF THE COOLDOWN REQUIRED FOR THE INFREQUENTLY USED PRODUCT FILL OR PUMPOUT LINES. REFRIGERATION DUTIES FROM SHIP PUMP ENERGY, LINE HEAT LEAK, DISPLACED VAPOR, ETC. MUST BE EVALUATED AND PROPERLY ACCOMMODATED IN THE LAND STORAGE FACILITY WHICH RECEIVES REFRIGERATED PRODUCT. ALSO, VERY CAREFUL ATTENTION MUST BE GIVEN TO SOILS INVESTIGATIONS AND DESIGN OF FOUNDATIONS FOR REFRIGERATED STORAGE TANKS SO AS TO LIMIT SETTLEMENTS TO VALUES MUCH LOWER THAN ARE OFTEN THOUGHT PERMISSIBLE FOR OIL OR WATER STORAGE TANKS. THIS ARTICLE DISCUSSES THESE AND OTHER ASPECTS OF REFRIGERATED PRODUCT TERMINAL DESIGN - INCLUDING LNG, ETHYLENE AND LPG.

-PERTINENT FIGURES-

FIG.1 PRINCIPAL COMPONENTS OF A MARINE TERMINAL FOR LNG, ETHYLENE AND, LPG //FIG.2 HEAT DUTIES ASSOCIATED WITH THE UNLOADING OF A COLD PRODUCT AT A MARINE TERMINAL//FIG.3 MODERN LNG AND ETHYLENE STORAGE TANK//FIG.5 RESILIENT BLANKET CONCEPT FOR COLD PRODUCT STORAGE//FIG.7 RINGWALL FOUNDATION FOR REFRIGERATED STORAGE TANKS//FIG.8 PILING AND CAP FOUNDATION FOR REFRIGERATED STORAGE TANKS

-BIBLIOGRAPHY-

HANKE,C.C., CHICAGO BRIDGE AND IRON COMPANY-ABOVE-GROUND STORAGE OF LNG IS SAFE AND PRACTICAL, THE OIL AND GAS JOURNAL-FEBRUARY, 1966//WISSMILLER,I.L., CHICAGO BRIDGE AND IRON COMPANY-ABOVE-GROUND STORAGE TANKS FOR LIQUEFIED NATURAL GAS, WINTER ANNUAL MEETING ASME NOVEMBER, 1966//LUSK,D.T., CHICAGO BRIDGE AND IRON COMPANY, DORNEY,D.C., CHICAGO BRIDGE LTD., ADVANCEMENTS IN CONSTRUCTION AND PERFORMANCE OF ABOVEGROUND STORAGE TANKS FOR LNG, 12TH INTERNATIONAL CONGRESS OF REFRIGERATION, MADRID, SPAIN, SEPTEMBER 1967// MARSHALL,H.T.,

JOHNSON,P.C., CHICAGO BRIDGE AND IRON COMPANY, DESIGN AND CONSTRUCTION OF AN LNG FACILITY, 12TH INTERNATIONAL CONGRESS OF REFRIGERATION, MADRID, SPAIN, SEPTEMBER 1967//SELCUKOGLU,Y.A., CHICAGO BRIDGE LIMITED, NEW DEVELOPMENTS IN INSULATION SYSTEMS FOR CRYOGENIC STORAGE TANKS, 2ND INTERNATIONAL CRYOGENIC ENGINEERING CONFERENCE, BRIGHTON, ENGLAND, MAY 1968//HANKE,C.C., CHICAGO BRIDGE AND IRON COMPANY, NEW DEVELOPMENTS IN ABOVE GROUND METAL LNG CONTAINERS, AMERICAN GAS ASSOCIATION DISTRIBUTION CONFERENCE, MAY 1968

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.

JOURNAL PROCEEDINGS -
NATIONAL MEETING, 68TH, AND PETROCHEMICAL AND REFINING EXPOSITION, 6TH, (PRES. AT) HOUSTON, TEX., FEB 28-MAR 4, 1971

OTHER INFORMATION -
0008 PAGES, 0008 FIGURES, 0001 TABLES, 0019 REFERENCES

keys 19659 through 19660

THE BALANCE BETWEEN INNOVATIONS AND RISKS IN THE LNG INDUSTRY

by

PASTUHOV, A.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE RAPID GROWTH OF THE LNG INDUSTRY HAS LED TO A DEMAND FOR INNOVATIONS TO INCREASE EFFICIENCY AND DECREASE COSTS. INNOVATION IS USEFUL AS LONG AS IT DOES NOT PROCEED AT SUCH A GREAT RATE THAT IT LEADS TO EXCESSIVE RISK THROUGH ELIMINATION OF NECESSARY DESIGN ANALYSES AND PROTOTYPE DEVELOPMENTS. THIS PAPER DOES NOT ATTEMPT TO DEFINE DETAILED DESIGN APPROACHES, BUT RATHER IS A GENERALIZED DISCUSSION OF THE FACTORS TO BE CONSIDERED IN ANY LNG PROJECT. THE ENGINEERS IN THE LNG INDUSTRY MUST CONTINUE TO ASSUME AND RECOGNIZE TO THE BEST OF THEIR ABILITY THE IMPORTANT RESPONSIBILITIES THEY HAVE WHEN THEY SEEK TO ACHIEVE ECONOMIES. THE INDUSTRY WAS BADLY AFFECTED AND ITS POTENTIAL GROWTH COMPLETELY STOPPED FOR YEARS BECAUSE OF THE CLEVELAND DISASTER, AND IT WOULD BE EXTREMELY UNFORTUNATE TO HAVE HISTORY REPEAT ITSELF. THE INDUSTRY MUST STRIVE TO WORK IN UNISON AND FACE UP TO ITS RESPONSIBILITIES REALISTICALLY. FOR INSTANCE, THE HAZARDS OF WATER AND LAND SPILLS MUST CONTINUE TO BE ASSESSED ANALYTICALLY AND EXPERIMENTALLY, AND THE RESULTS UNDERSTOOD AND INTERPRETED CAREFULLY, DIFFERENCES OF OPINION MUST BE RESOLVED IN A RATIONAL MANNER AND REGULATORY AGENCIES, INDUSTRIAL ASSOCIATIONS, AND THE INDUSTRY MUST ALL PARTICIPATE AND CONTRIBUTE TO ASSURE A SAFE FUTURE FOR LIQUEFIED NATURAL GAS.

-PERTINENT FIGURES-

FIG.1 GROWTH OF ABOVE-GROUND STORAGE VOLUME FOR LNG, PAGE 71//FIG.2 GROWTH IN TANKER CAPACITY, PAGE 71//FIG.3 EFFECT OF INSURANCE RATE INCREASES ON LNG SHIPPING COSTS, PAGE 72

-SOURCE INFORMATION-

CORPORATE SOURCE -
GAZOCEAN, PARIS, FRANCE
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 17, 69-73 (1972) (PAPER B-1)
PUBLISHER -
PLENUM PRESS, NEW YORK

LNG TERMINAL DESIGN

by

CRAWFORD, D. B.
DURR, C. A.

11/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE PURPOSE OF THIS ARTICLE IS TO PRESENT THE BASIC COMPONENTS OF AN LNG RECEIVING TERMINAL AND TO ANALYSE SEVERAL OF THE TECHNICAL PROBLEMS ENCOUNTERED IN DESIGNING SUCH TERMINALS, EMPHASIS IS PLACED ON THE SHIP UNLOADING AND VAPOR HANDLING SYSTEMS.

-PERTINENT FIGURES-

TAB.1 TYPICAL PARAMETERS FOR LNG TERMINALS, PAGE 211//FIG.1 LNG RECEIVING TERMINAL, PAGE 211//FIG.2 VALVE OPENING VARIES WITH STROKE MOVEMENT FOR DIFFERENT TYPES OF VALVES, PAGE 212//FIG.3 EXCESS PRESSURE FOR VALVE SHUT-OFF IS HIGHEST FOR GATE VALVES, PAGE 212//FIG.4 LNG RECIRCULATION SYSTEM, PAGE 213

-BIBLIOGRAPHY-

WOOD,D.J. AND JONES,S.E., WATER-HAMMER CHARTS FOR VARIOUS TYPES OF VALVES, JOURNAL OF THE HYDRAULICS DIVISION, ASCE, 99, 167 (1973)//MORGAN,S.K. AND BRADY,H.F., ELIMINATION OF THE GEYSERING EFFECT IN MISSILES, IN TIMMERHAUS,K.D., ADVANCES IN CRYOGENIC ENGINEERING, PLENUM PRESS, NEW YORK, VOL. 9, 1963, P. 206//MURPHY,D.W., AN EXPERIMENTAL INVESTIGATION OF GEYSERING IN VERTICAL TUBES, IN TIMMERHAUS,K.D., ADVANCES IN CRYOGENIC ENGINEERING, PLENUM PRESS, NEW YORK, VOL. 11, 1965, P. 353

-SOURCE INFORMATION-

CORPORATE SOURCE -
KELLOGG (M. W.) CO., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 52, NO. 11, 211-4 (NOV 1973)
OTHER INFORMATION -
0004 PAGES, 0005 FIGURES, 0003 TABLES, 0006 REFERENCES

keys 19661 throu

HEAT TRANSFER PROBLEMS IN LIQUEFIED NATURAL GAS PLA

by

DEAN, L. E.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	EN
U/Unrestricted	Unlimited	Summary	Ac

-ABSTRACT-

FOR THE PURPOSE OF THIS DISCUSSION, HEAT EXCHANGER PROB
BEEN CLASSIFIED AS EXTERNAL AND INTERNAL. EXTERNAL PRO
THOSE WHICH CAUSE A HEAT EXCHANGER MALFUNCTION DUE TO
CONDITIONING OF THE GAS. INTERNAL PROBLEMS ARE THOSE A
WITH THE ACTUAL DESIGN OF THE EXCHANGER SYSTEM ITSELF, AN
SUCH CRITERIA AS VAPOR-LIQUID DISTRIBUTION, VAP
EQUILIBRIUM, PRESSURE DROPS, AND RELATED PHENOMENA.
PROBLEMS ARE USUALLY APPLICABLE TO ANY TYPE OF HEAT EXCHA
CONTAMINANTS CAUSING PROBLEMS CAN BE EITHER VAPOR, LIQ
SOLIDS, AND ARE NOT NECESSARILY LIMITED TO COMPONENTS IN
GAS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
PHILLIPS PETROLEUM CO., BARTLESVILLE, OKLA.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 18, 27-31 (1973) (PROC. OF
ENGINEERING CONF., 18TH, BOULDER, COLO., AUG 9-
PAPER A-3)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0005 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFEREN

keys 19667 through 19669

EXPLOSIVE BOILING OF LIQUEFIED HYDROCARBON/WATER SYSTEMS

by

ENGER, T.
HARTMAN, D. E.
SEYMOUR, E. V.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE THREE ISOLATED EXPLOSIONS OBSERVED AT THE BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR, IN 1969 DURING LNG SPILLAGE TESTS ON WATER CAN BE EXPLAINED IN TERMS OF A RAPID PHASE TRANSFORMATION AND VIOLENT EXPANSION OF VAPOR FROM SUPERHEATED LIQUEFIED GAS. A LAYER OF LIQUEFIED GAS, LESS THAN 10(-2) CM THICK, IN CONTACT WITH THE WATER BECOMES SUPERHEATED DURING A SHORT DELAY TIME BETWEEN WATER CONTACT AND THE EXPLOSION. WHEN THE THIN LAYER OF LIQUEFIED GAS REACHES ITS LIMIT OF SUPERHEAT, A SUDDEN TRANSFORMATION TO VAPOR OCCURS BY HOMOGENEOUS NUCLEATION RESULTING IN A PRESSURE WAVE. THE HIGH HEAT FLUX NECESSARY IN ORDER THAT THE LIQUEFIED GAS BECOME SUFFICIENTLY SUPERHEATED OCCURS DURING PERIODS OF LIQUID-TO-LIQUID CONTACT IN TRANSITION BOILING. THE CRITICAL TRANSITION REGION IS FIXED BY THE TEMPERATURE AND COMPOSITION OF THE LIQUEFIED GAS AND THE TEMPERATURE OF THE WATER. VAPOR EXPLOSIONS FROM LNG SPILLED ONTO OPEN WATER AT AMBIENT TEMPERATURE CAN ONLY OCCUR IF THE METHANE CONTENT OF THE LNG IS LESS THAN 40 MOL PERCENT. FURTHERMORE, EXPLOSIONS WILL NOT OCCUR IF THE MOLE RATIO OF PROPANE TO ETHANE IS 1 TO 3 OR GREATER. LNG CAN EVENTUALLY AGE IN A STORAGE TANK, BY BOILING OFF METHANE, TO REACH THE COMPOSITION REQUIRED TO PRODUCE A VAPOR EXPLOSION ON AMBIENT WATER. HOWEVER, IF THE METHANE CONTENT IS 95 MOL PERCENT INITIALLY, ONLY 10 PERCENT OF THE INITIAL VOLUME OF LIQUID WILL REMAIN WHEN THE LNG HAS AGED TO THE CRITICAL COMPOSITION (LESS THAN 40 MOL PERCENT METHANE). AT THIS TIME, THE NORMAL BOILING POINT OF THE LIQUID REMAINING WILL BE ABOUT [illegible] DEGREES C WARMER THAN NORMAL LNG. THE ENERGY RELEASE FROM LIQUEFIED GAS-WATER EXPLOSIONS IS LIMITED BY THE HEAT TRANSFERRED DURING DIRECT LIQUID CONTACT BEFORE THE LIMIT OF SUPERHEAT IS REACHED. THE ESTIMATED MECHANICAL ENERGY RELEASE IS OF THE ORDER OF ONLY 0.5 CAL.CM(2) OF INTERFACE AREA.

-PERTINENT FIGURES-

TAB.1 CRITICAL EMBRYO SIZE, WORK OF FORMATION, AND STEADY-STATE RATE OF BUBBLE FORMATION AT THREE SUPERHEATS OF ETHANE, PAGE 34//TAB.2 LIQUEFIED GAS SPILLAGE ON WATER, PAGE 34//TAB.3

TRANSITION REGION OF SOME PURE HYDROCARBON-WATER SYSTEMS, PAGE 35//FIG.1 ETHANE MIXTURE SPILL ON 24 DEG C WATER, PAGE 36//FIG.2 VAPOR EXPLOSION COMPOSITIONAL ENVELOPE FOR ETHANE & PROPANE & N-BUTANE MIXTURES ON AMBIENT WATER, PAGE 36

-BIBLIOGRAPHY-

BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, SRC REPORT NO. S-4105, U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES, PITTSBURGH, PENNSYLVANIA (FEB 1970)//ENGER,T. AND HARTMAN,D.E., LNG SPILLAGE ON WATER. I. EXPLORATORY RESEARCH ON RAPID PHASE TRANSFORMATIONS, SHELL PIPE LINE CORPORATION, RESEARCH AND DEVELOPMENT LABORATORY, TPR NO. 1-71 (FEB 1971)//ENGER,T. AND HARTMAN,D.E., LNG SPILLAGE ON WATER. II. FINAL REPORT ON RAPID PHASE TRANSFORMATIONS, SHELL PIPE LINE CORPORATION, RESEARCH AND DEVELOPMENT LABORATORY, TPR NO. 1-72 (FEB 1972)// APFEL,R.E., VAPOR CAVITY FORMATION IN LIQUIDS, NR-384-903, TECHNICAL MEMORANDUM NO. 62, HARVARD UNIVERSITY, CAMBRIDGE, MASSACHUSETTS (FEB 1970)// SKRIPOV,V.P. AND PAVLOV,P.A., TEPLOFIZ. VYSOK. TEMP., VOL 8, NO. 4, PP 833 (1970)//BECKER,R. AND DORING,W., ANNAL. PHYSIK, VOL 24, PP 719 (1935)

-SOURCE INFORMATION-

CORPORATE SOURCE -
SHELL PIPE LINE CORP., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 18, 32-41 (1973) (PROC. OF CRYOGENIC ENGINEERING CONF., 18TH, BOULDER, COLO., AUG 9-11, 1972. PAPER A-4)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0010 PAGES, 0008 FIGURES, 0003 TABLES, 0006 REFERENCES

key 19676

DEVELOPMENT PROGRAM FOR A LIQUID METHANE HEAT PIPE

by

FOSTER, W. G.
MURRAY, D. O.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

A DEVELOPMENT PROGRAM WAS CONDUCTED TO PROVIDE HEAT PIPES OPERATING WITH A CONDENSER TEMPERATURE OF 110 K AND AT A POWER OF 2 W, WITH A MAXIMUM TEMPERATURE GRADIENT OF 2 K ALONG THE 4-FT LENGTHS. IT WAS FOUND THAT THIS RESULT COULD BE ACCOMPLISHED WITH A SIMPLE WIRE-CLOTH WICK, USING METHANE AS THE WORKING FLUID. THERMAL TESTS IN A ONE-G FIELD WERE CONDUCTED AND RESULTS AGREED CLOSELY WITH THE PREDICTED PERFORMANCE. THE RADIAL TEMPERATURE GRADIENT WAS FOUND TO BE SMALLER THAN ANTICIPATED FOR A METHANE HEAT PIPE. NO DEGRADATION IN PERFORMANCE WAS FOUND AFTER THE PROTOTYPE WAS SUBJECTED TO LAUNCH ENVIRONMENT TESTS.

-PERTINENT FIGURES-

FIG.2 THEORETICAL PERFORMANCE AT ZERO G, PAGE 98//FIG.3 THEORETICAL PERFORMANCE AT ONE G, PAGE 98//FIG.4 THROUGHPUT VS TEMPERATURE, PAGE 99// FIG.5 POWER TRANSFERRED VS TOTAL TEMPERATURE DROP, HORIZONTAL POSITION, PAGE 100//FIG.6 POWER TRANSFERRED VS TOTAL TEMPERATURE DROP, INCLINED 1 DEG WITH EVAPORATOR UP, PAGE 100//FIG.7 TEMPERATURE PROFILE, PAGE 101

-BIBLIOGRAPHY-

HASKIN,W.L., CRYOGENIC HEAT PIPE, AIR FORCE FLIGHT DYNAMICS LABORATORY, WRIGHT-PATTERSON AFB, OHIO (JUN 1967)//EGGERS,P.E. AND SERKIZ,A.W., DEVELOPMENT OF CRYOGENIC HEAT PIPES, ASME PAPER NO. 70-WA/ENER-1, PRESENTED AT THE ASME WINTER ANNUAL MEETING, NEW YORK (NOV 1970)//BIERNET,W., BRENNAN,P.J. AND SKRABEK,E.A., DESIGN AND DEVELOPMENT OF A PROTOTYPE STATIC CRYOGENIC HEAT TRANSFER SYSTEM, FINAL REPT. DYNATHERM CORP. CONTRACT NAS 5-21191 (AUG 1971)//BRENNAN,P., TRIMMER,D., SHERMAN,A. AND CYGNAROWICZ,T.A., ARTERIAL AND GROOVED CRYOGENIC HEAT PIPES, ASME PAPER NO. 71-WA/HT-42, PRESENTED AT ASME WINTER ANNUAL MEETING, LOS ANGELES, CALIFORNIA (DEC 1971)//JOY,P., OPTIMUM CRYOGENIC HEAT-PIPE DESIGN, ASME PAPER 70-HT/SPT-7, PRESENTED AT SPACE TECHNOLOGY AND HEAT TRANSFER CONFERENCE, LOS ANGELES, CALIFORNIA, JUNE 21-24 (1970)//CHI,S.W. AND CYGNAROWICZ,T.A., THEORETICAL ANALYSIS OF

CRYOGENIC HEAT PIPES, ASME PAPER NO. 70-HT/SP6-6, PRESENTED AT SPACE TECHNOLOGY AND HEAT TRANSFER CONFERENCE, LOS ANGELES, CALIFORNIA, JUNE 21-24 (1970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LOCKHEED MISSILES AND SPACE CO., PALO ALTO, CALIF. RESEARCH LABS.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 18, 96-102 (1973) (PROC. OF CRYOGENIC ENGINEERING CONF., 18TH, BOULDER, COLO., AUG 9-11, 1972. PAPER B-7)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0007 PAGES, 0007 FIGURES, 0000 TABLES, 0008 REFERENCES

PRESTRESSED CONCRETE FOR LNG--STATUS AND DEVELOPMENT REPORT

by

CLOSNER, J. J.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER DISCUSSES THE ADVANTAGES OF PRESTRESSED CONCRETE AS A MATERIAL OF CONSTRUCTION FOR LNG STORAGE TANKS, DIKES AND BERMS - FOR PROTECTION AGAINST EXTERNAL IMPACT OR FIRE AND AS A MEANS OF LIMITING THE POOL SIZE THAT MIGHT RESULT FROM A MAJOR SPILL FROM THE PRIMARY STORAGE CONTAINER. HISTORY AND CURRENT STATUS OF PRESTRESSED CONCRETE IN LNG FACILITIES CONSTRUCTION IS GIVEN.

-PERTINENT FIGURES-

FIG.5-1 600,000-BARREL PRESTRESSED CONCRETE TANK, TEXAS EASTERN CRYOGENIC CORPORATION, STATEN ISLAND, NEW YORK//FIG.5-3 350,000-BARREL PROTECTIVE DIKE, PHILADELPHIA ELECTRIC COMPANY//FIG.5-4 WALL PANEL ERECTION FOR FIRST OF TWO 583,000-BARREL PRESTRESSED CONCRETE TANKS, PHILADELPHIA GAS WORKS, PHILADELPHIA, PA.//FIG.5-5 TWO 900,000-BARREL PRESTRESSED CONCRETE TANKS, DISTRIGAS CORPORATION, STATEN ISLAND, NEW YORK

-BIBLIOGRAPHY-

CLOSNER,J.J., STORING CRYOGENS WITH PRESTRESSED CONCRETE, CRYOGENIC ENGINEERING NEWS//BELOWGROUND STORAGE OF LIQUEFIED NATURAL GAS IN PRESTRESSED CONCRETE, INSTITUTE OF GAS TECHNOLOGY REPORT NO. 8, 1963// CLOSNER,J.J., PRESTRESSED CONCRETE DIKE SYSTEMS FOR LNG STORAGE CONTAINER, DISTRIBUTION CONFERENCE, OPERATING SECTION, AMERICAN GAS ASSOCIATION, CHICAGO, MAY 1971

-SOURCE INFORMATION-

CORPORATE SOURCE -
PRELOAD ENGINEERING CO., GARDEN CITY, N.Y.
JOURNAL PROCEEDINGS -
APPLICATIONS OF CRYOGENIC TECHNOLOGY VOL 4, 80-8 (1972)
(PROC. OF CRYO-71, WASHINGTON, D.C., AUG 29-SEP 1, 1971)
PUBLISHER -
INFORMATION CORP., NEW YORK
OTHER INFORMATION -

keys 19743 through 19744

USE FOAM TO DISPERSE LNG VAPORS

by

BROWN, L. E.
WELKER, J. R.
WESSON, H. R.

02/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

THIS SHORT ARTICLE DESCRIBES FIELD TESTS THAT WERE CONDUCTED TO INVESTIGATE THE EFFECTS OF HIGH-EXPANSION FOAM APPLIED TO STEADY STATE LNG SPILLS. THE TESTS SHOWED THAT AMONG OTHER THINGS A BLANKET OF HIGH-EXPANSION FOAM EFFECTIVELY REDUCES GROUND-LEVEL METHANE CONCENTRATIONS DOWNWIND OF AN LNG SPILL.

-PERTINENT FIGURES-

FIG.1 TEMPERATURES ABOVE LNG SPILL BEFORE AND AFTER APPLICATION OF HIGH-EXPANSION FOAM, PAGE 119//FIG.2 REDUCTION OF METHANE CONCENTRATION BY HIGH-EXPANSION FOAM, PAGE 120

-BIBLIOGRAPHY-

WESSON,H.R., WELKER,J.R., BROWN,L.E., AND SLIEPCEVICH,C.M., CONTROL OF LNG SPILL FIRES ON LAND WITH HIGH EXPANSION FOAMS, HYDROCARBON PROCESSING, OCTOBER 1973

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 53, NO. 2, 119-20 (FEB 1974)
OTHER INFORMATION -
0002 PAGES, 0002 FIGURES, 0000 TABLES, 0001 REFERENCES

keys 19685 through 19687

DESIGN CONSIDERATIONS FOR AN AUTOMOTIVE CRYOGENIC FUEL SYSTEM

by

MARTINDALE, D. L.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

AN AUTOMOTIVE SYSTEM EMPLOYING A CRYOGENIC FLUID AS A FUEL ENCOMPASSES NEARLY AS MANY UNIQUE PROBLEMS AS THE DEVELOPMENT OF A UNIQUE VEHICLE POWER PLANT. THIS PAPER DESCRIBES THE PROBLEMS AND HOW THEY HAVE BEEN SOLVED BY TECHNOLOGICAL INNOVATION BASED ON RESEARCH AND TESTING. DETAILS OF FEATURES REQUIRED FOR A CRYOGENIC CONTAINER USED AS A FUEL STORAGE SUPPLY ARE DISCUSSED. SPECIFIC CONSIDERATIONS GIVEN THE FILL AND VENT COUPLINGS, THE FILL AND VENT VALVES, THE VENT MANIFOLD ASSEMBLY, THE RELIEF VALVE SELECTION, THE VAPOR AND FLUID WITHDRAWAL LINES, THE INSULATION, THE TANK SUPPORT MOUNTING, THE SELECTION OF MATERIALS, AND THE LIQUID LEVEL SYSTEM ARE ALL DESCRIBED. ADDITIONAL CRYOGENIC FEATURES NECESSARY FOR THE SYSTEM, SUCH AS CONTROL OF FLUID FOR ENGINE SUPPLY, ARE DISCUSSED. CONVERSION OF CRYOGENIC FLUID TO VAPOR AND ITS REGULATION IS INCLUDED. THE PAPER IS CONCLUDED WITH A DESCRIPTION OF AN OVERALL SYSTEM FOR VEHICLE OPERATION ON LNG AND PRODUCT DEVELOPMENT PROGRAMS NOW IN PROGRESS.

-PERTINENT FIGURES-

FIG.7-1 CRYOGENIC TANK SCHEMATIC//FIG.7-2 COMPONENT ILLUSTRATION, LNG SYSTEM FOR AUTOMOTIVE OPERATION//FIG.7-4 VAPOR CONTROL WITH PRESSURE SW// FIG.7-5 VAPOR CONTROL WITH B/P VALVE//FIG.7-6 NO-VENT SYSTEM

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMETEK-STRAZA, EL CAJON, CALIF.
JOURNAL PROCEEDINGS -
APPLICATIONS OF CRYOGENIC TECHNOLOGY VOL 4, 118-26 (1972)
(PROC. OF CRYO-71, WASHINGTON, D.C., AUG 29-SEP 1, 1971)
PUBLISHER -
INFORMATION CORP., NEW YORK
OTHER INFORMATION -
0009 PAGES, 0006 FIGURES, 0000 TABLES, 0000 REFERENCES

key 19688

AN LNG SHIP LOADING PIPELINE

by

CROWL, R. E.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

DETAILS OF THE SHELL-MITSUBISHI BRUNEI LNG SHIP-LOADING SYSTEMS ARE DESCRIBED IN THIS PAPER. THE LOADING LINES ARE ABOUT 2 1/2 MILES LONG, ARE INSULATED WITH POLYURETHANE FOAM AND ARE 18 INCHES IN DIAMETER.

-PERTINENT FIGURES-

FIG.8-3 TRESTLE-MOUNTED LOADING LINES//FIG.8-4 END OF TYPICAL INSULATED PIPE SECTION//FIG.8-5 EXPANSION JOINT ASSEMBLY//FIG.8-8 ANCHOR AND EXPANSION JOINT SUPPORTS

-SOURCE INFORMATION-

CORPORATE SOURCE -
COSMODYNE CORP., TORRANCE, CALIF.
JOURNAL PROCEEDINGS -
APPLICATIONS OF CRYOGENIC TECHNOLOGY VOL 4, 127-44 (1972)
(PROC. OF CRYO-71, WASHINGTON, D.C., AUG 29-SEP 1, 1971)
PUBLISHER -
INFORMATION CORP., NEW YORK
OTHER INFORMATION -
0008 PAGES, 0009 FIGURES, 0000 TABLES, 0003 REFERENCES

keys 19689 through 19691

SAFETY ASPECTS OF LNG IN TRANSPORTATION

by

LAKEY, R. J.
MCCONNAUGHEY, W. E.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

BULK TRANSPORTATION OF LNG IS RELATIVELY NEW, AND THE FIRST LARGE-SCALE MOVEMENTS WERE MADE BY WATER WHEN AN EXPERIMENTAL TANKER (METHANE PIONEER) MADE SEVERAL VOYAGES FROM THE GULF COAST TO ENGLAND. SINCE THE PRINCIPAL NEED FOR LNG TRANSPORT IS INTERNATIONAL, THE WATER MODE HAS CONTINUED TO PIONEER DEVELOPMENTS IN TECHNOLOGY AND IN THE EVALUATION OF HAZARDS. HOWEVER, PREDICTED ENERGY SHORTAGES IN THE UNITED STATES HAVE STIMULATED INTEREST IN LNG TRANSPORT BY ALL MODES. CURRENT AND ENVISIONED REGULATORY REQUIREMENTS FOR ALL MODES OF TRANSPORTATION, AS WELL AS ONGOING RESEARCH ON EVALUATION OF LNG HAZARDS, ARE DISCUSSED IN THIS PAPER. HAZARDS BEING STUDIED INCLUDE DOWNWIND VAPOR TRAVEL, THERMAL RADIATION FROM BURNING LNG, IGNITION OF VAPOR TRAILS WITH MEASUREMENTS OF RADIATION AND/OR OVERPRESSURE, AND FLAMELESS EXPLOSIONS IN WATER SPILLS.

-BIBLIOGRAPHY-

EMERGY,W.B. AND WHEELER,R.S., OPERATING EXPERIENCE, LNG TANKERS, PRESENTED AT API TANKER CONFERENCE, 1971//FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, BUREAU OF MINES REPORT NO. RI 6099, 1962//HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, BUREAU OF MINES FINAL REPORT TO U. S. COAST GUARD, FEBRUARY 1970, (NTIS ACCESSION NO. AD 705078//LNG SPILLS, TO BURN OR NOT TO BURN BY WELKER, WASSON, AND SLIEPCEVICH, PRESENTED AT THE DISTRUBITION CONFERENCE OPERATING SECTION, AMERICAN GAS ASSOCIATION, PHILADELPHIA, PA., MAY 1969//REPORTS AVAILABLE FROM AMERICAN GAS ASSOCIATION, 1515 WILSON BLVD., ARLINGTON, VIRGINIA, 22209, 1971. VOLS I AND II. A REPORT ON LNG SAFETY RESEARCH (A.D. LITTLE, INC.) VOL III. LNG SAFETY PROGRAM--PHASE I (BATTELLE COLUMBUS LABS.) VOL. IV. NON-GRAY THERMAL RADIATION FROM A FLAME ABOVE A POOL OF LIQUID NATURAL GAS (TRW SYSTEMS GROUP) VOL. V. AN EXPERIMENTAL VAPOR DISPERSION LAW FOR AN LNG SPILL (TRW SYSTEMS GROUP)//STORAGE AND HANDLING--LIQUEFIED NATURAL GAS, NFPA STANDARD NO. 59A, 1971

-SOURCE INFORMATION-

CORPORATE SOURCE -
    COAST GUARD, WASHINGTON, D.C.
JOURNAL PROCEEDINGS -
    APPLICATIONS OF CRYOGENIC TECHNOLOGY VOL 4, 167-81 (1972)
    (PROC. OF CRYO-71, WASHINGTON, D.C., AUG 29-SEP 1, 1971)
PUBLISHER -
    INFORMATION CORP., NEW YORK
OTHER INFORMATION -
    0015 PAGES, 0000 FIGURES, 0001 TABLES, 0017 REFERENCES

keys 19692 through 19696

LNG FOR BASE LOAD USE

by

PREUSSER, R. M.

06/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER BRIEFLY DESCRIBES THE BROOKLYN UNION GAS COMPANYS BASE-LOAD LNG LNG PLANT AND TERMINAL AT GREENPOINT, N.Y. EMPHASIS IS GIVEN TO THE SAFETY ASPECTS OF THE PLANT, INCLUDING EMERGENCY SYSTEMS AND PROCEDURES.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BROOKLYN UNION GAS CO., NEW YORK
JOURNAL PROCEEDINGS -
PIPE LINE IND. VOL 38, NO. 6, 26-9 (JUN 1973)
OTHER INFORMATION -
0004 PAGES, 0003 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 19705 through 19706

COMBINED STORAGE OF LPG AND NATURAL GAS

by

BACKHAUS, H. W.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE CONCEPT OF COMBINED STORAGE OF NATURAL GAS AND LPG IS BASED ON THE SOLUBILITY OF NATURAL GAS IN LPG. DATA ON THE LIQUID-VAPOR EQUILIBRIUM BETWEEN METHANE AND PROPANE ARE PRESENTED TO DEMONSTRATE THE PRINCIPLE. COMPARED WITH PRESSURIZED DRY STORAGE OF METHANE, THE ABSORPTION SCHEME OFFERS CONSIDERABLE ADVANTAGES WITH RESPECT TO THE STORAGE VOLUME. THE SAVINGS IN ENERGY ARE SIGNIFICANT COMPARED WITH THE LIQUEFACTION OF THE NATURAL GAS AND LIQUID STORAGE. THE STORAGE METHOD DESCRIBED THEREFORE HAS ITS PLACE BETWEEN THE PRESSURIZED DRY STORAGE IN CYLINDERS AND SPHERES AND THE LNG STORAGE. LOCAL CONDITIONS - SUCH AS THE CONTRACT BETWEEN THE GAS TRANSMISSION COMPANY AND THE GAS SUPPLY UTILITY - MAY INFLUENCE THE STORAGE CAPACITY FINALLY CHOSEN. THE STORAGE METHOD DESCRIBED BECOMES ECONOMIC FROM APPROXIMATELY 30,000 M(3) (STP) PER STORAGE CYCLE. OPTIMUM CONDITIONS WILL BE OBTAINED BETWEEN 50,000 AND 200,000 M(3) (STP). A PLANT OF THE LATTER CAPACITY IS ABLE TO STORE ABOUT 20,000,000 M(3) (STP) OF METHANE DURING A 100-DAY STORAGE SEASON. NEVERTHELESS, IT SHOULD BE RECOGNIZED THAT THE ABSORPTION SCHEME HAS TO BE REGARDED AS A SHORT TIME STORAGE CONCEPT, TYPICAL FOR DAY/NIGHT OR WEEK/WEEKEND PEAK SHAVING REQUIREMENTS.

-PERTINENT FIGURES-

TAB.1 PHASE EQUILIBRIA DATA FOR THE METHANE-PROPANE SYSTEM, PAGE 76//TAB.2 ABSORPTION COEFFICIENT AT 41 ATM AS A FUNCTION OF TEMPERATURE, PAGE 78// TAB.3 ABSORPTION COEFFICIENT AT -60 DEGREES C AS A FUNCTION OF PRESSURE, PAGE 78//FIG.1 EQUILIBRIUM DATA FOR VAPOR AND LIQUID PHASES OF THE PROPANE-METHANE SYSTEM, PAGE 76//FIG.2 TEMPERATURE AS A FUNCTION OF ABSORPTION COEFFICIENT, PAGE 77//FIG.3 DENSITY OF PROPANE-METHANE MIXTURE AS A FUNCTION OF TEMPERATURE, PAGE 79

-BIBLIOGRAPHY-

LOFFLER,H.J., THERMODYNAMISCHE EIGENSCHAFTEN BINARER GEMISCHE LEICHTER GESATTIGTER KOHLENWASSERSTOFFE IM KRITISCHEN GEBIET, VERLAG C. F. MULLER, KARLSRUHE (1962)//GROSSE,L., ARBEITSMAPPE FUR

MINERALOLINGENIEURE, VDI-VERLAG GMBH, DUSSELDORF (1962)//BENEDICT,M., WEBB,G.B., RUBIN,L.C. AND FRIEND,L., CHEM. ENG. PROGR., VOL 47, PP 571 (1951)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LIQUID GAS ANLAGEN UNION G.M.B.H., RAMAGEN-ROLANDSECK, WEST GERMANY
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 17, 74-83 (1972) (PRES. AT CRYOGENIC ENGINEERING CONF., BOULDER, COLO., JUN 17-9, 1970. PAPER B-2)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0010 PAGES, 0004 FIGURES, 0003 TABLES, 0003 REFERENCES

key 19707

LIQUEFACTION CYCLES FOR CRYOGENS

by

BARRON, R. F.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PRESENTATION WILL CONSIDER SOME OF THE SYSTEMS USED TO LIQUEFY COMMONLY-USED CRYOGENS, SUCH AS NITROGEN, OXYGEN, AIR, HYDROGEN, AND HELIUM, ALONG WITH SYSTEMS USED TO LIQUEFY NATURAL GAS. THE VARIOUS LIQUEFACTION SYSTEMS AND THERMODYNAMIC CYCLES ARE DESCRIBED, WITH THEIR ADVANTAGES AND DISADVANTAGES. THE SYSTEMS ARE EVALUATED AND COMPARED IN TERMS OF WORK PER UNIT MASS LIQUEFIED.

-PERTINENT FIGURES-

TAB.1 IDEAL WORK REQUIREMENTS FOR THE LIQUEFACTION OF GASES, PAGE 21//TAB.2 PERFORMANCE OF THE LINDE-HAMPSON SYSTEM USING DIFFERENT FLUIDS, PAGE 23// TAB.3 COMPARISON OF LIQUEFACTION SYSTEMS USING AIR AS A WORKING FLUID, PAGE 31

-BIBLIOGRAPHY-

BODLE,W.W. AND PROCTER,R.C., CRYO. ENGR. NEWS VOL 3, NO. 3, PP 22 (1968)// GARWIN,L., CRYOGENICS AND INDUSTRIAL GASES VOL 5, NO. 6, PP 23 (1970)// LINNETT,D.T. AND SMITH,K.C., ADVANCES IN CRYOGENIC ENGINEERING VOL 15, PLENUM PRESS, NEW YORK (1969)//PRATER,P.G., CRYOGENICS AND INDUSTRIAL GASES VOL 5, NO. 5, PP 15 (1970)//RITTER,C.L., CHEM. ENGR. PROG. VOL 58, PP 61 (1962)//SWEARINGEN,J.S., AM. GAS. JOURNAL VOL 47, PP 124 (1968)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LOUISIANA TECH UNIV., RUSTON
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 17, 20-36 (1972) (PRES. AT AICHE AND INSTITUTO MEXICANO DE INGENIEROS QUIMICOS JOINT MEETING, 3RD, DENVER, COLO., AUG 30-SEP 2, 1970. PAPER A-3)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -

keys 19736 through 19740

LNG RECEIVING TERMINAL DESIGN IS DIFFERENT

by

CRAWFORD, D. B.
DURR, C. A.

12/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE PURPOSE OF THIS ARTICLE IS TO PRESENT THE BASIC COMPONENTS OF AN LNG RECEIVING TERMINAL AND TO ANALYSE SEVERAL OF THE TECHNICAL PROBLEMS ENCOUNTERED IN DESIGNING SUCH TERMINALS, EMPHASIS IS PLACED ON THE SHIP UNLOADING AND VAPOR HANDLING SYSTEMS.

-PERTINENT FIGURES-

TAB.1 TYPICAL DESIGN PARAMETERS FOR LNG RECEIVING TERMINALS, PAGE 37// FIG.1 FLOW DIAGRAM OF LNG RECEIVING TERMINAL, PAGE 37//FIG.2 VALVE OPENING VS. STROKE MOVEMENT, PAGE 39//FIG.3 MAXIMUM PRESSURE VS. STROKE MOVEMENT, PAGE 39//FIG.4 FLOW DIAGRAM OF LNG RECIRCULATION, PAGE 39//FIG.5 VAPOR FLOW RATES VS. LNG UNLOADING RATE, PAGE 44

-BIBLIOGRAPHY-

WOOD,D.J. AND JONES,S.E., WATER-HAMMER CHARTS FOR VARIOUS TYPES OF VALVES, JOURNAL OF THE HYDRAULICS DIVISION, ASCE, 99.167 (1973)//MORGAN,S.K. AND BRADY,H.F., ELIMINATION OF THE GEYSERING EFFECT IN MISSILES, IN. K. D. TIMMERHAUS, ADVANCES IN CRYOGENIC ENGINEERING, PLENUM PRESS, NEW YORK, VOL. 9, 1963, P 206//MURPHY,D.W., AN EXPERIMENTAL INVESTIGATION OF GEYSERING IN VERTICAL TUBES, IN., K. D. TIMMERHAUS, ADVANCES IN CRYOGENIC ENGINEERING, PLENUM PRESS, NEW YORK, VOL. 11, 1965, P 353

-SOURCE INFORMATION-

CORPORATE SOURCE -
KELLOG (M.W.) CO., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 200, NO. 14, 37 & 39-40 & 44 & 46 (DEC 1973)
OTHER INFORMATION -
0005 PAGES, 0005 FIGURES, 0003 TABLES, 0006 REFERENCES

REMOVAL OF IMPURITIES FROM GASES TO BE PROCESSED AT LOW TEMPERATURES

by

DODGE, B. F.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Good/Excel.

-ABSTRACT-

ALL GASES OF INDUSTRIAL IMPORTANCE ARE MIXTURES (SOLUTIONS) OF TWO OR MORE COMPONENTS AND THE PROCESSES WITH WHICH THIS PAPER IS CONCERNED HAVE AS THEIR OBJECTIVE THE SEPARATION OF ONE OR MORE OF THE COMPONENTS IN A PURIFIED FORM EITHER AS A LIQUID OR A GAS. THE UNDESIRABLE COMPONENTS ARE CLASSED AS IMPURITIES AND THEIR CONCENTRATION MAY VARY OVER VERY WIDE LIMITS FROM FRACTIONS OF A PART PER MILLION TO OVER 50 PERCENT (BY VOLUME) AND EVEN APPROACHING 100 PERCENT IN THE CASE OF HELIUM PRODUCTION. IMPURITIES MUST BE REMOVED NOT ONLY TO OBTAIN A DESIRED PRODUCT PURITY BUT ALSO, PARTICULARLY IN CRYOGENIC PROCESSES, TO PREVENT THE DEPOSITION OF SOLIDS WHICH WOULD BLOCK PASSAGES AND SOON MAKE THE PROCESS INOPERATIVE, TO REMOVE AN EXPLOSION HAZARD, TO PREVENT THE BLANKETING OF HEAT-TRANSFER SURFACES BY NONCONDENSIBLE GASES, AND SOMETIMES TO PREVENT CORROSION. FOR THESE REASONS, THE REMOVAL OF IMPURITIES IS A VERY CRITICAL STEP IN ANY LOW-TEMPERATURE PROCESS. THIS PRESENTATION WILL REVIEW THE METHODS USED IN MOST OF THE IMPORTANT CRYOGENIC PROCESSES WITHOUT ENTERING INTO MUCH DETAIL. EACH OF THE METHODS TO BE DISCUSSED, IF TREATED IN DETAIL, WOULD FORM THE BASIS FOR A PAPER SO THAT IT IS CLEAR THAT IF THE PRESENT PAPER IS TO COVER THE FIELD COMPREHENSIVELY, IT MUST BE CONFINED TO GENERAL DESCRIPTIONS. IN SOME CASES, REFERENCES WILL BE CITED WHERE MORE DETAIL CAN BE OBTAINED. AS FAR AS IS KNOWN, NO COMPREHENSIVE DISCUSSION OF PURIFICATION METHODS AS APPLIED TO MOST OF THE CRYOGENIC PROCESSES OF INDUSTRIAL IMPORTANCE HAS APPEARED IN THE LITERATURE. THERE IS, OF COURSE, A CONSIDERABLE LITERATURE ON THE SUBJECT OF PURIFICATION, BUT IT IS LARGELY CONCERNED WITH ONE OR TWO PARTICULAR METHODS AND NOT THE BROAD TREATMENT ATTEMPTED HERE.

-PERTINENT FIGURES-

TAB.1 IMPURITIES IN AIR, PAGE 38//TAB.2 ENHANCEMENT FACTORS FOR THE SYSTEM, WATER-AIR, PAGE 39//TAB.3 ENHANCEMENT FACTORS FOR THE SYSTEM CO(2)-AIR, PAGE 44

-BIBLIOGRAPHY-

LANDSBAUM,E.M., DODDS,W.S. AND STUTZMAN,L.F., IND. ENG. CHEM. VOL 47, PP 101 (1955)//SCHUFTAN,P.M. AND MACKIE,A.G., TRANS. INST. CHEM. ENG. VOL 36, PP 137 (1958)//WEBSTER,T.J., PROC. ROY. SOC. (LONDON) VOL A214, PP 61 (1952)//MCKINLEY,C., BREWER,J. AND WNAG,E.S.J., ADVANCES IN CRYOGENIC ENGINEERING VOL 7, PLENUM PRESS, NEW YORK (1961), PP 114//HIZA,M.J., HECK,C.K. AND KIDNAY,A.J., CHEM. ENG. PROGR. SYMP. SER. VOL 64, NO. 88, PP 57 (1968)//DOKOUPIL, Z. VAN SOEST,G. AND SWENKER,M.P.D., APPL. SCI. RES. VOL A5, PP 182 (1956)

-SOURCE INFORMATION-

CORPORATE SOURCE -
YALE UNIV., NEW HAVEN, CONN.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 17, 37-55 (1972) (PRES. AT AICHE AND INSTITUTO MEXICANO DE INGENIEROS QUIMICOS JOINT MEETING, 3RD, DENVER, COLO., AUG 30-SEP 2, 1970. PAPER A-4)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0019 PAGES, 0000 FIGURES, 0003 TABLES, 0080 REFERENCES

keys 19711 through 19714

STORAGE AND HANDLING OF CRYOGENS

by

EDESKUTY, F. J.
WILLIAMSON, JR., K. D.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER PRESENTS A GENERAL REVIEW OF OPERATIONS INVOLVING CRYOGENS, UNDER THE HEADINGS OF STORAGE, HANDLING, AND SAFETY. THE STRESS OF THE PAPER IS ON LARGE SCALE OPERATIONS, INVOLVING LARGE AMOUNTS OF CRYOGENS, AND MANY OF THE EXAMPLES USED INVOLVE LIQUID HYDROGEN. THE PAPER IS TOO BRIEF TO COVER THE RANGE OF SUBJECTS IN MUCH DETAIL, BUT A GOOD GENERAL INTRODUCTION IS ACHIEVED, AND REFERENCES ARE GIVEN TO THE DETAILED INFORMATION.

-PERTINENT FIGURES-

TAB.3 TYPICAL LARGE SCALE CRYOGENIC CONTAINER PERFORMANCE, PAGE 58//FIG.2 TEMPERATURE DISTRIBUTION IN A 50000-GAL LIQUID HYDROGEN DEWAR, PAGE 60// FIG.3 OBSERVED AND CALCULATED PRESSURE RISE RATES FOR AN ALMOST FULL SEALED-OFF 50000-GAL LIQUID HYDROGEN DEWAR, PAGE 60//TAB.4 TYPICAL SHIPMENTS OF CRYOGENS, PAGE 64

-BIBLIOGRAPHY-

BOYER,K., OTWAY,H. AND PARKER,R.C., ADVANCES IN CRYOGENIC ENGINEERING, VOL 10, PLENUM PRESS, NEW YORK (1965), PP 273//EDESKUTY,F.J., WILLIAMSON,JR.,K.D. AND REIDER,R., CRYOGENIC FUNDAMENTALS (G. HASSELDEN, ED.), ACADEMIC PRESS, LONDON (1971), CH. 11//LAPIN,A., ADVANCES IN CRYOGENIC ENGINEERING, VOL 12, PLENUM PRESS, NEW YORK (1967), PP 198// THOMPSON,W.R. AND BONCORE,C.S., ADVANCES IN CRYOGENIC ENGINEERING VOL 12, PLENUM PRESS, NEW YORK (1967), PP 207

-SOURCE INFORMATION-

CORPORATE SOURCE -
    LOS ALAMOS SCIENTIFIC LAB., N.MEX.
JOURNAL PROCEEDINGS -
    ADVAN. CRYOG. ENG. VOL 17, 56-68 (1972) (PRES. AT AICHE AND INSTITUTO MEXICANO DE INGENIEROS QUIMICOS JOINT MEETING, 3RD, DENVER, COLO., AUG 30-SEP 2, 1970. PAPER A-5)

keys 10877 through 10879

INERT GAS GENERATORS BUILT BY DUTCH COMPANY

-ABSTRACT-

THE INCREASING WORLD PRODUCTION OF INFLAMMABLE, EXPLOSIVE, AND OXIDIZING SUBSTANCES IN SOLID, LIQUID, OR GASEOUS FORM HAS RESULTED IN A LARGE NUMBER OF SPECIALIZED SHIPS BEING BUILT CAPABLE OF SAFELY TRANSPORTING THESE DANGEROUS CARGOES. THESE SHIPS MUST BE ARRANGED TO CONFORM TO SPECIFIC SAFETY REQUIREMENTS. ONE OF THE METHODS OFTEN ADOPTED BY OWNERS FOR THE PROTECTION OF VESSELS THAT SHIP LPG AND LNG INVOLVES THE USE OF INERT GASES. THIS PAPER DISCUSSES THE INERT GAS GENERATOR, WHICH IS ONE OF THE MOST SATISFACTORY WAYS OF OBTAINING A SUPPLY OF INERT GAS.

-PERTINENT FIGURES-

FIG.1 SCHEMATIC DIAGRAM SHOWING THE WORKING OF A LOW PRESSURE INERT GAS GENERATOR, PAGE 516

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
SHIPPING WORLD AND SHIPBUILDER VOL 165, NO. 3868 (APR 1972)
OTHER INFORMATION -
0001 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 19727 through 19728

FIGHT LNG FIRES WITH FOAM

by

BROWN, L. E.
SLIEPCEVICH, C. M.
WELKER, J. R.
WESSON, H. R.

10/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

RESULTS OF THE FIRE TEST PROGRAM DISCUSSED IN THIS ARTICLE INDICATE THAT, WHEN FIGHTING STEADY STATE LNG FIRES. 1. HIGH QUALITY HI-EX FOAM PROVIDES ADEQUATE CONTROL OF LNG SPILL FIRES ON LAND, REDUCING EXTERNAL RADIATION EFFECTS TO THE LEVEL THAT SUPPLEMENTAL EXPOSURE CONTROL PROVISIONS WILL NOT BE REQUIRED BEYOND ONE-QUARTER OR MORE POOL DIAMETERS. 2. THE 500.1 FOAM EXPANSION RATIO APPEARS SUPERIOR TO BOTH HIGHER AND LOWER EXPANSION RATIOS. 3. HI-EX FOAM SYSTEMS FOR CONTROL OF LARGE LNG SPILL FIRES REQUIRING A HIGH DEGREE OF EXPOSURE PROTECTION APPEAR TO OFFER LARGE FIRST COST SAVINGS OVER CONVENTIONAL WATER EXPOSURE-PROTECTION SYSTEMS. OPERATING COSTS ARE MUCH HIGHER FOR THE FOAM SYSTEMS. HOWEVER, DUE TO THE ANTICIPATED LIMITED USAGE FOR THESE FOAM SYSTEMS, THE FIRST COST MAY BE THE DECIDING FACTOR IN CHOOSING THE EXPOSURE CONTROL SYSTEM. 4. THE REDUCTION IN RADIATION FLUX BY THE WATER CURTAIN SYSTEM WAS FAR LESS THAN THAT OBTAINED WITH HI-EX FOAMS APPLIED TO THE FIRE AREA. CONSIDERABLY HIGHER WATER FLOW RATES AND SUPPLY PRESSURES WERE REQUIRED.

-PERTINENT FIGURES-

TAB.1 SUMMARY OF TEST PROGRAM CONDUCTED FOR EVALUATION OF FIRE CONTROL CHARACTERISTICS OF HIGH EXPANSION FOAMS ON LNG SPILLS ON LAND, PAGE 167// TAB.2 OUTLINE OF TEST PROGRAM CONDUCTED FOR EVALUATION OF THE FIRE CONTROL CHARACTERISTICS AND VAPOR SUPPRESSION CAPABILITIES OF HIGH EXPANSION FOAMS ON LNG SPILLS, PAGE 169//FIG.1 EFFECTS OF FOAM APPLICATION RATE ON LNG FIRE CONTROL TIME WITH FOAM EXPANSION RATIO AND FOAM BRANDS AS PARAMETERS, PAGE 168//FIG.2 EFFECTS OF FOAM EXPANSION RATIO ON EXTERNAL RADIATION HEAT FLUX LEVELS WITH FOAM BRAND AS A PARAMETER, PAGE 170//FIG.3 CORRELATION OF THE HIGH EXPANSION FOAM FIRE CONTROL TIMES, PAGE 171

-BIBLIOGRAPHY-

WESSON,H.R., WELKER,J.R., AND BROWN,L.E., CONTROL OF LNG SPILL FIRES WITH HIGH EXPANSION FOAMS, PRESENTED AT 1972 ASME PETROLEUMS MECHANICAL ENGINEERING CONFERENCE, NEW ORLEANS, LA., PAPER NO. 72-PET-46//WALLS,W.L., LNG, A FIRE DEVICE APPRAISAL, PART I, FIRE JOURNAL (JANUARY 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 52, NO. 10, 165-71 (OCT 1973)
OTHER INFORMATION -
0007 PAGES, 0003 FIGURES, 0002 TABLES, 0002 REFERENCES

FIGHT LNG SPILL FIRES WITH DRY CHEMICALS

by

BROWN, L. E.
SLIEPCEVICH, C. M.
WELKER, J. R.
WESSON, H. R.

11/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

AS A RESULT OF THE EXPERIMENTAL TESTING PROGRAM REPORTED HERE, DATA WERE OBTAINED ON PORTABLE EXTINGUISHERS, HOSE LINE UNITS, MONITOR NOZZLES AND FIXED SYSTEMS ON FULL-SCALE LNG SPILL FIRES IN SIMULATED LNG PLANT EQUIPMENT AREAS. VALUES FOR THE MINIMUM DRY CHEMICAL APPLICATION RATE AT WHICH A STEADY STATE LNG SPILL FIRE ON LAND CAN BE EXTINGUISHED WERE OBTAINED FOR THE AGENTS TESTED. IN ADDITION, THE EFFECTS OF APPLICATION RATES ABOVE THIS MINIMUM ON FIRE EXTINGUISHING TIMES WERE ALSO OBTAINED FOR ALL AGENTS TESTED. THE EFFECTS OF OBSTRUCTIONS WITHIN THE ACTIVE FIRE ZONE ON REQUIRED EXTINGUISHING FLOW RATES AND EXTINGUISHING TIMES WERE ALSO EVALUATED.

-PERTINENT FIGURES-

TAB.1 SUMMARY OF TEST PROGRAM CONDUCTED FOR EVALUATION OF FIRE EXTINGUISHING CHARACTERISTICS OF DRY CHEMICALS ON LNG SPILL FIRES ON LAND, PAGE 237// TAB.2 COMPARISON OF DRY CHEMICAL AGENT THRESHOLD LIMITS FOR THE EXTINGUISHMENT OF EXPOSED LNG POOL FIRES WITH A TOTAL LNG EVAPORATION RATE OF NOT MORE THAN 0.5 INCHES PER MINUTE, PAGE 239//TAB.3 COST EFFECTIVENESS COMPARISON OF THE DIFFERENT DRY CHEMICAL AGENTS USED FOR EXTINGUISHMENT OF A 1200 SQUARE FOOT LNG SPILL FIRE AT VARIOUS FLOW RATES, PAGE 240//FIG.5 RECOMMENDED MINIMUM DRY CHEMICAL APPLICATION RATES FOR EXTINGUISHMENT OF LNG SPILL FIRES WITH DRY CHEMICAL TYPES AS PARAMETERS, PAGE 240//FIG.6 EFFECTS OF DRY CHEMICAL FLOW RATE ON THE QUANTITY OF DRY CHEMICAL REQUIRED TO EXTINGUISH A 1200-SQUARE-FOOT LNG SPILL FIRE AT STEADY STATE BURNING CONDITIONS, PAGE 240

-BIBLIOGRAPHY-

BURGESS,D. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, BUREAU OF MINES REPORT RI-6099 (1962)//WESSON,H.R., WELKER,J.R., AND BROWN,L.E., CONTROL

OF LNG SPILL FIRES WITH HIGH EXPANSION FOAMS, PRESENTED AT 1972 ASME PETROLEUM MECHANICAL ENGINEERING CONFERENCE, NEW ORLEANS, LA., PAPER NO. 72-PET-46//LNG FIRE CONTROL, FIRE EXTINGUISHMENT AND VAPOR DISPERSION TESTS, REPORT ON PROJECT IS-3-1 TO AGA BY UNIVERSITY ENGINEERS, INC. (JULY 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 52, NO. 11, 234 & 237 & 239-40 & 242 & 244 (NOV 1973)
OTHER INFORMATION -
0005 PAGES, 0006 FIGURES, 0003 TABLES, 0004 REFERENCES

keys 12499 through 12503

LNG STRATIFICATION AND ROLLOVER

by

SARSTEN,J.A.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS REPORT COVERS AN INCIDENT WHERE LNG WAS STRATIFIED IN AN LNG STORAGE TANK DURING FILLING AND HOW THAT STRATIFICATION SUBSEQUENTLY RESULTED IN A ROLLOVER OF THE TANK CONTENTS AND THE RELEASE OF A LARGE QUANTITY OF GAS. A TANK CONTAINING A HEEL OF COOL BUT LIGHT LIQUID WAS FILLED FROM THE BOTTOM WITH WARMER BUT DENSER LIQUID. VAPOR FROM THE WARMER LIQUID WAS HELD DOWN BY THE LAYER OF LESS DENSE LIQUID ABOVE. DURING THE NEXT 18 HOURS THE DENSITIES EQUALIZED UNTIL A ROLLOVER OCCURRED. THEN, WITH THE VAPOR NO LONGER HELD DOWN, THE TANK PRESSURE ROSE WITH RAPID VENTING AND LOSS OF VAPOR. TO PREVENT SUCH AN OCCURRENCE IN THE FUTURE, MIXING NOZZLES WILL BE INSTALLED TO PREVENT STRATIFICATION DURING FILLING OF THE TANK. ONCE A TANK OF LNG IS WELL MIXED, IT WOULD NOT BE EXPECTED TO STRATIFY NATURALLY. THIS UNSTABLE STRATIFICATION LEADING TO ROLLOVER WAS THE RESULT OF DIFFERENCES IN COMPOSITION OF TWO BATCHES OF LNG. SUCH AN EFFECT IS NOT EXPECTED OF HOMOGENEOUS FLUIDS, LIQUID OXYGEN OR LIQUID HYDROGEN, WHICH DO NOT VARY IN COMPOSITION.

-PERTINENT FIGURES-

TAB.1 LNG STORAGE TANK S-1 AND ESSO BREGA CARGO COMPOSITIONS SNAM LNG TERMINAL, PAGE 37//FIG.3 LNG STORAGE TANK S-1 LOADING HISTORY AT SNAM LNG TERMINAL, PAGE 38//FIG.4 TEMPERATURE AND DENSITY PROFILE OF TANK S-1 AT SNAM LNG TERMINAL, PAGE 38//FIG.5 LNG STORAGE TANK S-1 HEAT TRANSFER SUMMARY PRIOR TO ROLLOVER, PAGE 39//FIG.6 DENSITY VARIATION PRIOR TO ROLLOVER LNG STORAGE TANK S-1 SNAM LNG TERMINAL, PAGE 39

-BIBLIOGRAPHY-

FOSSETT, H. AND PROSSER, L. E., THE APPLICATION OF FREE JETS TO THE MIXING OF FLUIDS IN BULK, PROC. INSTN. MECH. ENGRS. (LONDON), 160, 2, 224, (1949)//RUSHTON, J. H., PERSONAL COMMUNICATIONS WITH A. M. GOLDSTEIN (ERE) IN AUGUST, SEPTEMBER, 1971//DONALD, M. B. AND SINGER, H., ENTRAINMENT IN TURBULENT FLUID JETS, TRANS. INSTN. CHEM. ENGRS., 37, 255, (1959)//FOLSOM, R. G. AND FERGUSON, C. K., JET MIXING OF TWO LIQUIDS, TRANS. ASME, 71, 73, (1949)//STERBACEK,

Z. AND TAUSK, P., MIXING IN THE CHEMICAL INDUSTRY, PERGAMON PRESS, OXFORD, (1965)//SINCLAIR, C. J. AND MCNAUGHTON K. H., RESIDENCE TIME DISTRIBUTIONS IN JET STIRRED VESSELS WITH LINEAR SCALE FROM 0.5 TO 4 FEET, CANAD. J. CHEM. ENGR., 48, 411, (1970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
ESSO RESEARCH AND ENGINEERING CO., FLORHAM PARK, N.J.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 11, 37-9 (SEP 1972)
OTHER INFORMATION -
0003 PAGES, 0006 FIGURES, 0001 TABLES, 0006 REFERENCES

keys 12504 through 12507

THE EFFECTS OF STRATIFICATION ON BOIL-OFF RATES IN LNG TANKS

by

CHATTERJEE, N.
GEIST, J.M.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

ROLL-OVER IS A TERM THAT HAS BEEN USED TO DESCRIBE A PHENOMENON IN WHICH A BOTTOM PORTION OF THE LIQUID IN A CRYOGENIC STORAGE TANK IS SUPERHEATED, AS A RESULT OF HEAT LEAK, AND THEN MIGRATES SUDDENLY TO THE SURFACE ACCOMPANIED BY THE EVOLUTION OF A LARGE QUANTITY OF VAPOR. STUDIES HAVE SHOWN THAT ROLL-OVER CANNOT OCCUR IN LARGE CRYOGENIC STORAGE TANKS CONTAINING NEARLY PURE LIQUIDS. ROLL-OVER HAS NOT BEEN OBSERVED IN CRYOGENIC TANKS THAT HAVE BEEN USED FOR STORING LNG OF ESSENTIALLY UNIFORM COMPOSITION AND DENSITY, AMMONIA, LIQUID OXYGEN, OR LIQUID NITROGEN. THE ADDITION OF LNG OF DIFFERENT DENSITIES TO PARTIALLY FILLED LNG TANKS CAN LEAD TO THE TEMPORARY FORMATION OF STRATIFIED LAYERS. THE SUBSEQUENT MIXING OF THESE STRATIFIED LAYERS, AS A RESULT OF HEAT AND MASS TRANSFER BETWEEN THE LAYERS, LEADS TO CHANGES IN VAPORIZATION RATES. THESE CHANGES IN VAPORIZATION RATES MAY BE SMALL AND INSIGNIFICANT FOR MANY MODES OF OPERATION. UNDER SOME CONDITIONS, HOWEVER, THE INCREASES IN VAPORIZATION RATES MAY BE LARGE AND MIGHT LEAD TO OVERPRESSURIZATION OF STORAGE TANKS. A MATHEMATICAL MODEL HAS BEEN DEVELOPED FOR DESCRIBING THE PHYSICAL BEHAVIOR IN STRATIFIED LNG TANKS AND THE RESULTS HAVE BEEN STUDIED TO ESTABLISH GUIDELINES FOR MINIMIZING THE CHANCES FOR STRATIFICATION AND FOR MITIGATING THE PROBLEMS ASSOCIATED WITH ROLL-OVER. THE VALIDITY OF THE COMPUTER CALCULATIONS HAS BEEN CONFIRMED BY COMPARING PREDICTIONS AND OBSERVATIONS FOR THREE KNOWN CASES IN WHICH LNG TANKS EXPERIENCED SUDDEN INCREASES IN BOIL-OFF RATES.

-PERTINENT FIGURES-

FIG.3 BOIL-OFF RATE IN STRATIFIED LNG TANKS, PAGE 41//FIG.6 EFFECT OF VARIATIONS IN HEAT AND MASS TRANSFER COEFFICIENTS ON BOIL-OFF RATE, PAGE 42//FIG.7 EFFECT OF HEIGHT OF INTERMEDIATE LAYER ON BOIL-OFF RATE, PAGE 43//FIG.8 EFFECT OF INITIAL CHANGE IN TEMPERATURE BETWEEN LAYERS ON ELAPSED TIME TO REACH PEAK VAPORIZATION RATES, PAGE 43//FIG.10 EFFECT OF QUANTITY OF HEAVY LIQUID ON PEAK VAPORIZATION RATES, PAGE 44//FIG.11 EFFECT OF DENSITY DIFFERENCES BETWEEN FEED AND TANK LNG ON PEAK BOIL-OFF

RATES FOR TRAILER UNLOADING, PAGE 45

-BIBLIOGRAPHY-

TURNER, S., INT. J. HEAT AND MASS TRANSFER, 8, 759-767, (1965)// EXPERIMENTS AT R AND D DEPT., AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.//SWALLOW, J. C., AND CREASE, J., NATURE, 205, 165-166, (1965)//HOARE, R. A., NATURE, 210, 787-790 (1966)//CAPP PROGRAM, MANAGEMENT INFORMATION DEPARTMENT, AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 11, 40-5 (SEP 1972)
OTHER INFORMATION -
0006 PAGES, 0012 FIGURES, 0001 TABLES, 0004 REFERENCES

keys 12508 through 12510

ROLL-OVER AND THERMAL OVERFILL IN FLAT BOTTOM LNG TANKS

by

MAHER,J.B.
VAN GELDER,L.R.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THERE HAVE BEEN REPORTS OF SUDDEN VENTING OCCURRING IN TWO OR THREE FLAT BOTTOM LNG TANKS. IN EACH CASE A WARMER AND MORE DENSE LIQUID HAD BEEN FILLED INTO THE BOTTOM OF THE TANK AND VENTING OCCURRED BEFORE THE FILLING REFRIGERATION REQUIREMENTS HAD BEEN FULFILLED. EVAPORATION SUSTAINED BY THE VAPOR WITHDRAWAL SYSTEM PROVIDED THE REFRIGERATION. DATA AVAILABLE FROM THESE INSTALLATIONS ARE NOT COMPLETE. TANK TEMPERATURES, PRESSURES, WEATHER DATA, AND OPERATING PROCEDURES PRIOR TO OR DURING THE SUDDEN VENTING ARE NOT WELL DOCUMENTED. SOME INVESTIGATORS HAVE ATTRIBUTED THE TYPE OF VENTING ENCOUNTERED TO A ROLL-OVER PHENOMENON OCCURRING IN THE STORAGE TANK. IT IS THE FEELING OF THE AUTHORS THAT THE AVAILABLE DATA DO NOT NECESSARILY LEAD ONE TO CONCLUDE THAT THE VENTING ENCOUNTERED IS THE RESULT OF ROLL-OVER, BUT RATHER THAT IT CAN BE EXPLAINED IN TERMS OF THE CONCEPT OF A THERMAL OVERFILL ALONG WITH THE PRESENCE OF A SURFACE LAYER PHENOMENON. THE CONCEPTS OF ROLL-OVER, THERMAL OVERFILL, AND SURFACE LAYER PHENOMENON ARE BRIEFLY DISCUSSED AND THE APPLICATION OF THESE CONCEPTS TO LNG STORAGE TANKS ARE ILLUSTRATED BY SOME EXAMPLE SITUATIONS.

-PERTINENT FIGURES-

FIG.1 EXAMPLE OF ROLL-OVER IN A FLAT-BOTTOM LNG TANK, PAGE 47//FIG.2 EXAMPLE OF ROLL-OVER WITH TANK MAINTAINED AT 1 PSIA, PAGE 47//FIG.3 SURFACE LAYER PHENOMENON OF A FLAT-BOTTOM TANK, PAGE 47//FIG.4 SURFACE LAYER PHENOMENON RECORDED ON THE TANK PRESSURE RECORDER, PAGE 47//FIG.5 EXAMPLE OF THERMAL OVERFILL IN A FLAT-BOTTOM TANK, PAGE 48//FIG.6 THERMAL OVERFILL SHOWN BY TANK PRESSURE, TANK VAPOR WITHDRAWL RATE, AND REFRIGERATION, PAGE 48

-BIBLIOGRAPHY-

KITTRELL, F. W. THERMAL STRATIFICATION IN RESERVOIRS, PROC. SYMPOSIUM ON STREAMFLOW REGULATION FOR QUANTITY CONTROL, PUBLIC HEALTH SERVICE, PUB. NO. 999-WP-30, JUNE, 1965, PP. 57-67//CHURCHHILL, S. W., CHEMICAL ENG. PROG., VOL, 58, NO. 55

(1962)//HASHEMI, H. T., AND WESSON, H. R., HYDROCARBON PROCESSING, VOL. 50, NO. 8, (1971) PP. 117-120

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 11, 46-8, 113 (SEP 1972)
OTHER INFORMATION -
0004 PAGES, 0006 FIGURES, 0000 TABLES, 0003 REFERENCES

keys 15252 through 15257

INTRODUCTION TO LNG FOR PERSONNEL SAFETY

by

PIERSON,A.
SAMMIS,J.W.
GRAY,T.M.
RANDOLPH,A.B.
ANDERSON,D.E.
ET AL.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	State Of Art	Good/Excel.

-ABSTRACT-

THE INTRODUCTION TO LNG FOR PERSONNEL SAFETY WAS DEVELOPED FOR THE NATURAL GAS INDUSTRY AS A VEHICLE ON SAFETY AT LIQUEFIED NATURAL GAS (LNG) PLANTS. THE OBJECTIVE IS TO ACQUAINT SAFETY PROFESSIONALS AND PLANT OPERATORS WITH CRYOGENIC AND LNG PLANT SAFETY. INCLUDED IN THIS SAFETY MANUAL ARE A DESCRIPTION OF LNG AND ITS USES, LIQUEFACTION PLANTS, ABOVE AND BELOW GROUND STORAGE FACILITIES, VAPORIZERS, GENERAL SAFETY IN THE DESIGN, CONSTRUCTION AND OPERATION OF LNG FACILITIES, PERSONNEL HAZARDS RESULTING FROM AN LNG SPILL (CRYOGENIC BURNS, HYPOXIA), PROCEDURES AND PRACTICES IN THE EVENT OF A SPILL (INCLUDES FIRE CONTROL AND PROTECTIVE EQUIPMENT) AND INVESTIGATION PROCEDURES INCLUDING INFORMATION RECORDING AND CODES. THE BOOK INCLUDES AND ANNOTATED BIBLIOGRAPHY OF 45 REFERENCES AND SOME SAFETY-RELATED PROPERTIES OF METHANE AND THE OTHER LOWER HYDROCARBONS.

-PERTINENT FIGURES-

TAB.3.2 APPLICATIONS OF SOME MATERIALS IN LNG PLANT DESIGN, PAGE 14// TAB.3.3 PARTIAL LIST OF STANDARDS APPLICABLE TO DESIGN, CONSTRUCTION AND OPERATION OF LNG FACILITIES, PAGE 15//TAB.5.1 FOUR STAGES OF ASPHYXIA WITH PHYSIOLOGICAL SYMPTOMS, PAGE 29//TAB.6.1 BUREAU OF MINES RECOMMENDATION FOR USE OF BREATHING APPARATUS IN LOW TEMPERATURE OPERATION, PAGE 33// TAB. SOME USEFUL INFORMATION AND FACTORS FOR METHANE, PAGE 51//TAB. PHYSICAL CONSTANTS OF METHANE, ETHANE, PROPANE, ISO-BUTANE, N-BUTANE, ISO-PENTANE, N-PENTANE, AND ETHYLENE, PAGE 52

-BIBLIOGRAPHY-

BRITISH CRYOGENICS COUNCIL, SAFETY PANEL, CRYOGENICS SAFETY MANUAL. LONDON, 1970//MCKINLEY,C., TECHNICAL CHARACTER OF CRYOGENIC HAZARDS, IN CRYOGENIC SAFETY, 23-28, ALLENTOWN, PA., AIR

PRODUCTS AND CHEMICALS, INC., 1960// NATIONAL FIRE PROTECTION ASSOCIATION, STORAGE AND HANDLING LIQUIEFIED NATURAL GAS 1971. BOSTON, 1971//AMERICAN GAS ASSOCIATION, LNG INFORMATION BOOK, NEW YORK (ARLINGTON, VA.), JULY 1968//WEBB,H.E., ACCIDENT INVESTIGATION, CHEM. ENG. 76, 88-90 (1969) FEB. 24//ZABETAKIS,M.G., SAFETY WITH CRYOGENIC FLUIDS, 147, NEW YORK, PLENUM PRESS, 1967

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN GAS ASSOCIATION, WASHINGTON, D.C.
OTHER INFORMATION -
0056 PAGES, 0009 FIGURES, 0011 TABLES, 0065 REFERENCES

keys 15266 through 15268

ON THE MEASUREMENT OF ENERGY RELEASE RATES IN VAPOR CLOUD EXPLOSIONS

by

STREHLOW,R.A.
SAVAGE,L.D.
VANCE,G.M.

02/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE ACCIDENTAL IGNITION AND SUBSEQUENT EXPLOSION OF LARGE UNCONFINED VAPOR CLOUDS HAS RECENTLY BECOME A PROBLEM OF MAJOR IMPORTANCE. TO DATE QUANTITATIVE EXPERIMENTAL STUDIES OF SUCH EXPLOSIONS ARE ESSENTIALLY NON-EXISTENT AND THEREFORE DANGER ASSESSMENT AND/OR RISK EVALUATION IS PRESENTLY BASED ON THE ESTIMATION OF A TNT EQUIVALENT FROM THE DAMAGE PATTERNS OF ACCIDENTAL EXPLOSIONS OF KNOWN SPILL SIZE ASSUMING THAT THE EXPLOSION WAS CAUSED BY A POINT SOURCE BLAST WAVE. IT IS KNOWN, HOWEVER, THAT THE BLAST WAVE THAT IT PRODUCES ARE FAR FROM IDEAL AND CANNOT BE APPROXIMATED ADEQUATELY BY EITHER OF THE CLASSICAL SELF SIMILAR SOLUTIONS. A TECHNIQUE FOR DETERMINING THE ENERGY RELEASE RATE OF UNCONFINED VAPOR CLOUDS EXPLOSIONS IS OUTLINED. THE TECHNIQUE IS BASED ON THE FINITE AMPLITUDE ISENTROPIC ACOUSTICS OF A CENTERED SPHERICAL WAVE AND INVOLVES THE REDUCTION OF DATA FROM THE THREE PRESSURE GAUGES WHICH ARE INSTRUMENTING THE EXPLOSION. THE METHOD OF CHARACTERISTICS IS USED TO BACK CALCULATE TO AN EFFECTIVE SPHERICAL PISTON WHICH REPLACES THE EXPLOSION TO ALLOY ENERGY RELEASE RATES AT THE EXPLOSION SITE TO BE CALCULATED.

-PERTINENT FIGURES-

FIG.1 GAUGE POSITIONS AS USED FOR THE CALCULATION OF THE VIRTUAL ORIGIN OF THE EXPLOSION, PAGE 308//FIG.2 PRESSURE AS A FUNCTION OF TIME AND FUNCTIONS DERIVED FROM IT FOR THE NEAR, INTERMEDIATE OR FAR FIELD CASES, PAGE 309// FIG.3 THE R,T PLANE AND ITS USE IN DEVELOPING THE METHODS OF CHARACTERISTICS TECHNIQUE TO DETERMINE HOW R VARIES WITH TIME, PAGE 310

-BIBLIOGRAPHY-

LAMB,H., 1932, HYDRODYNAMICS, 6TH EDITION, CAMBRIDGE UNIVERSITY PRESS, CAMBRIDGE, ENGLAND, P 489-495//RAYLEIGH,J.W.S., 1978, THE THEORY OF SOUND, VOLUME II, MACMILLAN, P. 16, 109-114//SIMPSON,D.W. AND BRASIE,W.C., 1968, GUIDELINES FOR

ESTIMATING DAMAGE FROM CHEMICAL EXPLOSIONS, REPRINT 21A, PRESENTED AT THE SYMPOSIUM IN LOSS PREVENTION IN THE PROCESS INDUSTRIES, AICHE 63RD NATIONAL MEETING, ST. LOUIS, MISSOURI, FEB 18-21, 1968// STREHLOW,R.A., 1973, UNCONFINED VAPOR CLOUD EXPLOSIONS - AN OVERVIEW, FOURTEENTH SYMPOSIUM (INTERNATIONAL OR COMBUSTION. THE COMBUSTION INSTITUTE, PITTSBURGH, PENNSYLVANIA (IN PRESS)//WOOLFOLK,R.W., 1971, CORRELATION OF RATE OF EXPLOSION WITH BLASH EFFECTS FOR NON-IDEAL EXPLOSIONS, FINAL REPORT, CONTRACT N00017-69-C-4433, DEPARTMENT OF THE NAVY, STANFORD RESEARCH INSTITUTE, PROJECT PRU-8056, JANUARY 25, 1971

-SOURCE INFORMATION-

CORPORATE SOURCE -
ILLINOIS UNIV., URBANA-CHAMPAIGN
JOURNAL PROCEEDINGS -
COMBUST. SCI. TECHNOL. VOL 6, NO. 6, 307-12 (FEB 1973)
OTHER INFORMATION -
0006 PAGES, 0003 FIGURES, 0000 TABLES, 0005 REFERENCES

AIRCRAFT GROUND FIRE SUPPRESSION AND RESCUE SYSTEMS-CURRENT TECHNOLOGY REVIEW

by

SALZBERG, F.
CAMPBELL, J.

10/22/69

-ABSTRACT-

An overview is presented on the state-of-the-art of aircraft ground fire suppression and rescue. Subjects considered include: hostile characteristics of liquid fuel fires, effectiveness of suppression agents, and fire suppression equipment. Current research related to aircraft ground fire suppression and rescue is identified and future studies are recommended. Only limited data are available for quantitatively comparing the effectivenesses of various suppression agents on two-dimensional fires containing obstacles. Light water and FC-194 are two to three times more efficient than protein foam in suppressing fires. Recommended agents for typical aviation ground fire situations based on present knowledge as well as those agents which should be investigated for future use are listed. No single agent or agent combination is recommended for all fire situations. Improved response of equipment is in very critical need. Three potential classes can be considered: the helicopter, automotive vehicles similar to the Ansul experimental Magnum X-2, and the ground effect machine. None of these provide rapid response and the ability to locate the crash under all conditions of weather and visibility. This ability is almost totally neglected in current vehicle design.

-BIBLIOGRAPHY-

CIVIL AIRCRAFT ACCIDENT REPORT ON THE ACCIDENT TO BOEING 707-465 G ARWE AT HEATHROW AIRPORT, LONDON, ON APRIL 8, 1968. C.A.P. 324, HER MAJESTY'S STATIONARY OFFICE//HOTTEL, H.C.: REVIEW OF CERTAIN LAWS GOVERNING DIFFUSE BURNING OF LIQUIDS. FIRE RES. ABS. AND REV., VOL. 1, NO. 2, JAN. 1959// FITTERS, D.W., GRIFFITHS, D.J., AND NASH, P.: THE USE OF 'LIGHT WATER' FOR MAJOR AIRCRAFT FIRES. FIRE RES. STATION NOTE NO. 762, APR. 1962//PETERSON, H.B., JABLONSKI, E.J., NEILL, R.R., GIPE, R.L., AND TUVE, R.L.: FULL-SCALE FIRE MODELING TEST STUDIES OF 'LIGHT WATER' AND PROTEIN TYPE FOAM. NRL REP. 6573, AUG. 1967//PINKEL, I., PRESTON, G., AND PESMAN, G.: MECHANISM OF START AND DEVELOPMENT OF AIRCRAFT CRASH FIRES. NASA REP. 1133, 1953//NITROGEN-BLOW FOAM USED IN PROXIMITY SUIT FOR BETTER HEAT SHIELD. FIRE ENG., 1968//PETERSON, H.: STUDIES ON THE FUEL IGNITION SUPPRESSION CAPABILITIES OF FOAM COVERED RUNWAYS FOR AIRCRAFT. NFPA AVIATION BULL. NO. 250, SEPT. 1960

-SOURCE INFORMATION-

CORPORATE SOURCE -
IIT RESEARCH INST., CHICAGO, ILL.
REPORT NUMBER -
AD-703393//AGFSRS-70-1//J6182-FR
SPONSOR -
AIRCRAFT GROUND FIRE SUPPRESSION AND RESCUE, ASWF, WRIGHT-PATTERSON AFB, OHIO.
CONTRACT NUMBER -
F33657-69-1183
OTHER INFORMATION -
0135 PAGES, 0016 FIGURES, 0024 TABLES, 0054 REFERENCES

key 523

FULL SCALE FIRE MODELING TEST STUDIES OF LIGHT WATER AND PROTEIN TYPE FOAM

by

PETERSON, H.B.
JABLONSKI, E.J.
NEILL, R.R.
GIPE, R.L.
TUVE, R.L.

08/15/67

-ABSTRACT-

Fire extinguishment effectiveness of light water and protein foams on full-scale fires associated with aircraft accidents was studied with an MB-5 aircraft fire-rescue vehicle utilizing a 250-gpm-solution-capacity foam pump. Some testing was also done on an experimental 06X vehicle carrying 2500 lb. of Purple K and 300 gal. of light water discharging 32 lb./sec. of Purple K and 180 gpm of light water for comparative purposes. Both foams were 6 percent solutions. An air aspirating nozzle and one using Refrigerant-12 were used for light foam. Avgas and JP-5 were the test fuels. In all cases, Avgas fires were more difficult to control than JP-5 fires. The margin of superiority of light water over protein foam was found to be as high as 3 to 1 for control as determined by radiometer and visual measurements of Avgas fires and as high a 1.5 to 1 for control of JP-5 fires. The dual-agent fire fighting concept showed no advantage over the use of light water alone. The light water solution was as effective when used with all test equipment. The small laboratory-scale fires required three times the application density to extinguish than the comparable outdoor fires.

-PERTINENT FIGURES-

FIG. 26 THERMAL RADIATION DURING EXTINGUISHMENT OF AVGAS FIRE BY HTL RADIOMETER PAGE 32//FIG. 29 WATER APPLICATION DENSITY REQUIRED FOR FIRE EXTINGUISHMENT WITH PROTEIN FOAM ON AVGAS AND JP-5 FUEL PAGE 34//FIG. 30 WATER APPLICATION DENSITY REQUIRED FOR FIRE EXTINGUISHMENT WITH LIGHT WATER ON AVGAS AND JP-5 FUELS PAGE 34//FIG. 32 FIRE EXTINGUISHMENT TIME AS A FUNCTION OF APPLICATION RATE ON AVGAS AND JP-5 PAGE 36//TAB. 2 COMPARATIVE PERFORMANCE OF AGENTS ON 28 SQ. FT. INDOOR JP-5 AND GASOLINE FIRES PAGE 22// TAB. 5 CONTROL AND EXTINGUISHMENT TIMES FOR LARGE AREA FIRES PAGE 26

-BIBLIOGRAPHY-

TUVE, R.L., PETERSON, H.B., JABLONSKI, E.J., AND NEILL, R.R.: A NEW VAPOR-SECURING AGENT FOR FLAMMABLE-LIQUID FIRE EXTINGUISHMENT.

NRL REP. 6057, MAR. 13, 1964//AIRCRAFT CRASH FIRE INCIDENT SIMULATION TESTS OF LIGHT WATER. ONR FILM REP. 7-64//EVALUATING FOAM FIRE FIGHTING EQUIPMENT ON AIRCRAFT RESCUE AND FIRE FIGHTING VEHICLES. PAMPHLET NO. 412, NFPA, BOSTON, MASS., 1964//PETERSON, H.B. AND GIPE, R.L.: A STUDY OF THE GAS TURBINE POWERED MB-5 AIRCRAFT FIRE FIGHTING AND RESCUE VEHICLE. NRL REP. 6309, SEPT. 22, 1965//CONLEY, D.: FOAM AND DRY CHEMICAL APPLICATION EXPERIMENTS. PROJ. NO° 410-002y02X, GAA TEST PLAT, JAN° 20, 1965// MIDDLESWORTH: C°M.: FOAM AND DRY CHEMICAL APPLICATION RATE EXPERIMENTS. PAPER 65-5; NGPA MEETING, BOSTON, MASS., 1956

-SOURCE INFORMATION-

CORPORATE SOURCE -
NAVAL RESEARCH LAB., WASHINGTON, D.C.
REPORT NUMBER -
AD-658318//NRL REP. 6573
OTHER INFORMATION -
0058 PAGES, 0032 FIGURES, 0008 TABLES, 0009 REFERENCES

keys 553 through 554

CRASH-FIRE PROTECTION AT LOS ANGELES INTERNATIONAL AIRPORT

by

MCKASKLE, A.J.

10/27/69

-ABSTRACT-

Problems and solutions associated with crash-fire protection at Los Angeles International Airport are reviewed. Divided responsibility between the city Fire Department and airport authorities poses problems. Other problems relate to airport size, traffic load, and handling of flammable fuel. Solutions to the problems were explored using past experience of military and civilian airports as guides. National Fire Protection Association Standards were studied and found to be inadequate. New fire extinguishing agents were tested. Promising results were obtained from comparative tests using light water, and recommendations were made for its use in crash protection. Jumbo jets necessitated the use of bigger and better crash apparatus than were currently in operation. Use of several units of apparatus with coordinated teamwork was recommended. Three new pieces of apparatus were built and old apparatus modified by replacing 300 gpm turrets with 600 gpm. Improvements were made and planned for dry chemical apparatus and structure fire-fighting equipment. Extinguishing agents in use at present are light water (in emergency situations), protein foam, Purple K, and other dry chemical agents. The cost of crash-fire protection is about one million dollars per year.

-SOURCE INFORMATION-

CORPORATE SOURCE -
LOS ANGELES CITY FIRE DEPT., CALIF.
JOURNAL PROCEEDINGS -
NATIONAL FLIGHT SAFETY, SURVIVAL AND PERSONAL EQUIPMENT SYMPOSIUM, 7TH, LAS VEGAS, NEV., OCT. 27-30, 1969
OTHER INFORMATION -
0008 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 715

FIRE EXTINGUISHERS. VOL. 1 OF 2 VOLS. DEC. 1960-DEC. 1968

by

DEFENSE DOCUMENTATION CENTER

10/00/69

-ABSTRACT-

The 53 references in this bibliography, which are unclassified and have unlimited distribution, are arranged in AD number sequence. They are the result of a DDC computer search of materials prepared between January 1953 and August 1969, and they are included under one of three topic headings: (1) extinguishers for aircraft, spacecraft, and ships; (2) chemical extinguishing agents; and (3) extinguishers and miscellamecus information. Extinguishing agents covered include foams, powders, inert gases, and water. Computer-generated indexes covering Corporate Author/Monitoring Agency, Subject, and AD number are provided. In addition, each reference includes index terms and an abstract of the document.

-SOURCE INFORMATION-

CORPORATE SOURCE -
DEFENSE DOCUMENTATION CENTER, ALEXANDRIA, VA.
REPORT NUMBER -
AD-696900//DDC-TAS-69-61-1
OTHER INFORMATION -
0069 PAGES, 0000 FIGURES, 0000 TABLES, 0053 REFERENCES

key 727

FIRE EXTINGUISHERS. VOL. 2. FEB. 1953-MAR. 1969

by

DEFENSE DOCUMENTATION CENTER

10/00/69

-ABSTRACT-

This bibliography, Volume 2 of two volumes, comprises 189 unclassifed references arranged in AD number sequence under one of four headings: extinguishers for aircraft, spacecraft, and ships; chemical extinguishing agents; and extinguishers and miscellaneous information. Computer generated indexes covering Corporate Author/Monitoring Agency, Subject, and AD number are provided. The materials cited in this bibliography cover the period January 1953 to August 1969. Some documents in this volume require release approval from the authority cited. Those in Volume 1 are unlimited in distribution.

-SOURCE INFORMATION-

CORPORATE SOURCE -
DEFENSE DOCUMENTATION CENTER, ALEXANDRIA, VA.
REPORT NUMBER -
AD-862201//DDC-TAS-69-61-11//AD-696900-VOL. 1
OTHER INFORMATION -
0235 PAGES, 0000 FIGURES, 0000 TABLES, 0189 REFERENCES

keys 525 through 526

THE USE OF LIGHT WATER FOR MAJOR AIRCRAFT FIRES

by

FITTES, D.W.
GRIFFITHS, D.J.
NASH, P.

11/00/69

-ABSTRACT-

Experimental fires were conducted in three confined areas bounded by low, firebrick walls. A cylindrical steel tube represented the aircraft fuselage, and steel drums at each side represented the mainplane/nacelle configuration. The fuels used were AVTUR (Jet A or JP-1) and AVTAG (Jet B or JP-4). The fire was allowed to burn freely for about 60 sec. after ignition before application of light water foam, protein foam, and fluorinated protein foam. In comparison with regular protein foam, light water foam was generally up to twice as effective in controlling major aircraft fires. Similarly, a fortified protein-based foam was about 25 percent more effective than regular protein foam. Light water was, in general, found to be proportionately more effective than protein foam in achieving a rapid initial reduction of heat radiation from the fire, although there were notable exceptions to this, possibly due to defective exploitation of its potential. Cost comparisons of the agents were made along with the overall cost of fire protection when using the new foams.

-PERTINENT FIGURES-

TAB. 3 PROTEIN FOAM PERFORMANCE PAGE 288//TAB. 4 LIGHT WATER FOAM PERFORMANCE PAGES 290-291//FIG. 7 COMPARISON OF FIRE CONTROL USING LIGHT WATER AND PROTEIN FOAMS PAGE 294

-BIBLIOGRAPHY-

NASH, P., FITTES, D.W., AND RICHARDSON, D.D.: FOAM FOR AIRCRAFT CRASH FIRES. FIRE RES. NOTE NO. 615, JOINT FIRE RES. ORG.

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
JOURNAL PROCEEDINGS -
FITCAA, FIRE TECHNOL, VOL. 5, NO. 4, 284-298 (NOV. 1969)
OTHER INFORMATION -
0015 PAGES, 0009 FIGURES, 0007 TABLES, 0002 REFERENCES

key 493

AIRCRAFT RESCUE AND FIRE FIGHTING 1969, STANDARD OPERATING PROCEDURES

by

NATIONAL FIRE PROTECTION ASSOCIATION

00/00/69

-ABSTRACT-

These recommendations deal with airport and municipal fire and rescue services, standard operating procedures designed to provide maximum effective use of aircraft rescue, and fire fighting equipment provided at airports. Included is information on conditions that may exist at the scene of an aircraft accident and a guide that can be used as a basis for establishing training programs and operational procedures. The recommendations are based on the premise that the rescue of aircraft occupants takes precedence over all other operations; and, until it is established that there is no further life hazard, fire suppression is an important enabling supporting measure. The appendixes deal with civil aircraft data for fire fighters and rescue crews, aircrew rescue data for military aircraft, air transport of radioactive materials and nuclear weapons, civil aircraft accident investigation, airport facilities and aids, procedural agreements with the U.S. Air Force and commercial airports, typical specialized runway foaming equipment, and color coding for aircraft piping.

-PERTINENT FIGURES-

TAB. 1 WATER AND FOAM LIQUID REQUIREMENTS FOR RUNWAY FOAMING PAGE 46

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
REPORT NUMBER -
NFPA NO. 402
OTHER INFORMATION -
Q123 PAGES, 0072 FIGURES, 0001 TABLES, 0000 REFERENCES

FIRE PROTECTION FOR BULK FUEL SYSTEMS. FINAL REPORT

by

WEATHERSBY, J.M.

01/00/72

-ABSTRACT-

Tests were conducted to develop practical active and passive fire protection measures to contain and extinguish fires within the Marine Corps Amphibious Assault Fuel Systems (AAFS) equipped with 20,000 gal. bulk fuel storage tanks. The twin agent containing potassium bicarbonate dry chemical (Purple K) and light water system was determined best to fulfill the requirements for fuel in-depth and pressure/spill fires. A total of 900 lb. of Purple K and 200 gal. of light water consisting of two 450/100 skid mounted units is sufficient to extinguish a 20,000 gal. tank fire. The proper tank spacing to minimize fire losses in the AAFS was determined to be 90 ft. between tank centerlines. Due to the difficulty in extinguishing a fire resulting from a catastrophic rupture of a bulk fuel tank, proper tank separation and containment of the initial fire to a single tank is most important. Successful extinguishment of a fire of this type is dependent on prompt reaction, well-trained fire fighters, and sufficient equipment to accomplish the task. Successful extinguishment of a 20,000 gal. tank fire can best be achieved by utilizing a total of four fire fighters: two per 450/100 unit, one fire fighter to direct the discharge of the twinned agent, the second to assist with the hose line and provide a maximum degree of mobility.

-PERTINENT FIGURES-

FIG. 1 OPTIMUM AGENT SELECTION PAGE 10

-SOURCE INFORMATION-

CORPORATE SOURCE -
MARINE CORPS DEVELOPMENT AND EDUCATION COMMAND, QUANTICO, VA.
REPORT NUMBER -
AD-890895L//4617DIJMW:VFW
SPONSOR -
MARINE CORPS, WASHINGTON, D.C.
CONTRACT NUMBER -
CONTRACT M00027-71-C-0092
OTHER INFORMATION -
0060 PAGES, 0002 FIGURES, 0000 TABLES, 0004 REFERENCES

key 737

APPLICATION OF LIGHT WATER ON AIRCRAFT CARRIER FLIGHT DECKS, INTERIM REPORT.

by

PETERSON, H.B.
GIPE, R.L.
NEILL, R.R.

07/00/69

-ABSTRACT-

A number of commercially available and especially modified water and foam nozzles were examined for their discharge rates, density of ground patterns, and light water foam output characteristics. Most work was done under no wind conditions, although some runs were made under 30 knot crosswind conditions. Water spray nozzles are effective for extinguishing JP-5 fuel fires with light water solutions even though the quality of foam produced is not as high as that from conventional foam making nozzles. The nozzles were studied as to their suitability for use on hose lines for the flight and hangar decks and for use as fixed nozzles mounted around the edge of the flight deck, pre-set to discharge toward the center. The best angle of discharge for the deck edge type nozzles has been selected as 10 deg. above the horizontal. This represents a compromise between maximum reach of the stream and excessive losses from windage. A modification for the existing 1 in. solid stream recessed nozzles has been designed to lower their angle of discharge from 45 deg. to 10 deg. to minimize wind losses and reduce the flow.

-PERTINENT FIGURES-

FIG. 11 WATER FLOW RATES FOR VARIED FLOW SETTINGS AND VARIED INLET PRESSURES - ELKHART 1 1/2 IN. SFL PAGE 31//FIG. 16 GROUND PATTERN OUTLINES OF 2 1/2 IN. FFF PRODUCED WITH AND WITHOUT SCREEN PAGE 36//FIG. 20 SELECT- O-FLOW NOZZIE MOUNTED FOR CROSSWIND PATTERN TEST WITH COLLECTION PAN ARRAY IN BACKGROUND PAGE 40//FIG. 28 LIGHT WATER SOLUTION DENSITIES IN GAL./MIN. FT. SQ. WITHIN GROUND OF SOLID STREAM RECESSED (CANNON) NOZZLE; (A) AS PRESENTLY INSTALLED WITH 45 DEG. DISCHARGE; (B) AS MODIFIED BY NRL WITH 10 DEG. DISCHARGE PAGE 48//TAB. 1 CANDIDATE NOZZLE DESCRIPTION PAGE 4//TAB. 2 LIGHT WATER FOAM CHARACTERISTICS PAGE 8

-BIBLIOGRAPHY-

PETERSON, H.B., TUVE, R.L., JABLONSKI, E.J., NEILL, R.R., BERTSCHY, A.W., AND GIPE, R.L.: FIRE EQUIPMENT TESTS ABOARD THE CVA-62 RELATED TO IMPROVED CARRIER SAFETY. NRL MEMO REP. 1851, JAN. 30, 1968

-SOURCE INFORMATION-

CORPORATE SOURCE -
NAVAL RESEARCH LAB., WASHINGTON, D.C.
REPORT NUMBER -
AD-858800IL//NRL-MR-2020
OTHER INFORMATION -
0051 PAGES, 0029 FIGURES, 0002 TABLES, 0001 REFERENCES

key 398

AIRCRAFT CARRIER AND FIRE

by

ROBERTS, II, J.W.

02/00/69

-ABSTRACT-

An assessment is made of the fire and explosion dangers aboard an aircraft carrier equipped with large amounts of aircraft fuel, jet fuel, and ordnance. The lack of space compounds the problem of sheer volume of flammable and explosive material. A small uncontrolled incident has the potential of becoming a definite hazard and even a tragedy similar to incidents aboard the USS Oriskany, the USS Forrestal, and the USS Enterprise. High performance jet aircraft are another serious hazard. Partial answers to minimizing these hazards are suggested which make use of the fire fighting ability of light water and Purple K and the design of systems to incorporate these extinguishants for carrier use. Training of crew personnel is also required. However, the reduction of accidents depends on design for safety i.e., overall improvement of aircraft carriers as a total weapons system.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
NVEJAX, NAV ENG J, VOL. 81, NO. 1, 143-146 (FEB. 1969)
OTHER INFORMATION -
0004 PAGES, 0011 FIGURES, 0000 TABLES, 0000 REFERENCES

key 399

LIGHT WATER PASSES EMERGENCY FIRE TEST

-ABSTRACT-

Fire crews at Miramar Naval Air Station, California, controlled a fuel depot fire in 45 sec. with light water. Although the fire was fed by thousands of gallons of jet fuel, it was completely secured 3 min. after the initial alarm was received. Ignition occurred near the fuel surface inside one of two tank trailers containing gaseous vapors from a previous load. Cause of the fire was presumed to be a static arc discharging from a metallic sampling apparatus to the fuel fill pipe. The resulting fire was fed by jet fuel cascading over one of the tank trailers onto the ground at 225 gpm causing the trailer's aluminum body to melt. Pre-burn, prior to the arrival of fire fighting rigs, was estimated to be about 90 sec. In similar incidents related to switch loading, entire fueling facilities and all shipping units were destroyed. In this case, extinguishment was so rapid that the rubber tires on the tank trailer unit which were involved did not explode. The resulting damage was confined to one of four fueling facilities, specifically the fuel piping filters and structural beams made of aluminum.

-PERTINENT FIGURES-

FIG. 1 FIREMEN APPLYING LIGHT WATER TO TRAILER TANK AT THE FUEL DEPOT PAGE 37//FIG. 2 TIRES WERE INTACT ALTHOUGH THE SIDE OF THE TANKER MELTED PAGE 38

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
SAFMAN, SAFETY MAINT, VOL. 137, NO. 1, 37-8 (JAN. 1969).
OTHER INFORMATION -
0002 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

key 901

EVALUATION OF FILM FORMING FOAMS FOR THE SUPPRESSION OF FUEL FIRES IN AIRCRAFT HANGARS

by

BREEN, D.E.

04/00/72

-ABSTRACT-

An evaluation of the technical feasibility of employing aqueous foams containing film-forming fluorosurfactants to control aircraft fuel fires in old and new hangars showed that their potential for upgrading sprinkler systems in older hangars protected by the standard sprinkler (SS) or the old style sprinkler (OSS) is promising. Tests were made by burning 900 sq. ft. of JP-4. Foam/Water (F/W), SS, and OSS nozzles were tested at densities (gal./min. per sq. ft.) of 0.20 and 0.16 (F/W), 0.16 and 0.125 (SS), and 0.20 (OSS). The most rapid control was achieved in 105 sec. using an SS system at a density of 0.16. An SS system is 1.3 to 1.6 times as effective on a time basis in achieving extinguishment as an F/W system. The fluorosurfactant foam and a protein foam in 6 percent water solution were compared. Rates of advance were slightly better for the former agent. No significant difference between the two agents was observed in burnback resistance. Fluorosurfactant based foam is approximately equivalent to protein foam in achieving control and extinguishment when discharged through an F/W system, but the fluorosurfactant foam, when discharged through an SS system, appears to be superior to the protein foam discharged through an F/W deluge system.

-PERTINENT FIGURES-

FIG. 1 FREQUENCY OF PERFORMANCE RATIOS OF LIGHT WATER TO PROTEIN FOAMS IN 90 PERCENT FIRE CONTROL PAGE 6//FIG. 2 FREQUENCY OF PERFORMANCE RATIOS OF LIGHT WATER TO PROTEIN FOAMS IN FIRE EXTINGUISHMENT PAGE 7//FIG. 7 BURNBACK RESISTANCE OF 6 PERCENT LIGHT WATER AND PROTEIN FOAMS GENERATED BY A GRINNELL F/W HEAD PAGE 22//TAB. 1 25 PERCENT DRAINAGE TIMES OF 6 PERCENT LIGHT WATER FOAMS PAGE 17//TAB. 3 GENERAL DELUGE SYSTEM TESTS AND OBSERVATIONS PAGE 29//TAB. 4 RADIOMETER AND THERMOCOUPLE DATA PAGE 30

-BIBLIOGRAPHY-

TUVE, R.L., PETERSON, H.B., JABLONSKI, E.J.: A NEW VAPOR-SECURING AGENT FOR FLAMMABLE LIQUID FIRE EXTINGUISHMENT. NRL REP., MAR. 13, 1964//PETERSON, H.B., ET AL.: FULL-SCALE FIRE MODELING TEST STUDIES OF LIGHT WATER AND PROTEIN TYPE FOAMS. NRL REPORT 6573, U.S. NAVAL RES. LAB., WASHINGTON, D.C., AUG. 15, 1967//AQUEOUS FILM FORMING FOAM TESTS. CHANUTE AFB, AUG. 19-20, 1970//MAGUIRE,

H.M.: LIGHT WATER COMES OUT ON TOP IN TESTS BY 3 FIRE DEPARTMENTS. FIRE ENG., VOL. 122 NO. 4, 44-48, APR. 1969//UNPUBLISHED DATA: TESTS CONDUCTED AT ONTARIO, CALIFORNIA, JAN. 1971//MORAN, H.E., BURNETT, J.C., AND LEONARD, J.T.: SUPPRESSION OF FUEL EVAPORATION BY AQUEOUS FILMS OF FLUOROCHEMICAL SURFACTANT SOLUTIONS. NRL REPORT 7247, NAVAL RES. LAB., WASHINGTON, D.C., APR. 1971

-SOURCE INFORMATION-

CORPORATE SOURCE -
FACTORY MUTUAL RESEARCH CORP., NORWOOD, MASS.
REPORT NUMBER -
WSCI-72-16
JOURNAL PROCEEDINGS -
WEST SECT COMBUST INST, SEATTLE, WASH., APR. 24-25, 1972
OTHER INFORMATION -
0044 PAGES, 0011 FIGURES, 0005 TABLES, 0029 REFERENCES

FLAMMABILITY PROPERTIES OF JET FUELS AND TECHNIQUES FOR FIRE AND EXPLOSION SUPPRESSION

by

BOTTERI, B.P.

08/00/71

-ABSTRACT-

Because of the large quantity and dispersed storage of fuel onboard aircraft under combat environment conditions, a high probability exists that gunfire hits will occur in fuel areas with consequent damaging effects of fire, explosion, and/or fuel depletion. Results of investigative efforts to establish the practical flammability envelopes and associated combustion damage potential for conventional jet fuels such as JP-4, JP-8 (similar to JET A-1), and JP-5 under simulated hostile operating environment conditions are presented. Testing included liquid-space gunfire hits to assess external fire hazard and vertical (liquid to vapor) firing trajectories to determine explosion hazard associated with projectile-induced fuel sprays and mists. All tests were performed in instrumented replica target tanks varying in volume from 15 to 90 gal. Principal test variables were fuel temperature, pressure, fuel depth, external void space, and internal and external air flow. All tests were conducted utilizing 0.50 caliber armor piercing incendiary projectiles. These tests indicate a considerable extension in the flammability range of all fuels compared to the equilibrium flammability limit values which are commonly utilized for fire safety analysis. Recent progress in the use of reticulated polyurethane foam, halogenated hydrocarbon chemical extinguishants, and other fuel-tank inerting techniques are reviewed.

-PERTINENT FIGURES-

FIG. 3 EXTENDED LEAN FLAMMABILITY (SLOSHING AT 17 CPM AND 1 ATM. INITIAL ULLAGE PRESSURE) PAGE 13-9//FIG. 6 EXPLOSION HAZARD UNDER VERTICAL GUNFIRE (ATMOSPHERIC PRESSURE, 90 GAL. TANK, 4 IN. FUEL DEPTH) PAGE 13-10//FIG. 10 TYPICAL PRESSURE-TIME PROFILES FOR JP-4, JP-8, AND JP-5 GUNFIRE INDUCED REACTIONS (ATMOSPHERIC PRESSURE, 70 DEG. F., 90 GAL. TANK, 4 IN. FUEL DEPTH) PAGE 13-11//TAB. 2 FIRE PROPERTIES OF JET FUELS PAGE 13-7//TAB. 3 RESULTS OF LIQUID-PHASE FUEL GUNFIRE TESTS PAGE 13-7//TAB. 4 QUALITATIVE COMPARISON OF JP-4 AND JP-8 FOR JET AIRCRAFT OPERATIONS PAGE 13-8

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR FORCE AERO PROPULSION LAB., WRIGHT-PATTERSON AFB, OHIO.
REPORT NUMBER -
AD-729570//AGARD-CP-84-71//N72-11668
JOURNAL PROCEEDINGS -
IN: AGARD AIRCRAFT FUELS, LUBRICANTS, AND FIRE SAFETY, 1971
(SEE F7200658)
OTHER INFORMATION -
0011 PAGES, 0010 FIGURES, 0004 TABLES, 0005 REFERENCES

CONTRIBUTION TO THE SELECTION OF FIRE EXTINGUISHING SYSTEMS AND AGENTS FOR AIRCRAFT FIRES

by

FIALA, R.

08/00/71

-ABSTRACT-

A description of a new fire extinguishing system for aircraft is given, which uses the exhaust gases of a solid propellant gas generator to pressurize the extinguisher bottle. The extinguishing efficiency of this hot bottle system is compared with that of the extinguishing system in present use. Both systems use halons as fire extinguishing agents. Quantitative values were obtained on the mass flow rates of extinguishant which are necessary for both systems to extinguish a flame under realistic conditions. With the hot bottle system the agent is again stored in a container which, however, is pressurized only during the time of discharge. The gas necessary for the discharge is produced by the combustion of a solid fuel which is contained in a small burning chamber situated at the tip of the hot bottle. In conclusion, it was stated that using a hot bottle system instead of the conventional extinguishing system used today would reduce the weight of the extinguishant needed to extinguish a fire by 20 percent. It is also believed that since the extinguishant is stored at low pressure the equipment weight can also be reduced by adapting the hardware to the special demands of the hot bottle system. A comparison of the extinguishing efficiency of halons and dry powders for fuel fires was carried out in a 4 sq. m. test pan.

-PERTINENT FIGURES-

FIG. 2 SCHEMATIC OF THE HOT BOTTLE PAGE 18-7//FIG. 4 INFLUENCE OF MASS FLOW RATE ON THE EXTINGUISHING EFFECT OF THE HOT BOTTLE SYSTEM, WHEN CARBON TETRACHLORIDE IS USED AS AN AGENT PAGE 18-8//FIG. 6 MASS FLOW OF AGENT TO ACHIEVE EXTINGUISHMENT FOR DIFFERENT AGENTS WHEN DISCHARGED WITH THE HOT BOTTLE SYSTEM AND THE NORMAL FIRE EXTINGUISHING SYSTEM PAGE 18-9//FIG. 8 EXTINGUISHING EFFICIENCY OF PYROLYSED AND HOT PYROLYSED BROMOCHLOROMETHANE PAGE 18-9//FIG. 9 AMOUNT OF AGENT PER SQ. M. NEEDED TO EXTINGUISH A FIRE IN A 4 SQ. M. TEST PAN PAGE 18-10//FIG. 10 PREVENTION OF REIGNITION INITIATED BY A HOT SIDE WALL BY HALONS PAGE 18-10

-BIBLIOGRAPHY-

VAN TIGGELEN, A. AND GROGNARD. M.: CONSIDERATIONS THEORIQUES SUR L

ACTION DES INHIBITEURS DANS LES FLAMMES. BULL. SOC. CHIM., 1818-1822, FRANCE, 1959//WILSON, JR., W.E., ODONOVAN, J.T., AND FRISTROM, R.M.: FLAME INHIBITION BY HALOGEN COMPOUNDS. 929-941, 12TH INTERN. SYMP. ON COMBUST., 1969//CONLEY, D.W.: POST-CRASH FIRE-FIGHTING STUDIES ON TRANSPORT CATEGORY AIRCRAFT. REP. RD-65-50, FAA, 1965//PESMAN, G.J.: APPRAISAL OF HAZARDS TO HUMAN SURVIVAL IN AIRPLANE CRASH FIRES. TECH. NOTE 2996, NAT. ADVISORY COMM. FOR AERONAUT., 1953//THORNE, P.F.: INHIBITION OF THE COMBUSTION OF LIQUID AND GASEOUS FUELS BY FINELY DIVIDED ORGANIC SALTS. FIRE RES. NOTE NO. 604, AUG. 1965//BIRCHALL, J.D.: ON THE MECHANISM OF FLAME INHIBITION BY ALKALI METAL SALTS. COMBUST. AND FLAME, VOL. 14, 85-96, 1970

-SOURCE INFORMATION-

CORPORATE SOURCE -
DEUTSCHE FORSCHUNGS- UND VERSUCHSANSTALT FUER LUFT- UND RAUMFAHRT E.V., PORZ-WAHN (WEST GERMANY).

REPORT NUMBER -
AD-729570//AGARD-CP-85-71//N72-11668

JOURNAL PROCEEDINGS -
IN: AGARD AIRCRAFT FUELS, LUBRICANTS, AND FIRE SAFETY, 1971 (SEE F7200658)

OTHER INFORMATION -
0011 PAGES, 0011 FIGURES, 0000 TABLES, 0011 REFERENCES

DANISH RAF FIRE FIGHTING TESTS CONDUCTED AT ESBJERG, DENMARK, 19 AND 20 NOVEMBER 1969

by

HOPKINS, W.A.

12/03/69

-ABSTRACT-

Tests were conducted to evaluate the effectiveness of various foaming agents on large scale JP-4 fires. In general, the foaming agents tested were comparable in terms of initial extinguishing capability; those used were protein foam (Tutogen T), synthetic base foam (Hi-Ex), a mixture of Hi-Ex and a halide (Fluobrene B-2), and light water. In general there was no significant difference in the time required for initial fire extinguishing for any of the four foams. The addition of Fluobrene, however, prevented reignition. Separate demonstrations of Fluobrene, which are discussed in an addendum, were spectacular, in that jet engine and spillage fires were extinguished practically instantaneously. The relatively high wind velccities encountered during the second day of testing were comparable to those experienced on the flight deck of a carrier underway. These tests, therefore, confirmed the capabilities of the agents for flight deck conditions. It was concluded that synthetic foam, when combined with Fluobrene, provided significant additional control of reignitiom on large scale fuel fires. It was recommended that Fluobrene be compared with such products as Purple K and other chemical extinguishers, both as a single agent and in combination with light water foam.

-PERTINENT FIGURES-

FIG. 1 EQUIPMENT LAY-OUT FOR TESTING DIELECTRIC STRENGTH PAGE 6

-SOURCE INFORMATION-

CORPORATE SOURCE -
OFFICE OF NAVAL RESEARCH, LONDON (ENGLAND).
REPORT NUMBER -
AD-862223//N-23-69
OTHER INFORMATION -
0021 PAGES, 0005 FIGURES, 0001 TABLES, 0000 REFERENCES

FIRE-FIGHTER PROTECTIVE CLOTHING CONCEPTS AND CONFIGURATIONS

by

MEADE, J. P.

09/27/70

-ABSTRACT-

Evaluations of fire fighters' proximity clothing revealed the following deficiencies: excessive weight and bulk of suits which decrease efficient functioning of personnel, coats too long, lack of durability of the suit material, poor ventilation, lack of hard-hat protection, and less than optimum visibility. Another area of concern was the lack of communication between the fire control coordinator and the fire fighters. The fire fighting operations in an aircraft crash are directed at preventing the spread of fire to the fuselage or fuel tanks, extinguishing the fire, and concurrently rescuing or assisting in the evacuation of occupants. The fire fighters need a suit of protective clothing of modern design to reduce total weight and to avoid loose flapping items. The hoods should cover and head and neck, possess hard-hat skull protection, and provide optimum visibility while self-contained breathing equipment is being worn. Overall, the protective clothing, excluding the boots, should not weigh more than 10 lb. per suit, should afford adequate protection for at least 18 months of service life, and must provide a combination of noncombustibility and heat reflectance so that the wearer is protected against 1800 deg. F. radiated heat for at least 2 min.

-SOURCE INFORMATION-

CORPORATE SOURCE -
DIRECTORATE OF AEROSPACE SAFETY, NORTON AFB, CALIF.
JOURNAL PROCEEDINGS -
FLIGHT SAFETY SURVIVAL AND PERSONAL EQUIPMENT SYMP., 8TH, LAS VEGAS, NEV., SEPT. 27-OCT. 1, 1970
OTHER INFORMATION -
0008 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 1170

OPERATIONAL TEST AND EVALUATION OF FIRE RESISTANT FLIGHT COVERALLS, CWU-20/P. FINAL REPORT

by

KASSON, H.D.

07/07/70

-ABSTRACT-

A total of 83 summer flight coveralls made from polybenzimidazole (PBI), a fiber which is highly flame resistant, were tested for a 5 month period by aircrew members while participating in regularly scheduled missions. Data were collected by the use of monthly questionnaires and a final questionnarie on the subjects of comfort, acceptability, and compatibility of the PBI summer flight suit while performing aircrew duties. Seventy-one percent of the test subjects recommended adopting the coverall as a replacement item for other coveralls in use. However, the majority of the test participants also recommended that an entirely new flight suit be developed for transport aircrew members, emphasizing comfort, appearance, and durability.

-SOURCE INFORMATION-

CORPORATE SOURCE -
MILITARY AIRLIFT COMMAND, SCOTT AFB, ILL. OPERATIONAL TEST AND EVALUATION DIV.
REPORT NUMBER -
AD-883487L//X71-78588//MAC OTR-7-7-70
OTHER INFORMATION -
0009 PAGES, 0000 FIGURES, 0001 TABLES, 0000 REFERENCES

key 1625

A NEW DEVELOPMENT IN DRY POWDER EXTINGUISHANTS

by

HARPUR, W.W.

00/00/70

-ABSTRACT-

TESTS WERE PERFORMED WHICH DEMONSTRATED THE EFFECTIVENESS OF MONNEX, A NEW DRY POWDER FIRE EXTINGUISHING AGENT, IN EXTINGUISHING FUEL FIRES. UNLIKE POTASSIUM OXALATE, WHICH IS HIGHLY TOXIC, MONNEX IS NON-TOXIC. IT READILY DECOMPOSES IN A FLAME PRODUCING SUB-MICRON PARTICLES WHICH QUICKLY KNOCK DOWN THE FLAME. POOL FIRES WERE USED TO MEASURE THE DISCHARGE RATE FOR MONNEX IN EXTINGUISHING CERTAIN SIZES OF FIRES. RESULTS SHOWED THAT MONNEX HAS A CRITICAL RATE OF APPLICATION ABOUT 10 TIMES LOWER THAN THAT OF SODIUM BICARBONATE, A WIDELY-USED FIRE EXTINGUISHING AGENT. TESTS WERE ALSO PERFORMED TO MEASURE THE EFFECTIVENESS OF MONNEX IN EXTINGUISHING FIRES IN WHICH THE FUEL IS IN MOTION, SUCH AS GAS LEAKING FROM A PIPE FLANGE. WHILE THE SODIUM BICARBONATE EXTINGUISHER COULD RARELY EXTINGUISH THE FIRE, THE MONNEX EXTINGUISHER QUICKLY EXTINGUISHED THE FIRE WITH COMPARATIVELY SMALL AMOUNTS OF POWDER. IT WAS FOUND THAT MONNEX IS COMPATIBLE WITH PROTEIN FOAM, WHICH MAKES IT USEFUL IN AIRCRAFT CRASH FIRES. TESTS SHOWED THAT POWDER APPLIED ON TOP OF A BLANKET OF FOAM FORMED AN EXTINGUISHANT WHICH EFFECTIVELY CONTAINED AND EXTINGUISHED THE TEST FIRES. IT WAS ALSO FOUND THAT MONNEX HAS GOOD STORAGE STABILITY, RETAINING ITS EFFECTIVENESS EVEN AFTER 6 MONTHS.

-PERTINENT FIGURES-

FIG. 5 APPLICATION RATE EXPERIMENTS WITH MONNEX AND SODIUM BICARBONATE POWDERS ON 800 AND 1200 SQ. FT. FIRES PAGE 61

-SOURCE INFORMATION-

CORPORATE SOURCE -
IMPERIAL CHEMICAL INDUSTRIES LTD., BIRMINGHAM (ENGLAND).
JOURNAL PROCEEDINGS -
FIRE INT, VOL. 3, NO. 29, 57-63 (1970)
OTHER INFORMATION -
0007 PAGES, 0005 FIGURES, 0002 TABLES, 0008 REFERENCES

key 2033

FOAM GENERATOR FOR AIRCRAFT FIRE CONTROL

by

NASH, P.
FITTES, D.W.

03/26/65

-ABSTRACT-

A GAS-TURBINE-OPERATED FOAM GENERATOR HAS BEEN DEVELOPED TO GIVE A RANGE OF PHYSICAL PROPERTIES AND APPLICATION RATES OF FOAM. THE PHYSICAL PROPERTIES WHICH ARE IMPORTANT TO THE EFFECTIVENESS OF FOAM ARE: (1) FOAM EXPANSION, WHICH IS THE RATIO OF THE VOL. OF FOAM TO THAT OF THE AQUEOUS SOLUTION FROM WHICH IT IS PRODUCED; (2) CRITICAL SHEAR STRESS, WHICH IS THE STIFFNESS OF THE FOAM, CONTROLLED BY THE ENERGY SUPPLIED IN FORMING THE BUBBLE STRUCTURE; (3) QUARTER DRAINAGE TIME, A MEASURE OF FOAM STABILITY; AND (4) APPLICATION RATE, EXPRESSED IN TERMS OF GALLONS OF FOAMING SOLUTION PER MIN. PER UNIT AREA OF FIRE. FIRE TESTS WERE CONDUCTED WITH SIMULATED AIRCRAFT FIRES IN ORDER TO DEMONSTRATE THE PERFORMANACE OF THE FOAM GENERATOR. IN THE TESTS, THE CONTROL TIME WAS MEASURED AS THE TIME UNTIL THE INTENSITY OF HEAT RADIATION FROM THE FIRE WAS REDUCED TO ONE-TENTH OF ITS INITIAL VALUE AT THE START OF FOAM APPLICATION. IT WAS FOUND THAT THE FOAM GENERATOR PROVIDES FLEXIBILITY IN SUPPRESSING AIRCRAFT FUEL FIRES. THE EQUIPMENT COULD BE USED, FOR EXAMPLE, IN HELICOPTERS WHICH COULD FLY STRAIGHT TO THE SCENE OF A CRASH AND USE AN AIR-BLEED SYSTEM FROM THEIR GAS-TURBINE DRIVING UNITS FOR FOAM-MAKING.

-PERTINENT FIGURES-

FIG. 1 DIAGRAMMATIC ARRANGEMENT CF FOAM GENERATOR PAGE 537

-BIBLIOGRAPHY-

NASH, P.: RESCENT RESEARCH ON FOAM IN THE UNITED KINGDOM. QUART INST. FIRE ENG., VOL. 21, NO. 41, 14-33, 1961

-SOURCE INFORMATION-

CORPORATE SOURCE -
JOINT FIRE RESEARCH ORGANIZATION, BOREHAM WOOD (ENGLAND).
JOURNAL PROCEEDINGS -
THE ENGINEER, VOL. 219, NO. 5696, 537-538 (MAR. 26, 1965)
OTHER INFORMATION -
0002 PAGES, 0004 FIGURES, 0001 TABLES, 0005 REFERENCES

keys 15916 through 15920

FIRE AND EXPLOSION HAZARDS FROM SPILLS INVOLVING LIQUID HYDROGEN AND OTHER FLAMMABLE FLUIDS

by

VAN DOLAH, R.W.

06/00/64

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER PRESENTS A FEW HIGHLIGHTS FROM THREE RATHER EXTENSIVE PROGRAMS ON THE FIRE AND EXPLOSION HAZARDS OF TWO CRYOGENIC FUELS, LIQUID HYDROGEN AND LNG. TWO TYPES OF HAZARDS EXIST, ONE ASSOCIATED WITH THE FIREBALL THAT OCCURS AFTER FLASH EVAPORATION AND IGNITION, THE OTHER WITH POOL FIRES. POOL FIRES INVOLVING THESE FUELS ARE NOT VERY MUCH DIFFERENT THAN THOSE INVOLVING NORMAL FUELS EXCEPT FOR PROBLEMS OF EXTINGUISHMENT. BECAUSE OF THE VERY READY EASE OF IGNITION AND THE ALWAYS-PRESENT FLAMMABLE MIXTURES, HYDROGEN POOL FIRES SHOULD BE ALLOWED TO BURN OUT. THE FIREBALL HAZARD IS MORE UNIQUE TO CRYOGENIC FUELS ALTHOUGH A FIREBALL CAN DEVELOP UPON IGNITION AFTER RUPTURE OF TANKS CONTAINING FUELS UNDER PRESSURE (LIQUEFIED PETROLEUM GAS). THE MAJOR CONSEQUENCE OF A FIREBALL IS USUALLY THERMAL RADIATION BUT WITH SOME CONFINEMENT SEVERE BLAST PRESSURES MAY OCCUR. SOME OF THE SPECIFIC TOPICS DISCUSSED IN THE PAPER ARE VAPORIZATION RATES, VAPOR DISPERSION, COMBUSTION ABOVE LIQUID POOLS AND IN VAPOR CLOUDS, RADIATION FROM FLAMES EFFECTS OF CONFINEMENT AND EXTINGUISHMENT.

-PERTINENT FIGURES-

FIG.1 RATE OF VAPORIZATION OF LIQUID HYDROGEN POURED ONTO WARM PARAFFIN WITHIN A 2.8 INCH DIAMETER DEWAR, PAGE 3//FIG.2 EXTENT OF THE FLAMMABLE MIXTURES AND HEIGHT OF THE VISIBLE CLOUD FORMED AFTER THE RAPID SPILLAGE OF 3 LITERS OF LIQUID HYDROGEN ON A DRY MACADAM SURFACE IN A QUIESCENT AIR ATMOSPHERE AT 59 DEGREES F, PAGE 5//FIG.3 LAYERING AND DISPERSION OF METHANE, PAGE 7//FIG.4 EXTENT OF FLAMMABLE ZONE ABOVE DOWNWIND DIKE FOLLOWING SPILLAGE OF LNG, PAGE 8//FIG.7 MAXIMUM VERTICAL CROSS SECTIONS OF FLAMES PRODUCED AT VARIOUS TIME INTERVALS FOLLOWING SPILLAGE OF 89 LITERS OF LIQUID HYDROGEN ON A GRAVEL SURFACE, PAGE 11//FIG.9 VARIATION IN DISTANCE FOR 2 CALORIES PER SQUARE CENTIMETER WITH MASS OF LIQUID HYDROGEN, PAGE 13

-BIBLIOGRAPHY-

ZABETAKIS,M.G. AND BURGESS,D., RESEARCH ON THE HAZARDS ASSOCIATED WITH THE PRODUCTION AND HANDLING OF LIQUID HYDROGEN. BUREAU OF MINES REPT. OF INVESTIGATIONS 5707, 1961, 50 PP.//BURGESS,D. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUIFIED NATURAL GAS. BUREAU OF MINES REPT. OF INVESTIGATIONS 6099, 1962, 33 PP.//ZABETAKIS,M.G., FURNO,A.L. AND PERLEE,H.E., HAZARDS IN USING LIQUID HYDROGEN IN BUBBLE CHAMBERS. BUREAU OF MINES REPT. OF INVESTIGATIONS 6309, 1963

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
JOURNAL PROCEEDINGS -
AEC SAFETY AND FIRE PROTECTION BULL. NO. 9 (JUN 1964)//SOCIETY OF FIRE PROTECTION ENGINEERS, CRYOGENIC STORAGE AND HANDLING OF HYDROGEN AND NATURAL GAS
OTHER INFORMATION -
0019 PAGES, 0011 FIGURES, 0003 TABLES, 0003 REFERENCES

keys 15977 through 15978

PRELIMINARY STAFF REPORT ON INVESTIGATION OF DISASTER AT TEXAS EASTERN TRANSMISSION CORPORATION LNG STORAGE TANK ON STATEN ISLAND, BOROUGH OF RICHMOND, NEW YORK CITY, NEW YORK FEBRUARY 10, 1973

-ABSTRACT-

ON FEBRUARY 10, 1973, AT APPROXIMATELY 1.05 P.M., A FIRE OF UNKNOWN ORIGIN BROKE OUT IN THE LNG STORAGE TANK OF TEXAS EASTERN TRANSMISSION CORPORATION, LOCATED IN THE BLOOMFIELD SECTION OF STATEN ISLAND, NEW YORK. THE FIRE RESULTED IN THE DEATH OF 40 MEN, WHO AT THE TIME WERE CARRYING OUT REPAIRS WITHIN THE TANK. PHYSICAL DAMAGE INCLUDED THE COMPLETE DESTRUCTION OF THE INTERNAL COMPONENTS OF THE TANK, THE DOME AND ASSOCIATED PIPING, THE FIRE FIGHTING APPARATUS ALONG THE EDGE OF THE DOME, AND SUBSTANTIAL DAMAGE TO THE ROADWAY ENCIRCLING THE TOP OF THE TANK. TWO MEN WORKING ON INTERNAL SCAFFOLDING AND ONE MAN NEAR THE TOP OF THE TANK SURVIVED THE DISASTER. THE SPECIFIC SOURCE AND CAUSE OF IGNITION OF THE FIRE HAS NOT BEEN DETERMINED BUT THE URETHANE INSULATION AND LAMINATED LINER THAT COVERED THE INTERNAL WALLS AND FLOOR OF THE TANK FUELED THE FIRE UNTIL EARLY THE FOLLOWING DAY. INVESTIGATIONS WERE INSTITUTED BY VARIOUS DEPARTMENTS OF THE CITY OF NEW YORK, THE U.S. DEPARTMENT OF LABOR, TEXAS EASTERN TRANSMISSION CORPORATION AND OTHER PUBLIC AND PRIVATE AGENCIES AS WELL AS THE FEDERAL POWER COMMISSION. THROUGH LATE-JUNE 1973, THE DATE OF THIS REPORT, NO FINDINGS HAVE BEEN ISSUED BY ANY OF THE INVESTIGATORY BODIES AS TO THE CAUSE OF THIS INCIDENT. THIS REPORT HAS BEEN PREPARED TO PROVIDE BACKGROUND INFORMATION ON TEXAS EASTERNS STATEN ISLAND TERMINAL INCLUDING THOSE ACTIONS TAKEN BY THE FPC IN ITS AUTHORIZATION AND TO DETAIL THE PURPOSE, SCOPE AND STATUS OF THE FPC STAFF INVESTIGATION OF THE FEBRUARY 10 DISASTER. THE AUTHORS FEEL THAT THE FPC INVESTIGATION WAS HAMPERED BY THE LACK OF COOPERATION ON THE PART OF OTHER GOVERNMENT AGENCIES.

-PERTINENT FIGURES-

PHOTO.1 AERIAL VIEW OF LNG TANK AFTER FEB 10, 1973 INCIDENT, APPENDIX E// PHOTO.2 VIEW OF NORTHWEST SIDE OF TANK, APPENDIX E//PHOTO.3 VIEW OF WEST SIDE OF TANK, APPENDIX E//PHOTO.4 VIEW OF NORTH END OF TANK, APPENDIX E

-SOURCE INFORMATION-

CORPORATE SOURCE -
FEDERAL POWER COMMISSION, WASHINGTON, D.C. BUREAU OF NATURAL GAS

OTHER INFORMATION -
0094 PAGES, 0004 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 16727 through 16756

SAFETY WITH CRYOGENIC FLUIDS (LKS* PART 1 OF 2.)

by

ZABETAKIS,M.G.

00/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Good/Excel.

-ABSTRACT-

THIS MONOGRAPH WAS PREPARED IN AN EFFORT TO PRESENT IN CONCISE FORM THE PRINCIPLES OF SAFETY THAT ARE APPLICABLE TO THE FIELD OF CRYOGENICS. THUS, WHILE IT INCLUDES SAFETY RULES, DESIGN DATA, FIRST-AID AND HAZARD CONTROL PROCEDURES, EMPHASIS HAS BEEN PLACED ON BASIC PRINCIPLES. AN APPRECIATION OF THESE PRINCIPLES PERMITS AN INDIVIDUAL TO CONDUCT A SAFE OPERATION UNDER A WIDER VARIETY OF CONDITIONS THAN IS POSSIBLE IF HE IS FAMILIAR ONLY WITH A LIST OF SAFETY RULES. ALTHOUGH SUCH RULES ARE USEFUL, THERE IS NO GUARANTEE THAT A COMPLETE SET CAN EVER BE ASSEMBLED IN ANY PARTICULAR CASE. FOR THIS REASON, GREATER EMPHASIS HAS BEEN PLACED ON THE FUNDAMENTALS THAT ON THE APPLICATIONS. AT THE SAME TIME, AN EXTENSIVE, ALTHOUGH BY NO MEANS EXHAUSTIVE, SET OF REFERENCES HAS BEEN PREPARED FOR USE BY THOSE WHO WISH TO DELVE INTO A PARTICULAR PRINCIPLE OR APPLICATION IN GREATER DETAIL, A SEPARATE MONOGRAPH COULD BE PREPARED ON EACH TOPIC CONSIDERED HERE-SUCH MONOGRAPHS ARE AVAILABLE IN MANY CASES. IT HAS BEEN ASSUMED THAT THE READER IS FAMILIAR WITH THE GENERAL SAFETY PROCEDURES USED IN ORDINARY LABORATORY AND PLANT OPERATIONS. WHERE THESE ARE APPLICABLE TO A PARTICULAR LOW- TEMPERATURE OPERATION, THEY ARE REVIEWED BRIEFLY, OR THE READER IS REFERRED TO A SPECIFIC TEXT OR JOURNAL ARTICLE FOR A DETAILED TREATMENT.

-PERTINENT FIGURES-

FIG.3 HYDROGEN CONCENTRATION IN AIR, PAGE 9//FIG.4 EFFECTS OF CARBON MONOXIDE ON THE HUMAN BODY, PAGE 10//FIG.5 VAPOR PRESSURES OF CRYOGENIC FLUIDS, PAGE 14//FIG.6 DENSITY OF HELIUM, PAGE 16//FIG.7 COMPRESSIBILITY FACTOR CHART FOR N-HYDROGEN, PAGE 17//FIG.8 GENERALIZED COMPRESSIBILITY FACTOR CHART, PAGE 17

-BIBLIOGRAPHY-

R. LANDAU AND R. ROSEN, INDUSTRIAL HANDLING OF FLUORINE, IND. ENG. CHEM., 39.281, 1947//THE HANDLING AND STORAGE OF LIQUID PROPELLANTS, OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C., 1963, PP. 95-108//HYGIENIC GUIDE SERIES, FLUORINE, AMERICAN

INDUSTRIAL HYGIENE ASSOCIATION, DETROIT, 1956, 2 PP//HYGIENIC GUIDE SERIES, OZONE, AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, DETROIT, 1957, 2 PP //EMMANUEL M. ROTH, SPACE-CABIN ATMOSPHERES, PART I, OXYGEN TOXICITY, NASA SP-47, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C., 1964, 51 PP//W. G. BIGELOW, W. T. MUSTARD, AND J. G. EVANS, SOME PHYSIOLOGIC CONCEPTS OF HYPOTHERMIA AND THEIR APPLICATIONS TO CARDIAC SURGERY, JOURNAL OF THORACIC SURGERY, 28, 463, 1954

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0147 PAGES, 0067 FIGURES, 0010 TABLES, 0211 REFERENCES

keys 17558 through 17559

INSTALLATION OF LIQUEFIED NATURAL GAS FUEL CONTAINERS AND SYSTEMS ON MOTOR VEHICLES

by

JOHNSON,R.K.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS ARTICLE OUTLINES THE PROCEDURES FOR THE INSTALLATION OF A LIQUEFIED NATURAL GAS (LNG) SYSTEM ON A MOTOR VEHICLE. EMPHASIS IS PLACED ON SAFETY DEVICES REQUIRED IN THE SYSTEM TO MINIMIZE THE HAZARDS OF LNG WHEN USED AS AN AUTO FUEL. THESE INCLUDE CONTAINER IDENTIFICATION, VENTING DEVICES, SHUTOFF VALVES, ELECTRICAL EQUIPMENT PRECAUTIONS AND ROAD CLEARANCES.

-BIBLIOGRAPHY-

CALIFORNIA ADMINISTRATIVE CODE, TITLE 13, SUB CHAPTER 4, ARTICLE 2

-SOURCE INFORMATION-

CORPORATE SOURCE -
CALIFORNIA HIGHWAY PATROL, SACRAMENTO
REPORT NUMBER -
ASTM STP 537
JOURNAL PROCEEDINGS -
CRYOGENS AND GASES. TESTING METHODS AND STANDARDS DEVELOPMENT, 12-6 (1973) (SYMP. PRES. AT THE AMERICAN SOCIETY FOR TESTING AND MATERIALS ANNUAL MEETING, 75TH, LOS ANGELES, CALIF., JUN 25-30, 1972)
OTHER INFORMATION -
0005 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 17564 through 17565

SENSITIVITY AND REACTION INTENSITY STUDIES OF LOX-LNG MIXTURES

by

BLACKSTONE,W.R.
WENZEL,A.B.
EVERY,R.L.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

MIXTURES OF LIQUID OXYGEN (LOX) AND LIQUID NATURAL GAS (LNG) ARE VERY ATTRACTIVE AS COMMERCIAL EXPLOSIVES BECAUSE THEY EXHIBIT VERY HIGH BRISANCE, OR SHATTERING POWER, AND BECAUSE THE BASIC MATERIALS ARE READILY AVAILABLE AND INEXPENSIVE. HOWEVER, THE MIXTURES CAN BE QUITE DANGEROUS IF MISHANDLED, AND THERE IS LITTLE OR NO INFORMATION AVAILABLE CONCERNING THE HANDLING HAZARDS. THE OBJECTIVE OF THIS PROGRAM WAS TO OBTAIN SUCH INFORMATION BY CONDUCTING A SERIES OF DROP TESTS TO CHARACTERIZE THE IMPACT IGNITION AND REACTION INTENSITY BEHAVIOR OF VARIOUS LOX-LNG MIXTURES AND TO DETERMINE WHETHER THE ADDITION OF AN INERT INHIBITOR WOULD CHANGE THE REACTION INTENSITY OR THE IMPACT SENSIVITY. IMPACT TESTS WERE CONDUCTED USING PENTAERYTHRITOL TETRANITRATE (PETN), AND THE RESULTS WERE COMPARED WITH THOSE FOR THE VARIOUS LOX-LNG MIXTURES. IN GENERAL LOX/LNG MIXTURES APPEAR TO HAVE THE SAME DEGREE OF HANDLING HAZARD AS PETN, BUT ARE POTENTIALLY MORE ENERGETIC. FURTHER, THE MIXTURE NEED NOT BE MADE UNTIL THE LAST MINUTE, THUS AVOIDING MANY HANDLING HAZARDS.

-PERTINENT FIGURES-

TAB.1 PROGRAM TEST PLAN, PAGE 41//TAB.2 SUMMARY OF TEST RESULTS, PAGE 50// FIG.9 REGRESSION OF STANDARD DEVIATION MEAN FOR REACTION INTENSITY MEASUREMENTS, PAGE 51//TAB.3 TRANSFORMED DATA FOR THE STANDARD DEVIATION AND MEAN FOR REACTION INTENSITY MEASUREMENTS, PAGE 52//TAB.4 ANALYSIS OF VARIANCE FOR TRANSFORMED REACTION INTENSITY DATA, PAGE 53//FIG.10 REACTION INTENSITY VERSUS O/F RATIO, PAGE 54

-BIBLIOGRAPHY-

BLACKSTONE,W.R., BABER,B.B., AND KU,P.M., TRANSACTIONS, AMERICAN SOCIETY OF LUBRICATION ENGINEERS, VOL 11, NO. 3, JULY 1968//PROPOSED METHOD OF TEST FOR COMPATIBILITY OF MATERIALS WITH LIQUID OXYGEN (REACTION INTENSITY METHOD), PUBLISHED FOR

INFORMATION ONLY IN 1970 EDITION OF PART 18, BOOK OF ANNUAL ASTM STANDARDS) ANNUAL ASTM STANDARDS//ROTHMAN,D., ALEXANDER,M.J., AND ZIMMERMAN,J.M., THE DESIGN AND ANALYSIS OF SENSITIVITY EXPERIMENTS, NASA CR-62026, VOLS. 2 AND 22, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, MAY 1965

-SOURCE INFORMATION-

CORPORATE SOURCE -
SOUTHWEST RESEARCH INST., SAN ANTONIO, TEX.//CONTINENTAL OIL CO., PONCA CITY, OKLA.

REPORT NUMBER -
ASTM STP 537

JOURNAL PROCEEDINGS -
CRYOGENS AND GASES. TESTING METHODS AND STANDARDS DEVELOPMENT, 40-58 (1973) (SYMP. PRES. AT THE AMERICAN SOCIETY FOR TESTING AND MATERIALS ANNUAL MEETING, 75TH, LOS ANGELES, CALIF., JUN 25-30, 1972)

OTHER INFORMATION -
0019 PAGES, 0013 FIGURES, 0005 TABLES, 0006 REFERENCES

keys 17568 through 17569

THERMODYNAMIC AND TRANSPORT PROPERTIES OF CRYOGENIC PROPELLANTS AND RELATED FLUIDS

by

JOHNSON,V.J.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

SIGNIFICANT ADVANCES HAVE BEEN MADE IN RECENT YEARS IN THE QUALITY AND RANGE OF THERMOPHYSICAL DATA FOR THE CRYOGENIC PROPELLANTS, PRESSURANTS, AND INERTANTS. THESE ADVANCES HAVE RESULTED FROM IMPROVED EVALUATION AND COMPILATION TECHNIQUES COUPLED WITH BETTER AND MORE EXTENSIVE EXPERIMENTAL DATA AND FROM A BETTER THEORETICAL UNDERSTANDING OF THE PHYSICAL PROPERTIES OF GASES. A REVIEW OF RECENTLY COMPLETED AND CURRENT DATA COMPILATION PROJECTS FOR HELIUM, HYDROGEN, ARGON, NITROGEN, OXYGEN, FLUORINE, AND METHANE WILL BE GIVEN AS WELL AS RECOMMENDED REFERENCES FOR THERMODYNAMIC AND TRANSPORT PROPERTY DATA TABLES FOR THESE FLUIDS. MODERN TECHNIQUES IN THE PLOTTING OF THERMODYNAMIC CHARTS FROM TABULAR DATA (OR FROM FUNCTIONS SUCH AS THE EQUATION OF STATE) HAVE GREATLY IMPROVED THEIR PRECISION AND VALUE. A LIST OF SUCH CHARTS IS INCLUDED. THE FLUIDS INCLUDED IN THIS SURVEY ARE HELIUM-4, PARAHYDROGEN, NORMAL HYDROGEN, ARGON, NITROGEN, OXYGEN, FLUORINE AND METHANE.

-BIBLIOGRAPHY-

MCCARTY,R.D., THERMOPHYSICAL PROPERTIES OF HELIUM-4 FROM 2 TO 1500 K WITH PRESSURES TO 1000 ATMOSPHERES, NATIONAL BUREAU OF STANDARDS TECHNICAL NOTE 631, NOV. 1972//RODER,H.M., WEBER,L.A. AND GOODWIN,R.D., THERMODYNAMIC AND RELATED PROPERTIES OF PARAHYDROGEN FROM THE TRIPLE POINT TO 100 K AT PRESSURES TO 340 ATMOSPHERES, NATIONAL BUREAU OF STANDARDS MONOGRAPH 94, AUG. 1965//MCCARTY,R.D. AND WEBER,L.A., THERMOPHYSICAL PROPERTIES OF PARA-HYDROGEN FROM THE FREEZING LIQUID LINE TO 5000 R FOR PRESSURES TO 10,000 PSIA, NATIONAL BUREAU OF STANDARDS TECHNICAL NOTE 617, APRIL 1972// JACOBSEN,R.T., THE THERMODYNAMIC PROPERTIES OF NITROGEN FROM 65 TO 2000 K WITH PRESSURES TO 10,000 ATM, PH.D. THESIS, WASHINGTON STATE UNIVERSITY, 1972//MCCARTY,R.D. AND WEBER,L.A., THERMOPHYSICAL PROPERTIES OF OXYGEN FROM THE FREEZING LINE TO 600 R FOR PRESSURES TO 5000 PSIA, NATIONAL BUREAU OF STANDARDS TECHNICAL NOTE 384, JULY 1971//PRYDZ,R. AND STRATY,G.C., THE THERMODYNAMIC PROPERTIES OF COMPRESSED GASEOUS AND LIQUID FLUORINE, NATIONAL BUREAU OF STANDARDS OF TECHNICAL NOTE 392, OCT. 1970

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL BUREAU OF STANDARDS, BOULDER, COLO. CRYOGENICS DIV.
REPORT NUMBER -
ASTM STP 537
JOURNAL PROCEEDINGS -
CRYOGENS AND GASES. TESTING METHODS AND STANDARDS DEVELOPMENT, 64-78 (1973) (SYMP. PRES. AT THE AMERICAN SOCIETY FOR TESTING AND MATERIALS ANNUAL MEETING, 75TH, LOS ANGELES, CALIF., JUN 25-30, 1972)
OTHER INFORMATION -
0015 PAGES, 0000 FIGURES, 0000 TABLES, 0061 REFERENCES

keys 17603 through 17607

EXPERIMENTAL STUDY OF EVAPORATION AND COMBUSTION OF LIQUEFIED GASES FROM A FREE SURFACE

by

GRISHIN,V.V.
KOMOV,V.F.
REUTT,V.CH.
SHEVYAKOV,G.G.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

EXPERIMENTAL DATA ARE PRESENTED ON THE DETERMINATION OF THE RATE OF EVAPORATION OF HYDROGEN, NITROGEN, OXYGEN AND METHANE AND THE RATES OF COMBUSTION OF METHANE AND OF A PROPANE-BUTANE MIXTURE ON THE SURFACES OF DIFFERENT MATERIALS (PLEXIGLAS, TEFLON, CEMENT, SAND AND STEEL) AND DEEP METAL RESERVOIRS.

-PERTINENT FIGURES-

FIG.1 EVAPORATION RATE OF LIQUEFIED GASES FROM THE SURFACE OF DIFFERENT MATERIALS FROM AN OPEN VESSEL WITH D EQUALS 15 CM, PAGE 92//FIG.2 EVAPORATION AND COMBUSTION OF METHANE IN AN OPEN VESSEL WITH D EQUALS 15 CM PAGE 93//FIG.3 EVAPORATION OF LIQUEFIED HYDROCARBON GASES FROM DEEP RESERVOIRS, PAGE 94

-BIBLIOGRAPHY-

LUIKOV,A.V., ANALYTICAL HEAT DIFFUSION THEORY. NEW YORK, ACADEMIC PRESS, 1968//OSIPOVA,V.A., EXPERIMENTAL STUDY OF HEAT TRANSFER PROCESSES. MOSCOW-LENINGRAD, ENERGIYA PRESS, 1964//FASTOVSKII,V.G., PETROVSKII,YU.V. AND ROVINSKII,A.YE., CY AND ROVINSKII,A.YE., CRYOGENIC ENGINEERING. MOSCOW, ENERGIYA PRESS, 1967// BORISHANSKII,V.M. AND KUTATELADZE,S.S., HANDBOOK ON HEAT TRANSFER. MOSCOW-LENINGRAD, GOSENERGOIZDAT PRESS, 1959//BURGESS, ET AL., FIVE RESEARCH ABSTRACTS AND REVIEWS, VOL 3, 3, 177-192, 1961

-SOURCE INFORMATION-

CORPORATE SOURCE -
ALL-UNION RESEARCH INST. OF FIREFIGHTING, MOSCOW, USSR
JOURNAL PROCEEDINGS -
HEAT TRANSFER SOV. RES. VOL 5, NO. 5, 91-5 (SEP-OCT 1973)

keys 17684 through 17686

IMPORTING LIQUEFIED NATURAL GAS - A SAFETY THREAT TO THE COASTS.

by

MAGNUSON,W.G.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER REVIEWS THE NEED AND CURRENT PRACTICE IN LNG IMPORTATION TO THE UNITED STATES. SOME DANGERS INVOLVED WITH SHIPPING IN LNG TANKERS ARE REVIEWED. AMONG THESE DANGERS IS THE REACTION OF SMALL FLAMELESS EXPLOSIONS WHEN LNG IS SPILLED ON WATER, AND THE POSSIBILITY THAT THESE EXPLOSIONS COULD BECOME SERIOUS WITH LARGER-SCALE SPILLS. ANOTHER DANGER IS THE CLOUD FORMATION AND CLOUD TRAVEL RESULTING FROM A SPILL, AND THE POSSIBILITY THAT A CLOUD COULD MOVE LONG DISTANCES BEFORE IGNITION, AND COULD FLASH BACK TO ITS SOURCE WHEN IGNITED, BURNING EVERYTHING IN ITS PATH. THE AUTHOR CONCLUDES THAT FURTHER GUIDELINES, STANDARDS, AND REGULATIONS WILL BE NEEDED, THAT JURISDICTION OVER SITE SELECTION FOR LNG PORT FACILITIES MUST BE CLARIFIED, AND THAT THESE RECOMMENDATIONS SHOULD BE CARRIED OUT TO PREVENT ACCIDENTS, RATHER THAN ACTING AFTER THE FACT.

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNITED STATES SENATE, WASHINGTON, D.C. COMMERCE COMMITTEE
JOURNAL PROCEEDINGS -
MAR. TECHNOL. SOC. J. VOL 7, NO. 7, 3-7 (OCT-NOV 1973)
OTHER INFORMATION -
0005 PAGES, 0005 FIGURES, 0000 TABLES, 0000 REFERENCES

INSULATED TANK TRUCK SPECIFICATION CGS-341 FOR COLD LIQUEFIED GASES TENTATIVE STANDARD

-ABSTRACT-

THIS TANK TRUCK SPECIFICATION REPRESENTS THE MINIMUM REQUIREMENTS RECOMMENDED BY THE COMPRESSED GAS ASSOCIATION, INC. (CGA) FOR INSULATED TANK TRUCKS INTENDED PRIMARILY FOR THE TRANSPORTATION OF COLD LIQUEFIED GASES, (FREQUENTLY REFERRED TO AS CRYOGENIC FLUIDS) WHOSE PRESSURE IF WARMED TO 115 F WOULD EXCEED THE SAFETY RELIEF VALVE SETTING OF THE TANK AND THEREFORE WOULD VENT IF LEFT INDEFINITELY.

-SOURCE INFORMATION-

CORPORATE SOURCE -
COMPRESSED GAS ASSOC., INC., NEW YORK
REPORT NUMBER -
PAMPHLET-CGA-341
OTHER INFORMATION -
0015 PAGES, 0000 FIGURES, 0004 TABLES, 0000 REFERENCES

keys 18725 through 18729

PRESTRESSED CONCRETE DIKE SYSTEMS FOR LNG STORAGE CONTAINERS

by

CLOSNER,J.J.

09/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

PRESTRESSED CONCRETE PROTECTIVE WALLS, OR SUCH WALLS COMBINED WITH A THICK CONCRETE BERM AS DESCRIBED FOR THE PHILADELPHIA GAS WORKS AND DISTRIGAS FACILITIES, PREVENT SIGNIFICANT LATERAL DISPERSION AT GROUND LEVEL OF CONTENTS OF THE PRIMARY TANK EITHER IN LIQUID OR VAPOROUS FORM. THE PROTECTIVE SYSTEM WILL FUNCTION WHETHER SPILLAGE FROM THE PRIMARY CONTAINER IS OF NOMINAL OR OF MASSIVE PROPORTIONS. INHERENT ELASTIC RECOVERY CAPABILITIES OF THE PRESTRESSED CONCRETE WALL MAKE IT PARTICULARLY SUITABLE FOR THIS APPLICATION AND SUPERIOR TO MOST OTHER AVAILABLE MATERIALS. BY CLOSE CONFINEMENT OF THE LNG OR GAS VAPORS AND FORCING THE PASSAGE OF THESE VAPORS TO THE TOP OF THE WALL, HIGH ABOVE THE GROUND, THE SYSTEM PROVIDES A HIGH DEGREE OF SAFETY AGAINST GROUND LEVEL DISPERSION OF HAZARDOUS CONCENTRATIONS OF VAPOR. BY COMBINING THE PRESTRESSED CONCRETE WALL WITH A THICK CONCRETE BERM, ADDED SECURITY IS PROVIDED AGAINST AN ACCIDENT DUE TO AN EXTERNAL CAUSE.

-PERTINENT FIGURES-

FIG.1 CUTAWAY SHOWS DESIGN OF TWO 583,000-BBL PRESTRESSED CONCRETE LNG TANKS FOR PHILADELPHIA GAS WORKS, PAGE 63//FIG.2 WALL SECTION OF THE PGW TANKS, PAGE 66//FIG.3 PRESTRESSED CONCRETE DIKE WALL TO BE USED AT PHILA. ELECTRIC CO. TO SURROUND AN ALL-METAL, 350,000-BBL STORAGE TANK, PAGE 66

-BIBLIOGRAPHY-

NPFA NO. 59A STANDARD

-SOURCE INFORMATION-

CORPORATE SOURCE -
PRELOAD ENGINEERING CO., GARDEN CITY, N.Y.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 198, NO. 11, 63 & 66 & 68-9 (SEP 1971)
OTHER INFORMATION -

keys 18719 through 18724

DESIGN AND CONSTRUCTION OF LNG INSTALLATIONS AT PETROLEUM TERMINALS, NATURAL GAS PROCESSING PLANTS, REFINERIES, AND OTHER INDUSTRIAL PLANTS

-ABSTRACT-

THIS STANDARD (DATED JUNE 1968) COVERS THE DESIGN, CONSTRUCTION, AND LOCATION OF INSTALLATIONS FOR THE LIQUEFACTION, STORAGE (BOTH ABOVEGROUND AND UNDERGROUND), LOADING OR UNLOADING, AND VAPORIZATION OF LIQUEFIED NATURAL GAS (LNG) AT PETROLEUM TERMINALS, NATURAL GAS PROCESSING PLANTS, REFINERIES, AND OTHER INDUSTRIAL PLANTS NOT COVERED BY NFPA NO. 59A. IT IS INTENDED TO SERVE AS A GUIDE FOR INSTALLING LNG FACILITIES SO THAT THEY CAN BE OPERATED SAFELY AND RELIABLY. IT IS RECOGNIZED THAT THE LIQUEFACTION AND VAPORIZATION FACILITIES MAY BE AN INTEGRAL PART OF A REFINERY, A GAS PROCESSING PLANT, OR OTHER INDUSTRIAL PLANTS, AS WELL AS A SEPARATE INSTALLATION. THIS LNG STANDARD IS NOT INTENDED TO APPLY TO THE DESIGN OF THE INDIVIDUAL PROCESS EQUIPMENT COMPONENTS WHICH MAKE UP THE LIQUEFACTION AND VAPORIZATION FACILITIES IN ANY INSTALLATION.

-PERTINENT FIGURES-

TAB. MINIMUM DISTANCE REQUIREMENTS FOR ABOVEGROUND TANKS OF LESS THAN 1000,000-GAL CAPACITY, PAGE 9//TAB. MINIMUM DISTANCE REQUIREMENTS FOR TANKS OF 100,000-GAL CAPACITY AND OVER, PAGE 10

-BIBLIOGRAPHY-

NFPA NO. 59A. STANDARD FOR STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS AT UTILITY GAS PLANTS, NATL. FIRE PROTECT. ASSOC., BOSTON (1967)//APPENDIX Q, 1968 SUPPLEMENT TO API STD. 620. RECOMMENDED RULES FOR DESIGN AND CONSTRUCTION OF LARGE, WELDED, LOW-PRESSURE STORAGE TANKS, 3RD EDN., AM. PETROL. INST., NEW YORK (1966)//API STD. 2000. GUIDE FOR VENTING ATMOSPHERIC AND LOW-PRESSURE STORAGE TANKS, AM. PETROL. INST., NEW YORK (1968)//USAS B31.3-1966. PETROLEUM REFINERY PIPING, AM. SOC. MECH. ENGRS., NEW YORK//NFPA NO. 70. NATIONAL ELECTRICAL CODE, NATL. FIRE PROTECT. ASSOC., BOSTON (1965)//API RP 2003. PROTECTION AGAINST IGNITIONS ARISING OUT OF STATIC, LIGNTNING, AND STRAY CURRENTS, AM. PETROL. INST., NEW YORK (1967)

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN PETROLEUM INST., NEW YORK
REPORT NUMBER -
API STANDARD 2510A
OTHER INFORMATION -
0016 PAGES, 0000 FIGURES, 0000 TABLES, 0015 REFERENCES

keys 17810 through 17812

THIRD ANNUAL REPORT OF THE SECRETARY OF TRANSPORTATION ON HAZARDOUS MATERIALS CONTROL HAZARDOUS MATERIALS TRANSPORTATION CONTROL ACT OF 1970, CALENDAR YEAR 1972

-ABSTRACT-

THIS REPORT GIVES THE TRANSPORTATION SECRETARYS REPORT AS REQUIRED BY THE HAZARDOUS MATERIALS TRANSPORTATION CONTROL ACT OF 1970. THE AREAS REPORTED ON INCLUDE (1) A THOROUGH STATISTICAL COMPILATION OF THE ACCIDENTS AND CASUALTIES OCCURRING IN SUCH YEAR WHICH INVOLVED THE TRANSPORTATION OF HAZARDOUS MATERIALS, (2) A LIST OF RELEVANT FEDERAL STANDARDS IN EFFECT OR ESTABLISHED IN SUCH YEAR, (3) A SUMMARY OF THE REASON FOR EACH WAIVER OR EXEMPTION GRANTED PURSUANT TO SECTIONS 831 TO 835, INCLUSIVE, OF TITLE 18 OF THE UNITED STATES CODE, (4) AN EVALUATION OF THE DEGREE OF OBSERVANCE OF SAFETY STANDARDS FOR THE TRANSPORTATION OF HAZARDOUS MATERIALS, AND (5) A SUMMARY OF OUTSTANDING PROBLEMS CREATED BY THE TRANSPORTATION OF HAZARDOUS MATERIALS. AMONG THE SUMMARY OF OUTSTANDING PROBLEMS IS THE IDENTIFICATION OF MULTIPLE HAZARDS ASSOCIATED WITH SOME COMMODITIES AND THE NEED FOR INTERNATIONAL COOPERATION IN ESTABLISHING REGULATIONS FOR THE TRANSPORTATION OF HAZARDOUS MATERIALS.

-PERTINENT FIGURES-

TAB.1 ACCIDENT AND CASUALTY REPORTING, 1971, PAGE 15//FIG.1 REPORTED MARINE CASUALTIES INVOLVING HAZARDOUS MATERIAL CARRIERS, PAGE 18//FIG.2 REPORTED MARINE CASULATIES INVOLVING HAZARDOUS MATERIAL CARRIERS, PAGE 19//FIG.3 REPORTED MARINE CASUALTIES INVOLVING HAZARDOUS MATERIAL CARRIERS, PAGE 20

-BIBLIOGRAPHY-

LNG - WATER EXPLOSIONS, REPORT TO U.S. COAST GUARD DATED MARCH 1972// SUPERHEAT - LIMIT EXPLOSIONS BY D. L. KATZ, CHEM. ENG. PROGR., MAY 1972// CONFERENCE PROCEEDINGS ON LNG IMPORTATION AND TERMINAL SAFETY, REPORT TO U.S. COAST GUARD SUBMITTED SEPTEMBER 1972//CONFERENCE ON VAPOR OR SUPERHEAT - LIMIT EXPLOSIONS BY R. L. MYERS, REPORT TO U.S. COAST GUARD SUBMITTED DECEMBER 6, 1972

-SOURCE INFORMATION-

CORPORATE SOURCE -
DEPARTMENT OF TRANSPORTATION, WASHINGTON, D.C.
OTHER INFORMATION -
0150 PAGES, 0006 FIGURES, 0002 TABLES, 0006 REFERENCES

keys 18049 through 18050

CONTROL VALVES FOR LNG FACILITIES

by

GOLDFEDER, L. B.

01/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE ARTICLE DESCRIBES MANY DESIGN FEATURES OF VALVES FOR USE IN LIQUEFIED NATURAL GAS INSTALLATIONS. WHILE THE STRESS IS ON LNG FACILITIES, MOST OF THE DESIGN CRITERIA, INCLUDING LEAK PREVENTION, HEAT LEAK REDUCTION, SEAL MATERIALS FOR LOW TEMPERATURES, AND LOW COOLDOWN WEIGHT, APPLY EQUALLY TO OTHER CRYOGENIC FLUIDS VALVES.

-SOURCE INFORMATION-

CORPORATE SOURCE -
FISHER CONTROLS CO., MARSHALLTOWN, IOWA
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 1, 58 & 62 & 66-7 & 72 & 74 (JAN 1972)
OTHER INFORMATION -
0006 PAGES, 0012 FIGURES, 0000 TABLES, 0000 REFERENCES

STEELS

by

PITCHER,J.H.

12/04/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS BRIEF ARTICLE SUMMARIZES THE PROPERTIES OF SEVERAL STEELS AND ALLOYS INTENDED FOR USE AT TEMPERATURES AS LOW AS 77 K. THE PRIMARY APPLICATION CONSIDERED IS TRANSPORT OF LIQUEFIED NATURAL GAS. USEFULNESS OF THE ARTICLE IS LIMITED BY ITS BREVITY, ITS ATTEMPT TO COVER OTHER SPECIAL STAINLESS STEELS AS WELL AS MATERIALS FOR CRYOGENIC SERVICE, AND THE LACK OF PROPERTIES DATA AT LOW TEMPERATURES.

-PERTINENT FIGURES-

TAB.2 TYPICAL COMPOSITION OF CRYOGENIC MATERIALS, PAGE 42//TAB.3 STRENGTH OF CRYOGENIC MATERIALS, PAGE 42

-SOURCE INFORMATION-

CORPORATE SOURCE -
ARMCO STEEL CORP., MIDDLETOWN, OHIO
JOURNAL PROCEEDINGS -
CHEM. ENG. (N.Y.) VOL 79, NO. 27, 39-42 (DEC 1972)
OTHER INFORMATION -
0004 PAGES, 0001 FIGURES, 0003 TABLES, 0000 REFERENCES

keys 18138 through 18145

FIRE HAZARDS OF CRYOGENIC FUELS

by

VAN DOLAH,R.W.

05/15/63

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE HAZARDS ASSOCIATED WITH THE PRODUCTION, TRANSPORTATION, STORAGE AND USE OF ANY CHEMICAL DEPEND ON ITS PHYSICAL AND CHEMICAL PROPERTIES AS WELL AS ON ITS INTERACTIONS WITH THE SURROUNDINGS AND ITS EFFECT ON MAN. OF PARTICULAR INTEREST HERE ARE THE FIRE AND EXPLOSION HAZARDS OF TWO COMMON FUELS, HYDROGEN AND NATURAL GAS, THAT ARE NOW BEING LIQUEFIED, STORED AND SHIPPED IN ATMOSPHERIC-PRESSURE CONTAINERS. THE POTENTIAL HAZARDS OF THE TWO CRYOGENIC FUELS THAT ARISE FOLLOWING SPILLAGE ARE DISCUSSED IN TERMS OF THEIR PROPERTIES, THE METHODS BY WHICH FLAMMABLE MIXTURES ARE FORMED AND IGNITED AND THE RESULTS OF THE COMBUSTION, AND METHODS OF FIRE FIGHTING. TWO TYPES OF HAZARDS EXIST, ONE ASSOCIATED WITH THE FIREBALL AFTER FLASH EVAPORATION AND IGNITION AND THE OTHER IS POOL FIRES. POOL FIRES WITH HYDROGEN AND LNG ARE NOT MUCH DIFFERENT THAN NORMAL FUELS FOR EXTINGUISHMENT. HYDROGEN POOL FIRES SHOULD BE ALLOWED TO BURN OUT. THE MAJOR CONSEQUENCE OF A FIREBALL IS USUALLY THERMAL RADIATION BUT WITH SOME CONFINEMENT, SEVERE BLAST PRESSURES MAY OCCUR. AN APPENDIX GIVES A REPORT OF THE 1944 CLEVELAND DISASTER.

-PERTINENT FIGURES-

FIG.1 RATE OF VAPORIZATION OF LIQUID HYDROGEN POURED ONTO WARM PARAFFIN WITHIN A 2.8-INCH-DIAMETER DEWAR, PAGE 3//FIG.2 EXTENT OF THE FLAMMABLE MIXTURES AND HEIGHT OF THE VISIBLE CLOUD FORMED AFTER THE RAPID SPILLAGE OF 3 LITERS OF LIQUID HYDROGEN ON A DRY MACADAM SURFACE IN A QUIESCENT AIR ATMOSPHERE AT 59 DEGREES F, PAGE 5//FIG.3 LAYERING AND DISPERSION OF METHANE, PAGE 7//FIG.4 EXTENT OF FLAMMABLE ZONE ZBOVE DOWNWIND DIKE FOLLOWING SPILLAGE OF LNG, PAGE 8//FIG.5 EFFECT OF POOL DIAMETER ON LIQUID BURNING RATE UNDER WINDLESS CONDITIONS, PAGE 9//FIG.8 MAXIMUM FLAME HEIGHT AND WIDTH PRODUCED BY THE IGNITION OF THE VAPOR-AIR MIXTURES FORMED BY THE SUDDEN SPILLAGE OF 2.8 TO 89 LITERS OF LIQUID HYDROGEN, PAGE 12

-BIBLIOGRAPHY-

ZABETAKIS,M.G., AND BURGESS,D., RESEARCH ON THE HAXARDS ASSOCIATED

WITH THE PRODUCTION AND HANDLING OF LIQUID HYDROGEN. BUREAU OF MINES REPORT OF INVESTIGATIONS 5707, 1961, 50 PP.//BURGESS,D., AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS. BUREAU OF MINES REPORT OF INVESTIGATIONS 6099, 1962, 33 PP.//ZABETAKIS,M.G., FURNO,M.G., AND PERLEE,H.E., HAZARDS IN USING LIQUID HYDROGEN IN BUBBLE CHAMBERS. BUREAU OF MINES REPORT OF INVESTIGATIONS 6309, 1963

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
JOURNAL PROCEEDINGS -
SOCIETY OF FIRE PROTECTION ENGINEERS ANNUAL MEETING, 13TH, (PRES. AT) PORTLAND, ORE., MAY 15, 1963
OTHER INFORMATION -
0024 PAGES, 0011 FIGURES, 0003 TABLES, 0003 REFERENCES

key 18387

PRELIMINARY APPRAISAL OF HYDROGEN AND METHANE FUEL IN A MACH 2.7 SUPERSONIC TRANSPORT

by

WHITLOW,JR.,J.B.
WEBER,R.J.
CIVINSKAS,K.C.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Acceptable

-ABSTRACT-

THE HIGHER HEATING VALUE OF HYDROGEN RELATIVE TO JP FUEL IS ESTIMATED TO REDUCE FUEL WEIGHT BY THREE FOLD AND GROSS WEIGHT BY 40 PERCENT FOR COMPARABLY DESIGNED AIRPLANES OF EQUAL PAYLOAD AND RANGE. NO ADVANTAGE WAS FOUND FOR TURBINE ROTOR-INLET TEMPERATURES HIGHER THAN 2725 F, REGARDLESS OF FUEL TYPE, FOR DUCT-BURNING TURBOFAN ENGINES CONSTRAINED BY FAR 36 NOISE LIMITS. ENGINE DESIGN PARAMETERS WERE VARIED TO DETERMINE THE INFLUENCE OF LOWER NOISE GOALS ON GROSS WEIGHT AND DIRECT OPERATING COST. AT CURRENT FUEL PRICES, THE DOC OF A HYDROGEN AIRPLANE WOULD BE MUCH HIGHER THAN THAT OF A JP AIRPLANE. A METHANE AIRPLANE COULD OFFER AN 8.5-PERCENT LOWER DOC THAN JP. BUT FUTURE SHORTAGES MAY ESCALATE THE PRICES OF BOTH JP AND METHANE, WHEREAS THE PRICE OF HYDROGEN MANUFACTURED HYDROLYTICALLY COULD BE REDUCED FROM PRESENT LEVELS. IF IN THE FUTURE ALL THREE FUELS ARE POSTULATED TO HAVE EQUAL COSTS PER UNIT OF ENERGY, THE DOC FOR HYDROGEN COULD BE AS MUCH AS 20 PERCENT BELOW THAT FOR JP ON THE REFERENCE 4000-NAUTICAL-MILE MISSION. LONGER RANGES OR LOWER NOISE REQUIREMENTS WOULD IMPROVE THE ADVANTAGE OF HYDROGEN. THE ADDITIONAL COMPLEXITIES OF DEVELOPING AND OPERATING CRYOGENIC SYSTEMS WOULD UNDOUBTEDLY PARE SOME OF THE APPARENT ADVANTAGE.

-PERTINENT FIGURES-

TAB.2 COMPONENT WEIGHTS OF REFERENCE JP-FUEL MACH 2.7 ARROW-WING AIRPLANE// TAB.3 COMPONENT CHARACTERISTICS OF A REPRESENTATIVE DUCT-BURNING TURBOFAN ENGINE USED IN THIS STUDY//TAB.4 SST WEIGHT BREAKDOWN (POUNDS)//TAB.5 MACH 2.7 SST CHARACTERISTICS//FIG.16 EFFECT OF FUEL TYPE ON DIRECT OPERATING COST OF A MACH 2.7 SST DESIGNED FOR A 4,000-N MI. RANGE WITH 250 PASSENGERS

-BIBLIOGRAPHY-

SILVERSTEIN,A. AND HALL,E.W., LIQUID HYDROGEN AS A JET FUEL FOR HIGH-ALTITUDE AIRCRAFT. NACA RM E55C28A, 1955//LEWIS LABORATORY

STAFF, HYDROGEN FOR TURBOJET AND RAMJET POWERED FLIGHT. NACA RM E57D23, 1957// GREGORY,D.P. AND WURM,J.E., A HYDROGEN ENERGY SYSTEM. PRESENTED AT THE CONFERENCE ON NATURAL GAS RESEARCH AND TECHNOLOGY, ATLANTA, GA., JUNE 5-7, 1972//WEBER,R.J., DUGAN,J.F.,JR. AND LUIDENS,R.W., METHANE-FUELED PROPULSION SYSTEMS. ASTRONAUTICS AND AERONAUTICS, VOL. 4, NO. 10, OCT. 1966, PP. 48-55//WHITLOW,J.B.,JR. AND KRAFT,G.A., POTENTIAL OF METHANE-FUELED SUPERSONIC TRANSPORTS OVER A RANGE OF CRUISE SPEEDS UP TO MACH 4. NASA TM X-2281, 1971//HEATHMAN,J.H., HYDROGEN TANKAGE APPLICATION TO MANNED AEROSPACE SYSTEMS. PHASES II AND III. VOL. I. DESIGN AND ANALYTICAL INVESTIGATIONS. REP. GDC-DCB68-008-VOL. 1, GENERAL DYNAMICS/CONVAIR (AD-83323), APR. 1968. (AVAILABLE TO QUALIFIED REQUESTORS FROM DDC, OTHERS FROM AIR FORCE FLIGHT DYNAMICS LAB., ATTN. FBS, WRIGHT-PATTERSON AFB, OH 45433.)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO//ARMY AIR MOBILITY RESEARCH AND DEVELOPMENT CENTER LAB., CLEVELAND, OHIO

REPORT NUMBER -
N73-22711//NASA-TMX-68222

OTHER INFORMATION -
0054 PAGES, 0019 FIGURES, 0005 TABLES, 0026 REFERENCES

keys 18492 through 18494

THERMOELASTIC MODEL STUDIES OF CRYOGENIC TANKER STRUCTURES

by

BECKER,H.
COLAO,A.

08/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

THEORETICAL CALCULATIONS AND EXPERIMENTAL MODEL STUDIES WERE CONDUCTED ON THE PROBLEM OF TEMPERATURE AND STRESS DETERMINATION IN A CRYOGENIC TANKER WHEN A HOLD IS SUDDENLY EXPOSED TO THE CHILLING ACTION OF THE COLD FLUID. MODEL STUDIES OF TEMPERATURES AND STRESSES WERE PERFORMED ON INSTRUMENTED STEEL VERSIONS OF A SHIP WITH CENTER HOLDS AND WING TANKS. SUPPLEMENTARY STUDIES ALSO WERE CONDUCTED ON PLASTIC MODELS USING PHOTOTHERMOELASTICITY (PTE) TO REVEAL THE STRESSES. THE HIGHLY SIMPLIFIED THEORETICAL PREDICTIONS OF TEMPERATURE WERE IN FAIR AGREEMENT WITH THE EXPERIMENTAL DATA IN THE TRANSIENT STAGE AND AFTER LONG INTERVALS. THE TEMPERATURES AND STRESSES REACHED PEAK VALUES IN EVERY CASE TESTED AND MAINTAINED THE PEAKS FOR SEVERAL MINUTES DURING WHICH TIME THE BEHAVIOR WAS QUASISTATIC. THE EXPERIMENTAL TEMPERATURES WERE IN GOOD AGREEMENT WITH PREDICTIONS FOR THE THIN MODELS REPRESENTATIVE OF SHIP CONSTRUCTION. EVIDENCE WAS FOUND FOR THE IMPORTANCE OF CONVECTIVE HEAT TRANSFER IN ESTABLISHING THE TEMPERATURES IN A SHIP. AN IMPORTANT RESULT OF THE PROJECT WAS THE GOOD AGREEMENT OF THE MAXIMUM EXPERIMENTAL STRESSES WITH THEORETICAL PREDICTIONS WHICH WERE MADE FROM THE SIMPLE CALCULATIONS.

-PERTINENT FIGURES-

TAB.V STRAIN GAGE CHARACTERISTICS AND LOCATIONS, PAGE 32//TAB.VI TEMPERATURES IN BOTTOM STRUCTURE, DEGREES F, PAGE 45//TAB.A-II TEMPERATURE DATA FOR THEORETICAL PROFILES, DEGREES F, PAGE 63//FIG.38 TEMPERATURE HISTORY IN THE COLD-SPOT MODEL, PAGE 50//FIG.39 TEMPERATURE MEASUREMENT HISTORY IN SHIP PTE MODEL, PAGE 51//FIG.43 PHOTOELASTIC FRINGE PATTERNS IN SIMULATED SHIP MODEL AT 5 MINUTES, PAGE 64

-BIBLIOGRAPHY-

TEMPERATURE-INDUCED STRESSES IN BEAMS AND SHIPS, NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER REPORT - DTMB NO. 937, JUNE 1955 (JASPER,N.H.)// PHOTOTHERMOELASTIC INVESTIGATION OF THERMAL

STRESSES IN FLAT PLATES, TRANS. ASME, JOURNAL OF BASIC ENGINEERING, VOL 85, SERIES D, NO. 4, PP. 566-568, DECEMBER 1963 (BECKER,H. AND COLAO,A.)//THERMAL STRESS CONCENTRATION CAUSED BY STRUCTURAL DISCONTINUITIES, EXPERIMENTAL MECHANICS, VOL 9, NO. 12, PP. 558-564, DECEMBER 1969 (EMERGY,A.F., WILLIAMS,J.A., AND AVERY,J.)//AN EXPLORATORY STUDY OF THREE-DIMENSIONAL PHOTOTHERMOELASTICITY, JOURNAL OF APPLIED MECHANICS, VOL 28, NO. 1, PP. 35-40, MARCH 1961 (TRAMPOSCH,H. AND GERARD,G.)

-SOURCE INFORMATION-

CORPORATE SOURCE -
SANDERS ASSOCIATES, INC., NASHUA, N.H.
REPORT NUMBER -
SSC-241//AD-771217
SPONSOR -
NAVAL SHIP SYSTEMS COMMAND, WASHINGTON, D.C.
CONTRACT NUMBER -
CONTRACT N00024-70-C-5119
OTHER INFORMATION -
0087 PAGES, 0046 FIGURES, 0014 TABLES, 0021 REFERENCES

keys 457 through 461

THE RELATIONSHIP OF PHYSICAL, CHEMICAL AND THERMODYNAMIC PROPERTIES TO SAFETY

by

MCKINLEY, C.

11/17/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

SEVERAL TESTS WERE CONDUCTED TO OBTAIN EXPERIMENTAL DATA ON THE EXPLOSIVE AND DETONATION CHARACTERISTICS OF HYDROCARBON - LIQUID OXYGEN MIXTURES. A LIQUID MIXTURE OF 25 MOLE PERCENT METHANE AND 75 MOLE PERCENT OXYGEN AT 76 K WAS DETONATED WITH A DYNAMITE CAP TO DETERMINE IF AN EXPLOSION COULD RESULT FROM CONDENSATION AND FRACTIONIZATION OF HYDROCARBONS AND AIR ON THE OUTSIDE OF A COLD PIPE. ANOTHER TEST WAS CONDUCTED TO DETERMINE THE LOWER EXPLOSIVE LIMITS OF A 50 - 50 METHANE - ETHANE MIXTURE IN LIQUID OXYGEN. IT WAS DETERMINED THAT THE LOWER EXPLOSIVE LIMIT FOR THE MIXTURE WAS ABOUT 6.2 MOLE PERCENT. THE POSSIBILITY OF A RELATIONSHIP BETWEEN THE EXPLOSIVE LIMITS OF GAS PHASE AND LIQUID PHASE CH(4)-O(2) MIXTURES WAS DISCUSSED. AN EXPERIMENTAL TEST WAS CONDUCTED TO DETERMINE THE LOWER AND UPPER EXPLOSION LIMITS OF METHANE IN LIQUID OXYGEN AT -320 DEGREES F, AND THE TEST RESULTS INDICATED THAT THESE LIMITS ARE 10.5 AND 59 MOLE PERCENT METHANE IN LIQUID OXYGEN. A TEST WAS CONDUCTED TO DETERMINE IF CONCENTRATED HYDROCARBON CONTAMINATION IN SILICA GEL ADSORBENT COULD DETONATE IN LIQUID OXYGEN. MIXTURES OF 4 AND 5 MOLE PERCENT ETHANE IN LIQUID OXYGEN WERE DETONATED AT -320 DEGREES F. VARIOUS ASPECTS OF THE EXPERIMENTAL TESTS WERE DISCUSSED.

-PERTINENT FIGURES-

TAB. 1 GAS PHASE FLAMMABLE LIMITS - CARBON ATOM APPROXIMATION PAGE 81

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
JOURNAL PROCEEDINGS -
CRYOG. SAFETY CONF., PROC. OF., SEMINAR NO. 3, 79-85, ALLENTOWN, PA., JUL 1959
PUBLISHER -
AIR PRODUCTS, INC., ALLENTOWN, PA.
OTHER INFORMATION -

keys 19584 through 19585

DOWNWIND TRAVEL OF VAPORS FROM LARGE POOLS OF CRYOGENIC LIQUIDS

by

PARKER, R. O.
SPATA, J. K.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

A METHOD FOR CALCULATING VAPOR CONCENTRATIONS DOWNWIND OF LARGE POOLS OF CRYOGENIC LIQUIDS IS DEVELOPED IN THIS PAPER. AREA SOURCES OF VAPOR ARE TREATED AS COLLECTIONS OF UNIFORMLY DISTRIBUTED POINT SOURCES. EACH POINT SOURCE HAS A STRENGTH WHICH IS A FUNCTION OF TIME BECAUSE OF THE VARYING RATE OF HEAT TRANSFER AT THE EARTH-LIQUID INTERFACE. VAPOR CONCENTRATION AT ANY DOWNWIND POSITION IS FOUND AS A FUNCTION OF TIME, WIND SPEED, AND WIND STRUCTURE. STANDARD METEOROLOGICAL OBSERVATIONS ARE USED TO OBTAIN THE LATERAL AND VERTICAL DISPERSION COEFFICIENTS, WHICH DEPEND UPON WIND STRUCTURE AND DISTANCE. USE OF THE METHOD IS ILLUSTRATED BY A CALCULATION OF VAPOR CONCENTRATIONS DOWNWIND OF A POOL OF LNG. PRACTICAL APPLICATIONS INCLUDE HAZARD STUDIES AND AIR POLLUTION ESTIMATES.

-BIBLIOGRAPHY-

ZABETAKIS,M.G. AND BURGESS,D.S., RESEARCH ON THE HAZARDS ASSOCIATED WITH THE PRODUCTION AND HANDLING OF LIQUID HYDROGEN, U.S. BUREAU OF MINES, R.I. 5707 //BURGESS,D.S. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUID NATURAL GAS, U.S. BUREAU OF MINES, R.I. 6099

-SOURCE INFORMATION-

CORPORATE SOURCE -
NEW YORK UNIV., N.Y.
JOURNAL PROCEEDINGS -
LNG INTERNATIONAL CONF., 1ST, (PROC. OF, SESSION NO. 5)
CHICAGO, ILL., APR 7-12, 1968. PAPER 24
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0012 PAGES, 0003 FIGURES, 0001 TABLES, 0012 REFERENCES

keys 18689 through 18692

HOW ESSO STORES REFRIGERATED LPG

by

SOMMER,E.C.

05/00/65

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

A PREMISE OF THIS ARTICLE IS THAT THE EFFECTS OF A CATASTROPHE CANNOT BE DESIGNED AGAINST ECONOMICALLY. THIS, THEN, POINTS OUT THE NEED FOR A CONSERVATIVE APPROACH TO MINIMIZE OR ELIMINATE THE POSSIBILITY OF A MINOR INCIDENT DEVELOPING INTO A CATASTROPHE. GUIDELINES ARE OFFERED FOR SPACING, DIKING, FIRE PROTECTION INSULATION, OVERPRESSURE PROTECTION, AND OTHER SAFETY ITEMS FOR ABOVE GROUND STORAGE OF C(1) THROUGH C(4) HYDROCARBONS, SINGLY OR IN ANY MIXTURE, FOR PRESSURES TO 15 PSIG. THE AUTHOR HAS RESPONSIBILITIES FOR FIRE AND SAFETY ENGINEERING AT ESSO AND IS AN INTERNATIONAL CONSULTANT FOR STANDARD OF NEW JERSEY AFFILIATES.

-BIBLIOGRAPHY-

BURGES,D. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, REPORT OF INVESTIGATION 6099, BUREAU OF MINES, U.S. DEPT. OF THE INTERIOR (1962)//NFPA NO. 59. STANDARD FOR THE STORAGE AND HANDLING OF LIQUEFIED PETROLEUM GASES AT UTILITY GAS PLANTS, 1963 EDN., NATIONAL FIRE CODES II 59-1 TO 59-48, NATIONAL FIRE PROTECTION ASSOC., BOSTON (1964)//API STANDARD 2510. DESIGN AND CONSTRUCTION OF LIQUEFIED PETROLEUM GAS INSTALLATION AT MARINE AND PIPELINE TERMINALS, NATURAL GAS PROCESSING PLANTS, REFINERIES, AND TANK FARMS, 2ND EDN., AM. PETROL. INST., NEW YORK (1965)//API RP 2000. GUIDE FOR VENTING ATMOSPHERIC AND LOW-PRESSURE STORAGE VESSELS, 2ND EDN., AM. PETROL. INST., NEW YORK (1965)// API RP 500. RECOMMENDED PRACTICE FOR CLASSIFICATION OF AREAS FOR ELECTRICAL INSTALLATIONS IN PETROLEUM REFINERIES, 2ND EDN., AM. PETROL. INST., NEW YORK (1957)

-SOURCE INFORMATION-

CORPORATE SOURCE -
ESSO RESEARCH AND ENGINEERING CO., LINDEN, N.J.
JOURNAL PROCEEDINGS -
PETROL. REFINER VOL 44, NO. 5, 195-8 (MAY 1965)
OTHER INFORMATION -
0004 PAGES, 0000 FIGURES, 0000 TABLES, 0010 REFERENCES

keys 18693 through 18696

LIQUEFIED NATURAL GAS

by

KELLY,C.I.

00/00/58

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS SERIES OF ARTICLES ON LIQUEFIED NATURAL GAS, WRITTEN IN 1958, REVIEWS THE HISTORY OF PRACTICAL DEVELOPMENTS IN THE LIQUEFACTION OF NATURAL GAS, THE STORAGE AND REGASIFICATION OF THE LIQUID, THE PERFORMANCE OF STORAGE VESSELS FOR LIQUEFIED NATURAL GAS IN LAND INSTALLATIONS, I.E. THOSE WHICH HAVE ACTUALLY BEEN DESIGNED, BUILT AND USED, THE DESIGN OF A STORAGE AND REGASIFICATION PLANT WHICH WAS NOT BUILT, THE DESIGN OF STORAGE VESSELS FOR INLAND WATER TRANSPORT, BUILT BUT NOT USED, THE DESIGN OF STORAGE VESSELS FOR SEA TRANSPORT IN A CONVERTED TANKER, THE CHARACTERISTICS OF NATURAL GAS. IT IS PRIMARILY OF HISTORICAL INTEREST AT THIS TIME. ITS ENDURING VALUE, HOWEVER, LIES IN THE CONSIDERABLE DETAIL WITH WHICH THE SUBJECT MATERIAL IS COVERED. APPRECIABLE ATTENTION IS GIVEN TO THE EAST OHIO GAS COMPANY LNG PLANT DISASTER IN CLEVELAND, OHIO ON OCTOBER 20, 1944 WHERE MANY PEOPLE WERE KILLED AND INJURED AND GREAT PROPERTY DAMAGE WAS INCURRED. EVENTS LEADING UP TO THIS INCIDENT ARE RETOLD AND THE INVESTIGATIVE BODYS (U.S. BUREAU OF MINES) CONCLUSIONS AND RECOMMENDATIONS ARE PRESENTED.

-PERTINENT FIGURES-

FIG.2 A SITE PLAN, SHOWING DISPOSITION OF VESSELS, BUILDINGS, ETC., EAST OHIO GAS COMPANY, CLEVELAND, OHIO, PAGE 123//FIG.3 THE CIRCLE OF A 1/4 MI RADIUS ENCLOSES THE AREA OF PROPERTY TOTALLY OR SERIOUSLY DAMAGED BY THE CLEVELAND L.S. AND R. PLANT DISASTER, EAST OHIO GAS COMPANY, CLEVELAND, OHIO, PAGE 124//FIG.1 LIQUID GAS HOLDER. DIAGRAMMATIC SKETCH SHOWING GENERAL FEATURES OF SPHERICAL STORAGE TANK, EAST OHIO GAS COMPANY, CLEVELAND, OHIO, PAGE 179//FIG.2 VERTICAL CROSS-SECTION OF NO. 4 TANK, EAST OHIO GAS COMPANY, CLEVELAND, OHIO, PAGE 180//FIG.4 VERTICAL CROSS-SECTION OF NO. 4 TANK SHOWING DETAILS OF INNER AND OUTER VESSELS AND WOODEN POSTS ON RING FOUNDATIONS, EAST OHIO GAS COMPANY, CLEVELAND, OHIO, PAGE 180

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
PETROL. TIMES (1958)

keys 18715 through 18718

SUBMERGED PUMPS FOR LNG SENDOUT

by

SMITH,L.R.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER PRESENTS A PHYSICAL DESCRIPTION OF THE SUBMERGED ELECTRIC MOTOR DRIVEN CENTRIFUGAL PUMP AS DEVELOPED BY THE J. C. CARTER COMPANY FOR THE LNG INDUSTRY. THE METHOD OF USING SOME OF THE PUMPED LNG TO COOL THE MOTOR AND PROVIDE LUBRICATION FOR THE BEARINGS IS SHOWN. PERFORMANCE IS DISCUSSED. SEVERAL PROBLEMS PECULIAR TO THE USE OF CENTRIFUGAL PUMPS IN LNG SERVICE ARE DISCUSSED. THESE COVER SUCH ITEMS AS THE HAZARDS OF FLASH-BACK AND THE PROBLEMS OF LOW FLOW OPERATION.

-PERTINENT FIGURES-

FIG.1 LNG CARGO UNLOADING PUMP, PAGE 97//FIG.2 STAGE LNG REGASIFIER PUMP FOR MOUNTING IN A SUCTION POT, PAGE 98

-SOURCE INFORMATION-

CORPORATE SOURCE -
CARTER (J. C.) CO., COSTA MESA, CALIF.
JOURNAL PROCEEDINGS -
AMERICAN GAS ASSOC. OPERATING SECTION DISTRIBUTION CONF., (PROC. OF) 1968. PAPER NO. 68-D-28
OTHER INFORMATION -
0003 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18700 through 18703

MAKING, HANDLING AND STORING LIQUEFIED NATURAL GAS

by

ABADIE,V.H.

01/17/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS ARTICLE DIVIDES AN LNG PLANT INTO ITS BASIC ELEMENTS - GAS TREATMENT, LIQUEFACTION, STORAGE AND VAPORIZATION - AND BRIEFLY DESCRIBES THE EQUIPMENT INVOLVED AND THE FUNCTION OF EACH MAJOR COMPONENT. PEAK-SHAVING AND BASE-LOAD PLANTS ARE GENERALLY DEFINED, WITH THE SALIENT FEATURES AND CHARACTERISTICS OF EACH TYPE NOTED.

-PERTINENT FIGURES-

FIG.1 BASIC ELEMENTS OF A LIQUEFIED NATURAL GAS PEAK-SHAVING PLANT, PAGE 151//FIG.2 CASCADED VAPOR-COMPRESSION LIQUEFACTION PLANT, PAGE 152//FIG.3 EXPANSION TURBINE ALSO PRODUCES REFRIGERATION, PAGE 153//FIG.4 MODIFIED CASCADE CYCLE FOR LIQUEFACTION, PAGE 154//FIG.5 FROZEN EARTH CAVITY FOR LNG STORAGE, PAGE 154

-BIBLIOGRAPHY-

AMERICAN GAS ASSN., LNG INFORMATION BOOK, MAY 1965//EAKIN,B.E., ET AL., BELOW GROUND STORAGE OF LIQUEFIED NATURAL GAS IN PRESTRESSED CONCRETE TANKS, INSTITUTE OF GAS TECHNOLOGY TECHNICAL REPORT NO. 8, AMERICAN GAS ASSN. 1963//ELLIOTT,M.A., ET AL., REPORT ON INVESTIGATION OF FIRE AT LIQUEFACTION, STORAGE AND REGASIFICATION PLANT OF EAST OHIO GAS CO., CLEVELAND, OCT 20, 1944, U.S. BUREAU OF MINES REPORT OF INVESTIGATION NO. 3867//LIQUID NATURAL GAS - CHARACTERISTICS AND BURNING BEHAVIOR, CONCH METHANE SERVICES, 1962//PETSINGER,R.E., HANKE,C.C., DESIGN OF 9 PERCENT NICKEL STEEL LNG STORAGE TANKS, ASME PAPER NO. 65-PET-47, AUG 1965// SCHORRE,C.T., LIQUEFIED NATURAL-GAS STORAGE SERVICE, ASME PAPER NO. 44-WA/PD-10

-SOURCE INFORMATION-

CORPORATE SOURCE -
    BROWN AND ROOT, INC., HOUSTON, TEX.
JOURNAL PROCEEDINGS -

CHEM. ENG. VOL. 73, NO. 2, 151-4 & 156 (JAN 1966)
OTHER INFORMATION -
0005 PAGES, 0005 FIGURES, 0000 TABLES, 0024 REFERENCES

keys 18704 through 18707

U.S.A. STANDARDS FOR DESIGN AND CONSTRUCTION OF LNG INSTALLATIONS

by

HANKE,C.C.

00/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IN THE UNITED STATES, INDUSTRIAL AND PUBLIC WORK IS UNDERTAKEN IN ACCORDANCE WITH APPLICABLE CODES. MOST STATE AND FEDERAL CODES USE AS THE BASIS FOR THEIR REGULATIONS STANDARDS ISSUED IN THE UNITED STATES BY THE API, ASTM, NFPA OR USASI. FORTUNATELY, THERE IS A REASONABLE DEGREE OF UNIFORMITY THAT EXISTS BETWEEN VARIOUS STATE CODES SO THAT PLANT DESIGN REQUIREMENTS FOR USE IN DIFFERENT GEOGRAPHICAL AREAS DO NOT VARY TO ANY GREAT EXTENT. CODES BECOME LEGAL DOCUMENTS WITH THE FORCE OF LAW IN THE UNITED STATES WHEN THEY HAVE BEEN OFFICIALLY ADOPTED BY EITHER OUR FEDERAL OR STATE GOVERNMENTS, THEREFORE, THEIR USE BECOMES BINDING AS SPECIFICALLY DEFINED IN EACH CASE. STANDARDS ARE NOT GENERALLY BIDING BY LAW, HOWEVER, IF NOT PART OF A CODE, ARE OFTEN USED TO FORM PARTS OF THE CONTRACTUAL SPECIFICATIONS OF A GIVEN PROJECT. THIS PAPER PROVIDES A RESUME OF U.S. STANDARDS AND CODES APPLICABLE TO THE DESIGN AND CONSTRUCTION OF LNG FACILITIES.

-PERTINENT FIGURES-

TAB.2 LNG PLANT MINIMUM SPACING AND LOCATION REQUIREMENTS NFPA NO. 59A STANDARD, PAGE 7//TAB.3 ACCEPTABLE PLATE AND STRUCTURAL MATERIALS FOR API STANDARD 620, APPENDIX Q LNG TANKS, PAGE 11//TAB.4 ALLOWABLE DESIGN STRESSES FOR PLATE AND STRUCTURAL MEMBERS API STANDARD 620, APPENDIX Q LNG TANKS, PAGE 12

-BIBLIOGRAPHY-

NFPA STANDARD NO. 59A//API STANDARD 620, APPENDIX Q//API STANDARD 2510A// NFPA NO. 70 NATIONAL ELECTRICAL CODE//ASME BOILER AND PRESSURE VESSEL CODE //ASA B31.3 PETROLEUM REFINERY PIPING CODE

-SOURCE INFORMATION-

CORPORATE SOURCE -
    CHICAGO BRIDGE AND IRON CO., ILL.
JOURNAL PROCEEDINGS -

PROGRESS IN REFRIGERATION SCIENCE AND TECHNOLOGY, 267-81 (1969) (PROC. OF THE INTERNATIONAL CONGRESS OF REFRIGERATION, 12TH, MADRID, SPAIN, AUG 30-SEP 6, 1967). PAPER NO. 1.18

PUBLISHER -

INTERNATIONAL INST. OF REFRIGERATION

OTHER INFORMATION -

0013 PAGES, 0005 FIGURES, 0004 TABLES, 0000 REFERENCES

LIQUID NATURAL GAS/CHARACTERISTICS AND BURNING BEHAVIOR

-ABSTRACT-

THIS REPORT SUMMARIZES THE PERTINENT RESULTS OBTAINED FROM THE U.S. BUREAU OF MINES SMALL-SCALE TESTS AT BRUCETON, PENNSYLVANIA, AND THE LARGE-SCALE TESTS AT LAKE CHARLES, LOUISIANA. INCLUDED ARE SECTIONS ON ANALYSIS OF PHYSICAL PROPERTIES, THE MAXIMUM HAZARD ASSOCIATED WITH VAPORIZATION OF LNG, MIXING OF LNG VAPORS WITH AIR, AND BURNING RATES, RADIATION TESTS, FLAME SHAPE, FIRE EXTINGUISHMENT, TEST CONCLUSIONS, STORAGE OF LNG SAFETY ADVANTAGES, AND STORAGE SPACING PRACTICES. THE LAYOUT, CONTENT AND COLOR PHOTOGRAPHS OF THE DOCUMENT ARE EXCEPTIONALLY WELL DONE.

-PERTINENT FIGURES-

FIG.4 EFFECT OF TEMPERATURE ON THE SPECIFIC GRAVITY OF METHANE VAPOR, PAGE 8//FIG.6 VAPORIZATION RATE OF LNG AFTER SPILLAGE INTO AN IRON TRAY ON WARM INSULATING SURFACES, PAGE 9//FIG.10A EFFECT OF POOL DIAMETER ON LINEAR BURNING RATE, PAGE 13//FIG.10B EFFECT OF POOL DIAMETER ON WEIGHT BURNING RATE, PAGE 13//FIG.11 RELATION BETWEEN BURNING RATES AND THEMOCHEMISTRY OF FUELS, PAGE 14//TAB.I COMPARISON OF COMBUSTION CHARACTERISTICS OF METHANE WITH THOSE OF OTHER FUELS, PAGE 6

-BIBLIOGRAPHY-

BURGESS,D. AND ZABETAKIS,M., FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, BUREAU OF MINES REPORT OF INVESTIGATION NO. 6099// BURGOYNE,J.H. AND RICHARDSON,J.F., FIRE AND EXPLOSION RISKS ASSOCIATION WITH LIQUID METHANE, FUEL XXVII-2, PAGES 37-42 (1948)//BURGOYNE,J.H., PRINCIPLES OF EXPLOSION PREVENTION, CHEMICAL ENGINEERING 157-161, APRIL 1961

-SOURCE INFORMATION-

CORPORATE SOURCE -
CONCH METHANE SERVICES, LTD., LONDON, ENGLAND
OTHER INFORMATION -
0020 PAGES, 0015 FIGURES, 0003 TABLES, 0000 REFERENCES

key 18714

HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED NATURAL GAS ON WATER

by

BURGESS,D.S.
MURPHY,J.N.
ZABETAKIS,M.G.

11/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Incremental	Good/Excel.

-ABSTRACT-

AN INVESTIGATION OF THE HAZARD OF SPILLAGE OF LIQUEFIED NATURAL GAS (LNG) ONTO WATER IS DESCRIBED. ABOUT 2,000 GALLONS OF LNG WERE CONSUMED IN VARIOUS TESTS. THE INITIAL VAPORIZATION RATE OF LNG FOLLOWING SPILLAGE WAS FOUND TO BE 0.037 LB/FT(2) SEC, WHEN THE SPILL WAS CONFINED, THIS VAPORIZATION RATE WAS MODERATED AFTER ABOUT 20 SECONDS BY THE GROWTH OF AN ICE LAYER ON THE WATER SURFACE, WHEN THE SPILL WAS UNCONFINED, A COHERENT ICE FLOE WAS NOT OBSERVED AND THE VAPORIZATION RATE WAS ESSENTIALLY TIME INDEPENDENT. THE MAXIMUM DIAMETER (IN FEET) OF THE SPREADING LNG POOL WAS FOUND TO BE GIVEN BY 6.25 W(0) (1/3), WHERE W(0) IS THE WEIGHT OF LNG IN POUNDS. DOWNWIND OF A NATURAL GAS SOURCE, TIME-AVERAGED METHANE CONCENTRATIONS WERE GIVEN IN GOOD APPROXIMATION BY STANDARD AIR POLLUTION EQUATIONS. HOWEVER, PEAK CONCENTRATIONS WERE AS MUCH AS TWENTYFOLD HIGHER THAN AVERAGE, ADDING AN ADDITIONAL FACTOR TO THE ASSESSMENT OF HAZARD. THE EFFECT OF LAYERING BY THE COLD VAPORIZED NATURAL GAS WAS SIMILAR TO THE EFFECT OF A TEMPERATURE INVERSION ON NORMAL GASES IN THE ATMOSPHERE. SMALL-SCALE EXPLOSIONS WERE OBSERVED ON POURING LNG ONTO A WATER SURFACE, NO SINGLE EXPLANATION SEEMS PERTINENT TO ALL OF THE INCIDENTS OBSERVED.

-PERTINENT FIGURES-

FIG.3 VAPORIZATION OF LNG ON WATER, PAGE 4//FIG.4 HEAT TRANSFER TO LIQUID METHANE AND TO LN(2) FROM CONDUCTIVE WARM SURFACES, PAGE 5//FIG.6 POOL DIAMETER AS FUNCTION OF TIME AFTER LNG SPILLS ON WATER, PAGE 7//FIG.7 MAXIMUM DIAMETERS AND DURATIONS OF LNG SPILLS ON WATER, PAGE 7//TAB.1 OBSERVED EVAPORATION RATES AND CALCULATED HEAT FLUXES IN SPILLAGE OF CRYOGENS, PAGE 5//TAB.8 CALCULATED VAPORIZATION RATES IN LARGE SPILLS, PAGE 15

-BIBLIOGRAPHY-

BURGESS,D.S. AND ZABETAKIS,M.G., FIRE AND EXPLOSION HAZARDS

ASSOCIATED WITH LIQUEFIED NATURAL GAS. BUMINES REPT. OF INV. 6099, 1962, 33 PP// SCIANCE,C.T., COLVER,C.P. AND SLIEPCEVICH,C.M., POOL BOILING OF METHANE BETWEEN ATMOSPHERIC PRESSURE AND CRITICAL PRESSURE. ADV. CRYOGENIC ENG., V. 12, 1967, PP 395//MERTE,H.,JR. AND CLARK,J.A., BOILING HEAT TRANSFER WITH CRYOGENIC FLUIDS AT STANDARD, FRACTIONAL, AND NEAR-ZERO GRAVITY. TRANS. ASME, SER. C, V. 86, 1964, PP 351-359//PARKER,R. AND SPATA,J., DOWNWIND TRAVEL OF VAPORS FROM LARGE POOLS OF CRYOGENIC LIQUIDS. PROC. FIRST INTERNAT. CONF. ON LNG, APR. 7-12, 1968 (EDITED AND PRODUCED BY INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.)//WELKER,J.R., WESSON,H.R. AND SLIEPCEVICH,C.M., LNG SPILLS. TO BURN OR NOT TO BURN. PRES. AT THE DISTRIBUTION CONFERENCE OPERATING SECTION, AMERICAN GAS ASSOCIATION, INC., PHILADELPHIA, PA., MAY 12-15, 1969, AVAILABLE FROM AUTHORS, 1215 WESTHEIMER DRIVE, NORMAN, OKLA. 73069

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA. SAFETY RESEARCH CENTER
REPORT NUMBER -
RI-7448
OTHER INFORMATION -
0030 PAGES, 0017 FIGURES, 0008 TABLES, 0015 REFERENCES

keys 14698 through 14700

PRODUCTION, STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS (LNG) STANDARD FOR THE

-ABSTRACT-

THIS STANDARD OUTLINES BASIC METHODS OF EQUIPMENT FABRICATION AND INSTALLATION AS WELL AS OPERATING PRACTICES FOR PROTECTION OF PERSONS AND PROPERTY AND PROVIDES GUIDANCE TO ALL PERSONS CONCERNED WITH THE CONSTRUCTION AND OPERATION OF EQUIPMENT FOR THE PRODUCTION, STORAGE, AND HANDLING OF LIQUEFIED NATURAL GAS (LNG). IT IS RECOGNIZED THAT ADVANCEMENT IN ENGINEERING AND IMPROVEMENTS IN EQUIPMENT MAY RESULT IN EQUIPMENT FABRICATION METHODS AND OPERATING PRACTICES WHICH DIFFER FROM THOSE SPECIFICALLY CALLED FOR IN THIS STANDARD. YET, SUCH DEVIATIONS OR IMPROVEMENTS MAY PROVIDE DESIRABLE SAFETY AND COMPATIBLE OPERATION MEETING THE INTENT OF THIS STANDARD. SUCH DEVIATIONS MAY BE ACCEPTED WHEN THE AUTHORITY HAVING JURISDICTION HAS MADE A SPECIAL INVESTIGATION OF ALL FACTORS AND, BASED ON SOUND EXPERIENCE AND ENGINEERING JUDGMENT, CONCLUDES THAT THE PROPSED DEVIATIONS MEET THE INTENT OF THIS STANDARD. WHERE EXISTING PLANTS, EQUIPMENT, BUILDINGS, STRUCTURES AND INSTALLATIONS MEET THE APPLICABLE DESIGN, FABRICATION OR CONSTRUCTION LAYOUT PROVISIONS OF THE EDITION OF THIS STANDARD IN EFFECT AT THE TIME OF INSTALLATION, THEY MAY BE CONTINUED IN USE PROVIDED THEY DO NOT CONSTITUTE A DISTINCT HAZARD TO LIFE OR ADJOINING PROPERTY. SPECIFIC SUBJECTS COVERED BY THE STANDARD ARE PROCESS SYSTEMS, LNG STORAGE CONTAINERS, VAPORIZERS, PIPING SYSTEMS AND COMPONENTS, INSTRUMENTATION AND ELECTRICAL SERVICES, TRANSFER SYSTEMS, AND FIRE PROTECTION AND SAFETY.

-PERTINENT FIGURES-

FIG.4-1 MAXIMUM FILLING VOLUME FOR PRESSURE CONTAINERS, PAGE 22

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
REPORT NUMBER -
NFPA 59A-1972
OTHER INFORMATION -
0057 PAGES, 0005 FIGURES, 0002 TABLES, 0001 REFERENCES

keys 18730 through 18733

NATURAL GAS FUEL TANKS FOR AUTOMOBILES. SAFETY PROBLEMS

by

JENNINGS,F.A.
STUDHALTER,W.R.

05/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE SAFETY ASPECTS OF NATURAL GAS VEHICLES ARE EXAMINED BY A SYSTEM SAFETY APPROACH, WHICH IDENTIFIES SEVEN PROBLEM AREAS REQUIRING CAREFUL ENGINEERING AND OPERATION ATTENTION. THESE AREAS ARE REVIEWED*, AND CONTRASTED WITH GASOLINE PRACTICE. WHEN PROPERLY DESIGNED, MAINTAINED, AND OPERATED, THE NATURAL GAS VEHICLES AND THEIR FUELING EQUIPMENT SHOULD BE AS SAFE OR SAFER THAN GASOLINE-FUELED COUNTERPARTS. THE EXPANDED USE OF NATURAL GAS FOR AUTOMOTIVE FUEL LEADS TO REDUCTION OF POLLUTION AND POTENTIAL COST SAVINGS. (*1. THE UNFIRED PRESSURE VESSEL PROBLEM, 2. THE FIRE AND EXPLOSION PROBLEM, 3. THE GARAGE PROBLEM, 4. THE ACCIDENT PROBLEM, 5. THE COMPONENT FAILURE PROBLEM, 6. THE FILLING PROBLEM, 7. THE REPAIR PROBLEM.)

-PERTINENT FIGURES-

FIG.1 FUEL SYSTEM COMPONENTS, COMPRESSED NATURAL GAS, PAGE 2//FIG.2 FUEL SYSTEM COMPONENTS, LIQUEFIED NATURAL GAS, PAGE 2//FIG.3 MAXIMUM POSSIBLE PRESSURE DEVELOPED BY A METHANE-AIR MIXTURE BURNING IN A VENTED ENCLOSURE, PAGE 5//FIG.5 TANK FOR LIQUEFIED NATURAL GAS, PAGE 5//TAB.1 FUNCTIONS CONSIDERED IN SYSTEM SAFETY ANALYSIS, PAGE 3//TAB.2 HAZARD LIST - SAMPLE PAGE, PAGE 4

-SOURCE INFORMATION-

CORPORATE SOURCE -
    ENVIRONMENTAL TECHNOLOGY AND ECONOMY, WOODLAND HILLS, CALIF.
JOURNAL PROCEEDINGS -
    ASME PRESSURE VESSELS AND PIPING CONF., (PRES. AT) SAN FRANCISCO, CALIF., MAY 10-2, 1971. PAPER 71-PVP-62
OTHER INFORMATION -
    0008 PAGES, 0005 FIGURES, 0002 TABLES, 0001 REFERENCES

keys 18734 through 18739

HOW TO USE LNG SAFELY

by

WISSMILLER,I.L.
MATTOCKS,E.O.

03/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS ARTICLE, IN VARIOUS SECTIONS, DISCUSSES TYPICAL LNG LIQUEFACTION AND STORAGE PLANT DESIGN AND CONSTRUCTION WITH EMPHASIS ON THE REQUIREMENTS OF NFPA NO. 59A STANDARD AS IT RELATES TO SUCH INSTALLATIONS. INCLUDED ARE GENERAL SECTIONS ON THE LNG STORAGE TANK AND ASSOCIATED PIPING, OTHER FACILITY PIPING AND VALVING, IMPOUNDING AREAS AND DRAINAGE TO COLLECT AND CONTAIN ANY POTENTIAL SPILLAGES, LIQUEFACTION AND PURIFICATION EQUIPMENT, SENDOUT PUMPS AND VAPORIZERS, FACILITY FIRE PROTECTION, AND A DISCUSSION OF TRANSPORT EQUIPMENT. ALTHOUGH THE COVERAGE IS BROAD AND RATHER SUPERFICIAL, THE PAPER SHOULD BE OF GENERAL INTEREST TO THE INITIATE INTO THIS AREA OF TECHNOLOGY.

-PERTINENT FIGURES-

FIG.3 LNG STORAGE TANK (SHOWS CONSTRUCTION DETAILS), PAGE 29

-BIBLIOGRAPHY-

NFPA NO. 59A STANDARD

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., ILL.
JOURNAL PROCEEDINGS -
PIPELINE GAS J. VOL 199, NO. 3, 28-32 (MAR 1972)
OTHER INFORMATION -
0005 PAGES, 0009 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18742 through 18746

THE DESIGN AND OPERATION OF LNG SHIPS WITH REGARD TO SAFETY

by

FILSTEAD,JR.,C.G.

02/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

ALTHOUGH THE CARRIAGE OF LIQUEFIED NATURAL GAS AT SEA IS A SPECIALIZED TRADE, THE GAS ITSELF IS CONSIDERED BY THE AUTHOR TO BE NO MORE DANGEROUS THAN OTHER VOLATILE PETROLEUM DERIVATIVES. HOWEVER, AS THIS TRADE HAS ONLY BEEN DEVELOPED OVER THE LAST 20 YEARS OR SO, IT HAS BEEN POSSIBLE TO INCORPORATE MANY SAFETY FEATURES IN THE CONSTRUCTION OF THESE SHIPS FROM THE BEGINNING, RATHER THAN WAITING FOR A SERIOUS ACCIDENT TO SHOW UP A WEAKNESS IN THE PARTICULAR DESIGN. THIS HAS LED TO A VERY GOOD SAFETY RECORD WITH THESE SHIPS AND THIS ARTICLE, ABSTRACTED FROM A PAPER PRESENTED BY MR. C. G. FILSTEAD JR, OF CONCH METHANE SERVICES LTD., BEFORE THE INTERNATIONAL TANKER SAFETY CONFERENCE HELD BY THE INTERNATIONAL CHAMBER OF SHIPPING, DESCRIBES THE GENERAL DESIGN AND OPERATION OF LNG SHIPS WITH REGARD TO THE SAFETY FACTOR.

-PERTINENT FIGURES-

TAB.1 ALTERNATIVE DESIGNS OF VARIOUS LNG SHIPS IN OPERATION OR UNDER CONSTRUCTION, PAGE 260

-BIBLIOGRAPHY-

GRAY,R.C. AND JOHNSON,L., THE DESIGN AND CONSTRUCTION OF LIQUEFIED GAS CARRIERS, NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, DEC 7, 1970//BURGOYNE,J.H. AND RICHARDSON,J.F., FIRE AND EXPLOSION RISKS ASSOCIATED WITH LIQUID METHANE. IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON. APR 1948//ROOKE,D.E. AND FILSTEAD,C.G., SIX YEARS OPERATIONAL EXPERIENCE WITH METHANE PRINCESS, METHANE PROGRESS. LNG 2 CONFERENCE, PARIS, OCT 1970

-SOURCE INFORMATION-

CORPORATE SOURCE -
CONCH METHANE SERVICES LTD., LONDON, ENGLAND
JOURNAL PROCEEDINGS -
SHIPPING WORLD SHIPBUILDER VOL 165, NO. 3866, 259-62 (FEB

key 11956

REDUCING BOIL-OFF FROM CRYOGENIC LIQUIDS

-ABSTRACT-

THE RATE OF EVAPORATION OF A CRYOGENIC LIQUID STORED IN A LARGE TANK CAN BE CONSIDERABLY RETARDED BY FLOATING A CLOSELY PACKED LAYER OF HOLLOW POLYPROPYLENE BALLS ON ITS SURFACE. THIS IS THE CONCLUSION REACHED IN A SPECIAL STUDY OF BALL BLANKETS MADE AT SOUTHHAMPTON UNIVERSITY ON BEHALF OF THE GAS COUNCIL, USING LIQUID NITROGEN AS THE CRYOGENIC MEDIUM. THE REPORT ON REDUCTION OF EVAPORATION OF CRYOGENIC LIQUIDS PROTECTED BY BALL BLANKETS STATES THAT THE BALLS ARE EFFECTIVE BY VIRTUE OF THE FACT THAT THEY SUBSTANTIALLY REDUCE THE HEAT FLUX INCIDENT ON THE SURFACE OF THE LIQUID. IT ALSO POINTS OUT THAT THE ECONOMIC FEASIBILITY OF THE BALL BLANKET SYSTEM DEPENDS ON THE MAGNITUDE OF THE SURFACE HEAT FLUX IN COMPARISON WITH OTHER HEAT FLUXES ENTERING THE LIQUID THROUGH THE WETTED AREA OF THE TANK WALL. THE SAVINGS ARE THEREFORE LIKELY TO BE RELATIVELY GREATEST ON WELL-ENGINEERED PLANTS. THIS REPORT SUGGESTS THE CONCEPT FOR STORAGE OF LIQUID NITROGEN OR LIQUID METHANE. THE USE OF POLYPROPYLENE ON THE SURFACE OF LIQUID OXYGEN WOULD CONSTITUTE A SEVERE FIRE HAZARD.

-PERTINENT FIGURES-

FIG.5 EVAPORATION RATE FROM LN(2) SURFACE AS A FUNCTION OF THE NUMBER LAYERS OF ALLPIAS BALLS USED, PAGE 87//FIG.6 PERCENTAGE OF RADIATION REACHING THE LN(2) SURFACE AS A FUNCTION OF THE NUMBER OF LAYERS IN THE BALL BLANKET, PAGE 87

-BIBLIOGRAPHY-

BOARDMAN, J., LYNAM, P., AND SCURLOCK, R. G. REDUCTION OF EVAPORATION OF CRYOGENIC LIQUIDS USING FLOATING HOLLOW POLYPROPYLENE BALLS, PROC ICEC3, BERLIN 1970//PROBERT, S. D. THERMAL INSULATION IN RELATION TO CRYOGENICS, THE REACTOR GROUP, HQ RISLEY, WARRINGTON, LANCS, TRG REPORT 1455 (R/X) (HMSO)//ALLEN AND VAN PAASSEN, PROC ADVANCE IN CRYOGENIC ENGINEERING VOL 6, 548 (1960)

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CRYOGENICS VOL 11, NO. 1, 85-7 (FEB 1971)
OTHER INFORMATION -
0003 PAGES, 0006 FIGURES, 0000 TABLES, 0003 REFERENCES

keys 18747 through 18749

WHAT HAPPENS WHEN LNG SPILLS

by

CROUCH,W.W.
HILLYER,J.C.

04/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER BRIEFLY REVIEWS THE DEVELOPMENT OF LNG TECHNOLOGY, CITES A NUMBER OF MISCONCEPTIONS REGARDING LNG, AND REVIEWS INFORMATION ON THE BEHAVIOR OF LNG DURING AND AFTER SPILLS.

-PERTINENT FIGURES-

FIG.1 CUTAWAY OF A METHANE TANKER CARGO TANK, PAGE 212//FIG.2 VAPORIZATION RATE OF LNG SPILLED ON LAND, PAGE 213//FIG.3 CONCENTRATION PROFILE DOWN WIND FROM LNG SPILL ON LAND, PAGE 213//FIG.4 TEMPERATURE OF METHANE-AIR MIXTURES, PAGE 214

-BIBLIOGRAPHY-

WELKER,J.R., WESSON,H.R. AND SLIEPCEVICH,C.M., PAP. 69-D-23 OF THE 1969 AGA OPERATING SECTION DISTRIBUTION CONFERENCE//BURGESS,D.S. AND ZABETAKIS,M.G., U.S. BUR. MINES, REP. INVEST. 6099 (1962)//BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., FINAL REPORT INVESTIGATION M1PR NO. Z-70099-9-92317, U.S. BUREAU OF MINES, PREPARED FOR U.S. COAST GUARD, FEB 1970//BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., U.S. BUR. MINES, REP. INVEST. 7448, NOV 1970//KATZ,D.L. AND SLIEPCEVICH,C.M., HYDROCARBON PROCESS., NOV, 240 (1971) //NAKANISHI,E. AND REID,R.C., CHEM. ENG. PROGR. VOL 67 (12), 36 (1971)

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
CHEM. TECH., 210-5 (APR 1972)
OTHER INFORMATION -
0006 PAGES, 0004 FIGURES, 0000 TABLES, 0015 REFERENCES

keys 18750 through 18753

ABS STUDYING LNG DESIGNS

by

SCHOEFER,C.J.L.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS ABSTRACT CONSTITUTES APPROXIMATELY ONE-HALF OF THE TOTAL ARTICLE. CLASSIFICATION RULES OF THE AMERICAN BUREAU OF SHIPPING ARE USUALLY BASED UPON SERVICE EXPERIENCE REPRESENTING MANY SHIP-YEARS OF OPERATION BY VARIOUS OWNERS. THE BUREAUS RULES ARE INTENDED TO ESTABLISH MINIMUM REQUIREMENTS FOR THE CONSTRUCTION OF HULLS AND MACHINERY, AND ARE CONTINUOUSLY UNDER REVIEW TO REFLECT HIGH STANDARDS REQUIRED BY THE MARINE INDUSTRY. SURVEY OF THE VESSELS DURING CONSTRUCTION REQUIRES CAREFUL EXAMINATION OF FABRICATION AND TESTING OF THE LNG SYSTEM COMPONENTS. OPERATIONAL TESTS FOR CARGO-HANDLING PROCEDURES AND EQUIPMENT PRIOR TO DELIVERY ARE OBSERVED CAREFULLY. BEFORE THE VESSEL CAN BE PRESENTED FORMALLY TO THE CLASSIFICATION COMMITTEE, THE SUCCESSFUL DISCHARGE OF A CARGO MUST HAVE BEEN WITNESSED AND REPORTED UPON. THE BUREAU HAS CONSIDERED MANY PROPOSALS FOR LNG CARRIERS. THE OVERALL SAFETY OF EXISTING AND PROPOSED LNG SYSTEMS IS MAINTAINED BY REQUIRING THAT THE RATE OF CRACK PROPAGATION AND LEAKAGE BE DETERMINED BASED ON FRACTURE MECHANICS STUDIES.

-SOURCE INFORMATION-

CORPORATE SOURCE -
AMERICAN BUREAU OF SHIPPING, NEW YORK
JOURNAL PROCEEDINGS -
MARINE ENG./LOG VOL 77, NO. 10, 131 (SEP 1972)
OTHER INFORMATION -
0001 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 18754

LNG TANK DYNAMICS

by

MAHER,J.B.
VAN GELDER,L.R.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IN LARGE FLAT BOTTOM LNG TANKS, TANK PRESSURE RESPONDS TO VARIATIONS IN THE VAPOR WITHDRAWAL RATE AND THE CONDITION OF THE SURFACE LAYER LIQUID. RAW DATA FROM A NUMBER OF DIFFERENT PLANTS IS PRESENTED AND CORRELATED.

-PERTINENT FIGURES-

FIG.1 TOP LAYER EFFECT (TANK PRESSURE VS TIME), PAGE 8//FIG.2 TOP LAYER EFFECT (VAPOR WITHDRAWAL RATE VS PRESSURE DIFFERENTIAL), PAGE 9//FIG.3 TIME REQUIRED TO ACHIEVE TOP LAYER EQUILIBRIUM, PAGE 10//FIG.4 PRESSURE HISTORIES FOR TWO SHUT-IN STORAGE TANKS, PAGE 11//FIG.5 PRESSURE RISE VS ULLAGE HEAT LEAK, PAGE 12//FIG.6 PRESSURE HISTORY FOR A TOP FILLED, 130 FOOT DIAMETER STORAGE TANK, PAGE 13

-BIBLIOGRAPHY-

HASHEMI,H.T. AND WESSON,H.R., HYDROCARBON PROCESSING, VOL 50, NO. 8, (1971) PP. 117-120

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., ILL.
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF. AND EXHIBITION, 3RD, (PROC. OF) WASHINGTON, D.C., SEP 24-8, 1972. SESSION II, PAPER 6
OTHER INFORMATION -
0015 PAGES, 0008 FIGURES, 0002 TABLES, 0001 REFERENCES

keys 18755 through 18756

LNG STORAGE TANK SYSTEMS

by

LUSK,D.T.
DORNEY,D.C.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

ABOVEGROUND METAL STORAGE TANKS HAVE EVOLVED FROM EXPERIENCE IN THE STORAGE OF PETROLEUM PRODUCTS OVER THE PAST HALF CENTURY. THE VARIOUS ELEMENTS MAKING UP THE LNG STORAGE TANKS ARE DESCRIBED AND COMPARED WITH SIMILAR DETAILS OF PROVEN STORAGE CONCEPTS. THE INHERENT SAFETY AND SUCCESSFUL OPERATING PERFORMANCE OF ABOVEGROUND, METAL LNG TANKS ARE DUE IN LARGE MEASURE TO THIS MANAGEABLE EXTRAPOLATION OF EXPERIENCE GAINED FROM PETROLEUM STORAGE.

-PERTINENT FIGURES-

FIG.1 STIFFENED SELF-SUPPORTING ROOF, PAGE 4//FIG.2 FREE BODY - TOP PORTION LNG TANK, PAGE 5//FIG.3 DETAIL ROOF-TO-SHELL JUNCTURE, PAGE 6//FIG.5 STRAIN AND ROTATION OF BOTTOM-TO-SHELL JUNCTURE, PAGE 8//FIG.6 CRYOGENIC ABOVEGROUND DOUBLE WALL INSULATED LNG TANK, PAGE 12

-BIBLIOGRAPHY-

API STANDARD 620

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., ILL.
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF. AND EXHIBITION, 3RD, (PROC. OF) WASHINGTON, D.C., SEP 24-8, 1972. SESSION V, PAPER 5
OTHER INFORMATION -
0012 PAGES, 0006 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18757 through 18761

LIQUEFACTION PLANT EXPERIENCE AT KENAI

by

CULBERTSON,L.
EMERY,II,W.B.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

WITH MORE THAN THREE YEARS OF SUCCESSFUL OPERATING EXPERIENCE NOW COMPLETED, THIS PAPER REVIEWS THE MORE SIGNIFICANT PROBLEMS ENCOUNTERED AND SOLUTIONS EMPLOYED IN OPERATION OF THE ALASKA TO JAPAN LNG PROJECT. EARLIER PAPERS PRESENTED AT THE FIRST AND SECOND INTERNATIONAL CONFERENCES ON LNG COVERED DESIGN, STARTUP AND EARLY OPERATIONAL EXPERIENCE OF THE PROJECT. THIS PAPER DISCUSSES IN SOME DETAIL THE SIGNIFICANT SPECIFIC PERFORMANCE HISTORY OF THE LIQUEFACTION PLANT AND SHIPS AS A SEQUEL TO THE EARLIER PAPERS, THUS ROUNDING OUT THE COMPLETE STORY OF THIS PROJECT FROM INITIAL PLANNING AND DESIGN THROUGH ITS SUCCESSFUL CONTINUING OPERATIONAL HISTORY.

-SOURCE INFORMATION-

CORPORATE SOURCE -
PHILLIPS PETROLEUM CO., BARTLESVILLE, OKLA.//MARATHON OIL CO., FINDLAY, OHIO
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF. AND EXHIBITION, 3RD, (PROC. OF) WASHINGTON, D.C., SEP 24-8, 1972. SESSION V, PAPER 7
OTHER INFORMATION -
0010 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 18762 through 18764

RAPID PHASE TRANSFORMATION DURING LNG SPILLAGE ON WATER

by

ENGER,T.
HARTMAN,D.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE CONDITIONS WHICH PRODUCE EXPLOSIONS WHEN LNG IS SPILLED ON WATER AT AMBIENT TEMPERATURE HAVE BEEN ISOLATED AND VERIFIED EXPERIMENTALLY. IT IS SHOWN THAT EXPLOSIONS CAN ONLY OCCUR WITH AGED LNG WHICH CONTAINS LESS THAN 40 MOLE PERCENT METHANE. CONTACT BETWEEN WATER AND LNG WITH MORE THAN 40 MOLE PERCENT METHANE PRODUCES NORMAL VAPORIZATION. FURTHERMORE, EXPLOSIONS WILL NOT OCCUR IF THE MOLE RATIO OF PROPANE TO ETHANE IN THE LNG IS 1 TO 3 OR GREATER. THE EXPLOSIVE INTERACTION BETWEEN A LIQUEFIED GAS AND WATER IS CAUSED BY THE RAPID PHASE TRANSFORMATION AND VIOLENT EXPANSION OF A THIN LAYER OF SUPERHEATED LIQUEFIED GAS AT THE LIQUEFIED GAS-WATER INTERFACE. NO BURNING OR CHEMICAL REACTION IS INVOLVED. THE SUPERHEATING OCCURS DURING A SHORT DELAY TIME, ON THE ORDER OF ONE SECOND, BETWEEN WATER CONTACT AND THE EXPLOSION. THE CONDITIONS FOR EXPLOSIONS, WHICH ARE MAINLY FUNCTIONS OF THE TEMPERATURE AND COMPOSITION OF THE LIQUEFIED GAS AND THE TEMPERATURE OF THE WATER, HAVE BEEN DETERMINED EXPERIMENTALLY FOR SEVERAL PURE LIQUEFIED GASES AND LIQUEFIED GAS MIXTURES.

-PERTINENT FIGURES-

TAB.2 LIQUEFIED GAS SPILLAGE ON WATER, PAGE 12//FIG.3 VAPOR EXPLOSION COMPOSITIONAL ENVELOPE FOR METHANE PLUS ETHANE PLUS PROPANE MIXTURES, PAGE 15//FIG.9 MOLE PERCENT METHANE AS A FUNCTION OF VOLUME REMAINING IN TANK, PAGE 21//FIG.11 MINIMUM SPILL SIZE TO REACH EXPLOSIVE COMPOSITION BEFORE BREAK-UP OF LNG, PAGE 23//FIG.12 TIME DELAY TO VAPOR EXPLOSIONS, PAGE 24// FIG.14 CHART FOR COMPUTING NUMBER OF DAYS FOR BOIL OFF, PAGE 26

-BIBLIOGRAPHY-

BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED NATURAL GAS ON WATER, REPORT OF INVESTIGATIONS 7448, U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF MINES, NOV. 1970//ENGER,T. AND HARTMAN,D.E., LNG SPILLAGE ON WATER. II. FINAL REPORT ON RAPID PHASE TRANSFORMATIONS, SHELL PIPE LINE CORPORATION, RESEARCH AND DEVELOPMENT LABORATORY, TECHNICAL

PROGRESS REPORT NO. 1-72, FEB 1972//GRAFSTEIN,D., PRESENTATION TO AGA LNG COMMITTEE AND AGA RESEARCH ADVISORY PANEL FOR THE AGA/BATTELLE RESEARCH PROGRAM, HOTEL AMERICANA, NEW YORK CITY, SEP 27, 1971 //NAKANISHI,E. AND REID,R.C., LIQUID NATURAL GAS-WATER REACTIONS, CHEMICAL ENGINEERING PROGRESS, VOL 67, NO. 12, DEC 1971, PP. 36-41//ENGER,T., LNG SPILLAGE ON WATER. III. SPREADING AND VAPORIZATION MODEL FOR AN INSTANTANEOUS SPILL, SHELL PIPE LINE CORPORATION, RESEARCH AND DEVELOPMENT LABORATORY, TECHNICAL PROGRESS REPORT NO. 6-72, APRIL 1972//BAUMEISTER,E.G., ET AL., ANOMALOUS BEHAVIOR OF LIQUID-NITROGEN DROPS IN FILM BOILING, ADVANCES IN CRYOGENIC ENGINEERING, VOL 16, PLENEM PRESS, 1971

-SOURCE INFORMATION-

CORPORATE SOURCE -
    SHELL PIPE LINE CORP., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
    LIQUEFIED NATURAL GAS INTERNATIONAL CONF. AND EXHIBITION, 3RD, (PROC. OF) WASHINGTON, D.C., SEP 24-8, 1972. SESSION VI, PAPER 2
OTHER INFORMATION -
    0026 PAGES, 0014 FIGURES, 0002 TABLES, 0015 REFERENCES

keys 18765 through 18766

EXPERIMENTAL STUDY OF VAPOR EXPLOSIONS

by

ANDERSON,R.P.
ARMSTRONG,D.R.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

EXPLOSIONS OF LNG IN WATER WHICH HAVE CAUSED RECENT CONCERN IN THE TRANSPORTATION INDUSTRY ARE IDENTIFIED AS VAPOR EXPLOSIONS. VARIOUS ASPECTS OF VAPOR EXPLOSIONS ARE SUMMARIZED. PARTICULAR EMPHASIS IS PLACED ON METHODS OF EVALUATING THE DESTRUCTIVE KINETIC ENERGY RELEASE FROM A SPECIFIED ACCIDENT. A THEORETICAL METHOD OF CALCULATING THE MAXIMUM DESTRUCTIVE ENERGY IS OUTLINED AND COMPARED WITH MEASURED VALUES FOR MEDIUM SIZE INTERACTIONS (50 KG OF HOT LIQUID). EXTRAPOLATION OF THIS THEORETICAL APPROACH TO LARGE SIZE INTERACTIONS PREDICTS VERY LARGE SHOCK WAVE ENERGIES. PRACTICAL CONSIDERATIONS WHICH MAY REDUCE THE ACTUAL SHOCK WAVE ENERGY BELOW THAT PREDICTED IN AN EXPLOSION ARE MENTIONED.

-PERTINENT FIGURES-

FIG. 1 RATE LIMITED MODEL, PAGE 9

-BIBLIOGRAPHY-

BURGESS,D.S., MURPHY,J.N. AND ZABETAKIS,M.G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, U.S. DEPT. OF INTERIOR, BUREAU OF MINES REPORT S-4105, FEB (1970)//KATZ,D.L., SLIEPCEVICH,C.M., LNG/WATER EXPLOSIONS. CAUSE AND EFFECT, HYDROCARBON PROCESSING, NOV (1971)//LIPSETT,S.G., EXPLOSIONS FROM MOLTEN MATERIALS AND WATER, FIRE TECHNOLOGY VOL 2, BOSTON (1966) PP. 118-126

-SOURCE INFORMATION-

CORPORATE SOURCE -
ARGONNE NATIONAL LAB., ILL.
JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF. AND EXHIBITION, 3RD, (PROC. OF) WASHINGTON, D.C., SEP 24-8, 1972. SESSION VI, PAPER 3
OTHER INFORMATION -
0012 PAGES, 0003 FIGURES, 0000 TABLES, 0006 REFERENCES

keys 18767 through 18771

SAFETY OF LNG STORAGE TANKS

by

KUMPER,E.F.
KOPPERS,H.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE FEDERAL REPUBLIC OF GERMANY HAS, DURING THE RECENT YEARS, BEEN THE SCENE OF LARGE-SCALE CONVERSION FROM CITY GAS TO NATURAL GAS WITHIN THE NATIONAL GAS DISTRIBUTION NETWORKS. TO COVER PEAK GAS REQUIREMENTS, STORAGE SYSTEMS FOR LIQUEFIED NATURAL GAS HAVE, FOR SOME CONSIDERABLE TIME, BEEN PROJECTED AND BUILT. A COMPARISON OF THE SAFETY-ENGINEERING INDEX DATA OF METHANE WITH OTHER HYDROCARBONS PROVES THAT NATURAL GAS IN GASEOUS AS WELL AS IN LIQUEFIED CONDITION IS, BY NO MEANS, MORE DANGEROUS THAN OTHER COMBUSTIBLE GASES. IT IS OUTLINED HEREIN WHAT LAWS, DIRECTIVES AND SPECIFICATIONS HAVE TO BE COMPLIED WITH IN THE CONSTRUCTION OF LNG-SYSTEMS IN WEST GERMANY. THIS PRESENTATION IS BASED ON THE EXAMPLE OF THE LNG-STORAGE SYSTEM CONSTRUCTED BY THE LINDE-KOPPERS CONSORTIUM FOR TECHNISCHE WERKE DER STADT STUTTGART AG OF STUTTGART, WEST GERMANY. THE REPORT IS FINALIZED BY A REVIEW OF THE QUESTIONS INVOLVED WITH INSTRUMENTATION, AUTOMATION AND SAFEGUARDING OF LNG-SYSTEMS.

-PERTINENT FIGURES-

FIG.1 BASIC DIAGRAM OF AN LNG PLANT, PAGE 3//FIG.2 SAFETY DEVICES AT ONE LNG STORAGE UNIT, PAGE 7//TAB.1 SAFETY DATA ON INFLAMMABLE GASES AND VAPOURS, PAGE 4//TAB.2 IGNITION GROUPS AND EXPLOSION CLASSES, PAGE 5

-BIBLIOGRAPHY-

TUTTON,R.C., LIQUID NATURAL GAS. STORAGE AND SEA TRANSPORT, THE CHEMICAL ENGINEER 36-40 (1965) MARCH//SAFETY DATA ON INFLAMMABLE GASES AND VAPOURS, COMPILED FOR THE PHYSIKALISCH-TECHNISCHE BUNDESANSTALT BRAUNSCHWEIG, BY K. NABERT AND G. SCHOEN, SECOND ENLARGED EDITION, BERLIN, 1963, DEUTSCHER EICHVERLAG GMBH, BERLIN//LIQUEFIED NATURAL GAS AT UTILITY GAS PLANTS, ISSUED BY NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, 1967

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
LIQUEFIED NATURAL GAS INTERNATIONAL CONF. AND EXHIBITION, 3RD, (PROC. OF) WASHINGTON, D.C., SEP 24-8, 1972. SESSION VI, PAPER 5

OTHER INFORMATION -
0012 PAGES, 0003 FIGURES, 0002 TABLES, 0010 REFERENCES

keys 18772 through 18773

SAFETY ASPECTS OF LNG TRANSPORTATION WITH SPECIAL CONSIDERATION OF INLAND WATERWAYS AND COASTAL PORTS

by

KOBER,D.
MARTIN,E.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

INCREASING TRANSPORT OF INFLAMMABLE CARGO LIKE LPG AND IN FUTURE TO A LARGER EXTENT LNG ON INLAND WATERWAYS THROUGH DENSELY POPULATED AREAS AND ALONGSIDE INDUSTRIAL PLANTS AND NUCLEAR POWER STATIONS REPRESENTS A RISK FACTOR WHICH SHOULD BE DEFINED AS EXACTLY AS POSSIBLE BY MODEL CONCEPTIONS IN ORDER TO POSSIBLY TAKE CARE FOR THE NECESSARY PRECAUTIONS. DUE TO THE CONSIDERABLE TRAFFIC DENSITY ON WEST GERMAN WATERWAYS THE DANGER OF COLLISION AND SUBSEQUENT LEAKAGE OF GAS TANKERS IS ESPECIALLY HIGH. THIS PAPER IS PART OF A SAFETY INVESTIGATION AND DISPLAYS CONDITIONS AND DEVELOPMENT OF SUCH COLLISIONS AND THE SUBSEQUENT RELEASE OF THE CARGO. IT INDICATES THAT THE TYPES OF SHIPS OPERATING THERE MAY IN CASE OF COLLISION CAUSE SUCH DAMAGE TO A GAS TANKER THAT WITHIN A VERY SHORT PERIOD THE CARGO WILL ESCAPE AND, BY VAPORIZATION ON THE WATER SURFACE, FORM AN EXPLOSIVE GAS CLOUD.

-PERTINENT FIGURES-

FIG.1 FREQUENCY DISTRIBUTION OF IMPACT SPOTS ALONG THE SHIP LENGTH FOR SHIPS BELOW 100 M OF LENGTH, PAGE 3

-BIBLIOGRAPHY-

BURGESS,D.S., MURPHY,I.N. AND ZABETAKIS,M.G., HAZARDS OF LNG SPILLAGE IN MARINE TRANSPORTATION, SRC REPORT NO. S - 4105 (1970) FEB//NARTER,A.N., SAFETY CONSIDERATIONS IN THE DESIGN AND CONSTRUCTION OF TANKERS FOR CRYOGENIC CARGOES, PRESENTED AT MEETING OF THE GREATER LOS ANGELES CHAPTER, NATIONAL SAFETY COUNCIL, 1971 MAY 12//NATIONAL TRANSPORTATION SAFETY BOARD RISK CONCEPTS IN DANGEROUS GOODS TRANSPORTATION REGULATIONS, REPORT NO. NTSB - STS - 71 - 1

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -

LIQUEFIED NATURAL GAS INTERNATIONAL CONF. AND EXHIBITION, 3RD, (PROC. OF) WASHINGTON, D.C., SEP 24-8, 1972. SESSION VI, PAPER 8

OTHER INFORMATION -

0016 PAGES, 0011 FIGURES, 0000 TABLES, 0008 REFERENCES

key 18774

CONTROL LNG-SPILL FIRES

by

WESSON,H.R.
WELKER,J.R.
BROWN,L.E.

12/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

IN SPITE OF MANY STUDIES AND TESTING PROGRAMS, CONTROVERSY STILL EXISTS OVER HOW TO BEST CONTROL LNG SPILL FIRES. WATER CURTAINS ARE A MAJOR CONTROL MEANS - APPLIED WHILE THE FIRE BURNS ITSELF OUT. BUT IN SOME OUTSIDE-U.S. INSTALLATIONS, HIGH-EXPANSION FOAM HAS BEEN USED WITH A HIGH LEVEL OF EFFECTIVENESS. UNIVERSITY ENGINEERS, TO CLARIFY SOME QUESTIONS ABOUT THE USE OF HIGH-EXPANSION FOAM IN FIGHTING LNG SPILL FIRES, RAN EXTENSIVE TESTS WITH THE FOLLOWING RESULTS. 1. HIGH EXPANSION FOAMS PROVIDE ADEQUATE CONTROL OF LNG FIRES AND REDUCE EXTERNAL RADIATION EFFECTS TO SAFE LEVELS BEYOND ONE-FOURTH OR MORE POOL DIAMETERS. 2. THE 500.1 FOAM EXPANSION RATIO APPEARS SUPERIOR TO HIGHER EXPANSION RATIOS SUCH AS 750.1 OR 1000.1. 3. THE 500.1 FOAM REDUCES STEADY STATE LNG EVAPORATION RATES. 4. THE 500.1 FOAM INITIALLY PROVIDES A MARKED DEGREE OF BUOYANCY (INCREASED BOIL-OFF VAPOR TEMPERATURES) TO THE BOIL-OFF VAPORS. THE BENEFIT PERIOD DEPENDS ON THE FOAM DEPTH AND VAPOR BOIL-OFF RATE SINCE THE BOIL-OFF VAPORS RESULT IN FREEZING OF THE FOAM BLANKET. THIS BUOYANCY EFFECT WILL REDUCE THE DOWNWIND TRAVEL OF FLAMMABLE CONCENTRATIONS NEAR GRADE LEVEL, RIGHT AFTER AN LNG SPILL. 5. A FOAM BLANKET AIDS IN EXTINGUISHING AN LNG FIRE WITH DRY CHEMICALS. 6. UNIVERSITY ENGINEERS DESIGN CRITERIA FOR DRY CHEMICAL FIRE PROTECTION SYSTEMS ARE COMPATIBLE WITH THE EXPERIMENTAL RESULTS FROM 14 TEST SERIES USING SODIUM BICARBONATE FOR EXTINGUISHMENT. 7. ADDITIONAL TESTS ARE NEEDED ON LARGER FIRES AND AT LOWER APPLICATION RATES TO CONFIRM LIMITED-SCALE DATA OBTAINED DURING THIS PROGRAM.

-PERTINENT FIGURES-

AND CONVENTIONAL LIQUID HYDROCARBON SPILL FIRES, PAGE 64

-BIBLIOGRAPHY-

WALLS,W.L., NFPA GASES FIELD SERVICE ENGINEER, LNG. A FIRE SERVICE APPRAISAL. PART I, FIRE JOURNAL (JAN 1972)//PIPKIN,O.A. AND SLIEPCEVICH,C.M., EFFECT ON WIND ON BUOYANT DIFFUSION FLAMES, I AND EC FUNDAMENTALS, 3.147 (1964)//WELKER,J.R. AND SLIEPCEVICH,C.M., BENDING OF WIND-BLOWN FLAMES FROM LIQUID POOLS, FIRE TECHNOLOGY, 2.127 (1966)// THOMAS,P.H., THE SIZE OF FLAMES FROM NATURAL FIRES, NINTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, THE COMBUSTION INSTITUTE, CORNELL UNIVERSITY (1962)//WALLS,W.L., NFPA GASES FIELD SERVICE ENGINEER, LNG. A FIRE SERVICE APPRAISAL. PART II, FIRE JOURNAL (MAR 1972)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UNIVERSITY ENGINEERS, INC., NORMAN, OKLA.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 51, NO. 12, 61-4 (DEC 1972)
OTHER INFORMATION -
0004 PAGES, 0007 FIGURES, 0000 TABLES, 0000 REFERENCES

EXPLOSIVE SYSTEMS CONTAINING LIQUID OXYGEN-LIQUID OXYGEN-LIQUID METHANE MIXTURES

by

STRENG,A.G.
KIRSHENBAUM,A.D.

04/00/59

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER PRESENTS RESULTS OF A PROGRAM TO TEST THE EXPLOSION CHARACTERISTICS OF THE SYSTEM LIQUID METHANE IN LIQUID OXYGEN. METHANE IS NEARLY COMPLETELY MISCIBLE IN LIQUID OXYGEN SO THAT MIXTURES OF VARYING COMPOSITION COULD BE TESTED. THE EXPLOSIVE LIMITS, ENERGIES AND VELOCITIES OF VARIOUS MIXTURES OF 6-80 MOLE PERCENT OF METHANE WERE MEASURED. THE MOST EXPLOSIVE MIXTURE WAS ONE CONTAINING 33 PERCENT METHANE. THE RESULTS WERE COMPARED WITH CALCULATED DATA FOR DETONATION VELOCITIES AND WITH EXPERIMENTAL DATA FROM ELSEWHERE. THE CALCULATED VALUES FOR THE LIQUID MIXTURES WERE SYSTEMATICALLY HIGHER THAN THE MEASURED VALUES. THE EXPERIMENTAL GASEOUS VELOCITIES FROM REFERENCES 3 AND 6 WERE CONSIDERABLY AS IS TO BE EXPECTED. THE SENSITIVITY TO IMPACT, FLAME, SHOCK WAVE AND SPARK WAS DETERMINED FOR THE 33 PERCENT CH(4)-67 PERCENT O(2) MIXTURE.

-PERTINENT FIGURES-

FIG.1 BRISANCE SETUP PAGE 128//FIG.2 STEEL TEST PLATES AFTER DETONATION OF 100-GRAM CHARGES PAGE 129//FIG.3 EXPLOSIVE CELL FOR MEASURING DETONATION VELOCITIES BY ROTATING MIRROR PAGE 129//FIG.4 TYPICAL ROTATING-MIRROR PICTURE OF LIQUID METHANE-LIQUID OXYGEN DETONATION PAGE 130//FIG.5 DETONATION VELOCITIES OF LIQUID AND GASEOUS CH(4) & O(2) MIXTURES PAGE 130// TAB.1 EXPLOSIVE RANGE OF LIQUID CH(4)-LIQUID O(2) MIXTURES AND EFFECT OF VARYING CH(4) TO O(2) RATIO ON BRISANCE PAGE 128//TAB.2 EXPLOSIVE LIMITS OF METHANE-OXYGEN MIXTURES PAGE 129//TAB.3 COMPARISON OF EXPERIMENTAL AND THEORETICAL DETONATION RATES OF LIQUID OXYGEN-LIQUID METHANE MIXTURES PAGE 129

-BIBLIOGRAPHY-

CAMPBELL,F.C., LITTLE,W.B., WHITWORTH,C., PROC. ROY. SOC. (LONDON) 137, 380 (1932)//COOK,M.A., J. CHEM. PHYS. 15, 518 (1947), 16, 1081 (1948)//LEWIS,B., ELBE,G. VON, COMBUSTION FLAMES AND EXPLOSIONS OF GASES, P. 584 (H. B. DIXONS DATA), ACADEMIC PRESS,

NEW YORK, 1951//FASTOVSKIL,V.G., KRESTINSKIL,J.A., J. CHEM. (U.S.S.R.) 15, 525 (1941)//GROSSE,A.V., KIRSHENBAUM,A.D., STRENG,A.G., J. AM. CHEM. SOC. 79, 6341 (1957)//KIRSHENBAUM,A.D., FINAL REPORT ON FUNDAMENTAL STUDIES OF NEW EXPLOSIVE REACTIONS FOR OFFICE OF ORDNANCE RESEARCH, CONTRACT NO. DA-36-034-ORD-1489, PROJECT NO. TB20001(916), RESEARCH INSTITUTE OF TEMPLE UNIVERSITY, APRIL 30, 1956//MORRISON,R.B., UNIV. OF MICHIGAN REPT. UMM-97, 99 (JANUARY, 1952)//NATL. BUR. STANDARDS, CIRC. C-461 (1947), C-564 (1955)//PAYMAN,W., J. CHEM. SOC. 1919, 1436// PAYMAN,W., WHEELER,R.V., FUEL 8, 4 (1929)//TAYLOR,J., DETONATION IN CONDENSED EXPLOSIVES, PP. 54-110//CLARENDON PRESS, OXFORD, ENGLAND, 1952

-SOURCE INFORMATION-

CORPORATE SOURCE -
RESEARCH INST. TEMPLE UNIV., PHILADELPHIA, PA.
JOURNAL PROCEEDINGS -
J. CHEM. ENG. DATA VOL 4, NO. 2, 127-31 (APR 1959)
OTHER INFORMATION -
0005 PAGES, 0005 FIGURES, 0003 TABLES, 0011 REFERENCES

keys 664 through 668

THE INFLUENCE OF ACCIDENTS IN THE CONTINUING DEVELOPMENT OF CRYOGENIC PROCEDURES

by

REIDER, R.

05/07/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS IS A REVIEW OF MAJOR AND TYPICAL MINOR MISADVENTURES INVOLVING CRYOGENIC FLUIDS. THE NATURE AND CONSEQUENCES OF INCIDENTS ARE DESCRIBED AND EXTRAPOLATED TO POTENTIAL INCIDENTS INVOLVING LARGER QUANTITIES OR ALTERNATE CIRCUMSTANCES. METHANE, OXYGEN AND HYDROGEN HAVE BEEN INVOLVED IN MAJOR EPISODES. LIQUEFIED AIR, INERT ATMOSPHERIC GASES AND HELIUM HAVE ALSO BEEN INVOLVED IN MISHAPS IN COMMERCIAL AND LABORATORY PRACTICE. THE DEVELOPMENT OF RATIONAL OPERATIONAL PROCEDURES CAN BE PROPERLY INFLUENCED BY A KNOWLEDGE OF ACCIDENTS. THIS REQUIRES ACCURATE INFORMATION ON ACCIDENTS TO BE MADE PUBLIC AS PROMPTLY AS THE FACTS PERMIT. REFERENCES ARE GIVEN FOR A NUMBER OF ACCIDENT REPORTS USED TO ILLUSTRATE TYPICAL HAZARDS INVOLVED WITH THE HANDLING OF CRYOGENIC FLUIDS.

-PERTINENT FIGURES-

FIG.1 A GENERAL VIEW OF THE SITE OF THE LIQUEFIED METHANE FACILITY TAKEN MONTHS AFTER THE INCIDENT, PAGE 155//FIG.2 THE RAPID PRESSURE RISE AND THERMAL SHOCK OF VAPORIZING CRYOGEN, PAGE 155//FIG.3 SAMPLE HOLDER THAT WAS IMMERSED IN LIQUID NITROGEN, PAGE 155//FIG.4 SECTION OF A PARTLY CHARRED WOODEN FLOOR, PAGE 156//FIG.5 A VIEW OF THE OXYGEN PLANT AFTER THE EXPLOSION, PAGE 156

-BIBLIOGRAPHY-

BARNES, G. E., BRAIDECH, M. M., AND DONALDSON, K. H., REPORT OF THE TECHNICAL CONSULTANTS BOARD OF INQUIRY FOR THE EAST OHIO GAS COMPANY FIRE, CLEVELAND, OHIO (JULY, 1945) - FROM THE PRIVATE COLLECTION OF MATHEW M. BRAIDECH//REPORT ON THE EAST OHIO GAS COMPANY EXPLOSION AND CONFLAGRATION, CLEVELAND, OHIO, BY THE NATIONAL BOARD OF FIRE UNDERWRITERS, NEW YORK, AND THE OHIO INSPECTION BUREAU, COLUMBUS, OHIO (OCTOBER 20, 1945)//LANG, A., CAUSES OF THE EXPLOSION OF AN AIR FRACTIONATION PLANT AND THE LESSONS LEARNED FROM THE ACCIDENT, GESELLSCHAFT FUR LINDES EISMACHINEN AG, WIESBADEN (1961)//BALL, W. L., HAZARD LEVEL OF

HYDROCARBON FILMS IN OXYGEN SYSTEMS, ANNUAL MEETING OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, AIR AND AMMONIA PLANT SYMPOSIA (SEPTEMBER, 1961)//CONKLIN, J. H., NITROGEN WASH INCIDENT, IN SAFETY IN AIR AND AMMONIA PLANT, VOLUME 3, CHEMICAL ENGINEERING PROGRESS, V57(4) (APRIL, 1961)//BOLLEN, -., SAFETY IN AIR AND AMMONIA PLANT, V2, P6-8, AMERICAN INSTITUTE OF CHEMICAL ENGINEERS (1960)// ZABETAKIS, M. G., SAFETY WITH CRYOGENIC FLUIDS, APPENDIX 2, PLENUM, NEW YORK (1967)//NEARY, R. M., AIR-CONDENSING CRYOGENIC FLUIDS, TRANS. NATN. SAF. CONGR., CHICAGO, (CHEMICAL AND FERTILISER INDUSTRIES), V5, (1963)// EHRENKRANZ, T. E., PROJECT ROVER LIQUID HYDROGEN SAFETY - A FIVE-YEAR LOOK, ADV. CRYOGEN. ENGNG, V12, PLENUM, NEW YORK (1967)//REPORT ON THE INVESTIGATION OF EXPLOSION AND FIRE-EXPERIMENTAL HALL-CAMBRIDGE ELECTRON ACCELERATOR, CAMBRIDGE, MASSACHUSETTS (JULY 5, 1965), UNITED STATES ATOMIC ENERGY COMMISSION, TID-22594 (FEBRUARY, 1966)//EDESKUTY, F. J., SAFETY PROBLEMS AND SAFETY CODES CONCERNING LIQUID HYDROGEN AND LIQUID HELIUM, PROCEEDINGS OF THE TWELFTH INTERNATIONAL CONGRESS OF REFRIGERATION, PAPER 1.24, MADRID, SPAIN (1967), TO BE PUBLISHED IN BULL. INT. INST. REFRIG.// EDESKUTY, F. J., CRYOGENIC TECHNOLOGY EDITED BY R. W. VANCE, CHAPTER 12, WILEY, NEW YORK (1963)//STANDARD FOR STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS AT UTILITY GAS PLANTS, NATIONAL FIRE PROTECTION ASSOCIATION, NFPA NO. 59-A, BOSTON, MASSACHUSETTS (1967)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LOS ALAMOS SCIENTIFIC LAB., N. MEX.
JOURNAL PROCEEDINGS -
INTERNATIONAL CRYOGENIC ENGINEERING CONFERENCE, PROCEEDINGS OF THE SECOND CONFERENCE, BRIGHTON, UNITED KINGDOM, (7-10 MAY 1968) 154-8 (1968)
PUBLISHER -
ILIFFE SCIENCE AND TECHNOLOGY PUBLICATIONS
OTHER INFORMATION -
0005 PAGES, 0005 FIGURES, 0000 TABLES, 0013 REFERENCES

DETECTION AND MEASUREMENT OF INFLAMMABLE VAPOURS IN AIRCRAFT

by

WYETH,H.W.G.
TIMMINS,G.W.

09/00/65

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Other	Govt./Contr.	Summary	Good/Excel.

-ABSTRACT-

A STUDY IS MADE OF THE FEASIBILITY OF DETECTING AND MEASURING CONCENTRATIONS OF INFLAMMABLE VAPOUR WITHIN COMPARTMENTS OF AIRCRAFT IN FLIGHT. THE BASIC REQUIREMENTS ARE OUTLINED. A REVIEW IS MADE OF PROPERTIES OF INFLAMMABLE VAPOURS THAT MIGHT BE EXPLOITED. MENTION IS MADE OF SOME EXISTING INSTRUMENTS AND TECHNIQUES, AND THEIR LIMITATIONS FOR THE PRESENT PURPOSE ARE DISCUSSED. ESPECIAL EMPHASIS IS GIVEN TO TECHNIQUES OF CATALYTIC COMBUSTION AND IONISATION WHICH WITH FURTHER DEVELOPMENT ARE THOUGHT LIKELY TO BE SUITABLE. THE AUTHORS CONCLUDE THAT TECHNIQUES BASED ON CATALYTIC COMBUSTION OFFER THE MOST HOPE OF PROVIDING THE REQUIRED INSTRUMENT. THEY ALSO CONCLUDE THAT HIGHER CONCENTRATIONS OF VAPOUR/AIR WOULD BE MOST ACCURATELY DETECTED BY MEANS OF AN IONIZATION EFFICIENCY DETECTOR. THE PRINCIPLES CONSIDERED IN THE STUDY ARE ABSORPTION, CALORIMETRY, SOUND, DIELECTRIC CONSTANT, ELECTRICAL CONDUCTIVITY, REFRACTIVE INDEX, VISCOSITY, OSMOSIS, EFFUSION, CHROMATOGRAPHY, MASS SPECTROMETRY, ULTRAVIOLET AND INFRARED SPECTROSCOPY, THERMAL CONDUCTIVITY, COMBUSTION AND IONIZATION.

-PERTINENT FIGURES-

FIG.1 LIMITS OF INFLAMMABILITY OF AIRCRAFT RUELS IN ATMOSPHERIC AIR, PAGE 47//FIG.2 EFFECT OF INCREASED TEMPERATURE ON LOWER INFLAMMABILITY LIMIT AT ATMOSPHERIC PRESSURE, PAGE 48//FIG.3 EFFECT OF REDUCED PRESSURE ON LOWER INFLAMMABILITY LIMIT, PAGE 49//FIG.4 LIMITS OF INFLAMMABILITY FOR AVTUR IN ATMOSPHERIC AIR AND IN OXYGEN RICH AIR EVOLVED FROM SOLUTION, PAGE 50//FIG.29 RESULTS FROM AN IONISATION EFFICIENCY DETECTOR, PAGE 75

-BIBLIOGRAPHY-

H. W. G. WYETH, R. E. MILLER, THE DETECTION AND MEASUREMENT OF OXYGEN IN AIRCRAFT FUEL TANKS, RAE TECH. NOTE. MECH. ENG. 393/CPM.41, NOV. 1963//J. A. MACDONALD, R. G. WHITE, SPONTANEOUS IGNITION OF KEROSENE (AVTUR) FUEL VAPOUR WITHIN A FOUR INCH

CYLINDRICAL VESSEL, RAE TECH. NOTE. MECH. ENG. 379, JUNE 1963//H. M. SPIERS, TECHNICAL DATA ON FUEL, PUBLISHED BY THE BRITISH NATIONAL COMMITTEE, WORLD POWER CONFERENCE, LONDON, 5TH EDITION, 1950//E. M. GOODGER, P. CADMAN, I. T. A. MURCHIE, PROTECTION OF AIRCRAFT FUEL TANKS AGAINST EXPLOSION HAZARDS USING INERT COMBUSTION PRODUCTS, COLLEGE OF AERONAUTICS REPORT NO. 85, OCT. 1955//E. H. COLEMAN, PORTABLE APPARATUS FOR DETECTING FLAMMABLE GASES AND VAPOURS, BRITISH CHEMICAL ENGINEERING, MARCH AND APRIL 1957//K. WINTER, PORTABLE APPARATUS FOR THE UNDERGROUND DETERMINATION OF FIRE-DAMP IN BITUMINOUS COAL MINES, THE 8TH INTERNATIONAL CONFERENCE OF DIRECTORS OF SAFETY IN MINES RESEARCH, DORTMUND-D, GERMANY, 1954, PAPER NO. 33, U.D.C. 622-412

-SOURCE INFORMATION-

CORPORATE SOURCE -
ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH, ENGLAND
REPORT NUMBER -
TR-65191//AD-477232
OTHER INFORMATION -
0077 PAGES, 0029 FIGURES, 0005 TABLES, 0072 REFERENCES

keys 12491 through 12492

SAFETY IN THE CHEMICAL LABORATORY. XC. IDENTIFICATION OF HAZARDOUS MATERIALS -PT. VI

by

STEERE,N.V.

03/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

THIS PAPER DESCRIBES AND REVIEWS THE US FEDERAL GOVERNMENTS NEW STANDARD FOR SYMBOLS FOR HAZARDOUS MATERIALS (STANDARD NO. 313). THE PURPOSE OF THE STANDARD IS TO REQUIRE UNIFORM SYMBOLS AND LABELS FOR PACKAGES AND CONTAINERS OF HAZARDOUS MATERIALS SHIPPED TO AND BY FEDERAL AGENCIES. FIVE SPECIFIC HAZARDOUS AREAS ARE IDENTIFIED-OXIDIZERS, ACIDS, ALKALIES, CORROZINES AND WATER REACTIVE MATERIALS. IN ADDITION THERE ARE THREE BROAD HAZARDS CATEGORIES - HEALTH, FIRE AND INSTABILITY (REACTIVITY). EACH OF THESE LAST ARE FURTHER BROKEN DOWN AS TO THE DEGREE OF THE HAZARD (THERE ARE FIVE DEGREES). CRYOGENIC FLUIDS ARE CLASS 4 OF FLAMMABILITY HAZARDS (CLASS 4 IS HIGHEST RISK). THE STANDARD PROVIDES FOR A CODE TO BE USED ON THE LABEL.

-BIBLIOGRAPHY-

SYMBOLS FOR PACKAGES AND CONTAINERS FOR HAZARDOUS INDUSTRIAL CHEMICALS AND MATERIALS, FEDERAL STANDARD NO. 313 (JULY 23, 1971)

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
J. CHEM. EDUC. VOL 49, NO. 3, A139-40,42,44-5 (MAR 1972)
OTHER INFORMATION -
0005 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 20649

HOW TO CALCULATE DENSITY OF LNG AT CRYOGENIC TEMPERATURES

-ABSTRACT-

THIS ARTICLE GIVES A SUMMARY OF A PAPER PRESENTED AT THE 2ND LNG CONFERENCE AND GIVES A METHOD FOR CALCULATING THE LIQUID DENSITY OF LNG MIXTURES. THE DENSITY IS GIVEN BY D = X(I)M(I)/X(I)V(I) - XC OVER THE RANGE -140 TO -185 DEGREES C. IT ALSO ASSUMES LESS THAN 5 PERCENT N2, O2 AND ISOPARAFFINS.

-PERTINENT FIGURES-

FIG.1 METHANE DENSITY, PAGE 56//FIG.2 EXAMPLE OF A DENSITY CALCULATICN FOR A HYPOTHETICAL LNG, PAGE 56//TAB.1 MOLAR VOLUMES OF INDIVIDUAL COMPONENTS, PAGE 57//TAB.2 CORRECTION, C, FOR VOLUME REDUCTION OF LNG MIXTURES, PAGE 57

-BIBLIOGRAPHY-

BOYLE,G,J. AND REECE,D., SHELL RESEARCH LTD., CHESTER, ENGLAND, CALCULATION OF DENSITIES OF LNG FROM A KNOWN COMPOSITION, TAKEN FROM THEIR PAPER, BULK MEASUREMENT OF LNG//KEYES, TAYLOR AND SMITH, THE THERMODYNAMIC PROPERTIES OF METHANE, J. MATH. PHYS. VOL 1, PP 211-42 (1922)//KLOSEK AND MCKINLEY, DENSITIES OF LNG AND OF LOW-MOLECULAR-WEIGHT HYDROCARBONS, PROC. OF THE FIRST INTERNATIONAL CONF. ON LNG, CHICAGO, ILL. (1968)// FUKS, LEGROS AND BELLEMANS, THE MOLAR VOLUMES OF LIQUID METHANE AND DEUTEROMETHANE, PHYSICA VOL 31, PP 606-12 (1965)//SHANAA, LIQUID DENSITY AND EXCESS VOLUME OF LIGHT HYDROCARBONS MIXTURES AT -165 DEGREES C AND AT SATURATION PRESSURE, PH.D. DISSERTATION, UNIV. OF OKLAHOMA (1966)// SINOR, THE SOLUBILITY PARTIAL MOLAR VOLUME AND DIFFUSIVITY OF HELIUM IN LIQUID METHANE, PH.D. DISSERTATION, UNIV. OF KANSAS (1965)

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
OIL GAS J. VOL 69, NO. 3, 56-7 (JAN 1971)
OTHER INFORMATION -
0002 PAGES, 0002 FIGURES, 0002 TABLES, 0005 REFERENCES

key 1460

FIRE RETARDANT FLEXIBLE URETHANE FOAM

by

BAUMANN, G.F.
SZABAT, J.F.

00/00/72

-ABSTRACT-

Technology is reviewed on fire retardant flexible urethane slabstock foam based on Mobay raw Materials Mondur TD-80, Multranol 7100, special additives E-9200 and E-9402 with Monsanto's nonreactive fire retardant Phosgard 2XC20. Special emphasis is also given to the self-extinguishing (S.E.) high resilient foams that can be produced in different grades without the use of any phosphorous halogen containing fire retardant. A summary is presented of the major fire safety regulations presently proposed as standards for home furnishings, carpets and rugs, bedding, automotive interior components, aircraft applications, and furnishings for offices and other public places. Several flame retardant foam grades are described as to their suitability in satisfying the flammability specifications of the standards for carpet underlay, automotive interior components, bedding, and other applications. A high resilient foam is also described; they offer latex like feel and are suitable for luxurious seating and bedding applications. They can pass a wide variety of flame tests without the use of any phosphorus halogen containing fire retardant and have a very low flame spread.

-SOURCE INFORMATION-

CORPORATE SOURCE -
MOBAY CHEMICAL CO., PITTSBURGH, PA.
JOURNAL PROCEEDINGS -
IN: ADVANCES IN FIRE RETARDANTS. PART 1 (PROG. IN FIRE RETARDANCY SER., VOL. 2) (SEE: F7300165)
OTHER INFORMATION -
0014 PAGES, 0000 FIGURES, 0004 TABLES, 0000 REFERENCES

keys 1762 through 1763

HANGAR FIRE PROTECTION WITH AUTOMATIC AFFF SYSTEMS

by

BREEN, D.E.

05/00/73

-ABSTRACT-

PREVIOUS RESEARCH HAD SHOWN THAT AQUEOUS FILM-FORMING FOAM (AFFF) IS APPROXIMATELY TWICE AS RAPID IN ACHIEVING CONTROL AND 2-1/2 TIMES AS RAPID IN ACHIEVING EXTINGUISHMENT AS PROTEIN FOAM. HOWEVER, THERE WAS NO PERFORMANCE EVALUATION FOR HIGH-CEILING SYSTEMS IN BUILDINGS SUCH AS AIRCRAFT HANGARS. TESTS WERE CONDUCTED TO COMPARE AFFF AND PROTEIN FOAM IN A HIGH-CEILING TEST BUILDING. THE FUEL USED WAS JP-4 JET FUEL. THREE TYPES OF SPRINKLER SYSTEMS WERE USED IN BOTH THE AFFF AND PROTEIN FOAM TESTS: (1) THE GRINNELL FOAM/WATER-UPRIGHT; (2) THE GRINNELL STANDARD SPRINKLER-UPRIGHT; AND (3) THE GRIMES OLD SYTLE SPRINKLER-UPRIGHT. RESULTS SHOWED THAT THE GRINNELL STANDARD SPRINKLER-UPRIGHT WAS SUPERIOR TO THE GRINNELL FOAM/WATER-UPRIGHT, PROBABLY DUE TO MORE EFFECTIVE PLUME PENETRATION AFFORDED BY HIGHER FOAM PARTICLE DENSITY. AFFF IS 1.3 TO 1.6 TIMES QUICKER IN SUPPRESSING A FIRE WHEN DISCHARGED THROUGH THE STANDARD SPRINKLER SYSTEM THAN WHEN DISCHARGED THROUGH A FOAM-WATER SYSTEM, AT APPLICATION RATES OF 0.16 GPM/SQ. FT. IT WAS CONCLUDED THAT THE CONTROL AND EXTINGUISHMENT OF FUEL FIRES USING AFFF DEPENDS NOT ONLY ON APPLICATION RATE BUT ALSO ON THE TYPE OF DISCHARGING DEVICE. IT WAS ALSO FOUND THAT IT IS MORE EFFECTIVE TO APPLY THE SUPPRESSANT DIRECTLY TO THE BURNING FUEL SURFACE THAN TO DEPEND ON FLOW OF A FOAM BLANKET INTO THE FIRE FROM THE PERIMETER.

-PERTINENT FIGURES-

FIG. 4 CONTROL AND EXTINGUISHMENT TIMES VS APPLICATION RATE FOR LIGHT WATER AFFF AND PROTEIN FOAM PAGE 129

-SOURCE INFORMATION-

CORPORATE SOURCE -
FACTORY MUTUAL RESEARCH CORP., NORWOOD, MASS.
JOURNAL PROCEEDINGS -
FITCAA, FIRE TECHNOL, VOL. 9, NO. 2, 119-131 (MAY 1973)
OTHER INFORMATION -
0013 PAGES, 0004 FIGURES, 0001 TABLES, 0026 REFERENCES

key 2042

PRINCIPLES OF FIGHTING AIRCRAFT FIRES

by

LEE, W.R.

09/00/68

-ABSTRACT-

THE FIRE FIGHTING PRINCIPLES USED BY THE PORT OF NEW YORK AUTHORITY AT THE NEW YORK AIRPORTS ARE MADE FOR THE MOST SEVERE CONDITIONS: THE LARGEST AIRCRAFT, FULLY OCCUPIED, IN A BURNING POOL OF HYDROCARBON FUEL. THREE MIN. ARE ALLOWED FOR EMERGENCY EQUIPMENT TO REACH AN AIRCRAFT DOWNED AT AN AIRPORT. THIS CRITERION IS CONDITIONED BY THE REASONABLE FACTORS OF OPTIMUM VISIBILITY AND SURFACE CONDITIONS. TWO MIN. ARE ALLOWED TO BRING THE CRITICAL FIRE AREA UNDER CONTROL, IN ORDER TO RESCUE PASSENGERS BEFORE FIRE REACHES THEM. EACH OF THE FIRE HOUSES AT KENNEDY AIRPORT IS EQUIPPED WITH A 3,000 GALLON FOAM TRUCK, A 2,750 GALLON SUPPLEMENTARY FOAM TRUCK, AND A QUICK RESPONSE VEHICLE CARRYING 900 LB. OF PURPLE K POWDER AND 125 GALLONS OF LIGHT WATER. THE WORST CASE FOR AN AIRCRAFT CRASH FIRE WOULD REQUIRE THE CONTROL IN 2 MIN. OF AN AIRCRAFT 150 FT. LONG, WITH A FUSELAGE DIA. OF 18 FT., AND A WING SPAN OF 40 FT. ON EACH SIDE. TO ESTABLISH CONTROL, A 2.4-IN. THICK BLANKET OF FOAM MUST BE APPLIED AT 0.15 GPM/SQ. FT. FOR 2 MIN. IN ORDER TO COVER THE TOTAL AREA, 4,400 GALLONS OF FOAM MIXTURE WOULD BE REQUIRED, EXPANDED AT A RATIO OF 8:1. AFTER THE FIRE IS EXTINGUISHED, HAND LINES MUST BE USED TO PATCH AND MAINTAIN THE FOAM BLANKET WHILE PASSENGERS ARE REMOVED, REQUIRING AN ADDITIONAL 2,600 GALLONS OF FOAM.

-SOURCE INFORMATION-

CORPORATE SOURCE -
PORT OF NEW YORK AUTHORITY, NEW YORK.
JOURNAL PROCEEDINGS -
FIENA2, FIRE ENG, VOL. 121, NO. 9, 114-115 (SEPT. 1968)
OTHER INFORMATION -
0002 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

key 2043

FIRE-FIGHTING AND RESCUE AT AIRCRAFT ACCIDENTS

by

LODGE, J.E.

10/00/68

-ABSTRACT-

LIFE SAFETY MEASURES AND FIRE EXTINGUISHING AGENTS FOR AIRCRAFTS FIRES ARE DESCRIBED. IT IS NOTED THAT 80 PERCENT OF ALL AIRCRAFT ACCIDENTS OCCUR AT OR NEAR AIRPORTS, AND IT IS RECOMMENDED THAT EFFECTIVE TRAINING AND FIRE FIGHTING EQUIPMENT BE PROVIDED. THE HUGE SIZES OF MODERN AIRCRAFT INCREASE THE DIFFICULTY OF FIRE FIGHTING BECAUSE OF THE LACK OF VISIBILITY FROM ONE SIDE TO THE OTHER, AND BECAUSE OF THE NEED TO APPLY THE EXTINGUISHING AGENT AT A MUCH HIGHER RATE IN ORDER TO SUPPRESS THE FIRE. IT IS ANTICIPATED THAT FOAM GENERATORS WILL HAVE TO HAVE RANGES OF 250 FT. OR MORE AND A LIQUID CAPACITY OF 1500 GPM IN ORDER TO DEAL WITH LARGE AIRCRAFT FIRES. NEW EXTINGUISHING AGENTS, SUCH AS FLUOROPROTEIN FOAMS AND LIGHT WATER, ARE SUGGESTED FOR USE IN AIRCRAFT FIRES. AN APPLIANCE IS BEING DEVELOPED WHICH HAS A DRY-POWDER MONITOR CAPABLE OF RANGES UP TO 120 FT., DELIVERING THE AGENT AT OUTPUT UP TO 88 LB. PER SEC. OTHER FACTORS TO BE CONSIDERED INCLUDE THE HAZARDS POSED BY JUMBO-JETS, THE NEED FOR LIGHTING EQUIPMENT, POWERED RESCUE TOOLS, COMMUNICATIONS EQUIPMENT, AND EFFECTIVE TRAINING OF FIRE FIGHTERS.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BOARD OF TRADE (ENGLAND).
JOURNAL PROCEEDINGS -
FIRE, VOL. 61, NO. 760, 227-228, 232 (OCT. 1968)
OTHER INFORMATION -
0003 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

CHARACTERIZATION AND SUPPRESSION OF AIRCRAFT AND FUEL FIRES

by

CAPENER, E.L.
ALGER, R.S.

10/00/70

-ABSTRACT-

TESTS WERE CONDUCTED WITH FUEL FIRES TO MEASURE HEAT FLUXES, BURNING RATES, AND SUPPRESSION CHARACTERISTICS. THE POOLS OF JP-5 JET FUEL USED IN THE TESTS WERE 3 FT. AND 10 FT. IN DIA. AND 50 FT. X 50 FT. AQUEOUS FILM-FORMING FOAM (AFFF) WAS USED AS A FIRE EXTINGUISHER IN THE TESTS. MEASUREMENTS WERE MADE OF BURNING RATE AND EXTINCTION TIME. A MODEL WAS CONSTRUCTED OF THE IDEAL EXTINGUISHMENT SYSTEM, WHICH WOULD GIVE A UNIFORM RATE OF APPLICATION OVER THE BURNING FUEL SURFACE. THE SUPPRESSANT SPRAY WAS CHARACTERIZED AS TO UNIFORMITY, AVERAGE DROP SIZE, AND INTERACTION KINETICS WITH THE FUEL SURFACE. RADIATION FLUXES AT VARYING DISTANCES FROM THE FIRE WERE AFFECTED BY WIND VELOCITY, LOCATION OF THE MEASURING STATION (VIEW FACTOR), TYPE OF SUBSTRATE, AND THE WATER CONTENT OF THE SUBSTRATE. FUEL BURNING RATES WERE INFLUENCED BY WIND VELOCITY AND SUBSTRATE CHARACTERISTICS. SUPPRESSION WITH 6 PERCENT LIGHT WATER SOLUTION WAS INFLUENCED PRIMARILY BY THE FIRE SIZE AND, SECONDARILY, BY THE TYPE OF SUBSTRATE.

-PERTINENT FIGURES-

FIG. 4 RADIATION FROM 10 FT. DIA. JP5 FIRES VS RADIOMETER LEVEL ABOVE GROUND PAGE 10//FIG. 5 RADIATION FROM 10 FT. DIA. JP5 FIRES WATER VS SAND SUBSTRATES PAGE 11

-BIBLIOGRAPHY-

BLINOV, V.I., AND KHUDIAKOV, G.N.: CERTAIN LAWS GOVERNING DIFFUSIVE BURNING OF LIQUIDS. FIRE RES. ABST. AND REV., VOL. 1, NO. 41, 1959//WELKER, J.R., AND SLIEPCEVICH, C.M.: BENDING OF WIND-BLOWN FLAMES FROM LIQUID POOLS. FIRE TECH., VOL. 2, NO. 127, 1966

-SOURCE INFORMATION-

CORPORATE SOURCE -
STANFORD RESEARCH INST., MENLO PARK, CALIF.//NAVAL ORDNANCE LAB., CORONA, CALIF.
REPORT NUMBER -
WSCI 72-26

JOURNAL PROCEEDINGS -
WEST SECT, COMBUST INST, FALL MEETING, MONTEREY, CALIF. (OCT. 30-31, 1972)

OTHER INFORMATION -
0034 PAGES, 0018 FIGURES, 0000 TABLES, 0002 REFERENCES

FIRE FIGHTER'S EXPOSURE STUDY

by

GRAVES, K.W.

12/00/70

-ABSTRACT-

Experimental fires of burning aircraft fuels were instrumented with heat meters to determine heat flux distributions for application to the design of protective clothing for fire fighting personnel. The spectral distribution of infrared radiation emitted by fires was also measured. Conditions affecting the fires and the resulting heat effects that were studied were wind velocity, fuel pool area, time of burning, orientation around the fire relative to wind direction, distance from the fire, and an extraneous object in a fire. Heating rates within the fire were found to be a maximum of 8.0 cal./sq.cm./sec. Since this imposed an extreme and impractical restriction upon clothing design and since the convective heating mode was significant only in a downwind direction from fires, it was concluded that radiative heating was the predominant mode that determines clothing design requirements for fire proximity. The maximum value of this heating that would be encountered for a large-scale fire was estimated at 1.8 cal./sq.cm./sec. A means for evaluating reflective clothing is described.

-PERTINENT FIGURES-

FIG. 2F EFFECT OF POOL SIZE UPON HEATING RATE NEAR FIRE FROM BURNING AIRCRAFT FUEL PAGE 20//FIG. 4D COMPARISON BETWEEN AVERAGE AND PEAK HEATING RATE TO A SURFACE NEAR FIRE FROM BURNING AIRCRAFT FUEL PAGE 23//FIG. 5 EFFECT OF WIND VELOCITY UPON SPECTRAL INTENSITY OF FLAME RADIATION PAGE 28// FIG. 14 EFFECT OF OBJECT IN FIRE UPON HEATING RATE TO A SURFACE NEAR FIRE FROM BURNING AIRCRAFT FUEL PAGE 41//TAB. 3 THERMOCOUPLE DATA FOR FIRES PAGE 12//TAB. AI RADIOMETER DETECTOR AND FILTER CHARACTERISTICS PAGE 67

-BIBLIOGRAPHY-

MILLIKAN, R.C.: OPTICAL PROPERTIES OF SOOT. J. OPT. SOC. OF AM., VOL. 51, 278, 1961//TOURIN, R.H.: MONOCHROMATIC RADIATION PYROMETRY OF HOT GASES, PLASMAS, AND DETONATIONS, TEMPERATURE: ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY. VOL. 3, PART 2, REINHOLD PUB. CORP., 1962//ECKERT, E.R. AND DRAKE, R.M.: HEAT AND MASS TRANSFER. MCGRAW-HILL BOOK CO., INC., 1959//THRING, M.W. AND FOSTER, P.J., ET AL.: PREDICTION OF THE EMISSIVITY OF HYDROCARBON FLAMES. PAPER NO. 96, 1961-1962 HEAT TRANSFER CONF., UNIV. OF COLO., BOULDER//SPENCER, D.E.: OUT-OF-FOCUS PHOTOMETRY. J. OPT.

SOC. OF AM., VOL. 55, NO. 4, APR. 1965//GARDON, R.: A TRANSDUCER FOR THE MEASUREMENT OF HEAT-FLOW RATE. TRANS. OF THE ASME J. OF HEAT TRANSFER, NOV. 1960

-SOURCE INFORMATION-

CORPORATE SOURCE -
CORNELL AERONAUTICAL LAB., INC., BUFFALO, N.Y.
REPORT NUMBER -
AD-722774//AGFSRS-71-2
SPONSOR -
AIRCRAFT GROUND FIRE SUPPRESSION AND RESCUE, WRIGHT-PATTERSON AFB, OHIO.
CONTRACT NUMBER -
CONTRACT F33615-70-C-1715
OTHER INFORMATION -
0085 PAGES, 0030 FIGURES, 0006 TABLES, 0011 REFERENCES

FOAM AND DRY CHEMICAL APPLICATION EXPERIMENTS. INTERIM REPORT.

by

GEYER, G.B.

12/00/68

-ABSTRACT-

Full-scale tests were conducted under fixed fire conditions employing air aspirating foam and dry powder dispensing equipment in which protein foams, light water, high expansion foam, compatible dry chemical powder, and Purple K powder were evaluated both alone and in combination. The time required to control circular pool fires of aviation gasoline, JP-4, and Jet A fuels 40, 60, and 80 ft. in dia., containing an obstacle, was determined. The optimum solution application rate for obtaining rapid fire control employing protein foam in air aspirating equipment used in the tests of Jet A pool fires up to 80 ft. in dia. is approximately 0.35 gal./ min.-sq. ft. JP-4 and aviation gasoline fires are more destructive to protein foam than Jet A fuel fires. The fluoroprotein agents, when considered as a class, and regular protein foam have essentially equivalent fire fighting capability in controlling 40 ft. dia. Jet A fuel fires. Light Water employed alone results in a significant reduction in the control time compared with that of protein foam under similar pool fire conditions and can be used with air aspirating equipment. High expansion foam is capable of obtaining rapid control and extinguishment of aviation fuel fires as low solution application densities, but its vulnerability to wind and limited vapor securing characteristics restrict its use as a crash fire fighting agent. Dry chemical powders may result in very rapid reduction in thermal radiation, but do not provide the fuel vapor securing action required to prevent flashback.

-PERTINENT FIGURES-

FIG. 4 FIRE CONTROL TIME DATA ON VARIOUS SIZE JET A FUEL FIRES USING PROTEIN FOAM AT DIFFERENT SOLUTION DISCHARGE RATES PAGE 7//FIG. 6 THE VARIATION IN FIRE CONTROL TIME WITH POOL FIRE SIZE PAGE 9//FIG. 8 FIRE CONTROL TIME DATA OF THE FLUOROPROTEIN AGENTS, FLIGHT WATER, AND PROTEIN FOAM ON 60 FT. DIA. JP-4 FIRES PAGE 12//FIG. 10 FIRE CONTROL TIME DATA FOR HIGH EXPANSION FOAM ON 60 FT. DIA. JP-4 FUEL FIRES PAGE 16//TAB. 1 FIRE TEST CONDITIONS AND RESULTS USING COMPATIBLE DRY CHEMICAL PAGE 15//TAB. 2 FIRE TEST CONDITIONS AND RESULTS USING PURPLE K POWDER PAGE 18

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER, ATLANTIC CITY, N.J.
REPORT NUMBER -
AD-680068//NA-68-34(RD-68-55)
OTHER INFORMATION -
0048 PAGES, 0019 FIGURES, 0002 TABLES, 0015 REFERENCES

key 1395

AIRCRAFT APPLICATIONS OF HALOGENATED HYDROCARBON FIRE EXTINGUISHING AGENTS

by

BOTTERI, B.P.
CRETCHER, R.E.
KANE, W.R.

00/00/72

-ABSTRACT-

In analyzing the applications of halogenated hydrocarbon fire extinguishants to the aircraft fire problems found in engine and auxiliary power installations, fuel tanks, and habitable and cargo compartments, the nature of the fire problem in each area is defined, the state of the art fire suppression techniques which could be applicable is reviewed, the preferred technique and the basis for its selection is identified, and, in those cases where use of halogenated hydrocarbon extinguishants is preferred, their overall practical performance record is reviewed. Halon agents presently offer the greatest advantage for the following aircraft fire protection applications: extinguishment of engine installation fires; suppression of fuel tank explosions induced by point type ignition sources, although complexity of internal fuel tank configuration may pose an installation problem; fire suppression in large cargo and habitable compartments by means of total flooding; and first aid fire extinguishers for Class A, B, and C fire protection capability. Halon fire extinguishing agents were not recommended for fuel tank inerting or multipoint ignition explosions caused by, e.g., gunfire.

-PERTINENT FIGURES-

TAB. 6 TYPICAL A/C ENGINE FIRE EXTINGUISHER SYSTEMS PAGE 224

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR FORCE AERO PROPULSION LAB., WRIGHT-PATTERSON AFB, OHIO.
JOURNAL PROCEEDINGS -
IN: NAS-NRC. AN APPRAISAL OF HALOGENATED FIRE EXTINGUISHING AGENTS. PROC OF A SYMP, WASHINGTON, D.C. (APR. 11-12, 1972) (SEE F7300022)
OTHER INFORMATION -
0024 PAGES, 0000 FIGURES, 0011 TABLES, 0012 REFERENCES

keys 1371 through 1379

AN APPRAISAL OF HALOGENATED FIRE EXTINGUISHING AGENTS.

by

NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL

00/00/72

-ABSTRACT-

Contents: Bauman, M.R., Comparative Effectiveness of Halogenated Agents and Other Extinguishants (See F7300023)//Stokinger, H.E., Principles and Procedures for Toxicologic and Physiologic Evaluation of the Safety of Materials (See F7300024)//Stewart, R.D., Use of Human Volunteers for the Toxicological Evaluation of Materials (See F7300025)//Zikria, B.A., Inhalation Injuries in Fires (See F7300026)//MacEwen, J.D., Toxicology of Pyrolysis Products of Halogenated Agents (See F7300027)//Clark, D.G., Toxicology of Halon 1211 (See F7300028)//Reinhardt, C.F., and Reinke, R.E., Toxicology of Halogenated Fire Extinguishing Agents, Halon 1301 (Bromotrifluoromethane)(See F7300029)//Rainaldi, N., Appraisal of Halogenated Fire Extinguishing Agents (See F7300030)//Back, K.C., and Van Stee, E.W., Cardiovascular and Nervous System Effects of Bromotrifluoromethane: A Short Review (See F7300031)//Harris, W.S., Cardiac Effects of Halogenated Hydrocarbons (See F7300032)//Call, D.W., Human and Rat Exposures to Halon 1301 Under Hypobaric Conditions (See F7300033)// Ford, C.L., Extinguishment of Surface and Deep-Seated Fires With Halon 1301 (See F7300034)//Gassmann, J.J., and Marcy, J.F., Application of Halon 1301 to Aircraft Cabin and Cargo Fires (See F7300035)//Steinberg, M., Toxic Hazards from Extinguishing Gasoline Fires Using Halon 1301 Extinguishers in Armored Personnel Carriers (See F7300036)//McDaniel, D.E., Evaluation of Halon 1301 for Shipboard Use (See F7300037)//Botteri, B.P., Cretcher, R.E., and Kane, W.R., Aircraft Applications of Halogenated Hydrocarbon Fire Extinguishing Agents (See F7300038)//Carhart, H.W., and Fielding, G.H., Applications of Gaseous Fire Extinguishants in Submarines (See F7300039)// Kuchta, J.M., and Burgess, D., Effectiveness of Halogenated Agents Against Gaseous Explosions and Propellant Fires (See F7300040)//Edmonds, A., Use of Halon 1211 in Hand Extinguishers and Local Application Systems (See F7300041)//Languille, E., Applications of Halon 1211 Fixed Systems in Normally Occupied Area (See F7300042)//Wickham, R.T., Engineering and Economic Aspects of Halon Extinguishing Equipment (See F7300043)//Grabowski, G.J., Fire Detection and Actuation Devices for Halon Extinguishing Systems (See F7300044)//Kerr, J.W., Practicalities of Halons from the Firefighter's Viewpoint (See F7300045)//Wands, R.C., Toxicology of Halogenated Agents (Halon 2402)(See F7300046)//Yamashika, S., Dependence of Extinction Time and Decomposition of Halogenated Extinguishing Agent on Its Application Rate (See F7300047)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL, WASHINGTON, D.C. COMMITTEE ON FIRE RESEARCH.//NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL, WASHINGTON, D.C. COMMITTEE ON TOXICOLOGY.

REPORT NUMBER -
AD-753218

JOURNAL PROCEEDINGS -
SYMP ON AN APPRAISAL OF HALOGENATED FIRE EXTINGUISHING AGENTS, PROC, WASHINGTON, D.C. (APR. 11-12, 1972) (SEE F7300023-F7300047)

OTHER INFORMATION -
9999 PAGES, 9999 FIGURES, 9999 TABLES, 9999 REFERENCES

EVALUATION OF AIRCRAFT GROUND FIREFIGHTING AGENTS AND TECHNIQUES

by

GEYER, G.B.

02/00/72

-ABSTRACT-

A summary, based on previous research and on full-scale and laboratory tests, is presented of the effectiveness of agents, equipment, and techniques used in aircraft ground crash fire fighting and rescue operations. The agents selected for study were categorized in 2 major groups, depending upon their principal function in the extinguishment of Class B fires: (1) foam vapor-securing and blanketing agents, and (2) auxiliary fire fighting agents (dry chemicals, dry powders, vaporizing liquids, carbon dioxide, and magnesium agents). Several kinds of chemical and mechanical foams were tested, and the results are reported. Special attention was given to the performance of aqueous film forming foam (AFFF) and to the compatibility of foams and powders in fire extinguishing systems. The chief results and conclusions were: (1) the most effective fuel vapor and blanketing agents are AFFF and 6 percent protein-type foam, (2) there is no incompatibility between protein foam and AFFF when they are dispensed from separate nozzles, and (3) both AFFF and 6 percent protein agents demonstrate acceptable degrees of compatibility when paired with dry chemicals. Evaluations of various foam dispensers are reported, and comparisons are made between the effectiveness of protein foam and AFFF in extinguishing JP-4 jet fuel fires. Recommendations are made for the kinds and uses of foam dispensers which will be most effective in applying fire fighting agents to crash fires.

-PERTINENT FIGURES-

FIG. 10 THE EFFECT OF SOLUTION CONCENTRATION ON FIRE CONTROL TIME USING PROTEIN FOAM AND AFFF PAGE 58//TAB. 11 EFFECT OF WATER HARDNESS ON FIRE PERFORMANCE EMPLOYING PROTEIN FOAM AND AFFF (MANUFACTURER E-3) PAGE 34

-BIBLIOGRAPHY-

CONLEY, D.W.: POST-CRASH FIRE-FIGHTING STUDIES ON TRANSPORT CATEGORY AIRCRAFT. REP. RD-65-50, FAA, NAT. AVIATION FACILITIES EXPERIMENTAL CENTER, SYSTEMS RES. AND DEV. SERVICE, ATLANTIC CITY, N.J., MAY 1966// TUVE, R.L., PETERSON, H.B., JABLONSKI, E.J., AND NEILL, R.R.: A NEW VAPOR-SECURING AGENT FOR FLAMMABLE LIQUID FIRE EXTINGUISHMENT. AD 435-612, NRL REP. 6057, MAR. 13, 1964//TUVE,

R.L., AND JABLONSKI, E.J.: METHOD OF EXTINGUISHING LIQUID HYDROCARBON FIRES, U.S. PATENT NO. 3,258,423, JUNE 23, 1966//MELDRUM, D.N., AND WILLIAMS, J.R.: THE EFFECT OF WATER SPRAY ON FIRE-FIGHTING FOAM. NAT. FIRE PROTECTION ASSSOC. FIRE J., VOL. 64, NO. 1, JAN. 1970

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER, ATLANTIC CITY, N.J.
REPORT NUMBER -
AD-741881//AGFSRS 71-1//FAA-RD-71-57//FAA-NA-72-20
SPONSOR -
AIRCRAFT GROUND FIRE SUPPRESSION AND RESCUE, WRIGHT-PATTERSON AFB, OHIO. TRI-SERVICE SYSTEM PROGRAM OFFICE.
CONTRACT NUMBER -
CONTRACT F33657-67-F-1538
OTHER INFORMATION -
0264 PAGES, 0092 FIGURES, 0045 TABLES, 0057 REFERENCES

A SELF-GENERATING OVERHEAT DETECTION SYSTEM FOR USE ON USAF AIRCRAFT

by

RIEMER, O.

08/00/72

-ABSTRACT-

A self-generating overheat detection system for USAF aircraft was developed, designed, fabricated, and tested. The system consisted of a loop of sensor cable connected by way of a junction box and thermocouple type extension wires to a control unit. The developed sensor consisted of a continuous coaxial cable which changes its electrical properties as cable temperature is changes. Cable thermo-electric voltage as well as impedance is utilized in establishing alarm signal levels. Theoretical work involving such factors as thermocouple signal transmission and detection, together with an investigation of cable materials and electronic componentry available for aircraft use is described. Test results of the sensors and associated electronics used for the prototype systems together with a description of operation is supplied. The performance testing of two completed systems under simulated environmental conditions is reported. A set of installation instructions and engineering drawings for the system are appended. It is concluded that, from the standpoints of long term cable stability, discrete alarm detection, and false alarm free operation, the use of cable voltage as well as impedance in establishing alarm levels provides an effective means of overheat detection.

-SOURCE INFORMATION-

CORPORATE SOURCE -
EDISON (THOMAS A.) INDUSTRIES, WEST ORANGE, N.J. INSTRUMENT DIV.
REPORT NUMBER -
AD-749474//AFAPL-TR-72-73
SPONSOR -
AIR FORCE AERO PROPULSION LAB., WRIGHT-PATTERSON AFB, OHIO.
CONTRACT NUMBER -
CONTRACT F33615-70-C-1271
OTHER INFORMATION -
0131 PAGES, 0020 FIGURES, 0005 TABLES, 0000 REFERENCES

key 2016

WHAT FIREFIGHTERS SHOULD KNOW ABOUT DRY CHEMICAL EXTINGUISHING SYSTEMS. PART 7

by

EAHME, C.W.

05/00/69

-ABSTRACT-

DRY CHEMICAL EXTINGUISHING SYSTEMS ARE DESCRIBED. IT IS NOTED THAT DRY POWDERS ARE GRAPHITE AND SPECIAL COMPOUNDS USED IN EXTINGUISHING FIRES IN SODIUM, MAGNESIUM, AND SIMILAR METALS, WHILE DRY CHEMICALS ARE USUALLY SODIUM BICARBONATE, POTASSIUM BICARBONATE (PURPLE K), MONOAMMONIUM PHOSPHATE, AND POTASSIUM CHLORIDE (SUPER K). DRY CHEMICALS CAN BE USED ON FLAMMABLE LIQUIDS FIRES AND ON ELECTRICAL EQUIPMENT FIRES. WHILE POTASSIUM CHLORIDE IS COMPATIBLE WITH ALL KINDS OF FOAM, THE COMPATIBILITY OF EACH DRY CHEMICAL USED WITH FOAM SIMULTANEOUSLY SHOULD BE CHECKED. TYPES OF DRY CHEMICALS SHOULD NEVER BE MIXED BECAUSE THEY MAY PRODUCE DANGEROUS GAS PRESSURES AND REDUCE THEIR EFFECTIVENESS. IT IS RECOMMENDED THAT CAREFUL INSPECTION AND MAINTENANCE OF DRY CHEMICAL SYSTEMS BE CARRIED OUT REGULARLY TO INSURE THAT ALL MECHANISMS ARE OPERABLE. IN FIGHTING A FIRE IN WHICH A DRY CHEMICAL SYSTEM HAS OPERATED, IT IS RECOMMENDED THAT THE FIRE AREA NOT BE OPENED UNTIL THE DRY CHEMICAL HAS FULLY EXTINGUISHED THE FIRE. FINALLY, IT IS RECOMMENDED THAT THE EXTINGUISHING SYSTEM BE REACTIVATED AS SOON AS POSSIELE AFTER A FIRE IN ORDER TO PROTECT AGAINST REIGNITION.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FIRE PROTECTION ASSOCIATION, BOSTON, MASS.
JOURNAL PROCEEDINGS -
FIREMEN, VOL. 36, NO. 5, 37-39 (MAY 1969)
OTHER INFORMATION -
0003 PAGES, 0001 FIGURES, 0000 TABLES, 0000 REFERENCES

AQUEOUS FILM-FORMING FOAMS, FACTS AND FALLACIES

by

MELDRUM, D.N.

01/00/72

-ABSTRACT-

The practical differences in the flammable liquid petroleum product fire fighting capabilities are discussed for conventional protein base mechanical foams, fluoroprotein foams, aqueous film forming foams (AFFF), and miscellaneous other synthetic foams. The advantages of the mechanical hydrolized protein foams are their flexibility, relatively low cost, and the existence of world wide standards. Their main disadvantages are relatively poor resistance to burnoff from fuel saturation if the foam is plunged into a depth of fuel, and relative incompatibility with several of the dry chemical agents. Flucroprotein foams have the advantage of regular type foams as well as good resistance to saturation by hydrocarbon fuels, and better compatibility with dry chemicals. Although slightly more expensive, the fluoroprotein foams have been found to be better than both the regular protein foams and the AFFF for securing fuel against reflash, and resistance to overhead water application and radiant heat. Tests made with AFFF toillustrate how rapidly an AFFF can knock down a spill fire are discussed at length. Comparison data are depicted for the various foams on tank fire control and extinguishment. An AFFF has the advantage of speed of spill fire knockdown and is best with dry chemicals; its disadvantages include fast draining, relatively poor long range fuel security, and high cost. Various extinguishment experiments with AFFF are described in detail.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL FOAM SYSTEMS, INC., WEST CHESTER, PA.
JOURNAL PROCEEDINGS -
FIJOAU, FIRE J, VOL. 66, NO. 1, 57-64 (JAN. 1972)
OTHER INFORMATION -
0008 PAGES, 0015 FIGURES, 0000 TABLES, 0004 REFERENCES

keys 11961 through 11963

HOW TO SPECIFY LOW TEMPERATURE STORAGE VESSELS

by

ZICK,L.P.
CLAPP,M.B.

06/00/64

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE FACTORS NEEDING SPECIAL CONSIDERATION WHEN SPECIFYING LOW TEMPERATURE STORAGE VESSELS ARE REVIEWED. SOME OF THESE FACTORS ARE MATERIAL SELECTION, REFRIGERATION, CONTAINER SHAPE, ECONOMICS OF STORAGE, TANK DESIGN PRESSURE, PROVISIONS FOR PRODUCT EXPANSION CODES AND STANDARDS, MANUFACTURING PROCEDURES, INSULATION, CLEANING AND PURGING. THIS IS A VERY GOOD GENERAL REVIEW, BUT WITH LIMITED SPECIFIC INFORMATION.

-PERTINENT FIGURES-

TAB.1 PLATE MATERIALS USED FOR LARGE FULLY REFRIGERATED STORAGE VESSELS, PAGE 126//TAB.2 ECONOMICS OF STORAGE, PAGE 128//TAB.3 ALLOWABLE STRESSES, PAGE 130

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., ILL.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS AND PETROL REFINER VOL 43, NO. 6, 125-32 (JUN 1964)
OTHER INFORMATION -
0008 PAGES, 0007 FIGURES, 0003 TABLES, 0000 REFERENCES

keys 19563 through 19568

ABOVE-GROUND STORAGE TANKS FOR LIQUEFIED NATURAL GAS

by

WISSMILLER, I. L.

00/00/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

CODES AND STANDARDS GOVERNING ABOVE-GROUND STORAGE TANKS FOR LIQUEFIED NATURAL GAS (LNG) ARE REVIEWED IN THIS PAPER. DETAILS OF THE FOUNDATION, INNER AND OUTER SHELLS, AND INSULATION SYSTEM FOR A 300,000 BBL. TANK CONSTRUCTED IN MEMPHIS, TENNESSEE ARE GIVEN.

-PERTINENT FIGURES-

FIG.3 CUTAWAY SKETCH SHOWING DOUBLE TANK SUPPORTED ON PILE AND SLAB FOUNDATION, PAGE 4//FIG.5 CUTAWAY SKETCH SHOWING OPEN-TOP INNER TANK, PAGE 6

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., OAK BROOK, ILL.
JOURNAL PROCEEDINGS -
ASME WINTER ANNUAL MEETING AND ENERGY SYSTEMS EXPOSITION, (PRES. AT) NEW YORK, NOV 27-DEC 1, 1966. PAPER 66-WA/PID-4
OTHER INFORMATION -
0007 PAGES, 0005 FIGURES, 0000 TABLES, 0001 REFERENCES

keys 19569 through 19573

BELOWGROUND STORAGE SYSTEMS FOR LNG

by

ANDERSON, P. J.
EAKIN, B. E.
KHAN, A. R.

00/00/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE CONCEPT OF STORING CRYOGENIC FLUIDS BELOW GROUND AND THE EXISTING DESIGNS FOR FROZEN IN-GROUND AND CONCRETE-TANK STORAGE SYSTEMS ARE REVIEWED. THE BASIC DESIGN FOR THE STORAGE OF LNG IN A LINED AND INSULATED QUARRIED CAVERN IS DESCRIBED. THE CALCULATION PROCEDURES ARE DISCUSSED WHICH HAVE BEEN USED TO PREDICT THE RATES OF HEAT INFLUX INTO THESE BELOWGROUND LNG STORAGE CONTAINERS. THE EQUATIONS, SIMPLIFYING, ASSUMPTIONS, AND HEAT TRANSFER MODELS WHICH HAVE BEEN USED ARE PRESENTED, AND THE DIFFERENCES IN THE RESULTS CALCULATED BY THE VARIOUS PROCEDURES ARE DISCUSSED.

-PERTINENT FIGURES-

FIG. 1 FROZEN IN-GROUND STORAGE, PAGE 2//FIG.2 BELOWGROUND LIQUEFIED NATURAL GAS DEMONSTRATION STORAGE TANK, PAGE 3//FIG.3 STORAGE FACILITY AT TEXAS EASTERN, PAGE 4//FIG.4 SCHEMATIC DIAGRAM OF AN INSULATED AND LINED MINED CAVERN, PAGE 4

-BIBLIOGRAPHY-

NEW TANKERS SPUR INTEREST IN CRYOGENIC METHANE, CHEMICAL ENGINEERING, VOL. 73, NO. 6, MARCH 14, 1966, PP. 108-110//KHAN,A.R., JOYCE,T.J. AND HUEBLER,J., STATUS OF LNG STORAGE, PAPER PRESENTED AT AMERICAN GAS ASSOCIATION PRODUCTION CONFERENCE, NEW YORK, N. Y., MAY 25, 1964// CORBETT,R.W. AND DAVIES,C.B., GROUND STORAGE OF LNG, PAPER NO. 308 PRESENTED AT THE 1ST INTERNATIONAL CONFERENCE ON PETROLEUM AND THE SEA, MONTE CARLO, MONACO, MAY 12-20, 1965//ANDERSON,P.J. AND KHAN,A.R., STORAGE CONTAINERS FOR LIQUEFIED NATURAL GAS, CIVIL ENGINEERING, VOL. 35, NO. 8, AUGUST 1965, PP. 65-67//EAKIN,B.E., BAIR,W.G., CLOSNER,J.J. AND MARSTI,R., BELOWGROUND STORAGE OF LIQUEFIED NATURAL GAS IN PRESTRESSED CONCRETE TANKS, INSTITUTE OF GAS TECHNOLOGY TECHNICAL REPORT NO. 8, AMERICAN GAS ASSOCIATION, NEW YORK, N. Y., JULY 1963//TEXAS EASTERN UNVEILS LNG TANK PLAN, OIL AND GAS JOURNAL, VOL. 63, NO. 37, SEPT 13, 1965, PP. 64-65

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -
ASME WINTER ANNUAL MEETING AND ENERGY SYSTEMS EXPOSITION, (PRES. AT) NEW YORK, NOV 27-DEC 1, 1966. PAPER 66-WA/PID-5
OTHER INFORMATION -
0009 PAGES, 0009 FIGURES, 0000 TABLES, 0006 REFERENCES

keys 19403 through 19404

DESIGN CONSIDERATIONS FOR A LIQUEFIED NATURAL GAS PIPELINE

by

COULTER,D.M.

00/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS STUDY IS PART OF A BROAD PROGRAM OF FUNDAMENTAL RESEARCH INTO LIQUEFIED NATURAL GAS PRESENTLY UNDER WAY AT THE UNIVERSITY OF CALGARY. THIS PAPER OUTLINES SOME OF THE DESIGN CONSIDERATIONS FOR MEDIUM- AND LONG-DISTANCE TRANSPORTATION OF LNG BY AN INSULATED PIPELINE. THE DESIGN OF A MEDIUM- OR LONG-DISTANCE LIQUEFIED NATURAL GAS PIPELINE MUST INCLUDE CONSIDERATION OF PUMPING AND COOLING STATION SPACING. FOR THE COOLING STATION SPACING AN IMPORTANT DESIGN FEATURE IS THE TURN-DOWN REQUIRED ONCE THE DIAMETER OF PIPE AND TYPE OF INSULATION HAVE BEEN ESTABLISHED. DESIGNING FOR ONLY MAXIMUM FLOW WITH THE CORRESPONDING MAXIMUM STATION SPACING WOULD RESULT IN AN INOPERABLE SYSTEM WITH INADEQUATE COOLING STATION SPACING FOR THE REDUCED FLOWS WHICH WOULD OCCUR IN PRACTICE. THE AMOUNT OF TURN-DOWN REQUIRED WOULD DICTATE THE COOLING STATION SPACING NECESSARY FOR A LIQUEFIED NATURAL GAS PIPELINE.

-PERTINENT FIGURES-

FIG.1 COMPARISON OF NATURAL GAS AND LNG PIPELINES, PAGE 30//FIG.2 COMPARISON OF COOLING STATION SPACING FOR LNG PIPELINES, PAGE 31// FIG.3 EFFECT OF TURN-DOWN ON LNG PIPELINES, PAGE 32//TAB.1 TURN-DOWN FOR 4-INCH URETHANE FOAM INSULATED LNG PIPELINE, PAGE 33//TAB.2 MAXIMUM COOLING STATION SPACING FOR VARIOUS DIAMETERS AND FLOWS USING 4 INCHES OF URETHANE FOAM, PAGE 33//FIG.4 COINCIDENCE OF PUMP AND COOLING STATION SPACING FOR LNG PIPELINES, PAGE 34

-BIBLIOGRAPHY-

UHL,A.B., ET AL., STEADY FLOW IN GAS PIPELINES, INSTITUTE OF GAS TECHNOLOGY TECHNICAL REPORT NO. 10, AMERICAN GAS ASSOCIATION, INC., NEW YORK (1965), P. 147//DUFFY,A.R. AND DAINORA,V., MATERIALS OF CONSTRUCTION FOR USE IN AN LNG PIPELINE, CATALOGUE NO. L 40000, AMERICAN GAS ASSOCIATION (1968)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CALGARY UNIV., ALBERTA
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 15, 28-35 (1970) (PROC. OF CRYOGENIC ENGINEERING CONF., 15TH, LOS ANGELES, CALIF., JUN 16-8, 1969. PAPER A-4)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0008 PAGES, 0004 FIGURES, 0002 TABLES, 0003 REFERENCES

keys 19578 through 19583

START-UP EXPERIENCES AND SPECIAL FEATURES AT MEMPHIS LNG PLANT

by

STANFILL, I. C.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

CONSTRUCTION OF THE MEMPHIS LNG PLANT BEGAN IN EARLY 1966 WITH THE STORAGE TANK, AND APPROXIMATELY EIGHTEEN MONTHS LATER INITIAL STARTUP PROCEDURES WERE BEGUN. WRITTEN SIX MONTHS AFTER THE FIRST ATTEMPT WAS MADE AT STARTUP, THIS PAPER DESCRIBES FOUR MAJOR AND SEVERAL MINOR EQUIPMENT MALFUNCTIONS OCCURRING DURING THE PERIOD. THE FOUR MAJOR PROBLEMS WERE (1) LEAKS IN THE ETHYLENE CONDENSER, (2) COLD BOX FAILURE, (3) LNG PIPING LEAKS, AND (4) SWITCHGEAR FAILURE.

-SOURCE INFORMATION-

CORPORATE SOURCE -
MEMPHIS LIGHT, GAS AND WATER DIV., TENN.
JOURNAL PROCEEDINGS -
LNG INTERNATIONAL CONF., 1ST, (PROC. OF, SESSION NO. 2)
CHICAGO, ILL., APR 7-12, 1968. PAPER 7
PUBLISHER -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
OTHER INFORMATION -
0011 PAGES, 0008 FIGURES, 0000 TABLES, 0002 REFERENCES

keys 19401 through 19402

COMPUTER SIMULATION OF NATURAL GAS LIQUEFACTION PLANT PROCESSES

by

LONGWELL,P.A.
KRUSE,J.W.

00/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE OBJECTIVE OF THIS WORK WAS TO DEVELOP COMPUTER PROGRAMS WHICH WOULD PRODUCE RAPID, PRECISE, AND COMPLETE PROCESS CALCULATIONS FOR A WIDE VARIETY OF FLOW-SHEETS FOR NATURAL GAS LIQUEFACTION PLANTS. THIS HAS BEEN ACCOMPLISHED, AND THE RESULTS OF THE DEVELOPMENT, INCLUDING A SUMMARY OF THE PROBLEMS ENCOUNTERED AND THEIR SOLUTIONS, ARE REPORTED HEREIN. THE PROGRAMS DESCRIBED HAVE ALREADY BEEN USED EXTENSIVELY IN DEVISING FLOW-SHEETS AND SELECTING OPERATING CONDITIONS FOR LNG PLANTS TO MEET SPECIFIED REQUIREMENTS. THE PROGRAMS HAVE BEEN INSTRUMENTAL IN DEVELOPING SIGNIFICANTLY BETTER PLANT DESIGNS THAN WOULD OTHERWISE HAVE BEEN DONE IN THE LIMITED TIMES AVAILABLE. IN ADDITION, THE PROGRAMS RESULT IN VERY PRECISE CALCULATIONS FOR THE ENTIRE PLANT, WHICH ARE VALUABLE TO THE DESIGNER AND WHICH WOULD BE DIFFICULT TO ACCOMPLISH MANUALLY EVEN WITH COMPUTER SOLUTIONS TO SPECIFIC UNIT OPERATIONS. FUTURE DEVELOPMENTS ARE FORESEEN IN WHICH EQUIPMENT COSTS WILL BE INCORPORATED IN THE PROGRAMS IN ORDER TO EXPEDITE COST OPTIMIZATION.

-PERTINENT FIGURES-

FIG.1 LNG FLOWSHEET, PAGE 19//TAB.1 SELECTED STREAM INFORMATION (FIG. 1) AS DEVELOPED BY COMPUTER PROGRAM, PAGE 21//TAB.2 COMPRESSOR AND EXPANDER INFORMATION (FIG. 1) AS DEVELOPED BY COMPUTER PROGRAM, PAGE 21//FIG.2 GENERAL CASCADE A REPRESENTATIVE FLOWSHEET, PAGE 23//TAB.3 SELECTED STREAM INFORMATION (FIG. 2) AS DEVELOPED BY COMPUTER PROGRAM, PAGE 24

-BIBLIOGRAPHY-

WALKER,A.W., PIPE LINE INDUSTRY, 29(4).83 (1968)//WILSON,G.M., ADVANCES IN CRYOGENIC ENGINEERING, VOL. 11, PLENUM PRESS, NEW YORK (1966), P. 392

-SOURCE INFORMATION-

CORPORATE SOURCE -
AEROJET-GENERAL CORP., EL MONTE, CALIF.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 15, 18-27 (1970) (PROC. OF CRYOGENIC ENGINEERING CONF., 15TH, LOS ANGELES, CALIF., JUN 16-8, 1969. PAPER A-3)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0010 PAGES, 0005 FIGURES, 0003 TABLES, 0002 REFERENCES

key 15771

ELECTRO-SUBMERSIBLE PUMPS FOR HYDROCARBONS, LIQUIFIED GASES AND DANGEROUS LIQUIDS (GROUPES MOTO-POMPES IMMERGES POUR HYDROCARBURE, GAZ LIQUEFIES ET LIQUIDES DANGEREUX)

by

CHERON,P.

00/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	None Given	Poor

-ABSTRACT-

THIS TYPE OF PUMP WAS DEVELOPED WITH THE GOAL OF PUMPING LIQUEFIED GASES AND DANGEROUS LIQUIDS, SUCH AS METHANE, PROPANE, AND AMMONIA, WITH ADVANTAGES OF 1) A HIGH DEGREE OF SAFETY, 2) UNATTENDED OPERATION, AND 3) LOW COST OF INSTALLATION. THIS PAPER DESCRIBES A SUBMERSIBLE PUMP, BUT GIVES FEW DETAILS OF ITS DESIGN AND PERFORMANCE.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
PUMPS - POMPES - PUMPEN, 17-9 (1970)
OTHER INFORMATION -
0003 PAGES, 0005 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 13108 through 13110

PERFORMANCE OF NBS CRYOGENIC FLOW RESEARCH FACILITY

by

BRENNAN,J.A.
MANN,D.B.
DEAN,J.W.
KNEEBONE,C.H.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER IS PRIMARILY CONCERNED WITH PRESENTING THE PROVISIONAL ACCURACY STATEMENT FOR THE NBS CRYOGENIC FLOW FACILITY AND THE MEANS BY WHICH THESE ACCURACIES WERE OBTAINED. THE PAPER ALSO GIVES SOME INFORMATION ON OPERATIONAL FEATURES OF THE FACILITY AND SOME TYPICAL RESULTS OF CALIBRATIONS. SOME DISCUSSION IS PRESENTED OF FUTURE PLANS. THE ACCURACY AVAILABLE AT PRESENT IS 0.18 PERCENT FOR MASS FLOW AND 0.47 PERCENT FOR VOLUMETRIC FLOW. THE ACCURACIES ARE LIMITED TO FLOW RATES BETWEEN 20 AND 100 GALLONS/MINUTE, PRESSURES FROM 50 TO 100 PSIG AND TEMPERATURES FROM 80 TO 90 K.

-PERTINENT FIGURES-

TAB.I ERRORS DUE TO PRESSURE AND TEMPERATURE MEASUREMENTS, PAGE 203// TAB.II SYSTEMATIC ERRORS, PAGE 203//FIG.3 PERFORMANCE AS A FUNCTION OF DENSITY, PAGE 204//FIG.4 PERFORMANCE AS A FUNCTION OF TIME/ORDER, PAGE 205

-BIBLIOGRAPHY-

J. W. DEAN, J. A. BRENNAN AND D. B. MANN IN, ADVANCES IN CRYOGENIC ENGINEERING, VOL 14, PLENUM PRESS, NEW YORK (1969), PAGE 299//T. R. STROBRIDGE, NBS TECH. NOTE 129 (JAN 1962)//J. W. DEAN, J. A. BRENNAN, D. B. MANN AND C. H. KNEEBONE, NBS TECH. NOTE NO. 606 (JUL 1971)//J. A. BRENNAN, J. W. DEAN, D. B. MANN AND C. H. KNEEBONE, NBS TECH. NOTE 605 (JUL 1971)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL BUREAU OF STANDARDS, BOULDER, COLO.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 17, 199-205 (1972)

keys 12433 through 12434

NATURAL CONVECTION FILM BOILING HEAT TRANSFER

by

CLEMENTS,L.D.
COLVER,C.P.

09/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Good/Excel.

-ABSTRACT-

A COMPREHENSIVE, IN DEPTH STUDY OF NATURAL CONVECTION FILM BOILING HEAT TRANSFER IS PRESENTED. FOR THE SAKE OF CLARITY AND LOGIC, WE PRESENT OUR DISCUSSION IN SEVERAL DISTINCT SECTIONS. INITIALLY, THE EARLY FILM BOILING WORK IS HISTORICALLY SURVEYED FROM ITS INCEPTION TO THE WORK OF NUKIYAMA. THEN, THE MANY SOURCES OF EXPERIMENTAL FILM BOILING DATA ARE PRESENTED BY SUBSTANCE, AND, WHERE APPROPRIATE, TRENDS IN THE DATA ARE ALLUDED TO AND DISCUSSED. THE DISCUSSION IS INTENDED AS A MEANS OF GAINING INSIGHT INTO THE RELATIVE CONSISTENCY OF DATA FOUND IN THE LITERATURE AND INTO FACTORS AFFECTING THE FILM BOILING PROCESS. A SHORT SECTION IS GIVEN THAT SUMMARIZES PHOTOGRAPHIC WORK. THE FOURTH SECTION TREATS AND OUTLINES THE DEVELOPMENT OF MATHEMATICAL MODELS THAT HAVE BEEN PROPOSED FOR MINIMUM FILM BOILING AND STABLE FILM BOILING, AND PRESENTS THEORETICAL AND SEMI-EMPIRICAL CORRELATIONS THAT HAVE BEEN MENTIONED IN THE LITERATURE. THE READER WHO IS INTERESTED IN A MORE DETAILED PRESENTATION OF THE BASIC MATHEMATICAL MODELS USED IN FILM BOILING IS REFERRED TO THE REVIEW BY JORDON.

-PERTINENT FIGURES-

FIG.1 HYDROGEN FILM BOILING DATA, PAGE 27//FIG.3 ATMOSPHERIC PRESSURE NITROGEN FILM BOILING DATA, PAGE 30//FIG.4 DIAMETER EFFECT FOR OXYGEN FILM BOILING ON HORIZONTAL STAINLESS STEEL TUBES, PAGE 31//TAB.1 SOURCES OF FILM BOILING, PAGE 28//TAB.6 PREDICTIVE EQUATIONS FOR THE MINIMUM FILM BOILING HEAT FLUX, PAGE 35//TAB.7 STABLE FILM BOILING CORRELATIONS, PAGE 36

-SOURCE INFORMATION-

CORPORATE SOURCE -
OKLAHOMA UNIV., NORMAN
JOURNAL PROCEEDINGS -
IND. ENG. CHEM. VOL 62, NO. 9, 26-46 (SEP 1970)
OTHER INFORMATION -
0021 PAGES, 0007 FIGURES, 0008 TABLES, 0236 REFERENCES

key 19295

PRESSURE DROP OF TWO-PHASE SINGLE COMPONENT ISOTHERMAL UPWARD FLOW OF NITROGEN AND METHANE AT HIGH PRESSURES

by

LAPIN,A.
BAUER,E.

00/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

IT WAS ESTABLISHED THAT ADDITIONAL THEORETICAL AND EXPERIMENTAL STUDIES ARE NEEDED IN THE AREA OF TWO-PHASE FLOW IN THE CRYOGENIC REGION. AN APPARATUS FOR THE ACCURATE MEASUREMENT OF ISOTHERMAL PRESSURE DROP IN THE CRYOGENIC REGION WAS DESIGNED AND BUILT. NITROGEN AND METHANE DATA WERE OBTAINED AT MASS VELOCITIES OF ABOUT 1.7 X 10(5) LB/HR-FT(2) IN THE PRESSURE RANGE OF 300 TO 600 PSIA. DATA EVALUATION SHOWED APPRECIABLE DIFFERENCES BETWEEN MEASURED PRESSURE DROPS AND THE ONES PREDICTED FROM AVAILABLE CORRELATIONS. THE CHENOWETH-MARTIN TYPE CORRELATION WAS FOUND TO BE THE MOST SATISFACTORY FOR PRESSURE DROP PREDICTION IN THE CRYOGENIC REGION. THE CALCULATED CURVES SHOULD ENABLE DESIGNERS TO CALCULATE TWO-PHASE FLOW PRESSURE DROP IN THE CRYOGENIC REGION TO WITHIN 25 PERCENT. CAUTION IN THE USE OF THESE CURVES SHOULD BE EXERCISED IF EXTRAPOLATION BEYOND THE EXPERIMENTAL REGION IS REQUIRED.

-PERTINENT FIGURES-

FIG.4 PRESSURE DROP CHARACTERISTICS OF TWO-PHASE NITROGEN STREAM AT 400 PSIA, -240 DEGREES F, 1.71 X 10(5) LB/HR-FT(2), PAGE 415//FIG.5 PRESSURE DROP CHARACTERISTICS IN TWO-PHASE METHANE STREAM AT 400 PSIA, -144.5 DEGREES F, 1.42 X 10(5) LB/HR-FT(2), PAGE 415//FIG.6 PRESSURE DROP CHARACTERISTICS IN TWO-PHASE METHANE STREAM, PAGE 416//FIG.7 PRESSURE DROP CHARACTERISTICS OF A TWO-PHASE METHANE FLOW STREAM AT 400 PSIA, 1.4 X 10(5) LB/HR-FT(2), PAGE 416//FIG.8 CHENOWETH-MARTIN CORRELATION - APCI CURVES, PAGE 417

-BIBLIOGRAPHY-

BADGER,W.L. AND BANCHERO,J.T., INTRODUCTION TO CHEMICAL ENGINEERING, MCGRAW-HILL BOOK CO., NEW YORK (1955), P. 43//CROCKER,S., PIPING HANDBOOK, 4TH ED., MCGRAW-HILL BOOK CO., NEW YORK (1945), P. 112//FLOW OF FLUIDS THROUGH VALVES, FITTINGS, AND PIPE, ENGINEERING AND RESEARCH DIV., CRANE COMPANY, CHICAGO,

TECHNICAL PAPER NO. 409 (MAY 1942), P. 6//LOCKHART,R.W. AND MARTINELLI,R.C., CHEM. ENG. PROGR., 45.39 (1949)//MARTINELLI,R.C., BOELTER,L.M.K., TAYLOR,T.H.M., THOMSEN,E.G., AND MOZZIN,E.H., TRANS. ASME 66.139 (1944)

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.//BETHLEHEM STEEL CO., PA.
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 12, 409-19 (1967) (PROC. OF CRYOGENIC ENGINEERING CONF., 12TH, BOULDER, COLO., JUN 13-5, 1966. PAPER F-1)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0011 PAGES, 0008 FIGURES, 0002 TABLES, 0019 REFERENCES

key 19300

POOL BOILING OF METHANE BETWEEN ATMOSPHERIC PRESSURE AND THE CRITICAL PRESSURE

by

SCIANCE,C.T.
COLVER,C.P.
SLIEPCEVICH,C.M.

00/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

NUCLEATE AND FILM SATURATED POOL BOILING DATA HAVE BEEN OBTAINED FOR METHANE AT 12 REDUCED PRESSURES BETWEEN 0.022 AND 0.9. A COMPLETE BURNOUT FLUX VS. REDUCED PRESSURE CURVE WAS OBTAINED, AND FOUR MINIMUM FILM BOILING FLUXES WERE ESTABLISHED. AN EMPIRICAL MODIFICATION OF THE FILM BOILING EQUATIONS OF CHANG AND OF BERENSON WAS OBTAINED WHICH FITS ALL OF THE METHANE DATA VERY WELL. THE BEST FIT SLOPE FALLS BETWEEN THE THEORETICAL EXTREMES PROPOSED BY BERENSON AND CHANG. THE NUCLEATE BOILING EQUATION OF ROHSENOW WAS MODIFIED TO OBTAIN AN EQUATION WHICH FITS THE DATA BELOW REDUCED PRESSURES OF 0.7 WITH REASONABLE ACCURACY, BUT IT OVER-ESTIMATES THE TEMPERATURE DIFFERENCE ENCOUNTERED AT VERY HIGH PRESSURES. THE PEAK NUCLEATE BOILING FLUX DATA WERE FOUND TO FIT THE EQUATION OF NOYES ACCURATELY OVER THE ENTIRE PRESSURE RANGE. PREDICTIONS OF THE MINIMUM FILM BOILING FLUX WERE FOUND TO BE TOO HIGH AT HIGH PRESSURES, BUT INSUFFICIENT DATA WERE OBTAINED TO PROPOSE A DIFFERENT CORRELATION.

-PERTINENT FIGURES-

FIG.5 METHANE NUCLEATE AND FILM BOILING DATA. (FOR CORRELATIONS SEE FIGS. 6 AND 8), PAGE 400//FIG.6 METHANE NUCLEATE BOILING DATA COMPARED WITH PROPOSED CORRELATION, PAGE 401//FIG.7 METHANE BURNOUT HEAT FLUX COMPARED WITH THE NOYES EQUATION, PAGE 402//FIG.8 METHANE FILM BOILING DATA COMPARED WITH THE PROPOSED CORRELATION, PAGE 404

-BIBLIOGRAPHY-

BERENSON,P.J., TRANSITION BOILING HEAT TRANSFER FROM A HORIZONTAL SURFACE, M.I.T. HEAT TRANSFER LABORATORY TECHNICAL REPORT NO. 17 (MARCH 1960)// BRENTARI,E.G., GIARRATANO,P.J., AND SMITH,R.V., BOILING HEAT TRANSFER FOR OXYGEN, NITROGEN, HYDROGEN, AND HELIUM, NBS TN 317 (SEP 1965)// FORSTER,K. AND GREIF,R., J. HEAT TRANSFER 81(1),43 (1959)//MADEJSKI,J., INT. J. HEAT AND MASS TRANSFER

8(1).155 (1965)//PARK,E.L.,JR., COLVER,C.P., AND SLIEPCEVICH,C.M., IN. ADVANCES IN CRYOGENIC ENGINEERING, VOL. 11, PLENUM PRESS, NEW YORK (1966), P. 516//ROHSENOW,W.M., TRANS. ASME 74.969 (1952)

-SOURCE INFORMATION-

CORPORATE SOURCE -
OKLAHOMA UNIV., NORMAN
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 12, 395-408 (1967) (PROC. OF CRYOGENIC ENGINEERING CONF., 12TH, BOULDER, COLO., JUN 13-5, 1966. PAPER E-9)
PUBLISHER -
PLENUM PRESS, NEW YORK
OTHER INFORMATION -
0014 PAGES, 0008 FIGURES, 0000 TABLES, 0027 REFERENCES

key 19358

NUCLEATE AND FILM BOILING HEAT TRANSFER TO LIQUEFIED NATURAL GAS

by

BROWN,L.E.
COLVER,C.P.

00/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

IN THE PRESENT STUDY, SATURATED AND POOL BOILING HEAT TRANSFER TO LIQUEFIED NATURAL GAS (LNG) WAS INVESTIGATED. THE STUDY WAS INITIATED NOT ONLY BECAUSE OF THE VITAL INDUSTRIAL IMPORTANCE OF LNG, BUT ALSO BECAUSE OF THE LARGE AMOUNT OF NUCLEATE AND FILM BOILING DATA AVAILABLE ON THE PRINCIPAL COMPONENTS CONTAINED IN LNG. NUCLEATE AND FILM-BOILING DATA WERE TAKEN AT PRESSURES RANGING FROM 1.7 TO 486 PSIA. THE NUCLEATE BOILING TEMPERATURE DIFFERENCES INCREASED WITH INCREASING PRESSURE, AND THE TEMPERATURE DIFFERENCES WERE MUCH LARGER THAN THOSE FOR PURE METHANE. BURNOUT HEAT FLUXES WERE DETERMINED AT PRESSURES RANGING FROM 300 TO 850 PSIA, AND WERE SHOWN TO BE MUCH HIGHER THAN FOR PURE METHANE. THE AVAILABLE CORRELATIONS FAILED TO PREDICT THE EXPERIMENTAL RESULTS.

-PERTINENT FIGURES-

TAB.1 LNG CHROMATOGRAPHIC ANALYSIS, PAGE 649//FIG.3 LNG BURNOUT HEAT FLUX COMPARED WITH THE EQUATION OF NOYES AND DATA OF SCIANCE, PAGE 651//FIG.4 LNG NUCLEATE AND FILM BOILING DATA, PAGE 651//FIG.5 CORRELATED LNG FILM BOILING DATA, PAGE 653

-BIBLIOGRAPHY-

PARK,JR.,E.L., PH.D. DISSERTATION, THE UNIVERSITY OF OKLAHOMA, NORMAN, OKLAHOMA (1965)//SCIANCE,C.T., PH.D. DISSERTATION, THE UNIVERSITY OF OKLAHOMA, NORMAN, OKLAHOMA (1966)//SCIANCE,C.T., COLVER,C.P., AND SLIEPCEVICH,C.M., CHEM. ENG. PROGR. SYMPOSIUM SERIES, 63, 77 (1967)// SCIANCE,C.T., COLVER,C.P., AND SLIEPCEVICH,C.M., ADVANCES IN CRYOGENIC ENGINEERING, VOL 12, PLENUM PRESS, NEW YORK (1967), P. 395//SCIANCE,C.T., COLVER,C.P., AND SLIEPCEVICH,C.M., CHEM. ENGR. PROGR. SYMPOSIUM SERIES, 63, 77 (1967)

-SOURCE INFORMATION-

CORPORATE SOURCE -
OKLAHOMA UNIV., NORMAN
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 13, 647-54 (1968) (PROC. OF CRYOGENIC ENGINEERING CONF., 13TH, STANFORD, CALIF., AUG 21-3, 1967. PAPER K-11)
PUBLISHER -
PLENUM PRESS, NEW YORK
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, WASHINGTON, D.C.
CONTRACT NUMBER -
GRANT NGR-37-003-026
OTHER INFORMATION -
0008 PAGES, 0005 FIGURES, 0001 TABLES, 0014 REFERENCES

keys 12713 through 12715

CRYOGENIC FUELS FOR AIRCRAFT

by

ESGAR,J.B.

11/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Acceptable

-ABSTRACT-

POSSIBLE APPLICATION OF LIQ. CH(4) TO SUPERSONIC TRANSPORT-TYPE AIRCRAFT AND OF LIQ. H TO AIR-BREATHING ENGINES FOR RECOVERABLE BOOSTERS AND ORBITERS IN THE SPACE SHUTTLE ARE DISCUSSED. IT IS CONCLUDED THAT THERE ARE NO INSURMOUNTABLE PROBLEMS FOR USING EITHER LIQ. CH(4) OR LIQ. H FOR AIRCRAFT GAS-TURBINE ENGINES. ADDITIONAL COMBUSTION RESEARCH IS REQUIRED FOR CH(4) PRIMARILY TO IMPROVE THE BLOWOUT LIMITS AT HIGH ALTITUDE. ENGINES HAVE BEEN RUN WITH THESE FUELS, ALTHOUGH CRYOGENIC PUMPS THAT HAVE ADEQUATE LIFE SPANS FOR LONG-TIME AIRCRAFT OPERATION WILL BE A DEVELOPMENT PROBLEM. STUDIES HAVE BEEN MADE ON THE OVERALL AIRCRAFT PROBLEMS RESULTING FROM USE OF THIS FUEL. THE PAPER DISCUSSES, IN GENERAL TERMS, THE SAFETY PROBLEMS POSED BY BOTH LIQUID METHANE AND LIQUID HYDROGEN. THE CONCLUSION IS THAT THE HAZARDS OF HYDROGEN (WIDE FLAMMABILITY LIMITS) ARE PROBABLY TOO GREAT TO USE IT IN SUPERSONIC AIRCRAFT (COST IS ALSO A FACTOR HERE). THE MOST IMPORTANT DISCUSSION IN THE PAPER CONCERNS STORAGE OF THE TWO FLUIDS AND THE PROBLEMS ASSOCIATED WITH STORAGE. ALONG WITH THIS THE QUESTION OF USING SLUSH OR GELLED METHANE IS DISCUSSED.

-PERTINENT FIGURES-

FIG.XII-1 FUEL PROPERTY TRENDS, PAGE 413//FIG.XII-5 METHANE BOILOFF FROM REDUCED TANK PRESSURE, PAGE 415//FIG.XII-6 INSULATED METHANE TANK WEIGHTS, PAGE 416//FIG.XII-7 LOADING SUBCOOLED METHANE, PAGE 416//FIG.XII-10 LIQUID METHANE BOILOFF FOR M EQUALS 2.7 SST MISSION, PAGE 418//FIG.XII-14 BLOWOUT LIMITS FOR JET A AND METHANE COMBUSTORS, PAGE 420

-BIBLIOGRAPHY-

WELKER, J. R., WESSON, H. R., AND SLIEPCEVICH, C. M., LNG SPILLS. TO BURN OR NOT TO BURN. PREPRINT 69-D-23, DISTRIBUTION CONFERENCE OF A.G.A., OPERATING SECTION, PHILADELPHIA, PA., MAY 12-15, 1969//WHITLOW, J. B., JR., EISENBERG, J. D., AND SHOVLIN, M. D., POTENTIAL OF LIQUID-METHANE FUEL FOR MACH-3 COMMERCIAL SUPERSONIC TRANSPORTS. NASA TN D-3471, 1966//WEBER, R. J., A REVIEW OF THE POTENTIAL OF LIQUID-METHANE FUEL FOR SUPERSONIC TRANSPORTS.

PRESENTED AT THE NATIONAL ACADEMY OF SCIENCES CRYOGENIC ENGINEERING CONFERENCE, CLEVELAND, OHIO, AUG. 19-21, 1968//WALTERS, F. M., AND BUCHMANN, O. A., HEAT TRANSFER AND FLUID FLOW ANALYSIS OF HYDROGEN-COOLED PANELS AND MANIFOLD SYSTEMS. AIRESEARCH MFG. CO. (NASA CR-66925), 1970//COLLADAY, R. S., THERMAL FEASIBILITY OF USING METHANE OR HYDROGEN FUEL FOR DIRECT COOLING OF A FIRST-STAGE TURBINE STATOR, NASA TN D-6042, 1970//CHAMBELLAN, R. E., AND BEVEVINO, W. A., COMPARATIVE STUDY OF FUSELAGE TANKS FOR LIQUID-METHANE-FUELED SUPERSONIC AIRCRAFT, NASA TN D-4837, 1968

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO
REPORT NUMBER -
N71-19463//NASA-SP-259
JOURNAL PROCEEDINGS -
AIRCRAFT PROPULSION CONF., 397-420, (PROC. OF.) LEWIS RESEARCH CENTER, CLEVELAND, OHIO, NOV 18-19, 1970
OTHER INFORMATION -
0024 PAGES, 0014 FIGURES, 0001 TABLES, 0014 REFERENCES

THERMAL FEASIBILITY OF USING METHANE OR HYDROGEN FUEL FOR DIRECT COOLING OF A FIRST-STAGE TURBINE STATOR

by

COLLADAY,R.S.

10/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Acceptable

-ABSTRACT-

THE FEASIBILITY OF COOLING THE FIRST-STAGE TURBINE STATOR DIRECTLY WITH CRYOGENIC FUELS IS INVESTIGATED BASED ON A NUMERICAL HEAT TRANSFER ANALYSIS OF METHANE- AND HYDROGEN-COOLED VANES. AN INSULATION BARRIER BETWEEN THE FUEL COOLING PASSAGES AND THE EXTERNAL VANE SURFACE WAS REQUIRED TO PREVENT ADVERSE COOLING CONDITIONS. THE COOLING CONFIGURATION ANALYZED WAS THAT OF TUBULAR COOLING PASSAGES EMBEDDED IN INSULATION MATERIAL SURROUNDED BY AN OUTER VANE SHELL. THE RESULTS INDICATED THAT THE TURBINE STATOR VANES COULD BE ADEQUATELY COOLED WITH METHANE OR HYDROGEN FUEL AT A 2490 DEGREES F (1639 K) LOCAL-HOT-SPOT GAS TEMPERATURE.

-PERTINENT FIGURES-

FIG.6 TEMPERATURE DISTRIBUTION IN METHANE-COOLED VANE UNDER CRUISE CONDITIONS, PAGE 11//FIG.7 TEMPERATURE DISTRIBUTION IN METHANE-COOLED VANE UNDER TAKEOFF CONDITIONS, PAGE 11//FIG.8 TEMPERATURE DISTRIBUTION IN HYDROGEN-COOLED VANE UNDER CRUISE CONDITIONS, PAGE 13//FIG.9 TEMPERATURE DISTRIBUTION IN HYDROGEN-COOLED VANE UNDER TAKEOFF CONDITIONS, PAGE 13

-BIBLIOGRAPHY-

STEPKA, FRANCIS S. CONSIDERATIONS OF TURBINE COOLING SYSTEMS FOR MACH 3 FLIGHT. NASA TN D-4491, 1968//WHITLOW, JOHN B., JR., EISENBERG, JOSEPH D., AND SHOVLIN, MICHAEL D. POTENTIAL OF LIQUID-METHANE FUEL FOR MACH-3 COMMERCIAL SUPERSONIC TRANSPORTS. NASA TN D-3471, 1966//ANON. THERMODYNAMIC PROPERTIES OF METHANE-NITROGEN MIXTURES. RES. BULL. NO. 21, INSTITUTE OF GAS TECHNOLOGY, FEB. 1955//ANON. INVESTIGATIONS OF LIGHT HYDROCARBON FUELS WITH FLOX MIXTURES AS LIQUID ROCKET PROPELLANTS. REP. PWA-FR-1207, PRATT AND WHITNEY AIRCRAFT, 1965//WOOLLEY, HAROLD W., SCOTT, RUSSELL B., AND BRICKWEDDE, F. G. COMPILATION OF THERMAL PROPERTIES OF HYDROGEN IN ITS VARIOUS ISOTOPIC AND ORTHO-PARA MODIFICATIONS. J. RES. NAT. BUR. STANDARDS, VOL. 41, NO. 5, NOV. 1948, PP. 379-475//HENDRICKS, ROBERT C., GRAHAM, ROBERT W., HSU, YIH Y., AND FRIEDMAN, ROBERT. EXPERIMENTAL HEAT-TRANSFER RESULTS

FOR CRYOGENIC HYDROGEN FLOWING IN TUBES AT SUBCRITICAL AND SUPERCRITICAL PRESSURES TO 800 POUNDS PER SQUARE INCH ABSOLUTE. NASA TN D-3095, 1966

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO
REPORT NUMBER -
N70-42326//NASA-TND-6042
OTHER INFORMATION -
0025 PAGES, 0012 FIGURES, 0005 TABLES, 0017 REFERENCES

keys 13598 through 13599

COMPARISON OF HYDROGEN AND METHANE AS COOLANTS IN REGENERATIVELY COOLED PANELS

by

RICHARD,C.E.
WALTERS,F.M.

03/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Acceptable

-ABSTRACT-

AN ANALYTICAL STUDY HAS BEEN MADE OF THE WEIGHTS AND COOLANT REQUIREMENTS OF METHANE- AND HYDROGEN-COOLED STRUCTURAL PANELS. THE WEIGHTS WERE BASED ON DESIGN PROCEDURES FOR MINIMUM WEIGHTS DEVELOPED UNDER REFERENCES 1 AND 2. THE PRESENT STUDIES ENCOMPASSED A RANGE OF HEAT FLUXES FROM 10 TO 500 BTU/SEC-FT(2) (114 TO 5680 KW/M(2)), A RANGE OF APPLIED PRESSURES FROM 6.9 TO 250 PSI (48 TO 1720 KN/M(2)), AND COOLANT OUTLET TEMPERATURES OF 1400, 1600, AND 1790 DEGREES R, (778, 889, AND 978 K). THE RESULTS OF THE STUDY INDICATE THAT THE WEIGHT OF METHANE REQUIRED TO ACCOMMODATE A GIVEN HEAT FLUX WILL BE 4.5 TO 4.8 TIMES THAT OF HYDROGEN, BUT THAT THE TANKAGE VOLUME FOR LIQUID METHANE WILL BE 20 TO 25 PERCENT LESS THAN THAT FOR THE LIQUID HYDROGEN. PRESSURE LOSSES IN THE METHANE COOLED PANELS WERE HIGHER AND THERMAL CONDUCTANCES WERE GENERALLY LOWER THAN THOSE IN THE HYDROGEN COOLED PANELS. CONSEQUENTLY, THE METHANE COOLED PANELS WERE GENERALLY SLIGHTLY HEAVIER THAN THE HYDROGEN COOLED PANELS AND COULD NOT BE DESIGNED TO ACCOMMODATE THE HIGHER HEAT FLUXES AT THE HIGHER COOLANT OUTLET TEMPERATURES.

-PERTINENT FIGURES-

TAB.5 MINIMUM WEIGHT CONCEPT 1 PANEL WEIGHTS FOR SELECTED HEATING, LOADING, AND COOLANT OUTLET TEMPERATURE CONDITIONS, PAGE 19//TAB.6 MINIMUM WEIGHT CONCEPT 2 PANEL WEIGHTS FOR SELECTED HEATING, LOADING AND COOLANT OUTLET TEMPERATURE CONDITIONS, 21//FIG.17 COMPARISON OF MINIMUM WEIGHTS FOR CONCEPT 1 AND CONCEPT 2 METHANE-COOLED PANELS AT THREE OUTLET TEMPERATURES WITH VARIOUS HEATING AND LOADING CONDITIONS, PAGE 39//FIG.18 COMPARISON OF THE MINIMUM CONCEPT 1 PANEL WEIGHTS FOR HYDROGEN AND METHANE COOLANTS AT THREE OUTLET TEMPERATURES WITH VARIOUS HEATING AND LOADING CONDITIONS, PAGE 40//FIG.19 COMPARISON OF THE MINIMUM CONCEPT 2 PANEL WEIGHT FOR HYDROGEN AND METHANE COOLANTS AT THREE OUTLET TEMPERATURES WITH VARIOUS HEATING AND LOADING CONDITIONS, PAGE 41

-BIBLIOGRAPHY-

FLIEDER, W. G., RICHARD, C. E., BUCHMANN, O. A., AND WALTERS, F. M. AN ANALYTICAL STUDY OF HYDROGEN COOLED PANELS FOR APPLICATION TO HYPERSONIC AIRCRAFT. NASA CR-1650, 1970//WALTERS, F. M., AND BUCHMANN, O. A. HEAT TRANSFER AND FLUID FLOW ANALYSIS OF HYDROGEN COOLED PANELS AND MANIFOLD SYSTEMS. NASA CR-66925, JULY 1970//WEBER, RICHARD J., DUGAN, JAMES F., AND LUIDENS, ROBER W. METHANE-FUELED PROPULSION SYSTEMS. ASTRONAUTICS AND AERONAUTICS, VOL. 4, NO. 10, OCTOBER 1966//WHITLOW, J. B., JR. EISENBERG, J. D., AND SHOVLIN, M. D. POTENTIAL OF LIQUID-METHANE FUEL FOR MACH 3 COMMERCIAL SUPERSONIC TRANSPORTS. NASA TN D-3471, 1966//ANON. PROPERTIES OF PARA HYDROGEN. REP. 9050-6S, AEROJET GENERAL CORP., PRA-SA-DSR-30, SEPTEMBER 1963

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIRESEARCH MFG. CO., LOS ANGELES, CALIF.
REPORT NUMBER -
N71-19289//NASA-CR-1652
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LANGLEY RESEARCH CENTER, LANGLEY STATION, VA.
CONTRACT NUMBER -
CONTRACT NAS1-5002
OTHER INFORMATION -
0043 PAGES, 0019 FIGURES, 0006 TABLES, 0011 REFERENCES

keys 15540 through 15546

A HYDROGEN-ENERGY SYSTEM

by

GREGORY,D.P.

08/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	State Of Art	Good/Excel.

-ABSTRACT-

BECAUSE OF THE LIMITED SUPPLIES OF FOSSIL FUELS AVAILABLE, OUR ENERGY SUPPLY PATTERN WILL UNDERGO SOME RADICAL CHANGES IN THE NEAR FUTURE. ONE OF THE CHANGES THAT IS POSSIBLE IS THE DEVELOPMENT OF A FUEL SYSTEM BASED UPON A SYNTHETIC CHEMICAL FUEL DERIVED FROM NUCLEAR ENERGY AND FULLY RECYCLABLE MATERIALS SUCH AS AIR AND WATER. OF THE VARIOUS FUELS THAT CAN BE CONSIDERED, THE MOST LIKELY TO COME INTO USE IS HYDROGEN. THE FEASIBILITY AND INTRODUCTION OF SUCH A SYSTEM WILL NOT BE WITHOUT MAJOR PROBLEMS, MANY OF WHICH WILL REQUIRE FAIRLY LONG LEAD TIMES FOR THEIR SOLUTION. ACCORDINGLY, THE INSTITUTE OF GAS TECHNOLOGY CARRIED OUT FOR THE AMERICAN GAS ASSOCIATION A STUDY OF A NATIONWIDE HYDROGEN ENERGY PRODUCTION, TRANSMISSION, DISTRIBUTION, AND UTILIZATION SYSTEM THAT MAY ULTIMATELY TAKE THE PLACE OF THE PRESENT NATURAL GAS SYSTEM WHEN OUR FOSSIL FUEL SUPPLIES BECOME SCARCE. THE STUDY WAS INTENDED TO ESTABLISH THE FEASIBILITY OF SUCH A CONCEPT, TO IDENTIFY MAJOR PROBLEMS AND TIMETABLES INVOLVED, AND TO RECOMMEND A PLAN FOR FURTHER INVESTIGATIONS. THAT STUDY, WHICH IS REPORTED HERE, COMMENCED IN JUNE 1971. THE STUDY CONSIDERS HYDROGEN PRODUCTION, TRANSMISSION, STORAGE, DISTRIBUTION, UTILIZATION, AND SAFETY, WITH THE CURRENT STATE OF THE ART AND WITH THE MOST PROBABLE IMPROVEMENTS. HYDROGEN IS COMPARED TO THE ALTERNATIVES IN TERMS OF COST AND SAFETY. THIS IS A VERY COMPLETE COVERAGE OF ALL PHASES OF THE SUBJECT.

-PERTINENT FIGURES-

TAB.3-2 SUMMARY OF ELECTROLYTIC HYDROGEN PLANT EQUIPMENT, PAGE III-15// TAB.4-1 MATERIALS GROUPED BY SUSCEPTABILITY TO HYDROGEN ENVIRONMENT EMBRITTLEMENT, PAGE IV-11//TAB.5-1 SOME DENSITY, HEATING VALUE, AND COMPRESSIBILITY FACTOR COMPARISONS BETWEEN NATURAL GAS (TAKEN AS METHANE) AND HYDROGEN, PAGE V-11//TAB.7-1 COMPARISON OF VARIOUS HYDROGEN STORAGE SYSTEMS, PAGE VII-37//TAB.8-1 HAZARDOUS PROPERTIES OF HYDROGEN AND A TYPICAL NATURAL GAS, PAGE VIII-2//TAB.8B1 REGULATORY GUIDELINES FOR DISTRIBUTION OF HYDROGEN, PAGE VIII-37

-BIBLIOGRAPHY-

DEPARTMENT OF TRANSPORTATION, HAZARDOUS MATERIALS REGULATIONS BOARD, TRANSPORTATION OF NATURAL AND OTHER GAS BY PIPELINE, MINIMUM SAFETY STANDARDS, FED. REGISTER VOL 35, NO. 161, PART II (1970) AUG 19//DRELL,I.L. AND BELLES,F.E., SURVEY OF HYDROGEN COMBUSTION PROPERTIES, NASA REP. 1383. CLEVELAND. LEWIS FLIGHT PROPULSION LABORATORY, 1958//HYDROGEN SAFETY MANUAL, REP. TM-X-52454, 15. WASHINGTON, D.C., NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, 1968//NATIONAL FIRE PROTECTION ASSOCIATION, NATIONAL FIRE CODE, VOL 2, GASES, 50A-1. BOSTON, 1970-71//ROSEN,B., DAYAN,V.H. AND PROFFIT,R.L., HYDROGEN LEAK AND FIRE DETECTION. A SURVEY, REP. SP-5092, 6. WASHINGTON, D.C., NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, 1970// ZABETAKIS,M.G. AND BURGESS,D.S., RESEARCH ON THE HAZARDS ASSOCIATED WITH PRODUCTION AND HANDLING OF LIQUID HYDROGEN, RI 5707. WASHINGTON, D.C., U.S. DEPARTMENT OF INTERIOR, BUREAU OF MINES, 1961

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
REPORT NUMBER -
L21173
SPONSOR -
AMERICAN GAS ASSOCIATION, ARLINGTON, VA.
CONTRACT NUMBER -
PROJECT IU-4-6
OTHER INFORMATION -
0460 PAGES, 0081 FIGURES, 0048 TABLES, 0196 REFERENCES

DETONATION AND BURNING CHARACTERISTICS OF LIQUID OXYGEN-LIQUID METHANE MIXTURES

by

OHARA, J.
ORTH, L.P.
SMITH, N.A.
BOYLAN, D.M.

01/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

AN EXPERIMENTAL INVESTIGATION WAS CONDUCTED INTO THE HAZARDOUS BEHAVIOR OF LIQUID OXYGEN-LIQUID METHANE MIXTURES. AN ATTEMPT WAS MADE TO FIND A CRITICAL DIAMETER/NON-FLOWING FOR MIXTURE RATIOS (MR) OF 3.5 AND 4.5, HOWEVER, NONE COULD BE FOUND. HOLE DIAMETERS (D) DOWN TO .006 INCHES WITH L/D IS GREATER THAN 10 AND DOWN TO .0155 INCHES WITH L/D IS GREATER THAN 100 WERE INVESTIGATED. IN EACH CASE THE DETONATION WAVE PROPAGATED THROUGH THE HOLE. A JET STREAM OF THE MIXTURE WAS PASSED THROUGH AN OPEN FLAME. AT THE HIGHER JET VELOCITIES THE STREAM WOULD NOT IGNITE, WHILE AT LOW VELOCITIES THE STREAM WOULD BURN SMOOTHLY. THE BURNING VELOCITY WAS FOUND TO BE ABOUT 3-1/2 FPS FOR D # .063 INCHES AND MR # 3.5 AND DECREASED TO ABOUT 2-1/2 FPS FOR D # .018 INCHES AND MR # 4.5. TESTS WERE CONDUCTED TO SEE IF A DETONATION WAVE WOULD PROPAGATE FROM ONE CONTAINER OF THE MIXTURE TO ANOTHER THROUGH A SOLID WALL SEPARATING THE TWO CONTAINERS. IT WAS FOUND THAT THE DETONATION WAVE WOULD NOT PROPAGATE THROUGH A 1/4 INCH THICK ALUMINUM BARRIER. IT WAS ALSO FOUND THAT A HALF SINE WAVE ACCELERATION OF 21 GS ALONG THE LONGITUDINAL AXIS OF A COLUMN OF THE MIXTURE 6 INCHES HIGH AND .33 INCHES IN DIAMETER WOULD NOT CAUSE THE MIXTURE TO DETONATE.

-PERTINENT FIGURES-

FIG.1 DIAGRAM OF PHYSICAL SYSTEM, PAGE 14//FIG.2 CONFIGURATION NF-3A, PAGE 15//FIG.7 CONFIGURATION FOR FLOW TESTS, PAGE 20//FIG.8 SHOCK TEST SAMPLE CUP, PAGE 21

-BIBLIOGRAPHY-

EVERY, R. L., AND THIEME, J. O., LIQUID OXYGEN AND LIQUID METHANE MIXTURES AS ROCKET MONOPROPELLANTS, JOURNAL OF SPACECRAFT AND ROCKETS, VOL. 2, NO. 5, SEPT. - OCT. 1965//MCKINLEY, C., AND HIMMELBERGER, F., THE ROLE OF AIR CONTAMINANTS IN FORMULATING

OXYGEN PLANT SAFETY PRINCIPLES, CHEMICAL ENGINEERING PROGRESS, VOL. 53, NO. 3, PP. 112-121, MARCH 1957//OHARA, J., ORTH, L. P., SMITH, N. A., AND BOYLAN, D. M., INVESTIGATION OF THE HAZARDOUS BEHAVIOR OF LIQUID OXYGEN-LIQUID METHANE MIXTURES, DEPARTMENT OF MECHANICAL ENGINEERING, TULANE UNIVERSITY, DECEMBER 1969//STRENG, A. G., AND KIRSHENBAUM, A. D., EXPLOSIVE SYSTEMS CONTAINING LIQUID OXYGEN, LIQUID OXYGEN-LIQUID METHANE MIXTURES, JOURNAL OF CHEMICAL AND ENGINEERING DATA, VOL. R, NO. 2, PP. 127-131, APRIL 1959//TAYLOR, J., DETONATION IN CONDENSED EXPLOSIVES, OXFORD 1952//THIEME, J. O., AND EVERY, R. L., IGNITION AND COMBUSTION CHARACTERISTICS OF LIQUID OXYGEN AND LIQUID METHANE MIXTURES, CHEM. ENG. PROG. SYMP. SERIES, AEROSPACE CHEM. ENG., VOL. 62, NO. 61, PP. 113-117, MAY 1965//THIEME, J. O., AND EVERY, R. L., EVALUATION OF LOX-LCH(4) MIXTURES AS ROCKET MONOPROPELLANTS, CONTINENTAL OIL COMPANY, RESEARCH REPORT NUMBER 566-1-1-63, DEC. 16, 1963 (PONCA CITY, OKLAHOMA)//THE BOEING COMPANY, LOX/METHANE MONOPROPELLANT FEASIBILITY STUDY, DOCUMENT NO. D5-14212, 1969

-SOURCE INFORMATION-

CORPORATE SOURCE -
TULANE UNIVERSITY, NEW ORLEANS, LA.
JOURNAL PROCEEDINGS -
CRYOG. ENG. CONF., 1-21, UNIVERSITY OF COLO., BOULDER, COLO, JUN 17-9, 1970. PAPER F-2
OTHER INFORMATION -
0021 PAGES, 0008 FIGURES, 0000 TABLES, 0008 REFERENCES

keys 9096 through 9100

FLAMMABILITY CHARACTERISTICS OF COMBUSTIBLE GASES AND VAPORS

by

ZABETAKIS, M.G.

00/00/65

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	State Of Art	Good/Excel.

-ABSTRACT-

THIS IS A SUMMARY OF THE AVAILABLE LIMIT OF FLAMMABILITY, AUTOIGNITION, AND BURNING-RATE DATA FOR MORE THAN 200 COMBUSTIBLE GASES AND VAPORS IN AIR AND OTHER OXIDANTS, AS WELL AS OF EMPIRICAL RULES AND GRAPHS THAT CAN BE USED TO PREDICT SIMILAR DATA FOR THOUSANDS OF OTHER COMBUSTIBLES UNDER A VARIETY OF ENVIRONMENTAL CONDITIONS. SPECIFIC DATA ARE PRESENTED ON THE PARAFFINIC, UNSATURATED, AROMATIC, AND ALICYCLIC HYDROCARBONS, ALCOHOLS, ETHERS, ALDEHYDES, KETONES, AND SULFUR COMPOUNDS, AND AN ASSORTMENT OF FUELS, FUEL BLENDS, HYDRAULIC FLUIDS, ENGINE OILS, AND MISCELLANEOUS COMBUSTIBLE GASES AND VAPORS. IN ADDITION THIS SURVEY CONTAINS A SECTION ON HYDROGEN INCLUDING INFORMATION ON LIQUID HYDROGEN BURNING CHARACTERISTICS AND RATES AS WELL AS THE HAZARDS ASSOCIATED WITH HYDROGEN SPILLS. SOME DATA IS ALSO INCLUDED ON LIQUID METHANE. THIS IS EXCELLENT WORK.

-PERTINENT FIGURES-

FIG.115 RATE OF VAPORIZATION OF LIQUID HYDROGEN FROM PARAFFIN IN A 2.8-INCH DEWAR FLASK. INITIAL LIQUID DEPTH -- 6.7 INCHES, PAGE 93//FIG.116 THEORETICAL LIQUID REGRESSION RATES FOLLOWING SPILLAGE OF LIQUID HYDROGEN ONTO, A, AN AVERAGE SOIL, B, MOIST SANDY SOIL, AND C, DRY SANDY SOIL, PAGE 93//FIG.118 EXTENT OF FLAMMABLE MIXTURES AND HEIGHT OF VISIBLE CLOUD FORMED AFTER RAPID SPILLAGE OF 3 LITERS OF LIQUID HYDROGEN ON A DRY MACADAM SURFACE IN A QUIESCENT AIR ATMOSPHERE AT 15 DEGREES C, PAGE 94//FIG.119 MOTION PICTURE SEQUENCE OF VISIBLE CLOUDS AND FLAMES RESULTING FROM RAPID SPILLAGE OF 7.8 LITERS OF LIQUID HYDROGEN ON A GRAVEL SURFACE AT 18 DEGREES C, PAGE 95//FIG.120 MAXIMUM FLAME HEIGHT AND WIDTH PRODUCED BY IGNITION OF VAPOR-AIR MIXTURES FORMED BY SUDDEN SPILLAGE OF 2.8 TO 89 LITERS OF LIQUID HYDROGEN, PAGE 96//FIG.121 BURNING RATES OF LIQUID HYDROGEN AND OF LIQUID METHANE AT THE BOILING POINTS IN 6-INCH-PYREX DEWAR FLASKS, PAGE 96

-SOURCE INFORMATION-

CORPORATE SOURCE -

BUREAU OF MINES, PITTSBURGH, PA.
REPORT NUMBER -
BM-BULL-627
OTHER INFORMATION -
0121 PAGES, 0131 FIGURES, 0022 TABLES, 0249 REFERENCES

keys 9143 through 9144

FIRE AND EXPLOSION HAZARDS OF CRYOGENIC LIQUIDS

by

VAN DOLAH,R.W.

06/09/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Good/Excel.

-ABSTRACT-

REVIEW OF PHYSICAL AND PHYSIOLOGICAL HAZARDS OF CRYOGENIC LIQUIDS, WITH EMPHASIS ON THE FIRE AND EXPLOSION PROBLEMS ASSOCIATED WITH STORAGE AND HANDLING. LIQUID HYDROGEN AND LIQUID METHANE ARE THE FUELS CONSIDERED, WITH HYDROGEN RECEIVING THE MOST EMPHASIS. PROBLEMS DISCUSSED ARE DETECTION, EASE OF IGNITION, EXPLOSION PRESSURES, POOL BURNING, AND LARGE VOLUME DISPOSAL BY MEANS OF VENT STACKS OR BURN PONDS. SEVERAL APPROACHES TO THE QUESTION OF SEPARATION DISTANCES FOR LARGE VOLUME STORAGE ARE EXAMINED. LIQUID OXIDIZERS SUCH AS OXYGEN, FLUORINE AND NITRIC OXIDE, WHICH PRESENT SEVERE FIRE PROBLEMS IF SPILLED BECAUSE OF INCREASED BURNING RATES OF COMBUSTIBLES IN THE OXIDANT-ENRICHED ATMOSPHERE AND THE POSSIBILITY OF MIXING WITH LIQUID FUELS TO PRODUCE CONDENSED PHASE EXPLOSIVES, ARE DISCUSSED. IN PARTICULAR, FLUORINE PRESENTS UNIQUE HAZARDS BECAUSE OF ITS EXTREME REACTIVITY WITH NEARLY ALL OF THE MATERIALS IT MAY CONTACT, AND NITRIC OXIDE HAS AN UNANTICIPATED SENSITIVITY TOWARD DETONATION.

-PERTINENT FIGURES-

FIG.9-2 DISPERSION OF METHANE FROM POOLS, PAGE 233//FIG.9-3 EXTENT OF FLAMMABLE ZONE ABOVE DOWNWIND DIKE FOLLOWING SPILLAGE OF LNG, PAGE 234// FIG.9-4 EXTENT OF THE FLAMMABLE MIXTURES AND HEIGHT OF THE VISIBLE CLOUD FORMED AFTER THE RAPID SPILLAGE OF LIQUID HYDROGEN, PAGE 235//FIG.9-5 RELATION BETWEEN BURNING RATES AND THERMOCHEMISTRY OF FUELS, PAGE 237// FIG.9-6 VARIATION IN DISTANCE FOR 2 CALORIES PER SQUARE CENTIMETER WITH MASS OF LIQUID HYDROGEN, PAGE 238//TAB.9-4 COMPARISON OF MINIMUM DISTANCES FROM LIQUID HYDROGEN STORAGE TO EXPOSURES, PAGE 239

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA. DEPARTMENT OF THE INTERIOR
REPORT NUMBER -
A69-33679
JOURNAL PROCEEDINGS -
APPLICATIONS OF CRYOGENIC TECHNOLOGY (CRYOGENIC TECHNOLOGY

SYMP. OF CRYO-68, CHICAGO, ILL., JUN 9-12, 1968. LECTURE)
OTHER INFORMATION -
0021 PAGES, 0006 FIGURES, 0006 TABLES, 0025 REFERENCES

keys 5853 through 5855

LABORATORY SAFETY

by

ZABETAKIS,M.G.

00/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

THIS CHAPTER IS CONCERNED WITH THE HANDLING AND STORAGE OF CRYOGENIC FLUIDS IN SMALL QUANTITIES, DISPOSAL OF SUCH FLUIDS, OPERATIONAL PROCEDURES ASSOCIATED WITH CRYOGENIC FLUIDS, AND PERSONNEL PROTECTION. BRIEF COVERAGE IS GIVEN TO MOST OF THE MATERIAL PRESENTED HERE, BUT IT PROVIDES A GOOD STARTING POINT FOR FURTHER STUDY.

-PERTINENT FIGURES-

FIG.51 FLAME-STABILITY DIAGRAM FOR METHANE IN AIR, PAGE 88

-BIBLIOGRAPHY-

THE GENERAL SAFETY COMMITTEE OF THE MANUFACTURING CHEMISTS ASSOCIATION, INC., GUIDE FOR SAFETY IN THE CHEMICAL LABORATORY, D. VAN NOSTRAND CO., INC., NEW YORK, 1954, PP. 1-6//NATIONAL SAFETY COUNCIL ACCIDENT PREVENTION MANUAL FOR INDUSTRIAL OPERATIONS, NATIONAL SAFETY COUNCIL, CHICAGO, 1959, CHAPTERS 1-10//H.A.J. PIETERS AND J.W. CREYGHTON, SAFETY IN THE CHEMICAL LABORATORY, ACADEMIC PRESS, INC., NEW YORK, 1957, PP. 1-305//HOWARD H. FAWCETT AND WILLIAM S. WOOD, SAFETY AND ACCIDENT PREVENTION IN CHEMICAL OPERATIONS, JOHN WILEY AND SONS, INC., NEW YORK, 1965, PP. 1-617//RUSSEL B. SCOTT, CRYOGENIC ENGINEERING, D. VAN NOSTRAND CO., INC., PRINCETON, N.J., 1959, PP. 142-214//RALPH LANDAU AND R. ROSEN, INDUSTRIAL HANDLING OF FLUORINE, IND. ENG. CHEM., 39.281-286 (1947)//S.G. TURNBULL, A.F. BENNING, G.W. FELDMANN, A.L. LINCH, R.C. MCHARNESS, AND M.K. RICHARDS, ANALYSIS AND DISPOSAL OF FLUORINE, IND. ENG. CHEM., 39.286-288 (1947)//W.P. HENDERSON (CHAIRMAN) ET AL., THE HANDLING AND STORAGE OF LIQUID PROPELLANTS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C., 1963, PP. 95-108//HAROLD W. SCHMIDT, REACTION OF FLUORINE WITH CARBON AS A MEANS OF FLUORINE DISPOSAL, NACA RM E57E02, NASA, WASHINGTON, D.C., 1957, PP. 1-17//DAVID BURGESS AND MICHAEL G. ZABETAKIS, FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS, BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR, REPORT OF INVESTIGATIONS 6099, PITTSBURGH, 1962, 34 PP.//JOSEPH GRUMER, MARGARET E. HARRIS, AND VALERIA R. ROWE, FUNDAMENTAL

FLASHBACK, BLOWOFF, AND YELLOW-TIP LIMITS OF FUEL GAS-AIR MIXTURES, BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR, REPORT OF INVESTIGATIONS 5225, PITTSBURGH, 1956, 199PP.//BERNARD LEWIS AND GUENTHER VON ELBE, COMBUSTION, FLAMES AND EXPLOSIONS OF GASES, 2ND ED., ACADEMIC PRESS, INC., NEW YORK, 1961, 731 PP.//J.D. HAJEK AND E.E. LUDWIG, HOW TO DESIGN SAFE FLARE STACKS, PETRO/CHEM ENGINEER, JUNE 1960, PP. C31-C38, JULY 1960, PP. C44-C51//A. ROBERTS, B.R. PURSALL, AND J.B. SELLERS, METHANE LAYERING IN MINE AIRWAYS COLLIERY GUARDIAN, 205.535-541, 588-593, 630-636, 723-732, 756-763 (1962)//HENRY E. PERLEE, ISRAEL LIEBMAN, AND MICHAEL G. ZABETAKIS, FORMATION AND FLAMMABILITY OF STRATIFIED METHANE-AIR MIXTURES, BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR, REPORT OF INVESTIGATIONS 6348, PITTSBURGH,

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.

JOURNAL PROCEEDINGS -
SAFETY WITH CRYOGENIC FLUIDS, CH. 5, 82-97 (1967)
OTHER INFORMATION -
0016 PAGES, 0004 FIGURES, 0000 TABLES, 0028 REFERENCES

keys 2984 through 2985

IGNITION AND COMBUSTION CHARACTERISTICS OF LIQUID OXYGEN AND LIQUID METHANE MIXTURES

by

THIEME,J.O.
EVERY,R.L.

05/00/65

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER PRESENTS THE RESULTS OF A STUDY NECESSARY TO EVALUATE THE POSSIBILITY OF USING LIQUID OXYGEN-LIQUID METHANE MIXTURES AS ROCKET MONO PROPELLANTS. THE EXPERIMENTS WERE DESIGNED TO DETERMINE THE IGNITION AND CONTROLLED BURNING FEASIBILITY OF THESE FUEL AND OXIDIZER MIXTURES. RESULTS OF THESE TESTS SHOW THAT LIQUID OXYGEN-LIQUID METHANE MIXTURES CAN BE BURNED UNDER CERTAIN CONDITIONS. THESE CONDITIONS ARE PRESENTED AS WELL AS LESS FAVORABLE CONDITIONS WHERE DETONATION CAN BE EXPECTED TO OCCUR. PHOTOGRAPHS OF THE DAMAGE INCURRED FROM AN UNEXPECTED DETONATION ARE ALSO INCLUDED. A CURSORY INVESTIGATION OF THE DAMAGED EQUIPMENT DID NOT REVEAL THE CAUSE ALTHOUGH A BLOCKED N(2) PRESSURIZATION LINE IS PROBABLE.

-PERTINENT FIGURES-

FIG.1 BIPROPELLANT TANK SYSTEM, PAGE 114//FIG.2 MONOPROPELLANT FUEL TANK, PAGE 114//FIG.3 LIQUID OXYGEN-LIQUID METHANE PRESSURE TANK, PAGE 115//FIG.4 OPERATIONAL SKETCH OF MONOPROPELLANT CHARGING SCHEME AND TEST EQUIPMENT, PAGE 115//FIG.5 LIQUID METHANE-AIR FLAME, PAGE 115//FIG.6 FUEL-RICH LIQUID OXYGEN-LIQUID METHANE FLAME, PAGE 115//FIG. 7 3 TO 1 LIQUID OXGYEN-LIQUID METHANE FLAME, PAGE 116//FIG.8 3 TO 1 LIQUID OXYGEN-LIQUID METHANE FLAME, PAGE 116//FIG.9 EXPLOSION DAMAGE, PAGE 116//FIG.10 EXPLOSION DAMAGE, PAGE 116

-BIBLIOGRAPHY-

EVERY, RICHARD L., AND JAMES O. THIEME, J. SPACECRAFT ROCKETS, 2 787-789 (1965)//STRENG,A.G., AND A.D. KIRSHENBAUM, J. CHEM. ENG. DATA, 4, 127-131 (1959)//MCKINLEY, CLYDE, IMPROVEMENTS IN AND RELATING TO EXPLOSIVES, BRITISH PATENT NO. 855, 200 (NOVEMBER 30, 1960)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CONTINENTAL OIL CO., PONCA CITY, OKLA.
JOURNAL PROCEEDINGS -
AEROSPACE CHEM. ENG., CHEM. ENG. PROG. SYMP. SER. VOL 62, NO. 61, 113-7 (MAY 1965)
OTHER INFORMATION -
0005 PAGES, 0010 FIGURES, 0000 TABLES, 0003 REFERENCES

NATURAL GAS-AIR EXPLOSIONS AT REDUCED PRESSURE. DETONATION VELOCITIES AND PRESSURES

by

GERSTEIN,M.
CARLSON,E.R.
HILL,F.U.

12/00/54

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

EXPLOSIONS OF STOICHIOMETRIC NATURAL GAS-AIR MIXTURES CAN DEVELOP VELOCITIES CHARACTERISTIC OF DETONATIONS AT INITIAL PRESSURES AS LOW AS 0.2 ATMOSPHERE. MEASURED EXPLOSION PRESSURES EXCEEDED THE THEORETICALLY PREDICTED PRESSURES OF A DETONATION. THE DETONATION HAZARD CAN BE REDUCED BY THE PROPER APPLICATION OF WATER SPRAYS IN THE REGION IN WHICH THE DETONATION IS BEING DEVELOPED. THE COMBINATION OF WATER SPRAYS AND A LARGE INCREASE IN THE VOLUME OF THE SYSTEM STOPPED THE ESTABLISHED DETONATION.

-PERTINENT FIGURES-

TAB.1 FINAL DETONATION VELOCITIES, PAGE 2561//TAB.2 DETONATION PRESSURES, PAGE 256//TAB.3 EFFECTIVENESS OF WATER INJECTION, PAGE 2562

-BIBLIOGRAPHY-

GERSTEIN, M., LEVINE, O., AND WONG, E. L., J. AM. CHEM. SOC. 72, 418-22 (1951)//JOST, W., EXPLOSION AND COMBUSTION PROCESSES IN GASES, NEW YORK, MCGRAW-HILL BOOK CO., 1946//LEWIS, B., AND VON ELBE, G., COMBUSTION, FLAMES AND EXPLOSIONS OF GASES, NEW YORK, ACADEMIC PRESS, 1951//NATL. BUR. STANDARDS, SELECTED VALUES OF PROPERTIES OF HYDROCARBONS, CIRC. C 461 (1947)//TURIN, J. J., AND HUEBLER, J., AMERICAN GASS ASSOCIATION, REPORTS TO COMMITTEE ON INDUSTRIAL AND COMMERCIAL GAS RESEARCH PROJECT 1 GR 59 (JULY 1950, APRIL 1951)

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, CLEVELAND, OHIO. LEWIS FLIGHT PROPULSION LAB.
JOURNAL PROCEEDINGS -

IND. ENG. CHEM. VOL 46, 2558-2562 (DEC 1954) (PRES. AT THE AMERICAN CHEMICAL SOCIETY MEETING, 124TH, CHICAGO, ILL.)
OTHER INFORMATION -
0005 PAGES, 0007 FIGURES, 0003 TABLES, 0005 REFERENCES

keys 15059 through 15068

REVIEW OF FIRE AND EXPLOSION HAZARDS OF FLIGHT VEHICLE COMBUSTIBLES

by

PERLEE, H. E.
LIEBMAN, I.
ZABETAKIS, M.G.

04/00/63

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Incremental	Good/Excel.

-ABSTRACT-

THIS IS THE THIRD IN A SERIES OF REPORTS ON THE FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH COMBUSTIBLES AND OTHER GASES LIKELY TO BE FOUND IN AIRCRAFT AND MISSILE SYSTEMS. IT PRESENTS THEORETICAL AND EXPERIMENTAL RESULTS ON HOMOGENEOUS AND HETEROGENEOUS MIXTURES IN AIR. TWO PRESSURE PEAKS WERE OBSERVED IN VENTING HYDROGEN-AIR MIXTURES INTO A LOW PRESSURE ATMOSPHERE. WHEN VENTING A FIRE ABOVE A LIQUID POOL UNDER THE SAME CONDITIONS, THE LIQUID REGRESSION RATE AND FLAME SIZE WERE FOUND TO INCREASE. MOLECULAR DIFFUSION APPEARS TO BE THE CHIEF FACTOR IN ESTABLISHING THE POSITION OF THE LOWER LIMIT OF FLAMMABILITY OF BOTH LIGHTER-THAN-AIR AND HEAVIER-THAN-AIR COMBUSTIBLE, QUIESCENT, GAS LAYERS, THE POSITION OF THE UPPER LIMIT CANNOT BE PREDICTED BY CONSIDERING MOLECULAR DIFFUSION ALONE. THE RATIO OF THE WORK DONE AGAINST THE GRAVITATIONAL FORCE TO THAT DONE BY THE TURBULENT STRESSES IS USEFUL IN ANALYZING MIXING PROCESSES IN FLOWING, LAYERED SYSTEMS. THE GRAVITATIONAL FIELD STRENGTH ALSO APPEARS TO AFFECT THE TIME DELAY BEFORE IGNITION OF A COMBUSTIBLE VAPOR IN AIR.

-PERTINENT FIGURES-

FIG.2 PRESSURE TRACES PRODUCED FOLLOWING THE IGNITION OF A UNIFORM HYDROGEN-AIR MIXTURE CONTAINING 13 VOLUME PERCENT HYDROGEN FOR VARIOUS EXTERNAL VENT PRESSURES, PAGE 15//FIG.5 MAXIMUM PRESSURES DEVELOPED DURING THE COMBUSTION OF STRATIFIED LAYERS OF METHANE-AIR MIXTURES IN AIR FOR VARIOUS DIFFUSION TIMES, AND INITIAL METHANE CONCENTRATIONS, PAGE 18//FIG.7 RANGE OF FLAMMABLE MIXTURE COMPOSITIONS FORMED FROM THE DIFFUSION OF METHANE INTO AIR AT 75 F, PAGE 20//FIG.20 EFFECTS OF NATURAL GAS FLOW RATE, VENTILATION VELOCITY, AND LOCATION OF IGNITION SOURCE ON THE FLAME VELOCITY THROUGH STRATIFIED NATURAL GAS-AIR LAYERS IN A 6.5-FT DIAMETER GALLERY, PAGE 33//FIG.23 PRESSURE HISTORIES FOLLOWING (A) VENTING A 24-INCH DIAMETER SPHERE AT 15 PSIA PRESSURE INTO A LOW PRESSURE ENVIRONMENT (0.01 PSIA), (B) VENTING THE SAME SPHERE CONTAINING A BURNING POOL OF LIQUID UDMH AND (C) VENTING A GAS

PHASE EXPLOSION OF GASOLINE VAPORS IN AIR, PAGE 36//FIG.24 AUTOIGNITION TIME DELAYS OF N-DECANE IN 5-INCH DIAMETER STAINLESS STEEL SPHERICAL VESSELS AT 417 DEGREES F FOR ACCELORATIONAL FIELDS OF 1 G AND 10 G, PAGE 37

-BIBLIOGRAPHY-

VAN DOLAH,R.W., ZABETAKIS,M.G., BURGESS,D.S., AND SCOTT,G.S., REVIEW OF FIRE AND EXPLOSION HAZARDS OF FLIGHT VEHICLE COMBUSTIBLES. ASD TECHNICAL REPORT 61-278, 1961//SCOTT,G.S., PERLEE,H.E., MARTINDILL,G.H., AND ZABETAKIS,M.G., REVIEW OF FIRE AND EXPLOSION HAZARDS OF FLIGHT VEHICLE COMBUSTIBLES. ASD TECHNICAL REPORT 61-278, SUPPLEMENT 1, 1962//SIMMONDS,W.A., AND CUBBAGE,P.A., THE DESIGN OF EXPLOSION RELIEFS FOR INDUSTRIAL DRYING OVENS. PROC. OF THE SYMPOSIUM ON CHEMICAL PROCESS HAZARDS. INST. OF CHEMICAL ENGINEERS (LONDON), 1960//COWARD,H.F., AND HARTWELL,F.J., STUDIES IN THE MECHANISM OF FLAME MOVEMENT. I. THE UNIFORM MOVEMENT OF FLAME IN MIXTURES OF METHANE AND AIR, IN RELATION TO TUBE DIAMETER. J. CHEM. SOC., 1932, PP. 1996-2004//BERGER,L.B., AND DAVENPORT,S.J., EFFECTS OF THE INHALATION OF OXYGEN. BUMINES INF. CIRC. 7575, 1950, P. 11//BURGESS,D.S., STRASSER,A., AND GRUMER,J., DIFFUSIVE BURNING OF LIQUID FUELS IN OPEN TRAYS. FIRE RESEARCH ABSTRACTS AND REVIEWS, V. 3, 1961, PP. 177-192

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
REPORT NUMBER -
ASD-TR-61-278-SUPPL-2//AD-417126
SPONSOR -
AIR FORCE SYSTEMS COMMAND, WRIGHT-PATTERSON AFB, OHIO. AERONAUTICAL SYSTEMS DIV.
CONTRACT NUMBER -
ORDER (33-616)-60-8
OTHER INFORMATION -
0049 PAGES, 0031 FIGURES, 0000 TABLES, 0013 REFERENCES

keys 13789 through 13791

EAST OHIO GAS COMPANY EXPLOSION AND CONFLAGRATION CLEVELAND, OHIO OCTOBER 20, 1944

by

NEWELL,H.E.
DE MELTO,V.N.
KRIEGER,H.L.
WRIGHT,T.H.

00/00/44

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	Summary	Acceptable

-ABSTRACT-

FIRE AND EXPLOSION, APPARENTLY RESULTING FROM A LEAK IN ONE OF FOUR STORAGE TANKS FOR LIQUEFIED NATURAL GAS, RESULTED IN THE DEATH OF APPROXIMATELY ONE HUNDRED AND THIRTY PERSONS AND SERIOUS PROPERTY DAMAGE VARIOUSLY ESTIMATED AT FROM 4 TO 6 MILLION DOLLARS. THE LOSS EXTENDED OVER A WIDE AREA INVOLVING MANY DWELLINGS, SOME MERCANTILES, INDUSTRIAL PROPERTIES AND A NUMBER OF AUTOMOBILES. THIS REPORT GIVES DETAILS CONCERNING THE OPERATION OF THE LNG PEAK SHAVING FACILITY AND THE HISTORY OF ITS CONSTRUCTION AND USE. THERE IS CONSIDERABLE DETAIL ON THE EVENTS LEADING UP TO THE ACCIDENT AND THE SUBSEQUENT SPREAD OF THE CONFLAGRATION. THE MOST DETAIL IN THE REPORT CENTERS ON THE DAMAGE DONE BY THE FIRE AND THE WAY IN WHICH THE FIRE AND VAPOR CLOUD SPREAD ABOUT THE CITY. THE REPORT ALSO GIVES SOME SPECULATION ON THE CAUSE. THE SUSPECTED CAUSE IS THE RUPTURE OF THE CYLINDRICAL STORAGE TANK AS A RESULT OF THE METAL BECOMING BRITTLE. THE TANK WAS CONSTRUCTED OF NICKEL STEEL, BUT THE NICKEL WAS NOT OF SUFFICIENT CONCENTRATION TO PREVENT EMBRITTLEMENT. THE REPORT DOES NOT GIVE THE RESULTS OF ANY METALLURGICAL STUDIES. THE ONLY RECOMMENDATIONS GIVEN CONCERN THE FUTURE ISOLATION OF SUCH FACILITIES.

-PERTINENT FIGURES-

FIG.1 FLAME FILLED SKIES PRESENT A TERRIFYING ASPECT, PAGE 5//FIG.2 EAST OHIO GAS CO. LIQUEFACTION PLANT AND SURROUNDING AREA, PAGE 7

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL BOARD OF FIRE UNDERWRITERS, N.Y.//OHIO INSPECTION BUREAU, COLUMBUS, OHIO
REPORT NUMBER -
NATIONAL BOARD OF FIRE UNDERWRITERS BULLETIN NO. 211

keys 13811 through 13818

EXCERPTS FROM REPORT OF THE TECHNICAL CONSULTANTS BOARD OF INQUIRY FOR THE MAYOR OF CLEVELAND ON THE EAST OHIO GAS COMPANY FIRE

by

BARNES,G.E.
BRAIDECH,M.M.
DONALDSON,K.H.

07/00/45

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Sp. DataBank	Summary	Good/Excel.

-ABSTRACT-

THIS REPORT CONSTITUTES THE CONCLUSIONS AND RECOMMENDATIONS OF THE EXPERT INVESTIGATORS ON THE CAUSE OF THE FAILURE OF THE LNG STORAGE TANK. THE CONCLUSIONS ARE SOUND AND EXPLICIT AND THE RECOMMENDATIONS ARE REASONABLY DRAWN. THE AUTHORS DO NOT CONCLUDE THAT ANY SINGLE FACTOR IS TOTALLY AT FAULT ALTHOUGH THE MAJOR BLAME RESTS WITH THE SELECTION OF THE MATERIAL FOR THE CONSTRUCTION OF THE TANK. MANY OF THE LINES WERE POORLY PLACED AND THE FINAL EXPANSION VALVE COULD IF INOPERABLE, TRANSMIT A DANGEROUSLY LARGE PRESSURE SURGE TO THE TANK. IN ADDITION, THE SAFETY PRECAUTIONS (DIKES, SEPARATION DISTANCES, AND CATCH BASINS) WERE ALMOST TOTALLY INADEQUATE. THE AUTHORS RECOMMEND THAT MORE TECHNICAL KNOWLEDGE BE BROUGHT TO BEAR WHEN CERTIFYING THIS TYPE OF INSTALLATION, RATHER THAN RELYING ON EXISTING CODES. THE BASIS OF THE RECOMMENDATIONS ARE THAT THE BURDEN OF PROOF OF SAFETY SHOULD REST WITH THE APPLICANT.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BOARD OF INQUIRY, CLEVELAND, OHIO. MAYORS OFFICE
OTHER INFORMATION -
0009 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

keys 13323 through 13325

LIMITS OF FLAMMABILITY OF GASES AND VAPORS

by

COWARD,H.F.
JONES,G.W.

00/00/52

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	State Of Art	Acceptable

-ABSTRACT-

THIS BULLETIN LISTS THE FLAMMABILITY LIMITS OF 155 SUBSTANCES IN AIR AND OXYGEN AS WELL AS SOME INFORMATION ON FLAMMABILITY IN OTHER ATMOSPHERES. THE BULLETIN INCLUDES RESULTS OF BUREAU OF MINES INVESTIGATIONS AS WELL AS OTHERS. THERE ARE 368 REFERENCES. SOME OF THE MORE IMPORTANT FLUIDS INCLUDED ARE HYDROGEN, PARAHYDROGEN, DEUTERIUM, AMMONIA, HYDRAZINE, CARBON MONOXIDE, METHANE, ETHANE, PROPANE, BUTANE, ETC., ETHYLENE, PROPYLENE, BUTYLENE, ACETYLENE, SEVERAL ALCOHOLS, SEVERAL ETHERS, AND A HOST OF OTHER ORGANIC MATERIALS. THE REPORT ALSO INCLUDES RESULTS ON SEVERAL MIXTURES.

-PERTINENT FIGURES-

FIG.1 LIMITS OF FLAMMABILITY OF HYDROGEN, CARBON MONOXIDE, AND METHANE CONTAINING VARIOUS AMOUNTS OF CARBON DIOXIDE AND NITROGEN, PAGE 7//FIG.2 LIMITS OF FLAMMABILITY OF ETHANE, ETHYLENE, AND BENZENE CONTAINING VARIOUS AMOUNTS OF CARBON DIOXIDE AND NITROGEN, PAGE 7//FIG.6 INFLUENCE OF TEMPERATURE ON LIMITS OF FLAMMABILITY OF HYDROGEN IN AIR (DOWNWARD PROPAGATION OF FLAME), PAGE 19//FIG.10 LIMITS OF FLAMMABILITY OF CARBON MONOXIDE IN AIR (DOWNWARD PROPAGATION), SHOWING EFFECT OF DIAMETER OF TUBE, PAGE 32//FIG.29 LIMITS OF FLAMMABILITY OF METHANE IN MIXTURES OF AIR WITH CERTAIN CHLORINATED HYDROCARBONS AND WITH CARBON DIOXIDE, PAGE 54//FIG.30 INFLUENCE OF PRESSURE ON THE LIMITS OF SOME PARAFFIN HYDROCARBONS (DOWNWARD PROPAGATION OF FLAME), PAGE 56

-BIBLIOGRAPHY-

COWARD, H. F. EXPLOSIBILITY OF ATMOSPHERES BEHIND STOPPINGS. TRANS. INST. MIN. ENG., VOL. 78, 1929, PP. 94-115//COWARD, H. F., AND BRINSLEY, F. THE DILUTION LIMITS OF INFLAMMABILITY OF GASEOUS MIXTURES. I. DETERMINATION OF DILUTION LIMITS. II. LOWER LIMITS FOR HYDROGEN, METHANE, AND CARBON MONOXIDE IN AIR JOUR. CHEM. SOC., VOL. 105, 1914, PP. 1859-1885//COWARD, H. F., CARPENTER, C. W., AND PAYMAN, W. THE DILUTION LIMITS OF INFLAMMABILITY OF GASEOUS MIXTURES. III. THE LOWER LIMITS OF SOME MIXED INFLAMMABLE

GASES WITH AIR. IV. THE UPPER LIMITS OF SOME GASES, SINGLY AND MIXED, IN AIR. JOUR. CHEM. SOC., VOL. 115, 1919, PP. 27-36//COWARD, H. F., COOPER, C., AND JACOBS, J. IGNITION OF GASEOUS MIXTURES BY ELECTRIC DISCHARGE. JOUR. CHEM. SOC., VOL. 105, 1914, PP. 1069-1092//COWARD, H. F., COOPER, C., AND WARBURTON, C. H. IGNITION OF ELECTROLYTIC GAS BY ELECTRIC DISCHARGE. JOUR. CHEM. SOC., VOL. 101, 1912, PP. 2278-2287//COWARD, H. F., AND GLEADALL, J. J. EXTINCTION OF METHANE FLAMES BY WATER VAPOR. JOUR. CHEM. SOC., 1930, PP. 243-248

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
REPORT NUMBER -
BULL. 503
OTHER INFORMATION -
0165 PAGES, 0063 FIGURES, 0046 TABLES, 0368 REFERENCES

keys 19542 through 19545

FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS

by

BURGESS, D.
ZABETAKIS, M. G.

00/00/62

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Summary	Good/Excel.

-ABSTRACT-

IN THIS REPORT, THE FACTORS TO BE CONSIDERED IN AN EVALUATION OF THE FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH ANY FUEL ARE EACH DISCUSSED BRIEFLY. THESE FACTORS ARE THEN USED TO ASSIST IN THE DESIGN OF EXPERIMENTS FOR THE EVALUATION OF THE HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS (LNG) RELATIVE TO THOSE ASSOCIATED WITH OTHER COMMON FUELS. EXPERIMENTS WERE CONDUCTED ON THE VAPORIZATION OF LNG, THE MIXING OF LNG VAPORS WITH AIR, THE EFFECT OF TEMPERATURE AND NITROGEN DILUTION ON THE LIMITS OF FLAMMABILITY OF METHANE IN AIR, THE BURNING RATES OF LNG AND OTHER FUELS, FLAME RADIATION, AND EXTINGUISHMENT OF FIRES ABOVE LIQUID POOLS. BASED ON THE RESULTS OF THESE EXPERIMENTS, THE AUTHORS CONCLUDE THAT LNG CAN BE STORED SAFELY IN SUITABLY DESIGNED ABOVE-GROUND TANKS SURROUNDED BY EARTHEN DIKES IN MUCH THE SAME MANNER AS GASOLINE.

-PERTINENT FIGURES-

TAB.2 COMPARISON OF COMBUSTION CHARACTERISTICS OF METHANE WITH THOSE OF OTHER FUELS, PAGE 4//TAB.5 THERMAL PROPERTIES OF THREE TYPICAL SOILS, PAGE 10//TAB.9 EFFECT OF POOL SIZE ON BURNING RATES AND FLAME RADIATION ENERGY, PAGE 23//FIG.5 VAPORIZATION RATE OF LNG AFTER SPILLAGE ONTO WARM INSULATING SURFACES, PAGE 11//FIG.6 COMBUSTIBLE GAS CONCENTRATION ABOVE DOWNWIND DIKE FOLLOWING SPILLAGE OF LNG INTO 5- BY 5-FOOT DIKED AREA, PAGE 11//FIG.11 EFFECT OF POOL DIAMETER ON LIQUID BURNING RATE UNDER WINDLESS CONDITIONS, PAGE 17

-BIBLIOGRAPHY-

ELLIOTT,M.A., SEIBEL,C.W., BROWN,F.W., ARTZ,R.T., AND BERGER,L.B., REPORT ON THE INVESTIGATION OF THE FIRE AT THE LIQUEFACTION STORAGE AND REGASIFICATION PLANT OF THE EAST OHIO GAS COMPANY, CLEVELAND, OHIO, OCTOBER 20, 1944. BUREAU OF MINES REPT. OF INVESTIGATIONS 3867, 1946, 44 PP //BAKKE,P., ON THE DISPERSION OF METHANE ROOF LAYERS BY VENTILATION. PAPER 44, 10TH INTERNAT. CONF. DIRECTORS OF SAFETY IN MINES RESEARCH, PITTSBURGH, PA., 1959, 26

PP

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
REPORT NUMBER -
R1-6099
OTHER INFORMATION -
0038 PAGES, 0021 FIGURES, 0010 TABLES, 0017 REFERENCES

PROGRESS REVIEW NO. 38. A REVIEW OF INFORMATION ON SELECTED ASPECTS OF GAS AND VAPOUR EXPLOSIONS

by

PALMER, K. N.

00/00/56

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

THIS REVIEW HAS BEEN UNDERTAKEN IN CONNECTION WITH A NEW RESEARCH PROGRAMME CONCERNED WITH THE HAZARDS OF GAS AND VAPOUR EXPLOSIONS. THE NEW PROJECT RELATES PARTICULARLY TO THE HAZARDS OF MIXTURES OF COMBUSTIBLE GAS OR VAPOUR WITH AIR OR OXYGEN IN CONFINED SPACES SUCH AS PIPES, DUCTS AND OTHER ENCLOSED PLANT, AND IS THUS CONCERNED CHIEFLY WITH PREMIXED FLAMES RATHER THAN DIFFUSION FLAMES. THE FIELD COVERED IN THIS REVIEW WAS ALSO RESTRICTED AFTER A CONSIDERATION OF THE NATURE OF THE EXPLOSION HAZARD. THUS, WITH REGARD TO FIRE AND BLAST DAMAGE, THE EXPLOSION PROPERTIES OF ESPECIAL INTEREST ARE QUANTITIES SUCH AS THE VELOCITY OF PROPAGATION OF COMBUSTION, THE RATES OF RISE IN PRESSURE, THE MAXIMUM PRESSURES OBTAINED AND THE VENTING AREAS DESIRABLE, ETC, THESE ASPECTS HAVE THEREFORE BEEN CONCENTRATED UPON IN THIS REVIEW, TO THE EXCLUSION OF OTHERS SUCH AS IGNITION PHENOMENA (EXCEPT WHERE RELATED TO FLAME QUENCHING), FLAMMABILITY LIMITS, AND, TO A LARGE EXTENT, THE CHEMISTRY OF FLAME REACTIONS. THE INFORMATION GIVEN IN THIS REVIEW HAS BEEN GROUPED UNDER THE FOLLOWING HEADINGS, FLAME PROPAGATION, COMBUSTION IN LONG PIPELINES, AND DETONATION, VENTING, FLAME QUENCHING. THE REVIEW POINTS OUR SEVERAL AREAS WHICH LACK ADEQUATE DATA. BURNING VELOCITY MEASUREMENTS FROM SEVERAL SOURCES DO NOT AGREE AND DATA OVER A LARGE RANGE FOR VARIOUS SPECIES DO NOT EXIST. MEASUREMENTS OF PRESSURES PRODUCED IN CONFINED AREAS AS A RESULT OF EXPLOSIONS ARE VERY IMPRECISE AND HAMPER THE FURTHERING OF VENTING STUDIES. MEASUREMENTS HAVE BEEN MADE REGARDING QUENCHING DISTANCES BUT THE ARRESTING OF DETONATIONS HAS PROVED TO BE VERY DIFFICULT. MOST OF THE DATA AVAILABLE IN THE LITERATURE COVERED BY THIS REVIEW ARE REALLY NOT ACCURATE OR EXTENSIVE ENOUGH TO ADVANCE THE STATE-OF-THE-ART.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
J. INST. FUEL, VOL 29, 293-309 (1956)
OTHER INFORMATION -
0017 PAGES, 0000 FIGURES, 0001 TABLES, 0435 REFERENCES

METHOD AND APPARATUS FOR DETERMINING HELIUM CONTENT OF GAS MIXTURES

by

EMERSON,D.E.
KAPLAN,R.L.

12/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

A METHOD AND APPARATUS ARE DESCRIBED FOR DETERMINING THE HELIUM CONTENT OF GASEOUS MIXTURES. THE WORK WAS DONE SO THAT THE BUREAU OF MINES COULD MORE ACCURATELY AND ECONOMICALLY ANALYZE HELIUM-CONTAINING NATURAL GASES, CRUDE HELIUM PURCHASED FROM PRIVATE INDUSTRIES, AND HELIUM IN GASES USED IN RESEARCH. ACTIVATED COCONUT CHARCOAL IS UTILIZED AT LIQUID NITROGEN TEMPERATURE TO ADSORB COMPONENTS OTHER THAN HELIUM IN THE MIXTURE. A TRANSDUCER IS THEN USED TO DETERMINE THE HELIUM PRESSURE. TWENTY OR MORE ANALYSES WITH A STANDARD DEVIATION OF PLUS AND MINUS 0.04 PERCENT CAN BE MADE IN AN 8-HOUR DAY.

-PERTINENT FIGURES-

TAB.1 HYDROGEN MIXTURES, PAGE 1748//TAB.2 ANALYSES OF HYDROGEN MIXTURES, PAGE 1748//TAB.3 ANALYSIS OF NATURAL GAS, PAGE 1748//TAB.4 SAMPLE ANALYSES, PAGE 1748

-BIBLIOGRAPHY-

H. P. CADY AND D. F. MCFARLAND, J. AMER. CHEM. SOC., 29, 1523-1536 (1907)// C. C. ANDERSON, U. S. BUR. MINES, INFORM. CIR., 6796 (1934)//E. M. FROST, JR., U. S. BUR. MINES REP. INVEST., 3899 (1946)//E. M. FROST, C. G. KIRKLAND, AND D. E. EMERSON, U.S. BUR. MINES REP. INVEST., 6545 (1964)//J. E. MILLER, A. J. CARROLL, AND D. E. EMERSON, U.S. BUR. MINES REP. INVEST., 6674 (1965)

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, AMARILLO, TEX.
JOURNAL PROCEEDINGS -
ANAL. CHEM. VOL 42, NO. 14, 1746-8 (DEC 1970)
OTHER INFORMATION -
0003 PAGES, 0001 FIGURES, 0004 TABLES, 0007 REFERENCES

key 19291

METHOD FOR DETERMINATION OF DENSITY OF CRYOGENIC LIQUIDS AND MIXTURES

by

SHANAA, M. Y.
CANFIELD, F. B.

00/00/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER DESCRIBES THE DEVELOPMENT OF A LOW-TEMPERATURE EXPERIMENTAL APPARATUS WHICH IS USED FOR THE DETERMINATION OF DENSITY OF CRYOGENIC LIQUIDS AND MIXTURES. THE DENSITY CAN BE DETERMINED UNDER ATMOSPHERIC AND SUBATMOSPHERIC PRESSURE AND IN A TEMPERATURE RANGE OF 77 TO 273 K. IN SELECTING A SUITABLE EXPERIMENTAL METHOD TO OBTAIN ACCURATE DENSITY DATA, A REVIEW OF THE METHODS PREVIOUSLY USED FOR SUCH MEASUREMENTS WAS MADE. AFTER CAREFUL STUDY OF THIS REVIEW AND ERROR ANALYSES OF DIFFERENT TECHNIQUES, IT WAS CONCLUDED THAT THE PYCNOMETER METHOD WOULD YIELD THE MOST ACCURATE DENSITY RESULTS. DESIGN OF THE FUSED-QUARTZ PYCNOMETER, THE STAINLESS STEEL WEIGHING BOMB, AND THE INTERCONNECTING AND ASSOCIATED EQUIPMENT ARE DISCUSSED.

-PERTINENT FIGURES-

FIG.1 SCHEMATIC DIAGRAM OF THE EXPERIMENTAL APPARATUS, PAGE 273//FIG.2 WEIGHING BOMB, PAGE 274//FIG.3 SCHEMATIC DIAGRAM OF FUSED QUARTZ PYCNOMETER, PAGE 274

-BIBLIOGRAPHY-

SHANAA,M.Y., PH.D. DISSERTATION, UNIVERSITY OF OKLAHOMA, IN PREPARATION// ARP,V., WILSON,J.H., WINRICH,L., AND SIKORA,P., CRYOGENICS 2, 230 (1962)// DIN,F. AND COCKETT,A.H., LOW TEMPERATURE TECHNIQUES, GEORGE NEWNES LTD., LONDON (1960), P. 83

-SOURCE INFORMATION-

CORPORATE SOURCE -
OKLAHOMA UNIV., NORMAN
JOURNAL PROCEEDINGS -
ADVAN. CRYOG. ENG. VOL 11, 272-6 (1966) (PROC. OF CRYOGENIC ENGINEERING CONF., 11TH, HOUSTON, TEX., AUG 23-5, 1965. PAPER E-2)

key 21018

THE SOLUBILITY OF HYDROCARBONS IN LIQUID METHANE

by

DAVENPORT, A.J.
ROWLINSON, J.S.

01/00/63

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

THE SOLUBILITY OF 24 HYDROCARBONS IN LIQUID METHANE HAS BEEN STUDIED FROM THEIR MELTING-POINTS TO THE CRITICAL TEMPERATURE OF METHANE. SOME HYDROCARBONS CONTAINING FIVE CARBON ATOMS, AND ALMOST ALL THOSE CONTAINING MORE THAN FIVE CARBON ATOMS, ARE INCOMPLETELY MISCIBLE WITH METHANE IN THIS RANGE OF TEMPERATURE. MANY SYSTEMS EXHIBIT LOWER CRITICAL SOLUTION POINTS. THE TEMPERATURES OF THESE POINTS FALL AS THE GAS-LIQUID CRITICAL TEMPERATURES OF THE SOLUTES RISE. THE HYDROCARBONS INCLUDE THE PENTANES, HEXANES AND HEPTANES AS WELL AS PENTANE AND HEXENE.

-PERTINENT FIGURES-

TAB.1 SOLUBILITY OF HYDROCARBONS IN LIQUID METHANE, PAGE 79//FIG.3 LIQUID-LIQUID AND LIQUID-SOLID CURVES FOR EIGHT OF THE SYSTEMS OF TABLE 1, PAGE 82//FIG.4 THE LOWER CRITICAL SOLUTION TEMPERATURES AS A FUNCTION OF THE GAS-LIQUID CRITICAL TEMPERATURES OF THE SOLUTES, PAGE 83//FIG.5 THE LOWER CRITICAL SOLUTION TEMPERATURES AS FUNCTIONS OF HILDEBRANDS SOLUBILITY PARAMETER DELTA, PAGE 84

-BIBLIOGRAPHY-

ROWLINSON AND FREEMAN, PURE APPL. CHEM. VOL 2, 329 (1961)//CLUSIUS AND RICCOBINI,A., PHYSIK. CHEM. B VOL 38, 81 (1937)//MICHELS AND NEDERBRACHT, PHYSICA VOL 2, 1000 (1935)//LAMBERT,J.D., ROBERTS, ROWLINSON AND WILKINSON, PROC. ROY SOC. A VOL 196, 113 (1949)//HAMANN AND LAMBERT,J.A., AUSTRAL. J. CHEM. VOL 7, 1 (1954)//DAVENPORT, FREEMAN AND ROWLINSON, AMER. INST. CHEM. ENG. J. VOL 8, 428 (1962)//KOBE AND LYNN, CHEM REV. VOL 52, 117 (1953)

-SOURCE INFORMATION-

CORPORATE SOURCE -
IMPERIAL COLL. OF SCIENCE AND TECHNOLOGY, LONDON, ENGLAND
JOURNAL PROCEEDINGS -
TRANS. FARADAY SOC. VOL 59, NO. 481, PT. 1, 78-84 (JAN 1963)

key 21022

THE ELECTRIC STRENGTH OF LIQUEFIED ARGON AND METHANE

by

GALLAGHER,T.J.
LEWIS,T.J.

00/00/64

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

THIS PAPER GIVES RESULTS OF AN EXPERIMENTAL PROGRAM TO MEASURE THE ELECTRICAL STRENGTH OF LIQUID METHANE AND LIQUID ARGON. THE EXPERIMENTS USED GOLD ALUMINUM AND STAINLESS STEEL AS ANODE MATERIAL AND TO MEASURE THE EFFECTS OF MATERIAL CHANGES. THE ELECTRICAL STRENGTH OF ARGON WAS 1.02 MV/CM AND SHOWED NO INFLUENCE TO ANODE MATERIAL. LIQUID METHANE, ON THE OTHER HAND, DID SHOW AS MUCH AS A 50 PERCENT EFFECT OF CATHODE AND ANODE MATERIALS, VARYING FROM 0.4 MV/CM FOR GOLD TO 1.5 MV/CM FOR STAINLESS STEEL. THE PRESENCE OF OXYGEN IONS IS KNOWN TO EFFECT THE STRENGTH.

-PERTINENT FIGURES-

TAB.1 ELECTRIC STRENGTH OF OXYGEN-FREE ARGON SHOWING ABSENCE OF ANODE INFLUENCE, PAGE 100//TAB.II INFLUENCE OF CATHODE AND ANODE SURFACES ON THE ELECTRIC STRENGTH OF LIQUID METHANE, PAGE 102//FIG.1 INFLUENCE OF CATHODE AND ANODE ON STRENGTH OF NORMAL ARGON, PAGE 99//FIG.2 INFLUENCE OF ELECTRODE OXIDATION ON STRENGTH OF OXYGEN-FREE ARGON, PAGE 100//FIG.3 STRENGTH OF NORMAL ARGON WITH PULSE VOLTAGES, PAGE 101

-BIBLIOGRAPHY-

SWAN,D.W. AND LEWIS,T.J., J. ELECTROCHEM. SOC. VOL 107, 180 (1960), SWAN,D.W. AND LEWIS,T.J., PROC. PHYS SOC. VOL 78, 448 (1961)//HANCOX,R., BRIT. J. APPL. PHYS. VOL 8, 476 (1957)//SWAN,D.W., PROC. PHYS. SOC. VOL 78, 423 (1961)//LEWIS,T.J. AND WRD,B.W., PROC. ROY. SOC. A VOL 269, 233 (1962)//DAVIS,H.T., RICE,S.A. AND MEYER,L., J. CHEM. PHYS. VOL 37, 947 (1962)

-SOURCE INFORMATION-

CORPORATE SOURCE -
QUEEN MARY COLL., LONDON, ENGLAND
JOURNAL PROCEEDINGS -

NATL. RES. COUNCIL, PUBL. NO. 1141, 98-102 (1964)
OTHER INFORMATION -
0005 PAGES, 0003 FIGURES, 0002 TABLES, 0007 REFERENCES

AUTOMATIC FIRE PROTECTION SYSTEM FOR MANNED HYPERBARIC CHAMBERS. PHASE I. SYSTEM DEVELOPMENT

by

EGGLESTON, L.A.
HERRERA, W.R.
COMMERFORD, G.E.

08/01/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

The problems of fire detection and suppression in dense atmospheres typical of diving chamber service are analyzed, with special attention to nitrogen- oxygen up to 8 atm. and helium-oxygen up to 45 atm. Spectral comparisons indicated either infrared (IR) or ultraviolet (UV) flame detectors may be used. The current IR equipment is the better choice. There is a need for a combustion products detector, and an acceptable model is available. Although it is sensitive to changes in atmospheric density, automatic compensation is feasible. Dense atmospheres affect the performance of water spray nozzles. Complete data are given for a typical line of commercial nozzles for four sizes and five nozzle angles, at flow pressures of 60 psig and chamber pressures up to 500 psig. A water rate for suppression is estimated at 2-3 gpm/sq. ft., and supported by fire test data. The flash- off of dissolved gases can be a serious problem in system design. A closed water loop balanced to chamber pressure and pump driven when needed is preferred to any system which exposes water to gas pressures above the chamber operating level for periods long enough to permit saturation.

-PERTINENT FIGURES-

FIG. 16 CORRELATION OF TEST DATA ON DRY CHEMICAL FLOW RATE REQUIREMENTS FOR EXTINGUISHING HYDROCARBON PIT AND SPILL FIRES PAGE 35

-BIBLIOGRAPHY-

EGGLESTON, L.A.: EVALUATION OF FIRE EXTINGUISHING SYSTEMS FOR USE IN OXYGEN RICH ATMOSPHERES. SWRI REP. 03-2094, MAY 18, 1967//COOK, G.A., DORR, V.A., AND SHIELDS, B.M.: REGIONS OF NONCOMBUSTION IN NITROGEN-OXYGEN AND HELIUM- OXYGEN DIVING ATMOSPHERES. IEC, VOL 7, 308, APR. 1968//TURNER, H.L. AND SEGAL, L.: FIRE BEHAVIOR AND PROTECTION IN HYPERBARIC CHAMBERS. FIRE TECH., VOL 1, NO. 4, NOV.

1965//AULT, W.E. AND CARTER, D.I.: THE INFLUENCE OF HYPERBARIC CHAMBER PRESSURE ON WATER SPRAY PATTERNS. FIRE J., VOL 61, NO. 6, NOV. 1967//TRUMBLE, T.M.: INTEGRATED FIRE AND OVERHEAT DETECTION SYSTEM FOR MANNED FLIGHT VEHICLES. TECH. REP. AFAPL-TR-67-129, WRIGHT-PATTERSON AFB//HILL, K. AND HORNSTEIN, B.: DETECTION OF HYDROGEN-AIR FIRES AND EXPLOSION IN AEROSPACE VEHICLES VIA OH BAND AND WATER BAND EMISSION. TECH. REP. ASD-TDR-63-113, WRIGHT-PATTERSON AFB

-SOURCE INFORMATION-

CORPORATE SOURCE -
SOUTHWEST RESEARCH INST., SAN ANTONIO, TEX.
REPORT NUMBER -
AD-712848//CR-70.003
SPONSOR -
NAVAL CIVIL ENGINEERING LAB., PORT HUENEME, CALIF.
CONTRACT NUMBER -
CONTRACT N62399-68-C-0022
OTHER INFORMATION -
0136 PAGES, 0059 FIGURES, 0006 TABLES, 0015 REFERENCES

RECENT DEVELOPMENTS IN THE LASER BEAM FIRE DETECTION SYSTEM

by

GHOSH, B.K.

03/08/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

Improvements made in a helium-neon laser beam fire detection system overcame the following disadvantages: (1) Due to thermal effects, the spot of light can move; a large photocell was used to accommodate this movement. (2) Over long path lengths, the beam can move completely off either the corner cube mirror or the photocell due to various ambient causes, and it has to be manually readjusted. The modified system consists of a 1 mW helium-neon laser which passes through two lenses which form a collimator. There are two servo-driven glass plates between the two lenses, which can rotate to produce a small change in the direction of the beam. The beam then moves under the ceiling over the length of the area to be protected, falls on a corner cube mirror, and comes back onto a quadrant photocell. The signals from the photocells are processed in the same way as in the basic system to give a fire alarm. There is also provision for a fault alarm in case of laser failure.

-BIBLIOGRAPHY-

LAWSON, D.I.: FIRE DETECTION USING LASER BEAMS. INSTITUTION OF FIRE ENG. QUARTERLY, VOL. 39, NO. 71, 255-264, 1968, FIRE PROTECTION REV., VOL. 31, NO. 333, 372-375, 1968, FIRE, VOL. 61, NO. 757, 78-79, 1968 FIRE TECH., VOL. 4, NO. 4, 257-264, 1968//LAWSON, D.I.: A LASER BEAM FIRE DETECTION SYSTEM. INSTITUTION OF FIRE ENG. QUARTERLY, VOL. 30, NO. 79, 284-300, 1970, ANTINCENDIO, VOL. 22, NO. 9, 502-508, 1970, FIRE TECH., VOL. 6, NO. 4, 305- 311, 1970//OSULLIVAN, E.F., GHOSH, B.K., AND TURNER, J.: EXPERIMENTS ON THE USE OF A LASER BEAM FOR FIRE DETECTION, PART 1, HEAT DETECTION. FIRE RES. NOTE NO. 823, JOINT FIRE RES. ORG., 1970

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
JOURNAL PROCEEDINGS -
IN ITS: SYMPOSIUM OF AUTOMATIC FIRE PROTECTION, LONDON, MAR.

OPERATING EXPERIENCE WITH THE LASER FIRE DETECTION SYSTEM

by

PEBERDY, W.T.

03/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

A brief description is given of the laser system operating principles, the approach to the alignment problem, and the addition of the smoke detection facility in the laser fire detection system. Performance information is assessed from two pilot installations: a power station and a building the size of a large aircraft hangar. These systems respectively illustrate the two extremes of operating conditions: long, low, confined areas such as cable tunnels and high large volume areas such as warehouses. The results of a full-scale test program carried out in a simulated coal mine gallery are then discussed, with particular emphasis placed on the effects due to air movement and the presence of discrete amounts of coal dust in the atmosphere. Finally, laboratory experience which relates to such matters as laser tube life, ambient light compensation and other allied optical considerations is discussed.

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND)
JOURNAL PROCEEDINGS -
IN ITS: SYMPOSIUM ON AUTOMATIC FIRE DETECTION, LONDON, MAR. 8-10, 1972
OTHER INFORMATION -
0020 PAGES, 0012 FIGURES, 0001 TABLES, 0002 REFERENCES

keys 987 through 988

A SURVEY OF THE PRINCIPAL OPERATIONAL CHARACTERISTICS OF FIRE DETECTOR MECHANISMS

by

WAGNER, J.P.

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL:
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

The current state of the art of leading fire detector designs is reviewed. The detectors are classified into two categories: (1) conventional, readily available from a commercial supplier and in current use; and (2) non- conventional, in the research or development stage, and/or not used in the fire detection field. Fire type, its rate of progression, and convective ascent and lateral spreading of a fire plume are also examined since they are important to the detection problem. The limitations and salient features of the two types of detectors are outlined in relation to their response to combustion products, visible smoke, light, heat, and sound. It was concluded that a standardized or interrelated test procedure is needed whereby one can rate the various detector types according to response time and frequency of false alarming. The problem is complicated by the operational differences in the detectors and the numerous types of fires. In assessing or comparing detector response time, the complete fire environment must be considered. Small-scale laboratory test results are not representative of actual room size tests. If laboratory test results are to be used, then at least the dependence of fire plume velocity and spreading on height should be known.

-BIBLIOGRAPHY-

CHAFFEE, D.L.: A STUDY OF FIRE ALARMS AND FIRE ALARM SYSTEMS. TN-980, NAVAL CIVIL ENG. LAB., PORT HUENEME, CALIF., AUG. 1968//WATERS, G.L.: ADVANCES IN INFRARED FIRE DETECTION. FIRE INTERN., VOL. 27, 67-70, JAN. 1970//GRABOWSKI, G.J.: THE FUTURE OF AUTOMATIC FIRE PROTECTION. COLLOQUIA ON FIRE PROBLEMS, APPLIED PHYSICS LAB., THE JOHNS HOPKINS UNIV., MAY 6, 1971//PUTNAM, T.M. AND PARKER, J.E.: TESTS OF COMBUSTION PRODUCT DETECTORS IN A RADIATION ENVIRONMENT. FIRE TECH., VOL. 5, NO. 4, 274-283,

-SOURCE INFORMATION-

CORPORATE SOURCE -
JOHNS HOPKINS UNIV., SILVER SPRING, MD. APPLIED PHYSICS LAB.

REPORT NUMBER -
APL/JHU FPP-TR3
JOURNAL PROCEEDINGS -
FIRE RES ABSTRACTS REV, VOL. 13, NO. 2, 95-113 (1971)
SPONSOR -
NATIONAL SCIENCE FOUNDATION, WASHINGTON, D.C.
CONTRACT NUMBER -
GRANT NSF-GI-12
OTHER INFORMATION -
0018 PAGES, 0003 FIGURES, 0003 TABLES, 0043 REFERENCES

key 1045

TESTING METHOD OF FIRE DETECTORS IN BUILDINGS

by

WATANABE, A.

03/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

After summarizing the behavior of room temperature under non-fire and fire conditions, a testing method is described for thermal detectors. The method is a linear temperature rise test using a slow horinzontal hot air stream and a step form temperature rise test using a vertical stream for spot type detectors. Similarly, experimental results on smoke movement determined the sensitivity of the smoke detectors for the purpose of saving lives from smoke in hotels, hospitals, and multistoried buildings. The effect of various smokes in a small room, of smoke movement on the operation of smoke detectors, and of the particle distribution of smoke obtained by sedimentation method on smoke detectors using the light scattering method for visible smoke and those using the ion counter method for invisible smoke are all briefly discussed, as are testing methods simulating various environmental conditions.

-PERTINENT FIGURES-

TAB. 1 SENSITIVITIES OF SMOKE DETECTORS//TAB. 2 SMOKE DENSITY AT THE TIME OF OPERATION OF TYPICAL SMOKE DETECTORS

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
JOURNAL PROCEEDINGS -
IN ITS: SYMP ON AUTOMATIC FIRE DETECTION, LONDON,(MAR. 8-10, 1972)
OTHER INFORMATION -
0019 PAGES, 0011 FIGURES, 0002 TABLES, 0015 REFERENCES

key 1060

PYROTECTOR FLAME AND SMOKE DETECTION SYSTEMS

by

HATHAWAY E.R.

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

Pyrotector flame and smoke detection systems are primarily designed to detect various type fires in aircraft engine nacelle, cargo compartments, and other unattended areas in aircraft. The systems are comprised of three major components: optical flame detectors, light scattering smoke detectors, and a control amplifier that can be used with either type detector. System components can be all flame detectors in the case of engine installations or all smoke detectors in the case of baggage and cargo compartment installations, or a combination of both. The flame detector utilizes two photoconductive cells to analyze the light radiation being received by the detector and provide a signal to a control amplifier. A cell that is responsive to visual infrared is connected in series with a cell that is responsive to the visual blue-white region of the spectrum. The smoke detector operates on the reflective light principle wherein a light beam is directed at right angles to the viewing path of a photoconductive cell inside a small circular chamber which has the ends covered with cup shaped covers mounted on spacers so that smoke can pass freely through the interior by convection. The system design, characteristics, and installation recommendations are summarized.

-SOURCE INFORMATION-

CORPORATE SOURCE -
PYROTECTOR, INC., HINGHAM, MASS.
REPORT NUMBER -
AD-730179
JOURNAL PROCEEDINGS -
IN: FAA AIRCRAFT FIRE DETECTION CONF, WASHINGTON, D.C. (NOV. 16-17, 1970) (SEE F7200765)
OTHER INFORMATION -
0012 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 1066

STATE-OF-THE-ART REVIEW OF FIRE AND OVERHEAT DETECTION TECHNIQUES DEVELOPED BY THE UNITED STATES AIR FORCE

by

TRUMBLE, T.M.

00/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Acceptable

-ABSTRACT-

An overview is presented of the fire and overheat detection techniques developed by the U.S. Air Force. An optical fire detction system was developed using the first environmentally qualified, coherent 12 1/2 ft. fiber optical bundle, coupled to an electronic light sensor using a 20 hz. low pass electronic filter. The fiber bundles exhibited excellent transmission in the visible spectrum and were qualified for use in 1000 deg. F. areas where existing infrared, ultraviolet, visible sensors could not operate. The feasibility of using ultraviolet sensitive gas multiplication tubes for hydrogen flame detection was proved. Work was done on the way fire and overheat detection could be used best. An integrated fire and overheat system was developed for aircraft. A computer tied together 4 each infrared, ultraviolet, and continuous elements in 5 modes. The normal mode requires one sensor to detect and another sensor to verify the presence of a fire or overheat. A survey was made of the state of the art of fire and overheat sensors.

-PERTINENT FIGURES-

FIG. 1 MICROCIRCUIT COMPUTER FOR INTEGRATED FIRE AND OVERHEAT DETECTION SYSTEM PAGE 229//FIG. 2 TYPICAL SENSOR CHARACTERISTICS PAGE 230

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR FORCE AERO PROPULSION LAB., WRIGHT-PATTERSON AFB, OHIO.
REPORT NUMBER -
AD-730179
JOURNAL PROCEEDINGS -
IN: FAA AIRCRAFT FIRE DETECTION CONF, WASHINGTON, D.C. (NOV. 16-17, 1970) (SEE F7200765)
OTHER INFORMATION -
0015 PAGES, 0002 FIGURES, 0000 TABLES, 0000 REFERENCES

key 1401

FIRE DETECTION AND ACTUATION DEVICES FOR HALON EXTINGUISHING SYSTEMS

by

GRABOWSKI, G.J.

00/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

A review is presented of the presently used techniques and installation conditions of fire detection: fixed temperature, rate of temperature rise, rate conpensation, particulate matter, visible smoke, flame ultraviolet, and flame infrared. The degree of sensitivity of each of the above fire detection techniques to the 3 classes for fires (Classes A,B, and C) is summarized. After selection of the proper detection technique that meets the system requirements, it is necessary to select equipment with consideration of sensitivity, reliability, maintainability, and stability. Each of these is discussed for the available devices on the market. While automatic systems will always require maximum performance, the use of Halons places an even greater emphasis on the important factors in the system design: detectors, wiring, power supply, and reliability analysis. Each of these components of a Halon suppression system is discussed.

-PERTINENT FIGURES-

TAB. 2 SENSITIVITY OF VARIOUS FIRE DETECTION TECHNIQUES PAGE 303//TAB. 3 SUMMARY OF DETECTOR RESPONSE PAGE 304//TAB. 4 DETECTION EQUIPMENT PERFORMANCE SUMMARY PAGE 305

-SOURCE INFORMATION-

CORPORATE SOURCE -
FENWAL, INC., NORWOOD, MASS.
JOURNAL PROCEEDINGS -
IN: NAS-NRC. AN APPRAISAL OF HALOGENATED FIRE EXTINGUISHING AGENTS. PROC OF A SYMP, WASHINGTON, D.C. (APR. 11-12, 1972) (SEE F7300022)
OTHER INFORMATION -
0014 PAGES, 0000 FIGURES, 0004 TABLES, 0000 REFERENCES

key 1615

EVALUATION OF RESEARCH TECHNIQUES FOR EVALUATING FULL-FLOW LIGHT EXTINCTION TYPE SMOKEMETERS

by

COORDINATING RESEARCH COUNCIL, INC.

01/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

SEVERAL TESTS HAVE BEEN DEVELOPED TO EVALUATE THE PERFORMANCE OF FULL-FLOW, LIGHT-EXTINCTION TYPE SMOKEMETERS. THE TESTS MEASURE THE FOLLOWING CHARACTERISTICS: (1) CALIBRATION, MEASURED BY USING NEUTRAL DENSITY OPTICAL FILTERS TO EVALUATE THE LINEARITY OF AN INSTRUMENT UNDER IDEAL CONDITIONS (I. E., ROOM TEMPERATURE, FULLY STABILIZED, CONSTANT SUPPLY VOLTAGE, NO SHOCK, VIBRATION, NOR POTENTIAL SOOT CONTAMINATION); (2) INSTRUMENT DRIFT; (3) INPUT VOLTAGE SENSITIVITY; (4) TEMPERATURE SENSITIVITY; (5) RESPONSE TIME; (6) SENSITIVITY TO AMBIENT LIGHT; (7) SHOCK AND VIBRATION RESISTANCE; AND (8) ENGINE TEST, UNDER ACTUAL OPERATING CONDITIONS. DATA FROM TESTS OF 6 SMOKEMETERS ARE PRESENTED AND A DISCUSSION OF METHODS OF EVALUATING SMOKE METERS IS INCLUDED.

-SOURCE INFORMATION-

CORPORATE SOURCE -
CCORDINATING RESEARCH COUNCIL, INC., NEW YORK.
REPORT NUMBER -
CRC REP. 453//CRC PROJ. CAPI-1-64
OTHER INFORMATION -
0043 PAGES, 0009 FIGURES, 0004 TABLES, 0000 REFERENCES

key 1783

THE BEHAVIOUR OF AUTOMATIC FIRE DETECTION SYSTEMS

by

FRY, J.F.
EVELEIGH, C.

03/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Govt. Only	Summary	Good/Excel.

-ABSTRACT-

ANALYSIS OF STATISTICS COLLECTED DURING 1 YR. HAS DEMONSTRATED THE FREQUENCY AND REASONS FOR THE OCCURRENCE OF FALSE ALARMS BY AUTOMATIC FIRE DETECTION SYSTEMS. THE DETECTION-ALARM SYSTEMS INCLUDED HEAT AND SMOKE DETECTORS, MANUAL ALARMS, AND SPRINKLER SYSTEMS. IT WAS FOUND THAT THE RATIO OF FALSE CALLS TO GENUINE FIRE CALLS GIVEN BY AUTOMATIC SYSTEMS OF ALL TYPES WAS ABOUT 11 TO 1. ABOUT 25 PERCENT OF THE FALSE CALLS RECEIVED WERE ATTRIBUTED TO AMBIENT CONDITIONS (SUCH AS EXTRANEOUS HEAT AND SMOKE, HIGH AMBIENT TEMPERATURE, SNOW, AND RAIN), ALMOST 50 PERCENT TO MECHANICAL AND ELECTRICAL PROBLEMS (SUCH AS DEFECTIVE WIRING, DEFECTIVE HEADS, AND VIBRATIONS), AND APPROXIMATELY 17 PERCENT FROM FAILURE IN OR MISUSE OF THE COMMUNICATION SYSTEMS. DATA CONCERNING THE DISTRIBUTION OF FALSE AND ACTUAL ALARMS DURING THE DAY SHOWED THAT THE RATIO OF FALSE TO TOTAL CALLS IS SLIGHTLY HIGHER DURING THE DAY THAN DURING THE NIGHT. DATA ALSO SHOWED THAT WHERE AUTOMATIC SYSTEMS WERE INSTALLED, ABOUT 68 PERCENT OF ALL CALLS TO GENUINE FIRES WERE MADE BY THEM. IT IS RECOMMENDED THAT BETTER INSPECTION AND MAINTENANCE BE USED TO ELIMINATE SOME OF THE FALSE ALARMS CAUSED BY DEFECTIVE WIRING AND OTHER MECHANICAL AND ELECTRICAL FAULTS. IT IS ALSO RECOMMENDED THAT A SENSITIVITY LEVEL BE SELECTED RELATED TO THE AMBIENT CONDITIONS IN WHICH A DETECTOR MUST OPERATE IN ORDER TO ELIMINATE MANY OF THE FALSE ALARMS RELATED TO AMBIENT CONDITIONS.

-PERTINENT FIGURES-

TAB. 2 SUMMARY TABLE OF REASONS FOR FALSE CALLS PAGE 311TAB. 4 REASON FOR FAILURE OR DELAY-CALL RECEIVED BY OTHER MEANS PAGE 5//TAB. 5 TIMES OF FIRE CALLS AND FALSE CALLS PAGE 5

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
REPORT NUMBER -
FR NOTE 810

key 1820

ADVANCES IN THE RAPID EXTINCTION OF FIRES IN HIGH-RACKED STORAGES

by

NASH, P.
BRIDGE, N.W.
YOUNG, R.A.

03/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

FIRE TESTS WERE CONDUCTED TO DETERMINE THE EFFECTIVENESS OF A NEW FIRE DETECTION AND SUPPRESSION SYSTEM FOR HIGH-RACKED PALLET STORAGE IN WAREHOUSES. THE SYSTEM HAS BEEN DESIGNED TO DETECT AND EXTINGUISH THE FIRE IN THE SLOW INITIAL STAGES OF ITS GROWTH. A LINE DETECTOR IS DISTRIBUTED AROUND THE RACKING, AND SPRINKLERS AT VARIOUS LEVELS (OR ZONES) OF THE STORAGE RACKS ARE ACTIVATED TO EXTINGUISH THE FIRE. THE PERFORMANCE REQUIREMENTS FOR THE SYSTEM ARE: (1) A 0-2 MIN. DETECTION TIME; (2) A RESPONSE TIME FOR SPRINKLERS OF NOT MORE THAN 1 MIN. AFTER DETECTION AND FULL SUPPRESSION WITHIN 8 MIN.; (3) MINIMUM PRODUCTION OF SMOKE; (4) COST WHICH DOES NOT EXCEED 10 PERCENT OF THE VALUE OF THE BUILDING AND RACKING INSTALLATION; AND (5) A FAIL SAFE WARNING WHEN THE SYSTEM IS INOPERATIVE. A LINE DETECTOR IS USED TO ACTIVATE AN ELECTRICAL CIRCUIT WHEN HEATED TO 68 DEG. C. THE CURRENT DETONATES A NYLON FRANGIBLE DISC IN THE SPRINKLER HEAD AND PERMITS WATER TO FLOW. IN THE FIRE TESTS, THERE WERE 6 LEVELS OF PALLETS, A TOTAL OF 11.4 M. HIGH, WITH SPRINKLERS AND DETECTORS AT EACH LEVEL. THE COMBUSTIBLE MATERIALS WHICH FILLED THE 72 PALLETS WERE CARDBOARD CARTONS, WOOD WOOL BALES, POLYURETHANE FOAM BLOCKS, BOXES OF AEROSOLS, AND FOAMED POLYTHENE REELS. RESULTS SHOWED THAT MAXIMUM FLAME HEIGHT REACH IN ANY TEST WAS ONLY 2.4 M. AND THE MAXIMUM DAMAGE TO GOODS BY FIRE WAS ONLY 2 PALLET LOADS. IT WAS CONCLUDED THAT THE SYSTEM SUCCESSFULLY PREVENTED FIRE SPREAD FROM THE CELL IN WHICH FIRE ORIGINATED, NO MATTER WHAT THE NATURE OF THE STORED GOODS. AN ENTIRELY-NON-ELECTRICAL SYSTEM, WHICH WAS ALSO TESTED AND SHOWN TO BE EFFECTIVE, IS DESCRIBED.

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
JOURNAL PROCEEDINGS -
FIRE INT, VOL. 4, NO. 39, 53-68 (MAR. 1973)
OTHER INFORMATION -
0016 PAGES, 0011 FIGURES, 0003 TABLES, 0010 REFERENCES

key 2062

THE PERFORMANCE OF SOME PORTABLE GAS DETECTORS WITH AVIATION FUEL VAPOURS AT ELEVATED TEMPERATURES. PART 1. TESTS WITH N-HEXANE, 'AVTAG' AND 'CIVGAS' VAPOURS

by

FARDELL, P.J.

07/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Govt. Only	Summary	Acceptable

-ABSTRACT-

TESTS WERE CONDUCTED TO EVALUATE THE PERFORMANCE OF 5 PORTABLE FLAMMABLE GAS DETECTORS AT ELEVATED TEMPERATURES. THE CATALYTIC-FILAMENT TYPE FLAMMABLE GAS DETECTORS WERE BASED ON THE PHENOMENON OF CATALYTIC OXIDATION. THEY COULD GIVE AN INDICATION OF THE EXPLOSIVE NATURE OF A MIXTURE OF FLAMMABLE GAS OR VAPOR AND AIR IN MANY SITUATIONS, INCLUDING NEWLY EMPTIED AVIATION FUEL STORAGE TANKS. THE DETECTORS WERE CALIBRATED IN PERCENTAGES OF THE LOWER EXPLOSION LIMIT CONCENTRATION OF FLAMMABLE GASES. THE FUELS USED IN THESE EXPERIMENTS WERE N-HEXANE, AVTAG (JP-4 JET FUEL), AND CIVGAS. N-HEXANE WAS TESTED AT 25 DEG. C. AND AT 65 DEG. C. TO DETERMINE TEMPERATURE EFFECT. ALL OTHER TESTS WERE CONDUCTED AT 65 DEG. C. IT WAS FOUND THAT FOR N-HEXANE GAS, 4 OF THE DETECTORS WERE LESS SENSITIVE AT 65 DEG. C. THAN AT 25 DEG. C. THE GAS-AIR MIXTURES WERE VARIED FROM 100 PERCENT OF THE LOWER EXPLOSION LIMIT TO 10 PERCENT. RESULTS SHOWED THAT WHEN WORKING WITH VAPOR CONCENTRATIONS OF LESS THAN 25 PERCENT OF THE LOWER EXPLOSION LIMIT CONCENTRATION, 2 OF THE DETECTORS DID NOT GIVE A STEADY READING. READINGS TAKEN ABOVE 50 PERCENT OF THE LOWER EXPLOSION LIMIT WERE GENERALLY QUITE STEADY AND ALL READINGS WERE REACHED WITHIN 15-25 SEC. OF PASSING THE GAS-AIR MIXTURE THROUGH THE INSTRUMENTS. IT WAS CONCLUDED THAT THE DETECTORS COULD BE USED TO GIVE AN ALARM WHEN THE CONCENTRATION OF A FLAMMABLE GAS EXCEEDS A CERTAIN VALUE, BUT THE DETECTORS ARE NOT RELIABLE BELOW ABOUT 25 PERCENT OF THE LOWER EXPLOSION LIMIT CONCENTRATION.

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
REPORT NUMBER -
FR NOTE 938
OTHER INFORMATION -
0020 PAGES, 0008 FIGURES, 0003 TABLES, 0010 REFERENCES

key 1995

THE PERFORMANCE OF SOME PORTABLE GAS DETECTORS WITH AVIATION FUEL VAPOURS AT ELEVATED TEMPERATURE. PART 2. TESTS WITH AVCAT, KERO B AND AVTUR VAPOURS

by

FARDELL, P.J.

01/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Govt. Only	Summary	Acceptable

-ABSTRACT-

TESTS WERE CONDUCTED TO MEASURE THE PERFORMANCE OF SOME PORTABLE GAS DETECTORS WITH AVIATION FUEL VAPORS AT ELEVATED TEMPERATURES. THE FUEL USED WERE AN AVIATION TURBINE FUEL (AVCAT), A KEROSENE FUEL (KERO B) AND JP-1 JET FUEL (AVTUR). THE TESTS WERE CONDUCTED AT 65 DEG. C. VARIOUS CONCENTRATIONS OF FUEL VAPOR IN AIR WERE PASSED INTO AN EXPLOSION LIMITS TUBE AND SUBJECTED TO AN ELECTRICAL SPARK. WHEN A VAPOR CONCENTRATION WAS FOUND WHICH, WHEN EXCEEDED, GAVE RISE TO A SELF-PROPAGATING FLAME, THIS WAS TAKEN AS THE LOWER EXPLOSION LIMIT (LEL) CONCENTRATION. THE LEL MIXTURE WAS THEN PASSED THROUGH THE DETECTOR AND THE READING CHECKED IN EACH CASE. RESULTS SHOWED THAT THE RESPONSE OF THE DETECTORS WAS LOW. IT WAS RECOMMENDED THAT A VAPOR BE FOUND WHICH, WHEN USED TO CALIBRATE THE DETECTORS, WOULD INSURE CORRECT OR HIGH (AND THUS ERRING ON THE SIDE OF SAFETY) READINGS WITH THESE FUELS.

-BIBLIOGRAPHY-

FARDELL, P.J.- THE PERFORMANCE OF SOME PORTABLE GAS DETECTORS WITH AVIATION FUEL VAPOURS AT ELEVATED TEMPERATURES. PART 1. TESTS WITH N-HEXANE, AVTAG AND CIVGAS VAPOURS. FIRE RES. NOTE 938, JOINT FIRE RES. ORG., JULY 1972

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
REPORT NUMBER -
FR NOTE 957
OTHER INFORMATION -
0013 PAGES, 0008 FIGURES, 0003 TABLES, 0001 REFERENCES

key 2564

THE PRINCIPLES OF THE DETECTION OF FLAMMABLE ATMOSPHERES BY CATALYTIC DEVICES

by

FIRTH, J. G.
JONES, A.
JONES, T. A.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE PRINCIPLES AND DESIGN OF INSTRUMENTS WHICH MEASURE THE EXPLOSIBILITY OF FUEL-AIR MIXTURES BY CATALYTIC OXIDATION WERE DESCRIBED. EQUATIONS DESCRIBING THE OUTPUT FROM THESE DEVICES WERE DERIVED, AND A METHOD OF PREDICTING THEIR PERFORMANCE IN MANY EXPLOSIVE ATMOSPHERES WAS GIVEN. GOOD AGREEMENT (TYPICALLY WITHIN 15 PERCENT) WAS FOUND BETWEEN EXPERIMENTAL AND CALCULATED CORRECTION FACTORS FOR 24 DIFFERENT FUELS. HOWEVER, IN SITUATIONS WHERE THE FUEL RESPONSIBLE FOR THE EXPLOSIVE HAZARD WAS UNKNOWN OR A VARIABLE MIXTURE, IT WAS DESIRABLE THAT THE DETECTOR READINGS BE MORE INDEPENDENT OF THE NATURE OF THE FUEL, I.E., CORRECTION FACTORS CLOSE TO UNITY. THIS CONDITION WOULD BE MORE NEARLY MET WITH A MEASUREMENT BASED ON THE EMPIRICAL CORRELATION BETWEEN THE HEAT OF OXIDATION OF THE FUEL AND ITS LOWER EXPLOSIVE LIMIT.

-SOURCE INFORMATION-

CORPORATE SOURCE -
SAFETY IN MINES RESEARCH ESTABLISHMENT, SHEFFIELD (ENGLAND).
JOURNAL PROCEEDINGS -
CBFMAO, COMBUST FLAME, VOL. 21, NO. 3, 303-311 (1973)
OTHER INFORMATION -
0009 PAGES, 0002 FIGURES, 0004 TABLES, 0009 REFERENCES

key 2587

OVERVIEW OF FIRE DETECTOR PRINCIPLES

by

WAGNER, J. P.

06/04/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

TYPES OF FIRE DETECTORS AND PRINCIPLES OF THEIR OPERATION AND LIMITATIONS WERE SURVEYED. TYPES DISCUSSED WERE (1) COMBUSTION PRODUCT DETECTORS, INCLUDING IONIZATION DETECTORS, LASER BEAMS, AND SOLID STATE DEVICES USING METAL OXIDES; (2) VISIBLE SMOKE DETECTORS USING PHOTOELECTRIC CELLS; (3) LIGHT DETECTORS INCLUDING INFRARED, NEAR INFRARED, AND FAR INFRARED DETECTORS AND ULTRAVIOLET DETECTORS; AND (4) HEAT DETECTORS, INCLUDING THOSE USING THE FIXED TEMPERATURE PRINCIPLE AND THOSE USING THE RATE OF RISE PRINCIPLE. DETECTORS WITH RAPID RESPONSE TIMES ARE MORE SUSCEPTIBLE TO FALSE ALARMS. ALTERNATIVELY, RELATIVELY LOW PERFORMANCE DETECTORS ARE LESS PRONE TO FALSE ALARMING; HOWEVER, THEIR CAPABILITY FOR TIMELY FIRE DETECTION IS ALSO DECREASED. IONIZATIN DETECTORS HAVE A RAPID RESPONSE TO MANY FIRES BUT APPEAR TO BE SLOWER IN DETECTING SLOWLY DEVELOPING SMOLDERING FIRES SUCH AS FROM POLYVINYL CHLORIDE. AT HIGH SETTINGS, AEROSOLS SUCH AS CIGARETTE SMOKE OR DUST PARTICLES WILL TRIGGER A FALSE ALARM; HOWEVER, USE OF HEAT SENSING DETECTORS IN CONJUCTION WITH THE IONIZATION DETECTOR WILL CIRCUMVENT THE PROBLEM. LASER DEVICES OFFER TREMENDOUS POTENTIAL FOR LARGE ROOM COVERAGE. THE TAGUCHI GAS SENSOR IS ATTRACTIVE BECAUSE OF ITS LOW COST, BUT SOME LONG TERM RELIABILITY DATA ON IT IS LACKING. PHOTOELECTRIC DETECTORS ARE PREFERRED TO IONIZATION TYPES IN REGIONS WHERE THERE IS A NORMAL HIGH AMBIENT LEVEL OF COMBUSTION GASES OR WHERE THE MATERIAL PROTECTED IS EXPECTED TO PRODUCE DENSE HEAVY SMOKE. MANY PROBLEMS EXIST FOR LIGHT DETECTORS BECAUSE OF THE HIGH COST AND HIGH PROBABILITY OF FALSE ALARMING. THEY RESPOND RAPIDLY TO FLASH TYPE FIRES AND APPEAR TO BE USEFUL FOR PROTECTING FUEL STORAGE AREAS. HEAT DETECTORS USING THE FIXED TEMPERATURE PRINCIPLE ARE LOW IN COST, RELIABLE, AND FREE FROM MAINTENANCE; HOWEVER, RESPONSE TIMES ARE GENERALLY SLOW. BOTH RATE OF RISE DETECTORS AND FIXED TEMPERATURE DETECTORS ARE NOT SUITABLE FOR DETECTING SMOLDERING TYPE FIRES.

-BIBLIOGRAPHY-

GASKILL, J.R. SMOKE HAZARDS AND THEIR MEASUREMENT---A RESEARCHER'S VIEWPOINT. ARMSTRONG SYMP., LANCASTER, PA., MARCH 8, 1973, UCRL-74573 (REPRINT)// ENGINEERING AND TECHNICAL CONFERENCE

ON EARLY WARNING FIRE DETECTION PRINCIPLES. PYROTRONICS, INC., WASHINGTON, D.C., NOV. 4-5, 1970//CHAFFEE, D.L. A STUDY OF FIRE ALARMS AND FIRE ALARM SYSTEMS. NAVAL CIVIL ENGINEERING LAB., TN-980, PORT HUENEME, CALIF., AUG. 1968//WATERS, G.L.C. ADVANCES IN INFRARED FIRE DETECTION. VOL. 27,67-70, JAN. 1970

-SOURCE INFORMATION-

CORPORATE SOURCE -
FACTORY MUTUAL RESEARCH CORP., NORWOOD, MASS.
JOURNAL PROCEEDINGS -
IN UTAH UNIV, POLYMER CONF SERIES, 1973, PROC., SALT LAKE CITY, JUNE 4-9, 1973 (TEM NO D0285)
OTHER INFORMATION -
0042 PAGES, 0005 FIGURES, 0001 TABLES, 0041 REFERENCES

key 2920

CHARACTERISTICS OF INVISIBLE PARTICLES GENERATED BY PRECOMBUSTION AND COMBUSTION

by

VAN LUIK, JR., F. W.

05/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

TO BETTER UNDERSTAND THE GENERATION AND BEHAVIOR OF SUBMICRON PARTICLES RELEASED BY HEATED MATERIALS, A SERIES OF TESTS WAS CONDUCTED TO DETERMINE THE TEMPERATURE AT WHICH PARTICLES ARE FIRST EMITTED, THE AMOUNT OF MATERIAL RELEASED, AND THE BEHAVIOR OF THESE PARTICLES IN THE ATMOSPHERE. BOTH LABORATORY TESTS AND SIMULATED FIRE CONDITIONS WERE USED TO STUDY THE FIRST FEW MINUTES OF A PARTICLE'S EXISTENCE IN AIR. IN ADDITION, SINCE DETECTION OF INCIPIENT AND VERY SMALL FIRES WAS OF INTEREST AND ABSOLUTE CONCENTRATION AS WELL AS SIZE CHARACTERISTIC DATA WERE WANTED, A WILSON CLOUD CHAMBER TYPE OF PARTICLE DETECTOR WAS USED FOR MEASUREMENTS. SUBMICRON PARTICLES RANGING FROM 0.0035 TO 0.016 MICRON IN AVERAGE DIAMETER WERE PRODUCED BY COMBUSTION IN AIR OF CELLULOSIC MATERIALS. FOR PARTICLE CONCENTRATIONS RANGING FROM 130,000 TO 850,000 CM. THE AVERAGE DIAMETERS INCREASED BY 20 TO 90 PERCENT IN THE FIRST 15 MIN. AFTER CREATION. CONCENTRATION LEVELS ABOVE ONE MILLION PARTICLES PER CU. CM. WERE MEASURED FOR THE COMBUSTION OF 0.0054 GR. OF MATERIAL PER CU. FT. OF AIR. PARTICLES WERE LIBERATED FROM CONSTRUCTION AND ELECTRICAL INSULATION MATERIALS AT BELOW THEIR IGNITION TEMPERATURE. COMMON MATERIALS PRODUCED SUBMICRON PARTICLES FROM 300 TO 500 DEG. F. THE WILSON CLOUD CHAMBER TYPE OF PARTICLE DETECTOR RESPONDED TO PARTICLES PRODUCED BY FIRE AND TO INVISIBLE PARTICLES PRODUCED BY THE ONSET OF THERMAL DEGRADATION OF VARIOUS MATERIALS. THE DETECTOR ALSO RESPONDED TO SO-CALLED CLEAN FIRES, THOSE INVOLVING ALCOHOL, PROPANE, AND NATURAL GAS. THIS IS MADE POSSIBLE BY ITS ABILITY TO DETECT VERY SMALL PARTICLE DIAMETERS (LESS THAN 0.01 MICRON)

-PERTINENT FIGURES-

FIG.2 BLOCK DIAGRAM OF MEASURING SYSTEM PAGE 131//TAB. 2 PARTICLES PRODUCED IN AIR FOR 2.8 GRAMS OF MATERIAL BURNED PAGE 135//TAB.4 AVERAGE PARTICLE SIZE FOR DIFFERENT COMBUSTIBLES PAGE 136

-BIBLIOGRAPHY-

SKALA, G.F. A NEW INSTRUMENT FOR THE CONTINUOUS MEASUREMENT OF CONDENSATION NUCLEI. ANAL. CHEM., VOL. 35, MAY 1963//MURPHY, C.B. ET AL. TBA--A NEW METHOD FOR THERMAL ANALYSIS OF POLYMERIC MATERIALS. PLASTIC DESIGN AND PROCESSING, JULY 1964

-SOURCE INFORMATION-

CORPORATE SOURCE -
ENVIRONMENT ONE CORP., SCHENECTADY, N.Y.
JOURNAL PROCEEDINGS -
FITCAA, FIRE TECHNOL, VOL. 10, NO. 2, 129-139 (MAY 1974)
OTHER INFORMATION -
0011 PAGES, 0006 FIGURES, 0004 TABLES, 0005 REFERENCES

key 3050

FIRE DETECTION THE STATE-OF-THE-ART

by

BRIGHT, R. G.
CUSTER, R. L. P.

06/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	State Of Art	Good/Excel.

-ABSTRACT-

BOTH DATA ON THE OUTPUTS FROM THE COMBUSTION PROCESS THAT MIGHT BE USED TO DETECT FIRE, AND CURRENT FIRE DETECTOR TECHNOLOGY WERE DISCUSSED. FIRE SIGNATURES, CAUSES OF FATALITIES, AND THE CLASSIFICATION OF DETECTORS WERE BRIEFLY DEFINED TO ESTABLISH THE BACKGROUND FOR A DETAILED DISCUSSION OF DETECTOR OPERATING MECHANISMS. THE FUNCTION, THRESHOLD OF OPERATION AND USE OF EACH TYPE OF DETECTOR (E.G. PARTICLE IONIZATION TYPE, ULTRAVIOLET-INFRARED TYPE) WERE DISCUSSED. OTHER PROBLEMS, SUCH AS AUDIBILITY OF ALARM DEVICES, TROUBLE CIRCUITRY, EFFECTS OF AMBIENT CONDITIONS, AND RELIABILITY, WERE ALSO CONSIDERED. PERFORMANCE STANDARDS AND ACCEPTANCE CRITERIA IN THE U.S. WERE COMPARED WITH THOSE IN SOME OTHER COUNTRIES. THE EXPANDING BODY OF CODE REQUIREMENTS PERTAINING TO DETECTOR USE WAS REVIEWED. WITH THE PRESENT DETECTION TECHNOLOGY, ACHIEVEMENT OF FIRE DETECTION WITHIN MILLISECONDS OF INCEPTION WAS CONSIDERED POSSIBLE, ALTHOUGH COST COULD BE A PROBLEM. THE PROBLEMS OF FALSE ALARMS CAUSED BY EQUIPMENT FAILURE OR SIGNALS FROM SUCH BACKGROUND AEROSOLS AS CIGARETTE SMOKE AND COOKING FUMES WERE ACKNOWLEDGED. THE USE OF MULTIMODE DETECTORS REQUIRING SIGNALS FROM SEVERAL FIRE SIGNATURES BEFORE SOUNDING AN ALARM WAS A PROMISING APPROACH. DEVELOPMENT OF HARDWARE TO DETECT UNUSED SIGNATURES SUCH AS CARBON MONOXIDE WAS CONSIDERED NECESSARY, AS WERE UPGRADING AND STANDARDIZING TEST PROCEDURES AND PERFORMANCE REQUIREMENTS FOR DETECTION DEVICES.

-BIBLIOGRAPHY-

SCHEIDWEILER, A. NEW RESEARCH IN FIRE DETECTION TECHNOLOGY. INTERN. SYMP., 1968//WAGNER, J.P. A SURVEY OF THE PRINCIPLE OPERATIONAL CHARACTERISTICS OF FIRE DETECTION MECHANISMS. FIRE RES. ABSTRACTS AND REVIEWS, VOL. 13, NO. 2, 95-113, 1971//JOHNSON, J.E. ENGINEERING EARLY WARNING FIRE DETECTION. FIRE TECHNOL., VOL. 5, NO. 1, 5-15, FEB. 1969

-SOURCE INFORMATION-

CORPORATE SOURCE -

NATIONAL BUREAU OF STANDARDS, WASHINGTON, D.C. PROGRAMMATIC CENTER FOR FIRE RESEARCH

REPORT NUMBER -

NBS TN-839

SPONSOR -

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, CLEVELAND, OHIO. LEWIS RESEARCH CENTER.

OTHER INFORMATION -

0115 PAGES, 0030 FIGURES, 0005 TABLES, 0314 REFERENCES

key 3100

FIRE SUPPRESSION AND DETECTION SYSTEMS

by

BRYAN, J. L.

00/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

BASIC PRINCIPLES INVOLVED IN THE DESIGN AND OPERATION OF FIRE SUPPRESSION AND DETECTION SYSTEMS WERE PRESENTED. TOPICS DISCUSSED INCLUDED SUPPRESSION AGENTS AND PRINCIPLES, PORTABLE FIRE EXTINGUISHERS, PORTABLE AND MOBILE FOAM EQUIPMENT, FOAM EXTINGUISHING SYSTEMS, CARBON DIOXIDE EXTINGUISHING SYSTEMS, DRY CHEMICAL EXTINGUISHING SYSTEMS, HALOGENATED AGENT EXTINGUISHING SYSTEMS, EXPLOSION SUPPRESSION SYSTEMS, SPECIALIZED EXTINGUISHING SYSTEMS, FIRE DETECTION SYSTEMS, THERMAL DETECTION SYSTEMS, SMOKE DETECTION SYSTEMS, AND FLAME DETECTION SYSTEMS. THEORIES OF SUPPRESSION AND EXTINGUISHMENT AND PRINCIPLES OF DETECTION SYSTEM APPLICATIONS WERE GIVEN. THE VARIOUS TYPES AND APPLICATIONS OF SPECIFIC SYSTEMS FOR DETECTION AND EXTINGUISHMENT WERE DESCRIBED, WITH MANUFACTURERS' AND SUPPLIERS' IDENTITIES AND NOMENCLATURE PROVIDED WHERE USEFUL. ILLUSTRATIONS, SUMMARIES, AND SELECTED BIBLIOGRAPHY WERE INCLUDED. INFORMATION WAS ALSO PROVIDED ON INSTALLATION AND USE OF EQUIPMENT, EVALUATION OF EQUIPMENT, AND THE RELATIONSHIP OF EQUIPMENT TO LIFE SAFETY.

-BIBLIOGRAPHY-

GRABOWSKI, G.J. FIRE DETECTION AND ACTUATION DEVICES FOR HALON EXTINGUISHING SYSTEMS. SYMPOSIUM ON AN APPRAISAL OF HALOGENATED FIRE EXTINGUISHING AGENTS, 299-311. WASHINGTON, D.C., NATIONAL ACADEMY OF SCIENCES, 1972//HAESSLER, W.M. THE EXTINGUISHMENT OF FIRE. DAYTON, PYR-FYTER CORP., NORRIS INDUSTRIES, 1962

-SOURCE INFORMATION-

CORPORATE SOURCE -
MARYLAND UNIV., COLLEGE PARK.
PUBLISHER -
GLENCOE PRESS
OTHER INFORMATION -
0417 PAGES, 0271 FIGURES, 0000 TABLES, 0212 REFERENCES

keys 21114 through 21115

COMPRESSIBILITY FACTOR OF SOUR NATURAL GASES

by

WICHERT,E.
AZIZ,K.

04/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER PRESENTS A COMPARISON OF TWELVE SELECTED METHODS FOR THE PREDICTION OF THE COMPRESSIBILITY FACTOR OF NATURAL GASES CONTAINING H(2)S AND CO(2). THE METHODS ARE COMPARED WITH EXPERIMENTAL DATA FROM THE PUBLISHED LITERATURE AND WITH PREVIOUSLY UNPUBLISHED DATA MADE AVAILABLE BY OIL AND GAS COMPANIES OPERATING IN ALBERTA. THE METHOD OF ROBINSON, MACRYGEORGOS AND GOVIER, AND THE METHOD OF ROBINSON AND JACOBY ARE FOUND TO BE MOST ACCURATE OVER THE RANGE TESTED HERE. A BRIEF DESCRIPTION OF THE TWELVE METHODS CONSIDERED IS ALSO PRESENTED. THREE NEW METHODS ARE ALSO PROPOSED. TWO OF THE PROPOSED METHODS ARE MODIFICATIONS OF THE PITZER METHOD AND THE REDLICH-KWONG EQUATION OF STATE. THESE METHODS ARE SUITABLE FOR DIGITAL COMPUTER APPLICATIONS. THE THIRD METHOD PROPOSED HERE IS DEVELOPED FOR HAND CALCULATIONS. THE NEW METHODS, PRESENTED HERE ARE SUPERIOR TO THE TWELVE METHODS TESTED IN THIS STUDY.

-PERTINENT FIGURES-

TAB.2 COMPARISON OF ABSOLUTE PERCENT DEVIATIONS FOR TWELVE TESTED METHODS, PAGE 269//TAB.3 SUMMARY OF MAXIMUM PERCENT DEVIATIONS AND NUMBER OF POINTS DEVIATING MORE THAN + OR - 4 PERCENT, PAGE 269//TAB.4 AVERAGE ABSOLUTE PERCENT DEVIATIONS FROM EXPERIMENTAL DATA FOR THE THREE PROPOSED METHODS, PAGE 272//TAB.5 MAXIMUM PERCENT DEVIATION FROM EXPERIMENTAL DATA AND NUMBER OF POINTS OUTSIDE THE + OR - 4 PERCENT RANGE, PAGE 272//TAB.6 AVERAGE ABSOLUTE PERCENT DEVIATIONS FOR THE DATA OF SAGE AND LACEY, PAGE 273// FIG.2 PSEUDO-CRITICAL TEMPERATURE CORRECTION FACTOR, PAGE 272

-BIBLIOGRAPHY-

ROBINSON,D.B., MACRYGEORGOS,C.A. AND GOVIER,G.W., TRANS. AIME, VOL 219, 54 (1960)//PITZER,K.S., J. AM. CHEM. SOC. VOL 77, 3427 (1955)//PITZER,K.S., LIPPMANN,D.Z., CURL,R.F., ET AL., J. AM. CHEM. SOC. VOL 77, 3433 (1955)// REID,R.C. AND SHERWOOD,T.K., THE PROPERTIES OF GASES AND LIQUIDS, SECOND EDITION, MCGRAW-HILL, NEW

YORK (1966)//REDLICH,O. AND KWONG,J.N.S., CHEM. REV., VOL 44, 233 (1949)//SAGE,B.H. AND LACEY,W.N., MONOGRAPH ON API RESEARCH PROJECT 37, API (1955)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CALGARY UNIV., ALBERTA
JOURNAL PROCEEDINGS -
CAN. J. CHEM. ENG. VOL 49, NO. 2, 267-73 (APR 1971)
OTHER INFORMATION -
0007 PAGES, 0002 FIGURES, 0006 TABLES, 0026 REFERENCES

key 21068

ISOTOPIC ABUNDANCE OF NEON, ARGON, AND NITROGEN IN NATURAL GASES RELATIONSHIP TO HELIUM GENESIS

by

STROUD,L.
MEYER,T.O.
EMERSON,D.E.

04/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	NTIS	Incremental	Acceptable

-ABSTRACT-

TEN NATURAL GASES CONTAINING FROM 0.023 TO 8.4 PERCENT HELIUM WERE INVESTIGATED. IN SEVEN HIGH-HELIUM SAMPLES, THE ISOTOPIC ABUNDANCE OF NE(21) WAS GREATER THAN IN THE ATMOSPHERE, BEING SUPPLEMENTED BY 33 TO 85 PERCENT OF EXCESS OR RADIOGENIC NE(21). THE RATIO OF HE(4)/NE(21) IN THESE GASES WAS EVALUATED AND FOUND TO VARY BETWEEN 2.9 X 10(7) AND 5.9 X 10(7), A FACTOR OF APPROXIMATELY 2. ARGON CONCENTRATIONS WERE DETERMINED BY THE ISOTOPE DILUTION METHOD. THE ISOTOPIC RATIOS OF AR(40)/AR(36) IN THE HIGH-HELIUM GASES WERE FROM 5 TO 75 TIMES THE ATMOSPHERIC VALUE, WITH THE AR(40) BEING ABOUT 80 TO 99 PERCENT RADIOGENIC IN NATURE. THE RATIOS OF HE(4)/AR(40) IN ALL 10 GASES WERE EVALUATED AND FOUND TO RANGE FROM 4 TO 18. THE ISOTOPIC RATIO OF N(14)/N(15) IN FOUR OF THE HIGH-HELIUM GASES WAS ESSENTIALLY THE SAME AS IN THE ATMOSPHERE, IN THREE CASES IT WAS APPROXIMATELY 5 PERCENT HIGHER THAN THE ATMOSPHERIC VALUE OF 272.0. THE GENESIS OF NITROGEN AND THE RELATIONSHIP OF NITROGEN TO HELIUM IN NATURAL GASES WERE REVIEWED AND ARE DISCUSSED IN TERMS OF A THEORY FOR THE CONCURRENT GENERATION OF NITROGEN, HELIUM, RADIOGENIC NEON 21, AND PETROLEUM (HYDROCARBON GASES AND LIQUIDS).

-PERTINENT FIGURES-

TAB.2 PRODUCTION DATA FOR 10 NATURAL GASES, PAGE 6//TAB.3 NEON CONTENT IN NATURAL GASES AND HELIUM, PAGE 7//TAB.6 ISOTOPIC ABUNDANCE OF NEON FROM SEVEN HELIUM-BEARING NATURAL GASES, PAGE 11//TAB.8 ISOTOPIC ABUNDANCE OF ARGON FROM 10 NATURAL GASES, PAGE 16//TAB.9 ISOTOPIC RATIO OF N(14)/N(15) IN SEVEN HELIUM-BEARING NATURAL GASES, PAGE 17//TAB.10 RATIOS OF N(2)/HE AND N(2)/AR(ATM) IN 10 NATURAL GASES, PAGE 19

-BIBLIOGRAPHY-

BRANDT,L.W. AND STROUD,L., PHASE EQUILIBRIA IN NATURAL GAS SYSTEMS, APPARATUS WITH WINDOWED CELL FOR 800 PSIG AND

TEMPERATURES TO -320 DEGREES F., IND. AND ENG. CHEM., VOL 50, NO. 5, PP 849-52 (MAY 1958)//KIRKLAND,C.G., BRANDT,L.W. AND DEATON,W.M., DETERMINING TRACE IMPURITIES IN GRADE-A HELIUM. BUMINES REPT. OF INV. 5644, 12PP (1960)//PIERCE,A.P., STUDIES OF HELIUM AND ASSOCIATED NATURAL GASES, GEOLOGICAL SURVEY RESEARCH 1960, U S GEOL. SURVEY PROF. PAPER 400-B, PP B77-9 (1960)//PURER,A., SEITZ,C.A., A CHROMATOGRAPHIC METHOD FOR DETERMINATION OF TRACE IMPURITIES IN GRADE-A HELIUM, ANAL. CHEM., VOL 36, NO. 8, PP 1694-5 (JUL 1964)//ZARTMAN,R.E., WASSERBURG,G.J. AND REYNOLDS,J.H., HELIUM, ARGON, AND CARBON IN SOME NATURAL GASES, J. GEOPHYS. RES., VOL 66, PP 277-306 (1961)

-SOURCE INFORMATION-

CORPORATE SOURCE -
BUREAU OF MINES, PITTSBURGH, PA.
REPORT NUMBER -
N67-27400//RI-6936
OTHER INFORMATION -
0032 PAGES, 0002 FIGURES, 0011 TABLES, 0043 REFERENCES

key 20131

GRAPHICAL VISCOSITY CORRELATION FOR HYDROCARBONS

by

GONZALEZ, M. H.
LEE, A. L.

03/00/68

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER GIVES A GRAPHICAL METHOD OF ESTIMATING THE VISCOSITY OF NATURAL GAS MIXTURES IN THE RANGE 0.6 TO 3.0 IN REDUCED TEMPERATURE AND TO 14 IN REDUCED PRESSURE. THE CORRELATION PRESENTED HERE CAN BE APPLIED TO THE FOLLOWING SYSTEMS FOR TEMPERATURES FROM 40 DEGREES TO 460 DEGREES F AND PRESSURES FROM 14.7 TO 10,000 LB./SQ. IN. ABS. 1. PURE PARAFFINS FROM METHANE TO N-DECANE, I-BUTANE, NEO-PENTANE, NITROGEN, AND ETHYLENE. 2. MIXTURES OF HYDROCARBONS FROM METHANE TO N-BUTANE. 3. NATURAL GASES CONTAINING UP TO 10 MOLE PERCENT OF NITROGEN. 4. NATURAL GASES CONTAINING UP TO 10 MOLE PERCENT OF CARBON DIOXIDE. 5. CRITICAL-REGION VISCOSITIES FOR PURE HYDROCARBONS FROM METHANE TO N-PENTANE. NO ACCURACY ESTIMATES ARE GIVEN.

-PERTINENT FIGURES-

FIG.1 VISCOSITY OF HYDROCARBON SYSTEMS AS A FUNCTION OF REDUCED TEMPERATURE, PAGE 242//FIG.2 VISCOSITY OF HYDROCARBON SYSTEMS AS A FUNCTION OF REDUCED PRESSURE, PAGE 242//FIG.3 CORRECTION CHART FOR MIXTURES CONTAINING CARBON DIOXIDE, PAGE 243//TAB.1 COMPOSITIONS OF NATURAL GAS SAMPLES, PAGE 243

-BIBLIOGRAPHY-

BROMLEY,L.A. AND WILKE,C.R., IND. ENG. CHEM. VOL 43, 1641 (1951)// CARR,N.L., KOBAYASHI,R. AND BURROW,D.B., TRANS. AM. INST. MINING ENGRS. VOL 201, 264 (1954), J. PETROL. TECHNOL. VOL 6, 47 (1954)//DOLAN,J.P., ELLINGTON,R.T. AND LEE,A.L., J. CHEM. ENG. DATA VOL 9, 484 (1964)// DOLAN,J.P., STARLING,K.E., LEE,A.L., EAKIN,B.E. AND ELLINGTON,R.T., J. CHEM. ENG. DATA VOL 8, 396 (1963)//EAKIN,B.E. AND ELLINGTON,R.T., J. PETROL. TECHNOL. VOL 15, 210 (1963)//EAKIN,B.E., STARLING,K.E., DOLAN,J.P. AND ELLINGTON,R.T., J. CHEM. ENG. DATA VOL 7, 33 (1962)

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -
AICHE J. VOL 14, NO. 2, 242-4 (MAR 1968)
OTHER INFORMATION -
0003 PAGES, 0003 FIGURES, 0002 TABLES, 0042 REFERENCES

keys 21037 through 21040

DETERMINATION OF THE PHYSICAL CHARACTERISTICS OF LIQUEFIED NATURAL GAS (DETERMINATION DE QUELQUES CARACTERISTIQUES PHYSIQUES DU GAZ NATUREL LIQUEFIE)

by

VERNET,D.
KNIAZEFF,V.

12/00/64

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

FOR CALCULATING OF CERTAIN PLANTS OF THE TERMINUS OF LIQUEFIED NATUREL GAS AT LE HAVRE (EXCHANGERS, HIGH AND LOW PRESSURE PIPING, BLOWERS, ETC.), SEVERAL PHYSICAL CARACTERISTICS OF NATURAL GAS ARE NEEDED, VISCOSITY, HEAT CONDUCTION, SPECIFIC HEAT BETWEEN -160 DEGREES C AND 0 DEGREES C AT A PRESSURE OF 75 BARS (ABOUT 1067 PSI), HEAT OF VAPORIZATION UNDER THE ATMOSPHERE AND AT ABOUT -162 DEGREES C. AN ATTEMPT WAS MADE TO CALCULATE THESE CHARACTERISTICS THROUGH METHODS WHICH WERE FOUNDED UPON THE THEOREM OF CORRESPONDING STATES FOR THE VISCOSITY AND THE HEAT CONDUCTION, OR UPON CORRECTIONS OF PRESSURE FOR THE SPECIFIC HEAT. THE HEAT OF VAPORIZATION WAS CALCULATED THROUGH THE FORMULA OF CLAPEYRON USING THE EQUILIBRIUM COEFFICIENTS. EXPERIMENTAL MEASUREMENTS WERE THEN CARRIED OUT FOR THREE OF THE CHARACTERISTICS, THE VISCOSITY WAS MEASURED, THE HEAT CONDUCTION WAS INFERRED FROM A MEASURE OF THE TIME CONSTANT OF THE DISCHARGE OF A KNOWN THERMAL CAPACITY THROUGH A THERMAL RESISTANCE MADE OF THE NATURAL GAS, THE HEAT OF VAPORIZATION WAS INFERRED FROM THE EXPERIMENTAL DETERMINATION OF THE FACTORS OF THE CLAPEYRON FORMULA.

-PERTINENT FIGURES-

FIG.2 VISCOSITY OF NATURAL GAS AT 75 BARS, PAGE 1409//FIG.3 THERMAL CONDUCTIVITY, PAGE 1410//FIG.4 ENTHALPY AND SPECIFIC HEAT OF NATURAL GAS AT 75 BARS, PAGE 1411//FIG.4 VAPOR PRESSURE OF METHANE-NITROGEN MIXTURES, PAGE 1411

-BIBLIOGRAPHY-

JOSSI,J.A., STIEL,L.I. AND THODOS,G., THE VISCOSITY OF PURE SUBSTANCES IN THE DENSE GASEOUS AND LIQUID PHASES, AICHE J. VOL 8, NO. 1//BICHER AND KATZ, VISCOSITIES OF THE METHANE-PROPANE SYSTEM, AICHE J. VOL 35, NO. 7// INSTITUTE OF GAS TECHNOLOGY, THERMODYNAMIC PROPERTIES OF METHANE-NITROGEN MIXTURE, RESEARCH BULLETIN VOL 21 (FEB 1955)//WATERMAN,T.E., KIRSH,D.P. AND

BRABETS,R.I., CONDUCTIBILITE THERMIQUE DE L OZONE LIQUIDE DE -128 DEGREES C TO -196 DEGREES C, J. CHEM. PHYS. VOL 29, 905-8 (1958)

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
REV. INST. FRANC. PETROLE ANN. COMBUSTIBLES LIQUIDES VOL 19, NO. 12, 1405-20 (DEC 1964)
OTHER INFORMATION -
0016 PAGES, 0011 FIGURES, 0000 TABLES, 0010 REFERENCES

VAPOR-LIQUID EQUILIBRIA IN A NATURAL GAS-CONDENSATE-NITROGEN SYSTEM

by

ROBERTS,L.R.
MCKETTA,J.J.

10/00/63

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

NITROGEN IS OFTEN FOUND IN APPRECIABLE CONCENTRATIONS IN PETROLEUM FLUIDS EITHER AS A NATURAL OCCURRENCE OR AS A RESULT OF THE APPLICATION OF SECONDARY RECOVERY TECHNIQUES. THIS PAPER DESCRIBES AN EXPERIMENTAL INVESTIGATION ON THE EFFECT OF NITROGEN ON THE VAPOR-LIQUID EQUILIBRIUM RATIOS OF HYDROCARBONS IN THE NATURAL GAS-CONDENSATE SYSTEM. EXPERIMENTAL WORK WAS CARRIED OUT UNDER CONSTANT TEMPERATURE CONDITIONS AT 100 DEGREES F AND 220 DEGREES F. AT EACH TEMPERATURE, EXPERIMENTS WERE CONDUCTED AT PRESSURES OF 500, 1000, 1500, 2000, AND 3000 PSIA. NITROGEN CONCENTRATION IN THE VAPOR PHASE WAS VARIED FROM 10 PERCENT TO 50 PERCENT AT EACH PERCENTAGE. THE EQUILIBRIUM CONSTANTS FOR HYDROCARBONS AND FOR NITROGEN ARE SHOWN. ANALYSIS OF THE NATURAL GAS SAMPLES AND THE CONDENSATES IS PROVIDED.

-PERTINENT FIGURES-

TAB.1 EXPERIMENTAL DATA FOR THE COMPLEX SYSTEM AT 100 DEGREES F, PAGE 479// TAB.2 EXPERIMENTAL DATA FOR THE COMPLEX SYSTEM AT 220 DEGREES F, PAGE 479// TB.3 EXPERIMENTAL EQUILIBRIUM RATIOS FOR THE COMPLEX SYSTEM, PAGE 480// FIG.3 EXPERIMENTAL K-VALUES COMPARED TO NGAA CHARTS, PAGE 480//FIG.8 K-VALUES AT 220 DEGREES F, 975 PSIA, PAGE 482//FIG.9 K-VALUES AT 220 DEGREES F, 1520 PSIA, PAGE 482

-BIBLIOGRAPHY-

BLOOMER,O.T. AND PARENT,J.D., INSTITUTE OF GAS TECHNOLOGY RES. BULL. NUMBER 17 (1952)//POETTMAN,F.H., TRANS. AM. INST. MINING AND MET. ENGRS., PETROLEUM DIVISION, VOL 192, 141-4 (1951)//POETTMAN,F.H. AND KATZ,D.L., AICHE J. VOL 7, NO. 1, 173 91961)//ROBERTS,L.R. AND MCKETTA,J.J., J. CHEM. ENG. DATA, VOL 8, 161 (1963)

-SOURCE INFORMATION-

CORPORATE SOURCE -
TEXAS UNIV., AUSTIN
JOURNAL PROCEEDINGS -
J. CHEM. ENG. DATA VOL 8, NO. 4, 478-83 (OCT 1963)
OTHER INFORMATION -
0006 PAGES, 0009 FIGURES, 0005 TABLES, 0016 REFERENCES

keys 21035 through 21036

VISCOSITIES OF NATURAL GAS COMPONENTS AND MIXTURES

by

CARR,N.L.

06/00/53

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS BULLETIN PRESENTS A LITERATURE SURVEY, THE LABORATORY EQUIPMENT DESIGN, EXPERIMENTAL TECHNIQUES, THE EXPERIMENTAL DATA, AND CORRELATIONS, FOR THE DETERMINATION OF THE ABSOLUTE VISCOSITY OF METHANE AND THREE NATURAL GAS MIXTURES AT PRESSURES UP TO 10,000 POUNDS PER SQUARE INCH AND TEMPERATURES FROM 70 TO 250 DEGREES F. VISCOSITY-PRESSURE ISOTHERMS WERE PREPARED FOR METHANE AND THREE NATURAL GAS MIXTURES. THE DIAGRAMS SHOW THE EFFECT OF TEMPERATURE, PRESSURE AND COMPOSITION ON THE VISCOSITY OF THESE GASES. AN ALTERNATE METHOD FOR ESTIMATING HIGH-PRESSURE VISCOSITIES OF GASES AND GAS MIXTURES WAS DEVELOPED, AND COMPARED WITH EXPERIMENTAL VALUES AND FOUND TO BE REMARKABLY ACCURATE.

-PERTINENT FIGURES-

FIG.A CHART OF VISCOSITY VERSUS TEMPERATURE AT ATMOSPHERIC PRESSURE FOR NATURAL GAS COMPONENTS AND SOME NATURAL GAS MIXTURES, PAGE 2//TAB A CHEMICAL COMPOSITIONS AND VISCOSITIES OF TWENTY-FIVE NATURAL GASES AT 1 ATM AND 60 DEGREES F(6), PAGE 3//FIG.B VISCOSITY OF METHANE AT 75 DEGREES F AND PRESSURES TO 10,000 PSI, PAGE 4//FIG.G VISCOSITY OF A HIGH-ETHANE NATURAL GAS AT 79 DEGREES AND 150 DEGREES F, PAGE 6//FIG.H VISCOSITY OF A HIGH-NITROGEN NATURAL GAS AT 81 DEGREES AND 150 DEGREES F, PAGE 7//FIG.J VISCOSITY OF A LOW-ETHANE NATURAL GAS AT 85 DEGREES AND 200 DEGREES F, PAGE 7

-BIBLIOGRAPHY-

CARR,N.L. AND PARENT,J.D., THE VISCOSITY OF PURE GASES AND GAS MIXTURES AT HIGH PRESSURES - A LITERATURE SURVEY, UNPUBLISHED REPORT NO. 1, IGT PROJECT NO. B-147 (1951)//CHAPMAN,S. AND COWLING,T.G., THE MATHEMATICAL THEORY OF NON-UNIFORM GASES, CAMBRIDGE. CAMBRIDGE UNIV., PRESS (1939)// GONIKBERG,M.F., VISCOSITY OF GASES AT HIGH PRESSURES, J. TECH. PHYS. (USSR), VOL 21, 811 (1947)//KEYES,F.G., A SUMMARY OF VISCOSITY AND HEAT-CONDUCTION DATA FOR HE, A, H(2), O(2), N(2), CO, CO(2), H(2)O AND AIR, TRANS. AM. SOC. MECH. ENGRS., VOL 73, 589 (1951)//MICHELS,A. AND GIBSON,R.O., THE MEASUREMENT OF THE

VISCOSITY OF GASES AT HIGH PRESSURES, THE VISCOSITY OF NITROGEN TO 1000 ATMOSPHERES, PROC. ROY. SOC. A, VOL 134, 288 (1931)// TRAUTZ,M. AND SORG,K.G., VISCOSITY, HEAT CONDUCTIVITY AND DIFFUSION IN GAS MIXTURES, XVI, ANN. PHYSIK, VOL 10, SERIES 5, 81 (1931)

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -
INST. GAS TECHNOL. RES. BULL., NO. 23 (JUN 1953)
OTHER INFORMATION -
0063 PAGES, 0051 FIGURES, 0017 TABLES, 0118 REFERENCES

key 20607

DETERMINATION OF THE VISCOSITY AND DENSITY OF NATURAL GAS AND CALCULATION OF VISCOSITY DATA FOR METHANE (RUSSIAN)

by

PAVLOVICH, N. V.

00/00/61

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

THIS PAPER PRESENTS EXPERIMENTAL DATA FOR THE VISCOSITY OF A NUMBER OF RUSSIAN NATURAL GASES AS A FUCTION OF PRESSURE ALONG SEVERAL ISOTHERMS. PRESSURES RANGED TO 700 KG/CM(2) AND TEMPERATURES FROM 100 TO -161 DEGREES C. A DENSITY-VISCOSITY CORRELATION IS PRESENTED WITH MOLECULAR WEIGHT AS THE CORRELATOR. THE PAPER DOES NOT GIVE ANALYSES OF THE GASES MERELY THE ORIGIN.

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
IZV. VYSSH. UCHEBN. ZAVED. NEFT GAZ, NO. 8, 105-11 (1961)
OTHER INFORMATION -
0007 PAGES, 0000 FIGURES, 0006 TABLES, 0016 REFERENCES

keys 20590 through 20591

A METHOD OF PREDICTING THE VISCOSITIES OF NATURAL GASES FOR A WIDE RANGE OF PRESSURES AND TEMPERATURES

by

GIVENS, J. W.

00/00/65

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE VISCOSITIES OF NATURAL GASES HAVE BEEN CORRELATED AS A FUNCTION OF COMPOSITION, TEMPERATURE, AND PRESSURE. SIX EQUATIONS ARE PRESENTED WHICH EXPRESS THE VISCOSITY OF NATURAL GASES IN TERMS OF AVERAGE MOLECULAR WEIGHT, REDUCED TEMPERATURE, REDUCED PRESSURE, REDUCED VOLUME, REDUCED DENSITY, COMPOSITION, AND VISCOSITIES OF THE PURE COMPONENTS. IT WAS FOUND THAT THE VISCOSITIES OF NATURAL GASES CAN BE EXPRESSED OVER A WIDE RANGE OF TEMPERATURE AND PRESSURE IN TERMS OF THE VISCOSITIES OF THEIR COMPONENTS. COEFFICIENTS FOR EAKINS EQUATION HAVE BEEN REDETERMINED FOR METHANE, ETHANE, PROPANE, AND N-BUTANE AND SIMILAR COEFFICIENTS FOR NITROGEN, CARBON DIOXIDE, ISO-BUTANE, N-PENTANE, AND N-HEPTANE ARE PRESENTED FOR THE FIRST TIME. A TOTAL OF 345 VISCOSITY MEASUREMENTS WERE MADE FOR TEN LEAN NATURAL GASES OVER A RANGE OF PRESSURES FROM 1000 TO 10,000 PSIG AND TEMPERATURES FROM 77 DEGREES F TO 400 DEGREES F. 145 DATA POINTS ARE ALSO PRESENTED FOR SEVENTEEN RICH CONDENSATE GAS SAMPLES WHICH HAVE NOT BEEN PUBLISHED ELSEWHERE, ALONG WITH 121 MEASUREMENTS TAKEN FROM THE LITERATURE. AVERAGE DEVIATIONS OF FROM 8.8 TO 13.8 PERCENT WERE OBTAINED FOR THE SIX DIFFERENT EQUATIONS DEVELOPED FROM THE 611 DATA POINTS. THESE CORRELATIONS ARE SUBSTANTIALLY MORE ACCURATE THAN PREVIOUSLY AVAILABLE PROCEDURES, AND COVER A MUCH WIDER RANGE OF COMPOSITION.

-PERTINENT FIGURES-

TAB.1 COMPARISON OF PROCEDURES FOR CALCULATING DENSITIES, PAGE A-8//TAB.2 NEW COEFFICIENTS FOR EAKINS EQUATION, PAGE A-9//TAB.3 COMPARISON OF CORRELATIONS FOR NATURAL GAS VISCOSITIES, PAGE A-10//TAB.5 VISCOSITY DATA OF SAMPLES BY AUTHOR, PAGE A-12//TAB.7 VISCOSITY OF NATURAL GAS BY CARR, PAGE A-25//TAB.9 VISCOSITY OF CONDENSATE SAMPLES FROM A COMMERCIAL LABORATORY, PAGE A-33

-BIBLIOGRAPHY-

SAGE,B.H. AND LACEY,W.N., EFFECT OF PRESSURE UPON VISCOSITY OF METHANE AND TWO NATURAL GASES, TRANS. AIME VOL 127, 118

(1938)//SAGE,B.H., YALE,W.D. AND LACEY,W.N., EFFECT OF PRESSURE ON VISCOSITY OF N-BUTANE AND I-BUTANE, IND. ENG. CHEM. VOL 31, 223 (1939)//COMINGS,E.W. AND EGLY,R.S., VISCOSITY OF GASES AND VAPORS AT HIGH PRESSURES, IND. ENG. CHEM. VOL 32, 714 (1940)// BICHER,L.B. AND KATZ,D.L., VISCOSITIES OF THE METHANE-PROPANE SYSTEM, IND. ENG. CHEM. VOL 35, 754 (1943)//BICHER,L.B. AND KATZ,D.L., VISCOSITY OF NATURAL GASES, TRANS. AIME VOL 155, 246 (1944)//CARR,N.L., VISCOSITIES OF NATURAL GAS COMPONENTS AND MIXTURES, INSTITUTE OF GAS TECHNOLOGY RESEARCH BULLETIN NO. 23 (JUN 1953)

-SOURCE INFORMATION-

CORPORATE SOURCE -
TEXAS A AND M UNIV., COLLEGE STATION
OTHER INFORMATION -
0068 PAGES, 0004 FIGURES, 0015 TABLES, 0034 REFERENCES

key 20592

PREDICTING PHASE AND THERMODYNAMIC PROPERTIES OF NATURAL GASES WITH THE BENEDICT-WEBB-RUBIN EQUATION OF STATE

by

WOLFE, J. F.

03/00/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE BENEDICT-WEBB-RUBIN EQUATION OF STATE WAS USED IN DIGITAL COMPUTER PROGRAMS TO MAKE RAPID DETERMINATIONS OF NATURAL GAS EQUILIBRIUM PHASE COMPOSITIONS. MIXTURE COMPONENTS WERE THE NINE HYDROCARBONS, METHANE THROUGH HEPTANE. COMPARATIVE TESTS WERE MADE WITH DATA FROM FIELD SEPARATORS, PLANT EXCHANGERS AND LITERATURE SOURCES. FOR MOST TESTS MADE, THE B-W-R EQUATIONS PREDICTED COMPONENT K-VALUES, MIXTURE ENTHALPIES AND PHASE DENSITIES WITHIN THE ACCURACY OF AVAILABLE CORRELATIONS FOR NINE-COMPONENT MIXTURES. SIGNIFICANT DEVIATIONS WERE NOTED WHEN MIXTURES CONTAINED COMPONENTS HEAVIER THAN HEPTANE.

-PERTINENT FIGURES-

TAB.1 EXPERIMENTAL AND COMPUTED NATURAL GAS PHASE BEHAVIOR, PAGE 366//FIG.2 COMPARISON OF EXPERIMENTAL AND COMPUTED NATURAL GAS K-VALUES, PAGE 367// FIG.6 COMPARISON OF EXPERIMENTAL AND COMPUTED PHASE BEHAVIOR OF THE BINARY SYSTEM METHANE-ETHANE AT -100 F, PAGE 368

-BIBLIOGRAPHY-

BENEDICT,M., WEBB,G.B. AND RUBIN,L.C., AN EMPIRICAL EQUATION FOR THERMODYNAMIC PROPERTIES OF LIGHT HYDROCARBONS AND THEIR MIXTURES, CHEM. ENG. PROG. VOL 47, NO. 8, 419 (AUG 1951)//BENEDICT,M., WEBB,G.B. AND RUBIN,L.C., AN EMPIRICAL EQUATION FOR THERMODYNAMIC PROPERTIES OF LIGHT HYDROCARBONS AND THEIR MIXTURES, JOUR. CHEM. PHYS. VOL 8, 334 (APR 1940)// BENEDICT,M., WEBB,G.B. AND RUBIN,L.C., REDUCTION OF EQUATION TO CHARTS FOR PREDICTION OF LIQUID-VAPOR EQUILIBRIA, CHEM. ENG. PROG. VOL 47, NO. 11, 571 (NOV 1951)//KATZ,D., VAPOR-LIQUID EQUILIBRIUM FOR HYDROGEN-LIGHT HYDROCARBON SYSTEMS AT LOW TEMPERATURES, AICHE JOUR. VOL 3, 1 (MAR 1957)// OPFELL,J.B., PINGS,C.J. AND SAGE,B.H., EQUATIONS OF STATE FOR HYDROCARBONS, API, NEW YORK, N.Y. (1959)//OPFELL,J.B., SCHLINGER,W.G. AND SAGE,B.H., BENEDICT EQUATION OF STATE, APPLICATION TO METHANE, ETHANE, N-BUTANE AND N-PENTANE, IND ENG. CHEM. VOL 46, NO. 6, 1350 (1953)

-SOURCE INFORMATION-

CORPORATE SOURCE -
HUMBLE OIL AND REFINING CO., HOUSTON, TEX.
JOURNAL PROCEEDINGS -
J. PETROL. TECHNOL. VOL 18, NO. 3, 364-71 (MAR 1966) (PRES. AT SOCIETY OF PETROLEUM ENGINEERS ANNUAL FALL MEETING, DENVER, COLO., OCT 3-6, 1965. PAPER SPE 1252)
OTHER INFORMATION -
0009 PAGES, 0009 FIGURES, 0007 TABLES, 0019 REFERENCES

key 20684

THERMODYNAMIC PROPERTIES AT LOW TEMPERATURES

by

EDMISTER, W. C.
ERBAR, J. H.
LEE, B. I.

09/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

A COMPUTER ALGORITHM HAS BEEN DEVELOPED FOR PREDICTING THE THERMODYNAMIC PROPERTIES OF HYDROCARBON MIXTURES AND ASSOCIATED GASES WHICH IS ACCURATE OVER A WIDE RANGE OF TEMPERATURE AND PRESSURE CONDITIONS. THIS SUMMARY OF A LONGER PAPER GIVES THE EQUATIONS, AND VALUES OF CONSTANTS FOR USE IN THE EQUATIONS, FOR METHANE, NITROGEN, A GENERAL HYDROCARBON FLUID, AND MIXTURES OF THESE COMPONENTS.

-PERTINENT FIGURES-

TAB.1 VALUES OF THE 17 CONSTANTS IN EQUATION 8 FOR FIVE FLUIDS, PAGE 83// TAB.2 VALUES OF Q(1) THROUGH Q(5) FOR FIVE SETS OF CONDITIONS, PAGE 84

-BIBLIOGRAPHY-

LEE,B.I. AND EDMISTER,W.C., AICHE J. VOL 17, 412 (1971), IND. ENG. CHEM. FUNDAMENTALS VOL 10, 32 (1971), PROC. 50TH ANN. CONV. NGPA, 56 (1971)// CARRUTH,C.F., PH.D. THESIS, RICE UNIVER. (NOV 1970)//CHAO,K.C. AND SEADER,J.D., AICHE J. VOL 7, 598 (1961)//STARLING,K.E., JOHNSON,D.W. AND COLVER,C.P., PROC 50TH ANN. CONV. NGPA, 29 (1971)//K AND H COMPUTER PROGRAM, IBM SERIES 360, NATURAL GAS PROCESSORS ASSOC., TULSA

-SOURCE INFORMATION-

CORPORATE SOURCE -
PROCON, INC., DES PLAINES, ILL.//OKLAHOMA STATE UNIV., STILLWATER
JOURNAL PROCEEDINGS -
CHEM. ENG. PROGR. VOL 68, NO. 9, 83-4 + 99 (SEP 1972)
OTHER INFORMATION -
0003 PAGES, 0000 FIGURES, 0002 TABLES, 0005 REFERENCES

key 20711

THE PREDICTION OF THE DENSITIES OF LIQUEFIED NATURAL GAS AND OF LOWER MOLECULAR WEIGHT HYDROCARBONS

by

MOLLERUP, J.
ROWLINSON, J. S.

06/00/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE PRESENT PAPER DESCRIBES A METHOD FOR PREDICTING THE DENSITIES OF LIQUEFIED LIGHT NATURAL GASES AND OF MIXTURES OF LOWER MOLECULAR WEIGHT HYDROCARBONS NITROGEN AND CARBON DIOXIDE. THE RESULTS PRESENTED ARE MAINLY DENSITIES OF LNG AT LOW PRESSURES, BUT THE METHOD IS APPLICABLE AT HIGH PRESSURES. FOR LIQUID MIXTURES AT SATURATION, THE METHOD YIELDS ALSO DENSITIES AND VAPOUR COMPOSITIONS FROM THE SPECIFICATION OF EITHER TEMPERATURE AND LIQUID COMPOSITION OR OF THE PRESSURE AND LIQUID COMPOSITION. THE OVERALL AGREEMENT WITH KNOWN EXPERIMENTAL DENSITIES FOR LNG IS WITHIN 0.2 PERCENT.

-PERTINENT FIGURES-

TAB.1 PHYSICAL CONSTANTS FOR PURE FLUIDS, PAGE 1375//TAB.3 METHANE-NITROGEN SATURATED LIQUID VOLUME DIFFERENCES, PAGE 1379//TAB.4 SATURATED LIQUID VOLUME DIFFERENCES, PAGE 1379//TAB.5 CALCULATION OF LIQUID PHASE DENSITIES, VAPOUR PHASE COMPOSITION AND DENSITY OF SIMULATED LNG MIXTURE, PAGE 1379

-BIBLIOGRAPHY-

NBS, THIRD ANNUAL PROGRESS REPORT, NBS 73-300, BOULDER, COLO., APPENDIX A, D AND E//JENSEN,R.H. AND KURATA,F., J. PETROL. TECHNOL., 683 (JUN 1969)//KLOSEK,J. AND MCKINLEY,C., PROC. FIRST INT. CONF. ON LNG, IGT, PAPER 22, CHICAGO (1968)//SHANAA,M.Y. AND CANFIELD,F.B., TRANS. FARADAY SOC. VOL 64, 2281 (1968)//STOECKLI,H.F. AND STAVELEY,L.A.K., HELV. CHIM. ACTA. VOL 53, 1961 (1970)//FUKS,S. AND BELLEMANS,S., BULL. SOC. CHIM. BELG. VOL 76, 290 (1967)

-SOURCE INFORMATION-

CORPORATE SOURCE -
IMPERIAL COLL. OF SCIENCE AND TECHNOLOGY, LONDON, ENGLAND

JOURNAL PROCEEDINGS -
CHEM. ENG. SCI. VOL 29, NO. 6, 1373-81 (JUN 1974)
OTHER INFORMATION -
0009 PAGES, 0008 FIGURES, 0005 TABLES, 0039 REFERENCES

DENSITY OF LIQUEFIED NATURAL GAS

by

JENSEN,R.H.
KURATA,F.

06/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

AN EXPERIMENTALLY DERIVED TABULAR CORRELATION FOR LNG DENSITY AS A FUNCTION OF TEMPERATURE, PRESSURE, AND GAS GRAVITY HAS BEEN DESIGNED FOR USE IN THE FIELD. THE ADVANTAGES OF THIS CORRELATION ARE THAT A GAS GRAVITY ANALYSIS IS MORE EASILY OBTAINED THAN A COMPOSITION ANALYSIS AND THAT DENSITY IS DETERMINED BY DIRECT INTERPOLATION OF THE GAS GRAVITY TABLES. THE CORRELATION IS BASED ON EXPERIMENTAL MEASUREMENTS OF THE DENSITY OF PURE METHANE, ETHANE AND PROPANE, METHANE-ETHANE MIXTURES, METHANE-PROPANE MIXTURES, METHANE-NITROGEN MIXTURES AND SOME FIVE COMPONENT MIXTURES. THE CORRELATION IS PRESENTED AS A SERIES OF GAS GRAVITY VS. TEMPERATURE TABLES AT 20, 25, 30, 35, 40 AND 45 IN. HG. THE AUTHORS CLAIM ACCURACY TO ONE PERCENT.

-PERTINENT FIGURES-

TAB.11 LNG DENSITY, LB/CU FT, AS A FUNCTION OF GAS GRAVITY AND TEMPERATURE AT A PRESSURE OF 20 IN. HG, PAGE 688//TAB.12 LNG DENSITY, LB/CU FT, AS A FUNCTION OF GAS GRAVITY AND TEMPERATURE AT A PRESSURE OF 25 IN. HG, PAGE 689//TAB.13 LND DENSITY, LB/CU FT, AS A FUNCTION OF GAS GRAVITY AND TEMPERATURE AT A PRESSURE OF 30 IN. HG, PAGE 689//TAB.14 LNG DENSITY, LB/CU FT, AS A FUNCTION OF GAS GRAVITY AND TEMPERATURE AT A PRESSURE OF 35 IN. HG, PAGE 690//TAB.15 LNG DENSITY, LB/CU FT, AS A FUNCTION OF GAS GRAVITY AND TEMPERATURE AT A PRESSURE OF 40 IN. HG, PAGE 690//TAB.16 LNG DENSITY, LB/CU FT, AS A FUNCTION OF GAS GRAVITY AND TEMPERATURE AT A PRESSURE OF 45 IN. HG, PAGE 691

-BIBLIOGRAPHY-

HARMENS,A., ORTHOBARIC DENSITIES OF LIQUEFIED LIGHT HYDROCARBONS, CHEM. ENG. SCI. VOL 20, 813 (1965)//HARMENS,A., ORTHOBARIC DENSITIES OF LIQUEFIED LIGHT HYDROCARBONS, CHEM. ENG. SCI. VOL 21, 725 (1966)//CHUEH,P.L. AND PRAUSNITZ,J.M., VAPOR-LIQUID EQUILIBRIA AT HIGH PRESSURES. CALCULATION OF PARTIAL MOLAR VOLUMES IN NONPOLAR LIQUID MIXTURES, AICHE J. VOL 13, NO. 6, 1099 (1967)//SINOR,J.E., THE SOLUBILITY, PARTIAL MOLAL VOLUME, AND

DIFFUSIVITY OF HELIUM IN LIQUID METHANE, PHD DISSERTATION, U. OF KANSAS, LAWRENCE (1965)//SHANAA,M.Y., LIQUID DENSITY AND EXCESS VOLUME OF LIGHT HYDROCARBON MIXTURES AT -165.0C AND AT SATURATION PRESSURE, PHD DISSERTATION, U. OF OKLAHOMA, NORMAN (1966)//MATTHEWS,C.S. AND HURD,C.O., THERMODYNAMIC PROPERTIES OF METHANE, TRANS. AICHE VOL 42, 55 (1946)

-SOURCE INFORMATION-

CORPORATE SOURCE -
KANSAS UNIV., LAWRENCE
JOURNAL PROCEEDINGS -
J. PETROL. TECHNOL. VOL 21, 683-91 (JUN 1969) (PRES. AT SOCIETY OF PETROLEUM ENGINEERS REGIONAL GAS TECHNOLOGY SYMP., OMAHA, NEB., SEP 12-3, 1968. PAPER SPE 2351)
SPONSOR -
NATIONAL SCIENCE FOUNDATION, WASHINGTON, D.C.
CONTRACT NUMBER -
GRANT NSF GK-705
OTHER INFORMATION -
0009 PAGES, 0001 FIGURES, 0016 TABLES, 0012 REFERENCES

keys 20088 through 20089

THE SPECIFIC HEAT OF A NATURAL GAS AND METHANE AT 69 AND 103 ATMOSPHERES

by

FRONING, H. R.
GODDIN, C. S.
HUJSAK, K. L.

00/00/63

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE SPECIFIC HEAT AT CONSTANT PRESSURE OF METHANE AND A NATURAL GAS WERE OBTAINED IN A FLOW CALORIMETER AT 1,100 AND 1,500 LB./SQ. IN., IN THE TEMPERATURE RANGE -20 DEGREES TO 680 DEGREES F. THESE WERE COMPARED WITH VALUES COMPUTED BY SEVERAL OF THE COMMONLY USED METHODS, INCLUDING THE HOUGEN-WATSON GENERALIZED REDUCED TEMPERATURE AND PRESSURE CORRELATIONS, EDMISTERS GRAPHICAL TREATMENT OF PVT DATA, THE BENEDICT, WEBB, RUBIN EQUATION OF STATE, AND THE CORRELATIONS OF HEAT CONTENTS FOR LIGHT HYDROCARBONS PUBLISHED IN THE NATURAL GASOLINE SUPPLY MENS ASSOCIATION DATA BOOK. IT WAS CONCLUDED FROM THESE COMPARISONS THAT THE SPECIFIC HEATS OF METHANE CAN BE PREDICTED AT THE CONDITIONS INVESTIGATED BY THE BENEDICT, WEBB, RUBIN EQUATION OF STATE, FROM COMPRESSIBILITY DATA AS SHOWN BY HOUGEN AND WATSON, AND BY EDMISTERS GRAPHICAL TREATMENT OF PVT DATA. EDMISTERS METHOD GIVES RESULTS IN CLOSER AGREEMENT WITH THE EXPERIMENTAL DATA FOR THE NATURAL GAS THAN THE BENEDICT OR HOUGEN AND WATSON METHODS. THE EXTRAPOLATED DATA PUBLISHED IN THE NGSMA DATA BOOK APPEAR TO BE THE LEAST RELIABLE.

-PERTINENT FIGURES-

FIG.3 SPECIFIC HEAT OF METHANE AT 1,100 LB./SQ.IN. GAUGE, PAGE 92//FIG.4 SPECIFIC HEAT OF METHANE AT 1,500 LB./SQ.IN. GAUGE, PAGE 92//FIG.5 SPECIFIC HEAT OF NATURAL GAS AT 1,100 LB./SQ.IN. GAUGE, PAGE 93//FIG.6 SPECIFIC HEAT OF NATURAL GAS AT 1,500 LB./SQ.IN. GAUGE, PAGE 93//FIG.7 SPECIFIC HEAT OF METHANE CALCULATED FROM BENEDICT, WEBB, RUBIN EQUATION OF STATE, PAGE 93//FIG.8 SPECIFIC HEAT OF NATURAL GAS, MOLECULAR WEIGHT 17.68, CALCULATED FROM BENEDICT, WEBB, RUBIN EQUATION OF STATE

-BIBLIOGRAPHY-

CORCORAN,W.H., BOWLES,R.R., SAGE,B.H. AND LACEY,W.N., IND. ENG. CHEM. VOL 37, 825 (1945)//BENEDICT,M., WEBB,G.B. AND RUBIN,L.C.,

J. CHEM. PHYS. VOL 8, 334 (1940)//EDMISTER,W.C., PETROL. REFINER VOL 37, 153 (1958)//NATURAL GASOLINE SUPPLY MENS ASSOCIATION DATA BOOK, PP 121-132 (1957)//BENEDICT,M., WEBB,G.B. AND RUBIN,L.C., CHEM. ENG. PROGR. VOL 47, NO. 8, P 419 (1951)

-SOURCE INFORMATION-

CORPORATE SOURCE -
PAN AMERICAN PETROLEUM CORP., TULSA, OKLA.
JOURNAL PROCEEDINGS -
CHEM. ENG. PROGR. SYMP. SER. VOL 59, NO. 44, 88-94 (1963)
OTHER INFORMATION -
0007 PAGES, 0008 FIGURES, 0001 TABLES, 0007 REFERENCES

VAPOR-LIQUID EQUILIBRIA OF HYDROCARBON-NITROGEN SYSTEMS--METHANE-N-HEXANE-NITROGEN SYSTEM

by

POSTON,R.S.

00/00/65

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

THERE EXIST GAS AND GAS CONDENSATE RESERVOIRS WHICH CONTAIN SUBSTANTIAL CONCENTRATIONS OF NITROGEN AND OTHER INORGANIC GASES. MAXIMUM PRIMARY RECOVERY OF THE HYDROCARBON GASES FROM THE RESERVOIR REQUIRES A KNOWLEDGE OF THE PHASE BEHAVIOR AS THE RESERVOIR IS DEPLETED. IN ADDITION SECONDARY RECOVERY AND PRESSURE MAINTENANCE TECHNIQUES USING AIR AND FLUE GASES HAVE BEEN SUGGESTED. AN INVESTIGATION OF THE VAPOR-LIQUID PHASE EQUILIBRIUM OF THREE DIFFERENT HYDROCARBON SYSTEMS IS PRESENTED. THE THREE SYSTEMS ARE (1) THE BINARY SYSTEM, N-HEXANE-METHANE, (2) THE BINARY SYSTEM, N-HEXANE-NITROGEN, AND (3) THE TERNARY SYSTEM, METHANE-N-HEXANE-NITROGEN. THIS WORK DESCRIBES THE EFFECT OF VARYING QUANTITIES OF NITROGEN ON THE VAPOR-LIQUID PHASE EQUILIBRIA OF THE METHANE-N-HEXANE BINARY SYSTEM. ANALYSES OF EQUILIBRIUM PHASES AT DIFFERENT CONDITIONS OF TEMPERATURE AND PRESSURE ARE PRESENTED TO DESCRIBE COMPLETELY THE PHASE EQUILIBRIA OF EACH SYSTEM. TEMPERATURE INTERVALS WERE 60 DEGREES F, STARTING AT 100 DEGREES F AND INCREASING TO 340 DEGREES F. AT EACH TEMPERATURE, SAMPLES WERE TAKEN AT 500 PSIA, AND THE PRESSURE INCREASED IN 500 PSIA INTERVALS WITH SAMPLES TAKEN AT EACH INTERVAL, UP TO 5000 PSIA OR THE CRITICAL PRESSURE, WHICHEVER WAS LOWER. THIS INVESTIGATION WAS RESTRICTED TO THE TWO-PHASE VAPOR-LIQUID EQUILIBRIUM REGIONS OF THE SYSTEMS INVESTIGATED. THE EQUILIBRIUM RATIOS FOR THIS SYSTEM TOGETHER WITH OTHER PUBLISHED RATIOS ON HYDROCARBON-NITROGEN SYSTEMS WERE CORRELATED ON A HADDEN, GRAYSON, AND WINN NOMOGRAPH. GENERAL AGREEMENT WAS NOTED FOR THE LIGHT COMPONENTS, BUT CONSIDERABLE DEVIATION FROM EXPERIMENTAL DATA WAS EVIDENCED FOR HEAVIER COMPONENTS AS NITROGEN CONCENTRATION INCREASED.

-SOURCE INFORMATION-

CORPORATE SOURCE -
TEXAS UNIV., AUSTIN

OTHER INFORMATION -
0162 PAGES, 0000 FIGURES, 0000 TABLES, 0000 REFERENCES

key 20058

COMPRESSIBILITY FACTOR OF FUEL GASES AT 60 DEGREES F. AND 1 ATM.

by

EAKIN, B. E.
MASON, D. MCA.

10/00/61

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

COMPONENTS THAT NORMALLY OCCUR IN ONE OR MORE UTILITY FUEL GAS IN CONCENTRATIONS OF 5 PERCENT OR MORE INCLUDE METHANE, ETHANE, PROPANE, ETHYLENE, PROPENE, NITROGEN, AIR, CARBON DIOXIDE, CARBON MONOXIDE, AND HYDROGEN. MINOR AMOUNTS OF C(4) AND C(5) HYDROCARBONS ALSO OCCUR, TOGETHER WITH TRACES OF HEAVIER HYDROCARBONS. A REVIEW OF THE LITERATURE INDICATED THAT SUFFICIENTLY RELIABLE VALUES OF ATMOSPHERIC PRESSURE COMPRESSIBILITY FACTORS WERE NOT AVAILABLE FOR SOME COMPONENTS, PARTICULARLY THE HIGHER BOILING HYDROCARBONS. FURTHERMORE, ONLY VERY LIMITED DATA WERE AVAILABLE ON MIXTURES OF THESE COMPONENTS AT LOW PRESSURES. THEREFORE, COMPRESSIBILITY FACTOR MEASUREMENTS WERE MADE ON A NUMBER OF PURE COMPONENTS, AND ON A SERIES OF SELECTED MIXTURES. THE INTERACTION COEFFICIENTS AMONG THE COMPONENTS THAT NORMALLY OCCUR TOGETHER IN MAJOR CONCENTRATIONS WERE DETERMINED. A NUMBER OF SELECTED MAJOR-MINOR INTERACTION COEFFICIENTS WERE ALSO DETERMINED TO PROVIDE A BASIS FOR PREDICTION OF OTHER COEFFICIENTS.

-PERTINENT FIGURES-

TAB.1 EXPERIMENTAL DATA ON GAS LAW DEVIATIONS OF HYDROCARBONS AT 60 DEGREES F, PAGE 501//TAB.2 COMPARISON OF EXPERIMENTAL AND LITERATURE VALUES OF GAS LAW DEVIATIONS, PAGE 501//TAB.3 COMPRESSIBILITY FACTORS AND INTERACTION COEFFICIENTS OF BINARY MIXTURES OF FUEL GAS COMPONENTS, PAGE 502//TAB.4 GAS LAW DEVIATIONS OF FUEL GAS COMPONENTS AT 60 DEGREES F AND 1 ATM, PAGE 503//TAB.5 GAS LAW DEVIATIONS OF FOUR-COMPONENT MIXTURES AT 60 DEGREES F AND 1 ATM, PAGE 504

-BIBLIOGRAPHY-

AM. PETROL. INST., SELECTED VALUES OF PROPERTIES OF HYDROCARBONS AND RELATED COMPOUNDS, API RESEARCH PROJECT 44, CARNEGIE INST. TECH., PITTSBURGH, PA. (LOOSE-LEAF DATA SHEETS, EXTANT 1960)//MASON,D.MCA., EAKIN,B.E., DISTRIBUTION-PRODUCTION CONF. AM.

GAS ASSOC., PHILADELPHIA, PA., MAY 1961//ROSSINI,F.D., PITZER,K.S., ARNETT,R.L., BRAUN,R.M. AND PIMENTEL,G.C., SELECTED VALUES OF PHYSICAL AND THERMODYNAMIC PROPERTIES OF HYDROCARBONS AND RELATED COMPOUNDS, AM. PETROL. INST. RESEARCH PROJECT 44, CARNEGIE PRESS, PITTSBURGH, PA., 1953

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -
J. CHEM. ENG. DATA VOL 6, NO. 4, 499-504 (OCT 1961) (PRES. AT ACS MEETING, 138TH, NEW YORK, SEP 1960)
OTHER INFORMATION -
0006 PAGES, 0003 FIGURES, 0005 TABLES, 0017 REFERENCES

key 21069

COMPRESSIBILITY FACTORS FOR LEAN NATURAL GAS-CARBON DIOXIDE MIXTURES AT HIGH PRESSURE

by

BUXTON,T.S.
CAMPBELL,J.M.

03/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS STUDY INDICATES THAT, IF THE CORRESPONDING STATES PSEUDOCRITICAL TEMPERATURE AND PRESSURE USED TO DETERMINE THE REDUCED CONDITIONS ARE ADEQUATELY PREDICTED, CHARACTERIZATION OF NATURAL GAS-CARBON DIOXIDE MIXTURES WITH THE ACENTRIC FACTOR WILL ALLOW RELIABLE DETERMINATION OF THE COMPRESSIBILITY FACTOR. COMPARISONS OF PREDICTED AND EXPERIMENTAL COMPRESSIBILITY FACTORS HAVE SHOWN THAT THE PSEUDOCRITICAL CONSTANT RULES OF STEWART, BURKHARDT AND VOO ARE SATISFACTORY FOR HYDROCARBON MIXTURES. HOWEVER, THESE RULES FAIL TO PREDICT THE PSEDUOCRITICAL CONSTANTS FOR HYDROCARBON-CARBON DIOXIDE MIXTURES. BASED ON GRAPHICALLY DETERMINED PSEUDOCRITICAL TEMPERATURES FOR BINARY HYDROCARBON-CARBON DIOXIDE MIXTURES, A CORRELATION WHICH GIVES THE REQUIRED CORRECTION TO THE STEWART, BURKHARDT AND VOO RULES WAS PREPARED AND A COMPRESSIBILITY FACTOR PREDICTION TECHNIQUE WAS PROPOSED. TO TEST THE PROPOSED TECHNIQUE, COMPRESSIBILITY FACTORS FOR FIVE MIXTURES OF METHANE, CARBON DIOXIDE AND EITHER ETHANE OR PROPANE WERE EXPERIMENTALLY DETERMINED AT 100, 130 AND 160 F AND PRESSURES UP TO 7,026 PSIA. THE PREDICTED AND EXPERIMENTAL COMPRESSIBILITY FACTORS FOR THESE FIVE MIXTURES HAD AN AVERAGE ABSOLUTE DEVIATION OF 0.55 PERCENT.

-PERTINENT FIGURES-

TAB.1 PSEUDOCRITICAL CONSTANTS - BINARY MIXTURES, PAGE 82//TAB.2 COMPOSITION OF EXPERIMENTAL MIXTURES IN THIS STUDY (EXPRESSED AS MOLE FRACTION), PAGE 84//TAB.3 EXPERIMENTAL COMPRESSIBILITY FACTORS, PAGE 84// TAB.4 COMPARISON OF DEVIATIONS OF PREDICTED COMPRESSIBILITY FACTORS FROM EXPERIMENTAL VALUES, PAGE 85//FIG.1 SBV T(PC) MINUS THE GRAPHICALLY DETERMINED T(PC) VS PERCENT CARBON DIOXIDE, PAGE 83

-BIBLIOGRAPHY-

PITZER,K.S., J. CHEM. PHYS. VOL 7, 583 (1939)//STEWART,W.F., BURKHARDT,S.F. AND VOO,D., PREDICTION OF PSEUDOCRITICAL

PARAMETERS FOR MIXTURES, PAPER PRESENTED AT THE AICHE MEETING, KANSAS CITY, MO. (1959)

-SOURCE INFORMATION-

CORPORATE SOURCE -
PAN AMERICAN PETROLEUM CORP., TULSA, OKLA.//OKLAHOMA UNIV., NORMAN

JOURNAL PROCEEDINGS -
SOC. PETROL. ENGR. J. VOL 7, NO. 1, 80-6 (MAR 1967) (PRES. AT SOCIETY OF PETROLEUM ENGINEERS ANNUAL FALL MEETING, 41ST, DALLAS, TEX., OCT 2-5, 1966. PAPER SPE 1590)

OTHER INFORMATION -
0007 PAGES, 0003 FIGURES, 0004 TABLES, 0024 REFERENCES

key 20596

THE VISCOSITY OF NATURAL GASES

by

EAKIN, B. E.
GONZALEZ, M. H.
LEE, A. L.

08/00/66

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

EXPERIMENTAL VISCOSITY AND DENSITY DATA OF FOUR NATURAL GASES ARE PRESENTED FOR TEMPERATURES FROM 100 TO 340 F AND PRESSURES FROM 100 TO 8,000 PSIA. A CORRELATION IS ALSO DISCUSSED AND RESULTS REPORTED. THE VISCOSITY CORRELATION PREVIOUSLY REPORTED BY THE INSTITUTE OF GAS TECHNOLOGY IS FOUND TO PREDICT VISCOSITY VALUES WITH A STANDARD DEVIATION OF 2.7 PERCENT EVEN WHEN THE EQUATION IS EXTENDED BY OBTAINING COEFFICIENTS USING PREDICTED DENSITIES.

-PERTINENT FIGURES-

TAB.1 ANALYSIS OF NATURAL GAS SAMPLES, PAGE 997//TAB.2 VISCOSITY AND DENSITY VALUES FOR NATURAL GAS NO. 1, PAGE 998//TAB.3 VISCOSITY AND DENSITY VALUES FOR NATURAL GAS NO. 2, PAGE 998//TAB.4 VISCOSITY AND DENSITY VALUES FOR NATURAL GAS NO. 3, PAGE 999//TAB.5 VISCOSITY AND DENSITY VALUES FOR NATURAL GAS NO. 4, PAGE 999//FIG.2 COMPARISON OF VISCOSITY VALUES OF NATURAL GAS SAMPLE 4, PAGE 999

-BIBLIOGRAPHY-

BORN,M. AND GREEN,H.S., A GENERAL KINETIC THEORY OF LIQUIDS, III. DYNAMICAL PROPERTIES, PROC. ROYAL SOCIETY, LONDON, ENGLAND VOL A190, 455-474 (1947)// LEE,A.L., STARLING,K.E., DOLAND,J.P. AND ELLINGTON,R.T., VISCOSITY CORRELATION FOR LIGHT HYDROCARBON SYSTEMS, AICHE JOUR., 694-697 (SEP 1964) //LEE,A.L., VISCOSITY OF LIGHT HYDROCARBONS, API, NEW YORK, N.Y. (1950)// STARLING,K.E. AND ELLINGTON,R.T., VISCOSITY CORRELATIONS FOR NONPOLAR DENSE FLUIDS, AICHE JOUR., 11-15 (JAN 1964)

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -

J. PETROL. TECHNOL. VOL 18, NO. 8, 997-1000 (AUG 1966) (PRES. AT SOCIETY OF PETROLEUM ENGINEERS GAS TECHNOLOGY SYMP., SHREVEPORT, LA., NOV 11-2, 1965. PAPER SPE 1340)
OTHER INFORMATION -
0004 PAGES, 0002 FIGURES, 0004 TABLES, 0013 REFERENCES

key 20624

JOULE-THOMSON EFFECTS IN GAS MIXTURES. THE NITROGEN-METHANE-ETHANE SYSTEM

by

AHLERT, R. C.
WENZEL, L. A.

03/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

PRESSURE-TEMPERATURE DATA WERE OBTAINED ALONG ISENTHALPS FOR NITROGEN, METHANE, AND THREE TERNARY NITROGEN-METHANE-ETHANE MIXTURES. THESE DATA WERE DIFFERENTIATED TO OBTAIN JOULE-THOMSON COEFFICIENTS OVER THE TEMPERATURE RANGE FROM AMBIENT TO 200 K AND AT PRESSURES FROM 165 ATM TO ABOUT 5 ATM. DATA FOR NITROGEN WAS OBTAINED DOWN TO 140 K. THE RESULTING JOULE-THOMSON COEFFICIENTS WERE COMPARED WITH PREDICTIONS BASED ON THE BEATTIE-BRIDGEMAN AND BENEDICT-WEBB-RUBIN EQUATIONS OF STATE AND ON THE VIRIAL EQUATION OF STATE TRUNCATED AFTER THE THIRD VIRIAL COEFFICIENT. THESE COMPARISONS SHOW THAT THE BENEDICT-WEBB-RUBIN EQUATION COULD PREDICT THE DATA WITH A DEVIATION AVERAGING 1.7 PERCENT. IN ALL OF THESE COMPARISONS, THE VIRIAL COEFFICIENTS OF ETHANE APPEAR TO BE IN GREATEST UNCERTAINTY, AND THE PREDICTIONS OF MIXTURE DATA HIGH IN ETHANE WERE LEAST SATISFACTORY. THUS IS APPEARS THAT IMPROVED DATA ON THE PURE COMPONENTS, PARTICULARLY ETHANE, ARE VITAL TO ANY SATISFACTORY EVALUATION OF MIXTURE PROPERTIES.

-PERTINENT FIGURES-

FIG.2 EXPERIMENTAL ISENTHALPS FOR NITROGEN, PAGE 258//FIG.3 EXPERIMENTAL ISENTHALPS FOR METHANE, PAGE 258//FIG.4 EXPERIMENTAL ISENTHALPS FOR MIXTURE A (33.2 PERCENT C(2)H(6), 32.5 PERCENT CH(4), 34.3 PERCENT N(2)), PAGE 258//FIG.5 EXPERIMENTAL ISENTHALPS FOR MIXTURE B (9.6 PERCENT C(2)H(6), 46.0 PERCENT CH(4), 44.4 PERCENT N(2)), PAGE 259//FIG.6 EXPERIMENTAL ISENTHALPS FOR MIXTURE C (26.5 PERCENT C(2)H(6), 22.5 PERCENT CH(4), 51.0 PERCENT N(2)), PAGE 259//TAB.7 COMPARISON OF PREDICTED JOULE-THOMSON COEFFICIENTS USING THE VIRIAL EQUATION, PAGE 262

-BIBLIOGRAPHY-

BENEDICT,M., WEBB,G.B. AND RUBIN,L.C., J. CHEM. PHYS. VOL 8, 334 (1940)// DIN,F., THERMODYNAMIC FUNCTIONS OF GASES, VOL 3, ETHANE, METHANE AND NITROGEN, BUTTERWORTHS, LONDON (1961)//GOFF,J.A. AND GRATCH,S., TRANS. AM. SOC. MECH. ENG. VOL 72, 741

(1950)//MAGE,D.T., JONES,M.L., KATZ,D.L. AND ROEBUCK,J.R., CHEM. ENG. PROG. SYMPOSIUM SER. VOL 44, NO. 59, 61 (1963)//SAGE,B.H., WEBSTER,D.C. AND LACEY,W.N., IND. ENG. CHEM. VOL 29, 658 (1937)//STROBRIDGE,T.R., NATL. BUR. STAND. TECH. NOTE 129 (1962)

-SOURCE INFORMATION-

CORPORATE SOURCE -
LEHIGH UNIV., BETHLEHEM, PA.
JOURNAL PROCEEDINGS -
AICHE J. VOL 15, NO. 2, 256-63 (MAR 1969)
OTHER INFORMATION -
0008 PAGES, 0006 FIGURES, 0007 TABLES, 0015 REFERENCES

key 20625

PREDICT NATURAL GAS PROPERTIES

by

HANKINSON, R. W.
PHILLIPS, K. A.
THOMAS, L. K.

04/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS GIVES EQUATIONS TO CALCULATE THE COMPRESSIBILITY FACTOR, HEAT CAPACITY AND CRITICAL PROPERTIES OF NATURAL GASES (IN GAS PHASE ONLY) BASED ON A MOLE FRACTION AVERAGE OF THE SPECIFIC GRAVITY AND A BWR EQUATION OF STATE. ACCURACIES ARE GIVEN AS 2-6 PERCENT FOR TEMPERATURES AT 1.1 TIMES CRITICAL TO 2 TIMES CRITICAL. A SAMPLE CALCULATION IS GIVEN AND COMPARED WITH SOME UNIDENTIFIED DATA.

-PERTINENT FIGURES-

FIG.1 COMPARISON BETWEEN THE EXPERIMENTAL AND COMPRESSIBILITY FACTORS FOR NATURAL GAS, PAGE 106//TAB.1 COMPARISON OF PSEUDOCRITICAL PROPERTIES OF NATURAL GAS COMPUTED BY EQUATIONS 3 AND 4 WITH THOSE PRESENTED BY 10CC TABLES, PAGE 107//TAB.2 COEFFICIENTS FOR EQUATION 6, THE CORRELATION OF LOW PRESSURE ISOBARIC HEAT CAPACITY FOR NATURAL GAS AS FUNCTION OF TEMPERATURE AND GRAVITY, PAGE 107//TAB.3 EXAMPLE OF PROPERTY CALCULATION, PAGE 107//TAB.4 COEFFICIENTS FOR THE REDUCED BENEDICT-WEBB-RUBIN EQUATION OF STATE FOR NATURAL GAS, PAGE 107//TAB.5 ERROR PERCENTS IN CALCULATED COMPRESSIBILITY FACTORS, PAGE 107

-BIBLIOGRAPHY-

ENGINEERING DATA BOOK, NATURAL GAS PROCESSORS SUPPLIERS ASSOCIATION, TULSA, OKLA. (1966)//MANUAL OF BACK-PRESSURE TESTING OF GAS WELLS, INTERSTATE OIL COMPACT COMMISSION, OKLAHOMA CITY (1966)//SAGE,B.H., THERMODYNAMICS OF MULTICOMPONENT SYSTEMS, REINHOLD PUBLISHING CO., 218 (1965)

-SOURCE INFORMATION-

CORPORATE SOURCE -
PHILLIPS PETROLEUM CO., BARTLESVILLE, OKLA.
JOURNAL PROCEEDINGS -
HYDROCARBON PROCESS. VOL 48, NO. 4, 106-8 (APR 1969)

key 20614

USE OF THE BENEDICT-WEBB-RUBIN EQUATION OF STATE IN THERMODYNAMIC CALCULATIONS FOR THE SHEBELINSK NATURAL GAS (RUSSIAN)

by

BURNYKH, V. S.
KOVTSEV, A. F.

00/00/67

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE AUTHORS CONCLUDE THAT THE BENEDICT-WEBB-RUBIN EQUATION OF STATE CAN BE USED TO CALCULATE VARIOUS PVT RELATIONS OF MULTICOMPONENT HYDROCARBON GASEOUS MIXTURES. CALCULATIONS OF COMPRESSIBILITY FACTORS WITH THE EQUATION AGREE WELL WITH EXPERIMENTAL DATA ON SHEBELINSK NATURAL GAS AS GIVEN IN THE LITERATURE.

-PERTINENT FIGURES-

TAB.1 NUMERICAL VALUES OF COEFFICIENTS OF THE BENEDICT-WEBB-RUBIN EQUATION, PAGE 14//TAB.2 COMPONENT COMPOSITION OF SHEBELINSK GAS, PAGE 15//TAB.3 VALUES OF COEFFICIENTS OF THE BWR EQUATION FOR SHEBELINSK GAS, PAGE 15// TAB.4 VALUES OF COEFFICIENTS OF EQUATION, PAGE 16//TAB.5 ABSOLUTE AND REDUCED PARAMETERS OF SHEBELINSK GAS, PAGE 16

-BIBLIOGRAPHY-

BENEDICT,M., WEBB,G. AND RUBIN,L., EMPIRICAL EQUATION FOR CALCULATING THE THERMODYNAMIC PROPERTIES OF LIGHT HYDROCARBONS AND THEIR MIXTURES, IN THE BOOK PHASE EQUILIBRIA OF LIGHT HYDROCARBONS, GOSTOPTEKHIZDAT (1958)// KATZ,D.L., ET AL., HANDBOOK ON RECOVERY, TRANSPORT, AND TREATMENT OF NATURAL GAS, TRANSLATED FROM ENGLISH UNDER ED. KOROTAEV,YU.P. AND PONOMAREV,G.V., IZD NEDRA, 676 (1965)

-SOURCE INFORMATION-

CORPORATE SOURCE -
UKRAINIAN SCIENTIFIC-RESEARCH INST. FOR GAS
JOURNAL PROCEEDINGS -
GAZ. PROM. VOL 12, NO. 7, 14-6 (1967)
OTHER INFORMATION -

keys 20629 through 20632

CALCULATION OF THE COMPRESSIBILITY FACTOR OF NATURAL GASES (RUSSIAN)

by

GUREVICH, G. R.
LATONOV, V. V.

00/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER PRESENTS A METHOD OF CALCULATING THE COMPRESSIBILITY OF NATURAL GAS MIXTURES USING A SET OF MIXING RULES. THE AUTHORS PRESENT COMPARISONS WITH MIXTURES CONTAINING C1 THRU C4 PARAFFINS, C1 THRU C5 AND C1 THRU C10 PARAFFINS AS WELL AS SYSTEMS WITH NITROGEN SYSTEMS WITH CARBON DIOXIDE AND SYSTEMS WITH BOTH. DEVIATIONS VARY FROM 2 TO 10 PERCENT.

-BIBLIOGRAPHY-

MAXWELL,J.B., DATA BOOK ON HYDROCARBONS, D. VAN NOSTRAND CO., NEW YORK (1951)//PITZER,K.S., ET AL., THE VOLUMETRIC AND THERMODYNAMIC PROPERTIES OF FLUIDS. II. COMPRESSIBILITY FACTOR, VAPOR PRESSURE AND ENTROPY OF VAPORIZATION, J. AMER. CHEM. SOC. VOL 77, NO. 13 (1955)//SAREM,A.M., Z-FACTOR EQUATION DEVELOPED FOR USE IN DIGITAL COMPUTERS, OIL GAS. J., P 18 (SEP 1961)

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
GAZOV. PROM. VOL 14, NO. 2, 7-10 (1969)
OTHER INFORMATION -
0003 PAGES, 0000 FIGURES, 0001 TABLES, 0008 REFERENCES

key 20633

VAPOUR-LIQUID-EQUILIBRIUM OF LNG (JAPANESE)

by

KUROKI, M.
OGURA, M.
SAITO, I.
WATANABE, K.

00/00/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

METHANE, ETHANE AND PROPANE, THE MAIN COMPONENTS OF LNG, HAVE THE PROPERTY LIKE IDEAL GAS, BUT THEY DEVIATE FROM IDEAL SOLUTION IN MULTICOMPONENT SYSTEM BY THE EFFECT OF COMPOSITION. THOUGH IT IS ESSENTIAL TO HAVE CORRECT EQUILIBRIUM RATIO TO ANALYZE THE CONCENTRATION PROCESS OF LNG, WE CANNOT FIND ANY ADEQUATE EQUATIONS WHICH ESTIMATE CORRECTLY THE VAPOUR-LIQUID EQUILIBRIUM OF THE MULTICOMPONENT SYSTEM. WE HAVE OBTAINED K VALUES OF THE TERNARY SYSTEM OF METHANE, ETHANE AND PROPANE BY OBSERVATION, AND STUDIED THE CASES WHEN A SMALL QUANTITY OF BUTANE IS MIXED IN THE SYSTEM. BASED ON THESE DATA WE ANALYZED THE CONCENTRATION PROCESS OF LNG BY CALCULATING THE EQUILIBRIUM FLASH VAPORIZATION.

-PERTINENT FIGURES-

FIG.2 K VALUE-TEMPERATURE DIAGRAM FOR METHANE IN BINARY SYSTEM AT 1 ATM., PAGE 295//FIG.6 K VALUE-TEMPERATURE DIAGRAM FOR METHANE IN TERNARY SYSTEM AT 1 ATM., PAGE 296//TAB.3 EXPERIMENTAL EQUILIBRIUM DATA FOR BINARY SYSTEM OF LIGHT HYDROCARBONS (PRESSURE 1 ATM.), PAGE 297//TAB.4 EXPERIMENTAL EQUILIBRIUM DATA FOR METHANE-ETHANE-PROPANE SYSTEM (PRESSURE 1 ATM.), PAGE 298//FIG.12 THE CHANGE OF COMPONENTS IN LIQUID PHASE FOR METHANE-ETHANE-PROPANE SYSTEM, PAGE 300//FIG.13 ISOTHERMAL DIAGRAM FOR METHANE-ETHANE-PROPANE SYSTEM AT 1 ATM., PAGE 300

-BIBLIOGRAPHY-

BENNETT,C.O., ET AL., AICHE J. VOL 6, NO. 1, 67 (1960)//BENEDICT,M., ET AL., CHEM. ENG. PROG. VOL 47, NO. 8, 419 (1951)//BENEDICT,M., CHEM. ENG. PROG. VOL 47, NO. 9, 449 (1951)//STREETT,W.R., CRYOGENICS (FEB 1965)

-SOURCE INFORMATION-

CORPORATE SOURCE -
TOKYO GAS CO., LTD., JAPAN
JOURNAL PROCEEDINGS -
CRYOG. ENG. (TOKYO) VOL 4, NO. 6, 292-301 (1969)
OTHER INFORMATION -
0010 PAGES, 0014 FIGURES, 0004 TABLES, 0008 REFERENCES

key 20635

SIMPLE METHOD PERMITS PREDICTION OF NATURAL-GAS CRITICAL PROPERTIES

by

CAMPBELL, J. M.
MCLEOD, W. R.

07/07/69

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THIS PAPER PRESENTS A SIMPLE METHOD WHICH CAN PREDICT THE TRUE CRITICAL PROPERTIES FOR A NATURAL-GAS MIXTURE. IT IS BASED ON THE EYKMAN MOLECULAR REFRACTION (EMR), A MEASURABLE, TRUE PROPERTY AVAILABLE FROM REFRACTIVE-INDEX MEASUREMENTS. A SIMPLE KAY-TYPE COMBINATION RULE SUFFICES FOR THE DETERMINATIONS. THE PAPER INCLUDES A STEP-BY-STEP PROCEDURE FOR MAKING USE OF THE METHOD TO CALCULATE THE COMPRESSIBILITY FACTOR FOR MIXTURES.

-PERTINENT FIGURES-

TAB.1 PHYSICAL CONSTANTS, PAGE 115//TAB.2 EMR DETERMINATION FOR A NATURAL-GAS MIXTURE, PAGE 115//FIG.1 CORRELATION OF T(C)/P(C) AND EMR, PAGE 116//FIG.2 CORRELATION OF T(C)/(P(C))(0.5) AND EMR, PAGE 117//FIG.3 EYKMAN MOLECULAR REFRACTION (EMR) VS. P(2), PAGE 116//FIG.4 GENERALIZED COMPRESSIBILITY FACTOR Z, PAGE 117

-BIBLIOGRAPHY-

MCLEOD,W.R., PHD THESIS, OKLAHOMA UNIV. (1967)//STANDING,M.B. AND KATZ,D.L., TRANS. AIME VOL 146, 140 (1941)//PITZER,K.S., J. AM. CHEM. SOC. VOL 77, 3427 (1955)//SATTER,A. AND CAMPBELL,J.M., S.P.E.J., 333 (1963)// SMITH,C., PROC. ROY. SOC. (A) VOL 87, 366-71

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
OIL GAS J. VOL 67, 115-8 (JUL 1969) (PRES. AT NGPA MEETING, DALLAS, TEX., 1969)
OTHER INFORMATION -
0004 PAGES, 0004 FIGURES, 0002 TABLES, 0011 REFERENCES

key 20650

COMPRESSIBILITY OF NATURAL GASES

by

SIMMLER, W.
WOLOWSKI, E.

00/00/70

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

THE PRESENT PAPER DESCRIBES AN ATTEMPT AT CALCULATING THE COMPRESSIBILITY OF NATURAL GASES DISTRIBUTED IN THE FEDERAL REPUBLIC OF GERMANY. FOR THIS PURPOSE A SERIES OF COMPARABLE EXPERIMENTS WERE CARRIED OUT IN THE PRESSURE RANGE OF 0 TO 70 BAR(E) AND IN THE TEMPERATURE RANGE OF 0 TO 20 DEGREES C. THE GASES TESTED COMPRISED A TYPICAL SELECTION OF NATURAL GASES, THEY DIFFERED IN THEIR CONTENTS OF INERT GASES AND OF HIGHER HYDROCARBONS. A DEVIATION OF + OR - 0.5 PERCENT WAS TOLERATED. GIVEN THIS TOLERANCE, THERE WAS GOOD AGREEMENT BETWEEN THE CALCULATED AND THE EXPERIMENTALLY DETERMINED VALUES OF IDEAL GAS LAW DEVIATION FACTORS. SMALL DEVIATION FROM THIS AGREEMENT OCCURRED IN EITHER DIRECTION, BUT NEITHER THE DIRECTION NOR THE MAGNITUDE OF SUCH DEVIATIONS COULD BE ATTRIBUTED TO CERTAIN CHARACTERISTIC COMPONENTS OF A NATURAL GAS.

-PERTINENT FIGURES-

TAB.1 COMPOSITION, COMBUSTION CHARACTERISTICS AND ECONOMIC SIGNIFICANCE OF NATURAL GASES IN THE FEDERAL REPUBLIC OF GERMANY, PAGE 6//FIG.1 RELATIVE DEVIATION OF THE IDEAL GAS LAW DEVIATION FACTORS OF CH(4)/N(2), CH(4)/CO(2), CH(4)/C(2)H(6) AND CH(4)/H(2)S MIXTURES AS COMPARED WITH THE IDEAL GAS LAW DEVIATION FACTORS OF PURE METHANE (MIXTURE RATIO 80 . 15, TEMPERATURE 20 DEGREES C), PAGE 7//TAB.2 COMPOSITION, RELATIVE DENSITY AND CALORIFIC VALUE OF THE NATURAL GASES STUDIED, PAGE 19//TAB.3 EXPERIMENTALLY DETERMINED IDEAL GAS LAW DEVIATION FACTORS OF THE NATURAL GASES TESTED, PAGE 21//FIG.4 CUMULATIVE FREQUENCY OF THE PERCENTAGE DEVIATION BETWEEN THE CALCULATED AND THE MEASURED VALUES OBTAINED BY THE BATELLE COMPARISON METHOD, PAGE 25//FIG.5 CUMULATIVE FREQUENCY OF THE PERCENTAGE DEVIATION BETWEEN THE CALCULATED AND THE MEASURED VALUES BY THE RUSKA SINGLE-CHAMBER METHOD, PAGE 25

-BIBLIOGRAPHY-

BURNETT,E.S., COMPRESSIBILITY DETERMINATIONS WITHOUT VOLUME MEASUREMENT, ASME VOL 58 (1936), S. 136-140//HERNING,F. AND

WOLOWSKI,E., KOMPRESSIBILITAETSZAHL UND REALGASFAKTOR VON TECHNISCHEN GASEN, UNTERSUCHUNG VON FERNGAS. GWF VOL 105 (1964), H.3, S. 64-69//EDMISTER,W.C., VAIROGS,J. AND KLEKERS,A.J., A GENERALIZED BWR-EQUATION OF STATE, AICHE JOURNAL VOL 14 (1968), S. 479-482//KATZ,D.L. U.A., HANDBOOK OF NATURAL GAS ENGINEERING, MCGRAW-HILL BOOK COMPANY, INC., NEW YORK - TORONTO - LONDON (1959), S. 102//PITZER,K.S., ET AL., THE VOLUMETRIC AND THERMODYNAMIC PROPERTIES OF FLUIDS. PART II, COMPRESSIBILITY FACTOR, VAPOR PRESSURE AND ENTROPY OF VAPORIZATION, JOURNAL OF THE AMERICAN CHEMICAL SOCIETY VOL 77 (1955), S. 3433-3440//EILERTS,C.K., ET AL., EFFECT OF ADDED NITROGEN ON COMPRESSIBILITY OF NATURAL GAS, WORLD OIL 1281 (1948), S. 129-140 U. S. 144-160

-SOURCE INFORMATION-

JOURNAL PROCEEDINGS -
INTERNATIONAL GAS CONF., 11TH, (PRES. AT) MOSCOW, USSR, JUN 9-13, 1970
OTHER INFORMATION -
0032 PAGES, 0005 FIGURES, 0005 TABLES, 0016 REFERENCES

key 20657

CALCULATED AND MEASURED ISOTHERMAL AND ADIABATIC JOULE-THOMSON COEFFICIENTS FOR METHANE-ETHANE MIXTURES

by

ALKASAB, K. A.
BUDENHOLZER, R. A.
LAVERMAN, R. J.
SHAH, J. M.

05/00/71

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

MEASUREMENTS OF THE ISOTHERMAL AND THE ADIABATIC JOULE-THOMSON COEFFICIENTS WERE CARRIED OUT FOR THREE METHANE-ETHANE MIXTURES OVER A TEMPERATURE RANGE FROM -59 DEGREES F TO + 35 DEGREES F AND A PRESSURE RANGE FROM 50 PSIA TO 950 PSIA. COMPARISONS ARE MADE BETWEEN THE EXPERIMENTALLY DETERMINED ISOTHERMAL AND ISENTHALPIC EXPANSION DATA AND THAT PREDICTED BY A MODIFIED BENEDICT-WEBB-RUBIN (BWR) EQUATION OF STATE. A NEW SET OF COEFFICIENTS FOR THE BWR EQUATION OF STATE WERE DEVELOPED FOR ETHANE. THE AVERAGE ABSOLUTE DIFFERENCE BETWEEN EXPERIMENTAL AND CALCULATED ISOTHERMAL JOULE-THOMSON COEFFICIENTS FOR 47 POINTS WAS 1.37 PERCENT. THE AVERAGE ABSOLUTE DIFFERENCE BETWEEN THE CALCULATED AND THE EXPERIMENTALLY DETERMINED TEMPERATURES FOR 40 SEPARATE DATA POINTS ON 10 ISENTHALPIC EXPANSION LINES WAS 0.67 DEGREES F.

-PERTINENT FIGURES-

TAB.1 MIXTURE COMPOSITIONS FOR DATA OF ALKASAB (1970), PAGE 238//FIG.1 BWR COEFFICIENT C(0) VS. TEMPERATURE FOR ETHANE, PAGE 239//FIG.2 EXPERIMENTAL AND CALCULATED ISOTHERMAL COEFFICIENT-MIXTURE 1, PAGE 240//FIG.3 EXPERIMENTAL AND CALCULATED ISOTHERMAL COEFFICIENT-MIXTURE 2, PAGE 240// FIG.4 EXPERIMENTAL AND CALCULATED ISOTHERMAL COEFFICIENT-MIXTURE 3, PAGE 241//FIG.5 EXPERIMENTAL AND CALCULATED ISENTHALPS-MIXTURE 1, PAGE 241

-BIBLIOGRAPHY-

ALKASAB,K., THERMOPHYSICAL MEASUREMENTS OF METHANE-ETHANE MIXTURES WITH AN ISOTHERMAL-ISENTHALPIC CALORIMETER, PH.D. THESIS, ILLINOIS INST. OF TECH. (1970)//BENEDICT,M., WEBB,G. AND RUBIN,L., CHEM. ENG. PROGR. VOL 47, NO. 8 419 (1951)//DIN,F., THERMODYNAMIC FUNCTIONS OF GASES, VOL 3, 162, BUTTERWORTH, LONDON (1961)//ELLINGTON,R.T., BLOOMER,O.T., EAKIN,B.E. AND GARUI,D.C.,

THERMODYNAMIC AND TRANSPORT PROPERTIES OF GASES, LIQUIDS, AND SOLIDS, MCGRAW-HILL INC., N. Y., 102 (1959)//LAVERMAN,R. AND SELCUKOGLU,Y., CRY. ENG. NEWS VOL 64 (AUG 1967)//REAMER,H., OLDS,R., SAGE,R. AND LACEY,W., IND. ENG. CHEM. VOL 36, 956 (1944)

-SOURCE INFORMATION-

CORPORATE SOURCE -
CHICAGO BRIDGE AND IRON CO., PLAINFIELD, ILL.//ILLINOIS INST. OF TECH., CHICAGO
JOURNAL PROCEEDINGS -
IND. ENG. CHEM. FUNDAM. VOL 10, NO. 2, 237-44 (MAY 1971)
OTHER INFORMATION -
0008 PAGES, 0007 FIGURES, 0004 TABLES, 0016 REFERENCES

keys 20986 through 20988

THERMODYNAMIC PROPERTIES OF METHANE-NITROGEN MIXTURES

by

BLOOMER,O.T.
EAKIN,B.E.
ELLINGTON,R.T.
GAMI,D.C.

00/00/55

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THE BASIC PURPOSE OF THE PRESENT CONTINUING STUDY OF THE FUNDAMENTAL PHYSICAL-CHEMICAL AND THERMODYNAMIC PROPERTIES OF NATURAL GAS COMPONENTS IS TO OBTAIN THE DATA NECESSARY FOR THE ENGINEERING DESIGN OF PLANTS TO SEPARATE NITROGEN FROM NATURAL GAS BY LOW-TEMPERATURE FRACTIONATION. THE PURPOSE OF THE PRESENT WORK IS TO CALCULATE THE THERMODYNAMIC PROPERTIES OF TWO METHANE-NITROGEN MIXTURES, CONTAINING 10 AND 30 PERCENT NITROGEN RESPECTIVELY, IN THE TEMPERATURE RANGE -280 TO +200 DEGREES F, AND PRESSURE RANGE 10 TO 1500 PSIA, USING THE MORE RECENT FUNDAMENTAL DATA SELECTED IN A CRITICAL REVIEW OF THE LITERATURE, AND TO PRESENT THESE PROPERTIES IN A FORM CONVENIENT FOR COMPUTING PROCESS ENERGY REQUIREMENTS. THE REPORT CONTAINS H-S AND T-S DIAGRAMS, H-X AND COMPRESSIBILITY FACTOR CHARGS, DATA FOR VAPORIZATION EQUILIBRIUM FOR THE TWO MIXTURES. IN ADDITION THE PAPER PRESENTS TABLES AND CHARTS OF HEATING AND COOLING REQUIREMENTS FOR VARIOUS PLANT CONFIGURATIONS AND PROPERTIES. THE REPORT ALSO CONTAINS PROPERTIES TABLES AND EXTENSIVE CALCULATIONAL PROCEDURES.

-PERTINENT FIGURES-

FIG.3 TEMPERATURE-ENTROPY CHART FOR 90 PERCENT METHANE-10 PERCENT NITROGEN MIXTURE, PAGE 6//FIG.19 ISOBARIC TEMPERATURE-COMPOSITION DIAGRAMS, METHANE-NITROGEN SYSTEM, PAGE 22//TAB.2 OVERALL COLUMN REQUIREMENTS AS A FUNCTION OF COLUMN FEED CONDITION FOR 200 PSIA OPERATION, PAGE 23//TAB.3 COMPRESSOR ENERGY AND COOLING WATER REQUIREMENTS, AS INFLUENCED BY COLUMN FEED CONDITION, COLUMN PRESSURE AND FEED GAS PRESSURE, OF FIVE INDEPENDENT CYCLES IN THE SEPARATION OF A 70 PERCENT METHANE-30 PERCENT NITROGEN MIXTURE, PAGE 24//TAB.4 NET POWER AND WATER-COOLING REQUIREMENTS, AS INFLUENCED BY COLUMN PRESSURE AND COLUMN FEED CONDITION, FOR NITROGEN-SEPARATION WITH AN AMMONIA-ETHYLENE-METHANE REFRIGERATION CYCLE, PAGE 25//TAB.5 HEAT EXCHANGER REQUIREMENTS AS INFLUENCED BY COLUMN PRESSURE IN NITROGEN SEPARATION WITH AN AMMONIA-ETHYLENE-METHANE REFRIGERATION CYCLE, PAGE 25

-BIBLIOGRAPHY-

BLOOMER,O.T., GAMI,D.C. AND PARENT,J.D., PHYSICAL-CHEMICAL PROPERTIES OF METHANE-ETHANE MIXTURES, RESEARCH BULLETIN NO. 22, INSTITUTE OF GAS TECHNOLOGY, CHICAGO (1953)//BLOOMER,O.T. AND PARENT,J.D., PHYSICAL-CHEMICAL PROPERTIES OF METHANE-NITROGEN MIXTURES, RESEARCH BULLETIN NO. 17, INSTITUTE OF GAS TECHNOLOGY, CHICAGO (1952)//BLOOMER,O.T. AND RAO,K.N., THERMODYNAMIC PROPERTIES OF NITROGEN, RESEARCH BULLETIN NO. 18, INSTITUTE OF GAS TECHNOLOGY, CHICAGO (1952)//KEYES,F.G. AND BURKS,H.G., J. AM. CHEM. SOC. 50, 1100 (1928)//ROSSINI,F.D., ET AL., TABLES OF SELECTED VALUES OF PROPERTIES OF HYDROCARBONS, NATIONAL BUREAU OF STANDARDS CIRCULAR 161 (1947)//SAGE,B.H. AND LACEY,W.N., THERMODYNAMIC PROPERTIES OF THE LIGHTER PARAFFIN HYDROCARBONS AND NITROGEN, NEW YORK, AMERICAN PETROLEUM INSTITUTE, 1950

-SOURCE INFORMATION-

CORPORATE SOURCE -
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
JOURNAL PROCEEDINGS -
INST. GAS TECHNOL. RES. BULL., NO. 21 (1955)
OTHER INFORMATION -
0052 PAGES, 0030 FIGURES, 0014 TABLES, 0021 REFERENCES

keys 21006 through 21008

AN EMPIRICAL EQUATION FOR THERMODYNAMIC PROPERTIES OF LIGHT HYDROCARBCNS AND THEIR MIXTURES. REDUCTION OF EQUATION TO CHARTS FOR PREDICTION OF LIQUID-VAPOR EQUILIBRIA

by

BENEDICT,M.
WEBB,G.B.
RUBIN,L.C.
FRIEND,L.

11/00/51

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

EQUATIONS REPRESENTING FUGACITIES AND LIQUID-VAPOR DISTRIBUTION COEFFICIENTS IN MIXTURES OF LIGHT HYDROCARBONS DEVELOPED IN PREVIOUS PAPERS OF THIS SERIES ARE REDUCED TO CHART FORM TO FACILITATE ENGINEERING APPLICATION. THIS HAS BEEN MADE POSSIBLE BY THE DISCOVERY THAT THE EFFECT OF COMPOSITION ON FUGACITIES AND DISTRIBUTION COEFFICIENTS CAN BE REPRESENTED WITH SUFFICIENT ACCURACY BY A SINGLE COMPOSITION VARIABLE FOR EACH PHASE, ITS MOLAL AVERAGE BOILING POINT. A SET OF 324 CHARTS HAS BEEN PREPARED FOR THE 12 HYDROCARBONS METHANE, ETHYLENE, ETHANE, PROPYLENE, PROPANE, ISOBUTANE, ISOBUTYLENE, N-BUTANE, ISOPENTANE, N-PENTANE, N-HEXANE, AND N-HEPTANE AT 26 PRESSURES BETWEEN 14.7 AND 3600 LBS./SQ.-IN.ABS. THE CHARTS COVER A TEMPERATURE RANGE FROM -100 DEGREES TO + 400 DEGREES F AND A RANGE OF MOLAL AVERAGE BOILING POINTS FROM -255 DEGREES TO +180 DEGREES F. IN 12 MIXTURES OF LIGHT HYDROCARBONS THE AVERAGE DEVIATION OF CHART KS FROM THOSE EVALUATED BY THE FUGACITY EQUATIONS IS ONLY 3.2 PERCENT. IN 27 SYSTEMS, COMPRISING MOST OF THE REPORTED EXPERIMENTAL STUDIES OF LIQUID-VAPOR EQUILIBRIA IN LIGHT HYDROCARBON MIXTURES, THE AVERAGE DEVIATION OF OBSERVED KS FROM THOSE READ FROM THE CHARTS IS 7.1 PERCENT.

-PERTINENT FIGURES-

TAB.5 FUGACITIES CALCULATED AT 100 DEGREES F, PAGE 572-5//FIG.1 ACTIVITY COEFFICIENT OF METHANE IN GAS PHASE AT 100 DEGREES F, PAGE 576//FIG.2 FUGACITY COEFFICIENT OF METHANE IN LIQUID AT 100 DEGREES F, PAGE 576// FIG.3 ACTIVITY COEFFICIENT OF PROPANE IN GAS PHASE AT 100 DEGREES F, PAGE 577//FIG.4 FUGACITY COEFFICIENT OF PROPANE IN LIQUID AT 100 DEGREES F, PAGE 577

-SOURCE INFORMATION-

CORPORATE SOURCE -
KELLOGG (M.W.) CO., JERSEY CITY, N.J.
JOURNAL PROCEEDINGS -
CHEM. ENG. PROGR. VOL 47, NO. 11, 571-8 (NOV 1951)
OTHER INFORMATION -
0008 PAGES, 0004 FIGURES, 0001 TABLES, 0000 REFERENCES

keys 21009 through 21011

AN EMPIRICAL EQUATION FOR THERMODYNAMIC PROPERTIES OF LIGHT HYDROCARBONS AND THEIR MIXTURES. REDUCTION OF EQUATION TO CHARTS FOR PREDICTION OF LIQUID-VAPOR EQUILIBRIA

by

BENEDICT,M.
WEBB,G.B.
RUBIN,L.C.
FRIEND,L.

12/00/51

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Good/Excel.

-ABSTRACT-

THIS PAPER IS A CONTINUATION OF A PREVIOUS ONE AND PRESENTS CHARTS (SELECTED) RESULTING FROM THE FAMOUS BWR EQUATION OF STATE APPLIED TO SYSTEMS OF 12 HYDROCARBONS. EACH OF THE FINAL CHARTS REFERS TO A PARTICULAR COMPONENT AT A PARTICULAR CONSTANT PRESSURE. AT PRESSURES UP TO AND INCLUDING 1000 LB./SQ.IN.ABS. CHARTS REPRESENTING K-VALUES HAVE BEEN PREPARED. AT PRESSURES BETWEEN 1000 AND 3600 LB./SQ.IN.ABS., INCLUSIVE, THE FUGACITY COEFFICIENT IS THE PROPERTY REPRESENTED. IN ALL, 324 CHARTS WERE PREPARED FOR THESE 12 HYDROCARBONS AT 26 PRESSURES BETWEEN 14.7 AND 3600 LB./SQ.IN.ABS. THE TEMPERATURE RANGE FROM -100 DEGREES TO +400 DEGREES F AND THE MOLAL AVERAGE BOILING POINT RANGE FROM -255 DEGREES TO +180 DEGREES F ARE COVERED. THE SYSTEMS OF MOST INTEREST ARE THE NATURAL GAS SYSTEMS.

-PERTINENT FIGURES-

FIG.5 K-VALUE OF METHANE AT 550 LBS./SQ.IN.ABS., PAGE 610//TAB.9 FUGACITY FUNCTIONS OF METHANE AT 100 DEGREES F, PAGE 612//TAB.10 SAMPLE CALCULATION OF BUBBLE-POINT TEMPERATURE, PAGE 613//TAB.14 SUMMARIZED COMPARISON OF OBSERVED KS OF LIGHT HYDROCARBONS WITH THOSE READ FROM CHARTS, PAGE 616// TAB.15 TWO FIVE-COMPONENT SYSTEMS AT 100 DEGREES F, PAGE 616//TAB.17 LIQUID-VAPOR EQUILIBRIA IN GAS-DISTILLATE SYSTEM COMPARISON OF OBSERVED KS WITH CHARTS, PAGE 618

-BIBLIOGRAPHY-

BENEDICT,M., SOLOMON,E. AND RUBIN,L.C., IND. ENG. CHEM., VOL 37, 55 (1945) //BENEDICT,M., WEBB,G.B. AND RUBIN,L.C., J. CHEM. PHYS. VOL 8, 334 (1940) //BENEDICT,M., WEBB,G.B. AND RUBIN,L.C., J. CHEM. PHYS VOL 10, 747 (1942) //BENEDICT,M., WEBB,G.B. AND RUBIN,L.C., CHEM. ENG. PROGRESS VOL 47, 419 (1951)//BENEDICT,M.,

WEBB,G.B. AND RUBIN,L.C., CHEM. ENG. PROGRESS VOL 47, 449 (1951)//CARTER,R.T., SAGE,B.H. AND LACEY,W.N., AM. INST. MINING MET. ENGRS., TECH. PUB. NO. 1250 (1940)

-SOURCE INFORMATION-

CORPORATE SOURCE -
KELLOGG (M.W.) CO., JERSEY CITY, N.J.
JOURNAL PROCEEDINGS -
CHEM. ENG. PROGR. VOL 47, NO. 12, 609-20 (DEC 1951)
OTHER INFORMATION -
0012 PAGES, 0012 FIGURES, 0010 TABLES, 0034 REFERENCES

EXPLOSIVE BOILING OF LIQUIFIED GASES ON WATER

by

ENGER, T.
HARTMAN, D.E.

06/13/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

THE CONDITIONS FOR CETAINING EXPLOSIVE BOILING OF PURE LIQUEFIED GASES AND LIQUEFIED GAS MIXTURES ON AMBIENT WATER HAVE BEEN EXPERIMENTALLY DETERMINED. THESE CONDITIONS CORRESPOND TO TRANSITION BOILING OF LIQUID/LIQUID SYSTEMS. THE COLD LIQUEFIED GASES REACH THEIR LIMIT OF SUPERHEAT WHILE IN DIRECT CONTACT WITH THE WATER IN THE TRANSITION BOILING REGION, AND HOMOGENEOUS NUCLEATION AND SPONTANEOUS VAPOR FORMATION PRODUCES WEAK SHOCK WAVES. OBSERVED DELAY TIMES BETWEEN LIQUID CONTACT AND EXPLOSIVE BOILING HAVE BEEN ON THE ORDER OF ONE SECOND OR LESS. NO BURNING OR CHEMICAL REACTION OCCURS. THE EXPERIMENTAL CONDITIONS FOR EXPLOSIVE BOILING ARE SHOWN TO BE DEPENDENT ON THE TEMPERATURE AND COMPOSITION OF THE LIQUEFIED GAS, AND THE TEMPERATURE OF THE WATER. EXPLOSIVE BOILING OF A LIQUEFIED GAS MIXTURE SUCH AS LNG ON AMBIENT WATER CAN ONLY BE PRODUCED WHEN THE METHANE CONTENT IS LESS THAN 40 MOLE PERCENT. METHANE CONTENT IN EXCESS OF THIS ALLOWS THE LIQUEFIED GAS TO FILM BOIL ON THE WATER. FORCED AND NATURAL AGING OF METHANE-RICH LNG CAN REDUCE THE METHANE CONTENT TO LESS THAN 40 , BUT THIS IS NECESSARILY ACCOMPANIED BY A LARGE LIQUID VOLUME LOSS, OF THE ORDER OF 90 . THUS, THE POTENTIAL HAZARD OF HAVING EXPLOSIVE BOILING FROM AN LNG SPILL IS NEGLIGIBLE DURING COMMERCIAL TRANSPORTATION OF LNG. IN ADDITION, ENERGY ESTIMATES SHOW THAT THE POTENTIAL DAMAGE FROM EXPLOSIVE BOILING OF A LIQUEFIED GAS IS MINIMAL.

-PERTINENT FIGURES-

TABLE 2 LIQUEFIED GAS SPILLAGE ON WATER, PAGE 15// FIG. 7 LNG TANK USAGE AND BOIL OFF DATA, PAGE 17// FIG. 11 SPILL SIZE TO REACH EXPLOSIVE COMPOSITION, PAGE 18

-BIBLIOGRAPHY-

1. BURGESS, D.S., MURPHY, J.N. AND ZABETAKIS, M.G., "HAZARDS ASSOCIATED WITH THE SPILLAGE OF LIQUEFIED GAS ON WATER," REPORT OF INVESTIGATIONS 7448, U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF MINES, NOVEMBER 1970//2. ENGER, T. AND HARTMAN, D.E., "LNG

SPILLAGE ON WATER. I. EXPLORATORY RESEARCH ON RAPID PHASE TRANSFORMATIONS," SHELL PIPE LINE CORPORATION, RESEARCH AND DEVELOPMENT LABORATORY, TECHNICAL PROGRESS REPORT NO. 1-71, FEBRUARY, 1971//3. ENGER, T. AND HARTMAN, D.E., "LNG SPILLAGE ON WATER. II. FINAL REPORT ON RAPID PHASE TRANSFORMATIONS," SHELL PIPE LINE CORPORATION, RESEARCH AND DEVELOPMENT LABORATORY, TECHNICAL PROGRESS REPORT NO. 1-72, FEBRUARY 1972//4. NAKANISHI, E. AND REID, R.C., "LIQUID NATURAL GAS-WATER REACTIONS," CHEMICAL ENGINEERING PROGRESS, VOL. 67, NO. 12, DECEMBER, 1971, PP. 36-41//5. ENGER, T., "LNG SPILLAGE ON WATER. III. SPREADING AND VAPORIZATION MODEL FOR AN INSTANTANEOUS SPILL," SHELL PIPE LINE CORPORATION, RESEARCH AND DEVELOPMENT LABORATORY, TECHNICAL PROGRESS REPORT 6-72, APRIL 1972//6. KATZ, D.L. AND C.M. SLIEPCEVICH, "LNG/WATER EXPLOSIONS - CAUSE AND EFFECT," HYDROCARBON PROCESSING, VOL. 50, NO. 11, NOVEMBER 1971, PP. 240-244.

-SOURCE INFORMATION-

CORPORATE SOURCE -
SHELL DEVELOPMENT CO., HOUSTON, TEX.
PUBLISHER -
SHELL DEVELOPMENT CO.
SPONSOR -
SHELL DEVELOPMENT CO., HOUSTON, TEX.
OTHER INFORMATION -
0020 PAGES, 0015 FIGURES, 0002 TABLES, 0016 REFERENCES

A STUDY OF THE GROWING DANGER OF DETONATION IN UNCONFINED GAS CLOUD EXPLOSIONS

by

BROWN, JOHN A.

12/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

THERE IS A REAL AND GROWING DANGER OF DETONATION OF UNCONFINED FUEL-AIR CLOUDS FORMED BY GAS SPILLS AND THE DANGER INCREASES WITH THE SIZE OF THE SPILL. A SIMPLE FLAME IS PROBABLY NOT ENOUGH TO DETONATE THE GAS CLOUD BUT SMALL EXPLOSIONS SUCH AS A BURSTING PRESSURE VESSEL OR A MUFFLER BACKFIRE CAN INITIATE THE DETONATION OF OPEN-AIR CLOUDS. TECHNIQUES ARE AVAILABLE TO ASSESS THE DAMAGE POTENTIAL AND REDUCE THE RISK OF AN EXPLOSION. THIS REPORT IS A SCOUTING AND PLANNING STUDY INTENDED TO GIVE AN APPRECIATION FOR THE KIND AND AMOUNT OF INFORMATION THAT EXISTS ON UNCONFINED EXPLOSIONS AND TO ASSESS WHAT MIGHT BE ACCOMPLISHED BY A FULL-SCALE SAFETY R & D PROGRAM.

-PERTINENT FIGURES-

FIG.3 FLAMMABLE LIMITS OF ETHYLENE, OXYGEN, NITROGEN, MIXTURES, PAGE 6//FIG.5 CRITICAL THRESHOLD ENERGY FOR DETONATION INITIATION AS A FUNCTION OF MAPP CONCENTRATION IN AIR, PAGE 9//FIG.8 FLAMMABLE AND DETONABLE LIMITS OF HYDROGEN, OXYGEN, NITROGEN MIXTURES, PAGE 13// TABLE 8. LIMITS OF DETONABILITY AND OF FLAMMABILITY, PAGE 16//FIG.13 FLAMMABLE LIMITS OF HYDROCARBONS AS A FUNCTION OF MOLECULAR WEIGHT, PAGE 19//FIG. 19 STRUCTURAL DAMAGE RESULTING FROM VARIOUS OVERPRESSURES, PAGE 27.

-BIBLIOGRAPHY-

1. BURGESS, D.S., J.N. MURPHY, N.E. HANNA AND R.W. VAN DOLAH, LARGE-SCALE STUDIES OF GAS DETONATIONS. BUREAU OF MINES REPORT OF INVESTIGATIONS 7196. US DEPARTMENT OF THE INTERIOR. NOVEMBER 1968//2. STREHLOW, ROGER A., "UNCONFINED VAPOR-CLOUD EXPLOSIONS, AN OVERVIEW" SYMPOSIUM (INTERNATIONAL) ON COMBUSTION AT PENNSYLVANIA STATE UNIVERSITY, 1972. REPRINT ATTACHED HERETO AS APPENDIX.// 3. GLASSTONE, S., THE EFFECTS OF NUCLEAR WEAPONS, PUBLISHED BY THE US ATOMIC ENERGY COMMISSION, APRIL 1962; REVISED EDITION FEBRUARY 1974 AVAILABLE FROM THE SUPERINTENDENT OF DOCUMENTS, US GOVERNMENT PRINTING OFFICE.//4. ROBINSON, C.S., EXPLOSIONS, THEIR ANATOMY AND DESTRUCTIVENESS. MCGRAW-HILL, NY.

1944//5. PALMER, K.N., "THE QUENCHING OF FLAME BY PERFORATED SHEETING AND BLOCK FLAME ARRESTORS," SYMPOSIUM ON CHEMICAL PROCESS HAZARDS WITH SPECIAL REFERENCE TO PLANT DESIGN, MANCHESTER 29-31 MARCH 1960. PUBLISHED BY THE INSTITUTION OF CHEMICAL ENGINEERS, 16 BELGRAVE SQUARE, LONDON S.W.-1// 6. BAKER, W.E., EXPLOSIONS IN AIR, UNIVERSITY OF TEXAS PRESS, AUSTIN, TEXAS, 1973.

-SOURCE INFORMATION-

CORPORATE SOURCE -
BROWN (JOHN A.), BERKELEY HEIGHTS, N.J.
PUBLISHER -
JOHN BROWN ASSOCIATES, INC.
OTHER INFORMATION -
0058 PAGES, 0022 FIGURES, 0008 TABLES, 0059 REFERENCES

RADIATION FROM LARGE LIQUIFIED NATURAL GAS FIRES

by

MAY, W.G.
MCQUEEN, W.

00/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

RADIATION FROM FLAMES OF BURNING LIQUEFIED NATURAL GAS (LNG) HAS BEEN MEASURED. THE BURNING POOL WAS CONTAINED IN A TRENCH. A RANGE OF BURNING RATES FROM L3,500 TO 40,000 BBL/D OF LNG WAS STUDIED. MEASUREMENTS WERE MADE FROM GROUND LEVEL, 300 TO 600 FT. FROM FLAME CENTER AND FROM SEVERAL ELEVATED POINTS. MEASURED FLUX VARIED FROM ABOUT 60 TO 480 BTU/HR/SQ FT AND WAS COMPARED TO THE TOTAL FLUX THAT WOULD BE RECEIVED AT A GIVEN DISTANCE FROM FLAME CENTER IF THE ENTIRE HEATING VALUE OF THE FUEL WERE CONVERTED TO RADIANT ENERGY. AN INVERSE SQUARE LAW OF RADIATION VERSUS DISTANCE WAS SHOWN TO HOLD FAIRLY WELL. AN AVERAGE OF ABOUT 12 OF TOTAL FLUX WAS MEASURED AT GROUND LEVEL POINTS FAIRLY INDEPENDENT OF DISTANCE. ELEVATED MEASUREMENTS SHOWED AN INCREASE IN RADIATION AS THE INTERIOR OF THE TRENCH WAS VIEWED. THIS RAISED THE AVERAGE MEASURED FLUX TO ABOUT L6 OF TOTAL.

-PERTINENT FIGURES-

TABLE 3 LIQUEFIED NATURAL GAS (LNG) BURNING PIT RADIATION MEASUREMENTS, PAGE 53//FIG. 4 HEAT FLUX RECEIVED VS. DISTANCE FROM FLAME CENTER WITH PARAMETER OF FIRE SIZE//FIG. 6 DISTANCE FROM CONTAINMENT OF BURNING LIQUEFIED NATURAL GAS POOL TO RECEIVE SPECIFIED HEAT FLUX.

-BIBLIOGRAPHY-

1. BURGESS, D. AND ZABETAKIS, M.G. (1962), BUREAU OF MINES REPORT OF INVESTIGATION 6099, 162, "FIRE AND EXPLOSION HAZARD ASSOCIATED WITH LIQUEFIED NATURAL GAS."//2. LAWSON, D.I. AND SIMMS, G.L., (1952), THE IGNITION OF WOOD BY RADIATION, BRITISH J. APPLIED PHYSICS 3, 288.

-SOURCE INFORMATION-

CORPORATE SOURCE -
ESSO RESEARCH AND ENGINEERING CO., LINDEN, N.J.

JOURNAL PROCEEDINGS -
CBSTB9, COMBUST SCI TECH
PUBLISHER -
GORDON AND BREACH, SCIENCE PUBLISHERS LTD.
SPONSOR -
ESSO RESEARCH AND ENGINEERING CO., LINDEN, N.J.
OTHER INFORMATION -
0006 PAGES, 0007 FIGURES, 0005 TABLES, 0002 REFERENCES

THE ALLEVIATION OF BLAST WAVES FROM LARGE AND UNCONFINED CLOUDS OF VAPOR

by

NETTLETON, M. A.

03/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

THE DEVASTATION CAUSED BY THE EXPLOSION OF THE VAPOUR CLOUD AT FLIXBOROUGH HAS FOCUSSED ATTENTION ON THE DANGERS OF BLAST DAMAGE OCCURRING OUT WITH THE LIMITS OF FLAMMABLE GAS MIXTURE ASSOCIATED WITH SUCH AN EXPLOSION. THE PRESENT PAPER BRIEFLY DISCUSSES METHODS OF ALLEVIATING SUCH EXPLOSIONS BY DEALING EITHER WITH THE EXPANDING FLAME FRONT, OR WITH THE LEADING BLAST WAVE. IT ALSO INDICATES THAT SAFETY MEASURES SUCH AS WATER SPRAYS ARE LIKELY TO AFFECT BOTH FLAME AND BLASTWAVE. EXPERIMENTS IN WHICH PLANAR SHOCK WAVES IN AIR ARE ALLOWED TO REFRACT INTO HELIUM ARE DESCRIBED AND THE RESULTANT DECREASE IN THE STRENGTH OF THE TRANSMITTED SHOCK EMPHASIZED. THIS ATTENUATION IN THE TRANSMITTED SHOCK, TOGETHER WITH THE FACT THAT AN EXPANSION WAVE IS REFLECTED BACK INTO THE AIR LEADS TO THE SUGGESTION THAT A TRIGGERED HELIUM BARRIER COULD BE USED TO PROTECT STRUCTURES.

-PERTINENT FIGURES-

FIG.1 PRESSURE RECORDS OF SHOCK REFRACTION AT AIR-HELIUM INTERFACE, PAGE 4.3.2460//FIG.3 REFRACTION OF SHOCK WAVES AT AN AIR-HELIUM INTERFACE, PAGE 4.3.2462//FIG.4 THEORY FOR TRANSMITTED SHOCK AND REFLECTED EXPANSION WAVE AT AIR-HELIUM INTERFACE, PAGE 4.3.2463.

-BIBLIOGRAPHY-

1. NETTLETON, M.A., 1974, IGNITION AND COMBUSTION OF A FUEL OF LOW VOLATILITY (HEXADECANE) IN SHOCK-HEATED AIR, FUEL, 53, 88// 2. PATERSON, S., 1948, THE REFLECTION OF A PLANE SHOCK WAVE AT A GASEOUS INTERFACE, PROC. PHY. SOC., 61, 119//3. PENNEY, LORD, SAMUELS, D.E.J. AND SCORGIE, G.C., 1970, THE NUCLEAR EXPLOSIVE YIELDS AT HIROSHIMA AND NAGASAKI, PHIL. TRANS. ROY. SOC., 266, 357//4. SLOAN, S.A. AND NETTLETON, M.A., 1974A, THE PROPAGATION OF A SHOCK WAVE THROUGH AN ABRUPT INCREASE IN AREA I, THE DECAY OF THE OVER-PRESSURE ALONG THE AXIS, C.E.R.L. LABORATORY NOTE NO. RD/L/N 51/74//5. SLOAN, S.A. AND NETTLETON, M.A., 1974B, THE PROPAGATION OF A SHOCK WAVE THROUGH AN ABRUPT INCREASE IN AREA II,

AN EMPIRICAL MODEL FOR SHOCK DECAY, C.E.R.L. LABORATORY NOTE NO. RD/L/N 176/74//6. STREHLOW, R.A., 1973, UNCONFINED VAPOUR CLOUD EXPLOSIONS - AN OVERVIEW, 14TH SYMP. (INT.) COMB. (COMB. INST., PITTSBURGH), P. 1189.

-SOURCE INFORMATION-

CORPORATE SOURCE -
CENTRAL ELECTRICITY RESEARCH LABS., LEATHERHEAD (ENGLAND).
REPORT NUMBER -
RD/L/N 27/75
PUBLISHER -
CENTRAL ELECTRICITY RESEARCH LABS.
SPONSOR -
CENTRAL ELECTRICITY RESEARCH LABS., LEATHERHEAD (ENGLAND)
CONTRACT NUMBER -
JOB NO. VF 667
OTHER INFORMATION -
0015 PAGES, 0004 FIGURES, 0001 TABLES, 0006 REFERENCES

VULNERABILITY MODEL, SECOND INTERIM REPORT, 22 AUGUST, 1974

by

ENVIRC CONTROL, INC., ROCKVILLE, MD

08/22/74

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

THIS INTERIM REPORT DESCRIBES THE CURRENT STATUS OF DEVELOPMENT OF A DAMAGE ASSESSMENT COMPUTER MODEL AS PART OF THE RISK ANALYSIS PROGRAM OF THE UNITED STATES COAST GUARD. THE MODEL IS INTENDED TO PROVIDE ESTIMATES OF THE EXTENT TO WHICH MARITIME SPILLS OF HAZARDOUS CHEMICALS AFFECT PUBLIC SAFETY, ON-SHORE PROPERTY AND FACILITIES, CREWS, VESSELS AND THE ENVIRONMENT

-PERTINENT FIGURES-

FIG.1 CORRECTION FACTOR FOR MEANDER OF WIND, PAGE 9//FIG.2 SCHEMATIC OF MODEL USED TO ASSESS DAMAGE POTENTIAL OF FLASH BURNING OF THE VAPOR PLUME, PAGE 19//FIG.3 TENTATIVE SCHEDULE OF TASKS, PAGE 36//TABLE 1 DISPERSION COEFFICIENTS, M, PAGE 11//TABLE 2 SAMPLE OF TABULATED DATA FOR A REFERENCE EXPLOSION OF L KG OF TNT, PAGE 18.

-BIBLIOGRAPHY-

1. VULNERABILITY MODEL, DRAFT INTERIM REPORT, JUNE 22, 1974, ENVIRO CONTROL, INC.//2. HAZARD ASSESSMENT COMPUTER SYSTEM (HACS), IN PREPARATION//3. ASSESSMENT MODELS IN SUPPORT OF THE HAZARD ASSESSMENT HANDBOOK (CG-446-3), TECHNICAL REPORT, JANUARY 1974. DEPARTMENT OF TRANSPORATION, UNITED STATES COAST GUARD, OFFICE OF RESEARCH AND DEVELOPMENT, WASHINGTON, D.C. 20590//4. SLADE, DAVID H. (EDITOR), METEOROLOGY AND ATOMIC ENERGY 1968, U.S.ATOMIC ENERGY COMMISSION JULY 1968//5. CRAMER, H.E., L959 ENGINEERING ESTIMATES OF ATMOSPHERIC DISPERSAL CAPACITY. AMER. IND. HYG. ASSOC. J. 20, 3, 183-189//6. KINNEY, G.F., ENGINEERING ELEMENTS OF EXPLOSIONS, NAVAL WEAPONS CENTER, NOVEMBER 1968 NWC TP-4654.

-SOURCE INFORMATION-

CORPORATE SOURCE -
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, ROCKVILLE, MD
REPORT NUMBER -

CONTRACT DOT-CG-33377-A
PUBLISHER -
COAST GUARD, WASHINGTON, DC
SPONSOR -
COAST GUARD, WASHINGTON, DC
CONTRACT NUMBER -
CONTRACT DOT-CG-33377-A
OTHER INFORMATION -
0042 PAGES, 0003 FIGURES, 0002 TABLES, 0010 REFERENCES

ON THE BURNING OF A LARGE FLAMMABLE VAPOR CLOUD

by

RAJ, P. P.
EMMONS, H. W.

04/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

A THEORETICAL ANALYSIS IS PRESENTED TO ESTIMATE THE GROUND LEVEL WIDTH OF A TWO-DIMENSIONAL TURBULENT FLAME AS A FUNCTION OF TIME FOR THE BURNING OF A LARGE COMBUSTIBLE VAPOR CLOUD IN THE ATMOSPHERE FOR A GIVEN TURBULENT FLAME SPEED. THE BASE WIDTH OF THE FLAME IS ASSUMED TO BE CONTROLLED BY THE RATE AT WHICH THE VAPOR IS FED INTO THE COMBUSTION ZONE AND THE AIR ENTRAINMENT RATE. THE FORMER IS DEPENDENT ON THE TURBULENT FLAME SPEED, AND THE LATTER DEPENDS ON THE BUOYANCY PRODUCED BY COMBUSTION. THE RESULTS OF THE THEORY ARE COMPARED WITH LIMITED EXPERIMENTAL DATA.

-PERTINENT FIGURES-

TABLE 1 EXPERIMENTAL TEST RESULTS, PAGE 18// TABLE 2 EXPERIMENTAL TESTS RESULTS, PAGE 19// FIG.1 TURBULANT FLAME VELOCITY RELATIVE TO GAS IN VAPOR CLOUD VS. MEAN WIND VELOCITY, PAGE 20// FIG.4 COMPARISON OF THE EXPERIMENTAL DATA AND THEORETICAL PREDICTION FOR THE FLAME BASE WIDTH DEVELOPMENT WITH TIME, PAGE 23.

-BIBLIOGRAPHY-

1. "LNG SAFETY PROGRAM"; INTERIM REPORT ON PHASE II WORK, AMERICAN GAS ASSOCIATION, PROJECT IS-3-1, JULY 1974//2. "ESSAIS D'EPENDAGE DE GAZ NATUREL LIQUEFIE SUR DE SOL"; REPORT ON THE EXPERIMENTS CONDUCTED BY GAZ DE FRANCE, SEPTEMBER L972//3. "SPILLS OF LNG ON WATER" W. G., MAY, W. MCQUEEN AND R. H. WHIPP; PAPER PRESENTED AT THE CONFERENCE OF API, DIV. OF REFINING, PHILADELPHIA, MAY 1973//4. BURGESS, D. S., MURPHY, J. N., "HAZARDS OF SPILLAGE OF LNG INTO WATER," BUREAU OF MINES, MIPR NO. Z-70099-9, 12395, L972//5. "FIRE HAZARD PRESENTED BY A SPREADING, BURNING POOL OF LIQUEFIED NATIONAL GAS ON WATER" P. K. RAJ AND A. S. KALELKAR; PAPER PRESENTED AT THE WESTERN STATES SECTION MEETING OF THE COMBUSTION INSTITUTE, 1973. PAPER #73-25P P. 1-23//6. "AN EXPERIMENTAL INVESTIGATION OF ATMOSPHERIC DIFFUSION AND IGNITION OF BOIL-OFF ASSOCIATED WITH A SPILLAGE OF LIQUEFIED NATURAL GAS" T.R.W. REP # 08072-7 FOR THE AGA INC., NOV. 68 (FILM SECTION OF THE REPORT).

-SOURCE INFORMATION-

CORPORATE SOURCE -
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
SPONSOR -
DISTRIGAS CORPORATION, BOSTON MASS.// EASCOGAS LNG, INC., NEWARK, NJ
OTHER INFORMATION -
0023 PAGES, 0004 FIGURES, 0002 TABLES, 0011 REFERENCES

ON THE NATURE OF NON-IDEAL BLAST WAVES

by

STREHLOW, R. A.
ADAMCZYK, A. A.

04/00/75

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Acceptable

-ABSTRACT-

CONTAINED HEREIN ARE A DESCRIPTION OF A MODEL AND A CALCULATION PROCEDURE FOR PLANAR, CYLINDRICAL OR SPHERICAL GEOMETRIES USED TO PREDICT THE FLOW-FIELD PARAMETERS FOR NON-STEADY, NON-IDEAL BLAST WAVES, GENERATED BY THE DEPOSITION OF ENERGY OVER A KNOWN TEMPORAL AND SPATIAL REGIME. THIS MODELING CONSISTS OF ADDING ENERGY INTO A CONSTANT HEAT CAPACITY GAS AND NUMERICALLY INTEGRATING THE EQUATIONS OF MOTION USING A CONSTANT TIME-STEP METHOD OF CHARACTERISTICS, WITH APPROPRIATE INITIAL AND BOUNDARY CONDITIONS. TWO NON-DIMENSIONAL PARAMETERS ARE PRESENTED WHICH RELATE SIMILAR NON-IDEAL ENERGY SOURCES AND PREDICT THAT THEIR LIMIT BEHAVIORS SHOULD APPROACH AN IDEAL POINT SOURCE ON ONE HAND AND THE SOURCE WHICH GENERATES A PROPAGATING ACOUSTIC WAVE ON THE OTHER. FLOW-FIELD PARAMETERS GENERATED FROM SIMILAR COSINE-TYPE ENERGY DEPOSITION FUNCTIONS IN PLANAR AND SPHERICAL GEOMETRIES ARE PRESENTED AS THREE-DIMENSIONAL PLOTS. EACH PLOT DEPICTS THE TIME EVOLUTION OF FLOW-FIELD VARIABLES UNTIL A SHOCK IS FORMED WITHIN THE KERNEL. IT IS FOUND THAT A CRITICAL PARAMETER TO SHOCK FORMATION IS THE TIME RATE OF CHANGE OF ENERGY, POWER, AND THAT, AS POWER OR POWER DENSITY IS INCREASED, THE ENERGY NECESSARY TO FORM SHOCK OF EQUAL MACH NUMBER DECREASES.

-PERTINENT FIGURES-

FIG.6 THE RELATIONSHIP BETWEEN ENERGY/GRAM ADDED AT THE CENTER, TOTAL ENERGY AND THE SIZE OF THE KERNEL FOR A SPHERICAL GEOMETRY, PAGE 21//FIG.7 THE PRESSURE FIELD IN A SPHERICAL GEOMETRY GENERATED FROM A COSINE ENERGY FUNCTION WHEN APPLIED TO STANDARD ATMOSPHERIC AIR, PAGE 22//FIG.8 THE VELOCITY FIELD IN A SPHERICAL GEOMETRY GENERATED FROM A COSINE ENERGY FUNCTION WHEN APPLIED TO STANDARD ATMOSPHERIC AIR, PAGE 23//FIG.9 THE TEMPERATURE FIELD IN A SPHERICAL GEOMETRY GENERATED FROM A COSINE ENERGY ADDITION FUNCTION WHEN APPLIED TO STANDARD ATMOSPHERIC AIR, PAGE 24.

-BIBLIOGRAPHY-

1. R. A. STREHLOW, UNCONFINED VAPOR CLOUD EXPLOSIONS - AN

OVERVIEW, FOURTEENTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, THE COMBUSTION INSTITUTE, PITTSBURG, PA, 1189-1200 (L973)//2. A. L. KUHI, M. M. KAMEL AND A. K. OPPENHEIM, "ON FLAME GENERATED SELF SIMILAR BLAST WAVES," FOURTEENTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, THE COMBUSTION INSTITUTE, PITTSBURGH, PA., 1201-1215 (1973)// 3. S. R. BRINKLEY, SHOCK WAVES IN AIR GENERATED BY DEFLAGRATION EXPLOSIONS, PAPER PRESENTED AT DISASTER HAZARDS MEETING OF CSSCI, HOUSTON, TEXAS, APRIL 1970//4. L. J. ZAJAC AND A. J. OPPENHEIM, "DYNAMICS OF AN EXPLOSIVE REACTIVE CENTER," AIAA JOURNAL, 9, 4 (1971)//5. P. C. CHOU, R. R. KARPP, AND S. L. HUANY, "NUMERICAL CALCULATION OF BLAST WAVES BY THE METHOD OF CHARACTERISTICS," AIAA JOURNAL, 5, 4, 618-623 (APRIL, 1967)//6. S. L. HUANG AND P. C. CHOU, SOLUTION OF BLAST WAVES BY A CONSTANT TIME SCHEME IN THE METHOD OF CHARACTERISTICS, DIT REPORT NO. 125-9, CONTRACT NO. DA 18-001-AMC-876(X), DREXEL INSTITUTE OF TECHNOLOGY (AUGUST, 1966).

-SOURCE INFORMATION-

CORPORATE SOURCE -
ILLINOIS UNIV., CHAMPAIGN
REPORT NUMBER -
TECHNICAL REPORT AAE 74-2//UILU-ENG-740502// WSS/CI 74-12
PUBLISHER -
ENGINEERING EXPERIMENT STATION, COLLEGE OF ENGINEERING, UNIVERSITY OF ILLINOIS, URBANA
SPONSOR -
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, ARLINGTON, VA
CONTRACT NUMBER -
AFOSR 73-2524
OTHER INFORMATION -
0030 PAGES, 0012 FIGURES, 0000 TABLES, 0015 REFERENCES

TECHNIQUES FOR INVESTIGATION OF UNCONFINED FUEL-AIR DETONATIONS

by

PARSONS, G.H.
VANTA, E.G.
COLLINS, P.M.
BEARLEY, J.

11/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Other	Govt. Only	Incremental	Acceptable

-ABSTRACT-

AS PART OF AN EXPLORATORY DEVELOPMENT PROGRAM FOR FUEL-AIR EXPLOSIVE (FAE) MUNITIONS, A BAG TEST TECHNIQUE WAS REFINED TO DETERMINE DETONATION LIMITS, CRITICAL THRESHOLD INITIATION ENERGIES, AND OTHER FUEL-DETONATOR PARAMETERS FOR GASEOUS FUEL-AIR MIXTURES. A NEW SPRAY TEST TECHNIQUE WAS DEVELOPED AND SUCCESSFULLY USED TO ANALYZE UNCONFINED LIQUID DROPLET-AIR DETONATIONS. A COMBINATION OF THE BAG AND SPRAY TEST PROCEDURE WAS ALSO DEVELOPED TO ASSESS THE DETONABILITY OF LOW VAPOR PRESSURE LIQUID FUELS. THIS REPORT DESCRIBES EXPERIMENTAL EQUIPMENT AND PROCEDURES USED TO ECONOMICALLY INVESTIGATE FUEL-AIR DETONATION IN REALISTIC, YET CONTROLLED, ENVIRONMENTS.

-PERTINENT FIGURES-

FIG.2 BAG TEST PHOTOGRAPHIC RECORD, PAGE 7//FIG.4 FAE GAS BAG DETONATION PRESSURE-TIME PROFILE, PAGE 11//FIG.6 SPRAY TEST PHOTOGRAPHIC RECORD, PAGE 16.

-BIBLIOGRAPHY-

1. BENEDICK, W.B., KENNEDY, J.D., MOROSIN, B., DETONATION LIMITS OF UNCONFINED HYDROCARBON-AIR MIXTURES. COMBUSTION AND FLAME 15, 83, 1970// 2. COLLINS, P.M., PARSONS, G.H. AND UNREIN, P.J., CRTICAL ENERGY THRESHOLD FOR DETONATION INITIATION IN MAPP-AIR MIXTURES. AFATL-TR-72-192, AIR FORCE ARMAMENT LABORATORY, EGLIN AIR FORCE BASE, FLORIDA, SEPTEMBER 1972 (UNCLASSIFIED)//3. RAGLAND, K.W., DABORA, E.K. AND NICHOLLS, J.A., OBSERVED STRUCTURE OF SPRAY DETONATIONS. THE PHYSICS OF FLUIDS, VOL. II, NO. 11, PP. 2377-2388, 1968//4. VANTA, E.B., PARSONS, G.H. AND COLLINS, P.M., DETONABILITY OF PROPYLENE OXIDE/AIR AND N-PROPYL NITRATE/AIR MIXTURES. AFATL-TR-73-3, AIR FORCE ARMAMENT LABORATORY, EGLIN AIR FORCE BASE, FLORIDA, MARCH 1973 (UNCLASSIFIED)//5. LEE, D.O., STANDOFF DISTANCE VERSUS DETONATOR SIZE FOR A SUCCESSFUL FUEL-AIR

DETONATION. SC-DR-70-844, SANDIA LABORATORIES, ALBUQUERQUE, NEW MEXICO, JANUARY 1971 (CONFIDENTIAL).

-SOURCE INFORMATION-

CORPORATE SOURCE -
AIR FORCE ARMAMENT LAB., EGLIN AFB, FLA.
REPORT NUMBER -
AFATL-TR-73-230
PUBLISHER -
AIR FORCE ARMAMENT LAB., EGLIN AFB, FLA.
SPONSOR -
AIR FORCE ARMAMENT LAB., ELGIN AFB, FLA.
CONTRACT NUMBER -
PROJECT NO. 25170303 AND 25170304//AFATL-TR-73-230
OTHER INFORMATION -
0023 PAGES, 0008 FIGURES, 0001 TABLES, 0008 REFERENCES

FUNDAMENTAL ASPECTS OF UNCONFINED EXPLOSIONS

by

FRY, R.S.
GLASS, D.P.
HU, C.
NICHOLLS, J.A.
SICHEL, M.

06/00/73

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Other	Govt. Only	Incremental	Acceptable

-ABSTRACT-

THIS REPORT COVERS PROGRESS MADE IN THE SECOND YEAR OF THE RESEARCH PROGRAM. THE FIRST PART OF THE REPORT IS DEVOTED TO A GENERALIZED ANALYTICAL PREDICTION OF THE GROUND IMPULSE THAT CAN BE OBTAINED FROM A BLAST WAVE, DETONATION WAVE, AND AN IDEALIZED FUEL-AIR EXPLOSION. THE LATTER CONSISTS OF BLAST WAVE BEHAVIOR FOR RADIUS, R, LESS THAN A CRITICAL RADIUS, R*, AND CHAPMAN-JOUGUET DETONATION FOR R GREATER THAN R*. IN ALL CASES SO FAR, THE FINITE DIAMETER OF THE CLOUD WITH THE ATTENDANT SHOCK WAVE PROPAGATION BEYOND THE CLOUD HAS NOT BEEN TAKEN INTO ACCOUNT. THE LATTER PART OF THIS REPORT IS DEVOTED TO THE EXPERIMENTAL ASPECTS. IMPROVEMENTS IN THE FACILITY FOR GENERATING CYLINDRICAL SHOCK WAVES AND DETONATION WAVES ARE DESCRIBED. CONTROLLED EXPERIMENTS ON CYLINDRICAL BLAST WAVES WITH THE ASSOCIATED DATA REDUCTION TECHNIQUES ARE DISCUSSED. THE RESULTS ARE INTEPRETED TO YIELD A CALIBRATION ON THE EFFECTIVE ENERGY RELEASE OF THE INITIATING CHARGE OF DETASHEET. TWO PHASE CYLINDRICAL DETONATION EXPERIMENTS WERE ALSO CONDUCTED USING A HIGHLY REFINED FRACTION OF KEROSENE. THE RESULTS INDICATE THAT AT SMALL RADIUS BLAST WAVE BEHAVIOR PREDOMINATED WHEREAS AT LARGE RADIUS A CONSTANT VELOCITY DETONATION WAS REALIZED WHEN THE INITIATION ENERGY WAS SUFFICIENTLY HIGH. THE EXPERIMENTALLY DETERMINED TRANSITION RADIUS BETWEEN THE TWO TYPES OF BEHAVIOR AGREED VERY WELL WITH THEORETICAL VALUES. CYLINDRICAL DETONATIONS IN GASEOUS MAPP-AIR MIXTURES WERE ALSO STUDIED. THE VARIATION IN THRESHOLD ENERGY REQUIRED FOR INITIATION AS WELL AS RICH AND LEAN LIMITS WERE ESTABLISHED. THE RESULTS AGREE VERY WELL WITH LARGE SCALE FIELD TESTS.

-BIBLIOGRAPHY-

1. NICHOLLS, J. A., FRY, R. S., GLASS, D. R., SICHEL, M., VANDERSCHAFF, J., STERNSTEIN, A. J., "FUNDAMENTAL ASPECTS OF UNCONFINED EXPLOSIONS," TECHNICAL REPORT, AFATL-TR-72-49, MARCH 1972// 2. KOROBEINIKOV, V. P., "THE PROBLEM OF POINT EXPLOSION

EXPLOSION IN A DETONATING GAS, ASTRONAUTICA ACTA, 14, 1969, P. 411//3. BACH, G. G., KNYSTAUTAS, R., LEE, J. H., "INITIATION CRITERIA FOR DIVERGING GASEOUS DETONATIONS," THIRTEENTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, THE COMBUSTION INSTITUTE, 1971, P. 1097//4. TAYLOR, G. I., "THE FORMATION OF A BLAST WAVE BY A VERY INTENSE EXPLOSION," PROC. ROY. SOC., A201, P. 159, 175, 1950// 5. BRODE, H. L., GLASS, I. I., AND OPPENHEIM, A. K., "GAS DYNAMICS OF EXPLOSIONS TODAY," SHOCK TUBE RESEARCH, PROC. OF THE EIGHTH INTERNATIONAL SHOCK TUBE SYMPOSIUM, IMPERIAL COLLEGE, LONDON, 5-8 JULY 1971. STOLLER, J. L., GAYDON, A. D., AND OWEN, P. R., EDITORS// 6. BENEDICK, W. B., KENNEDY, J. D., AND MOROSIN, B., "DETONATION LIMITS OF UNCONFINED HYDROCARBON-AIR MIXTURES," COMBUSTION AND FLAME, 15, 83 (L970)

-SOURCE INFORMATION-

CORPORATE SOURCE -
MICHIGAN UNIV., ANN ARBOR
PUBLISHER -
AIR FORCE ARMAMENT LABORATORY, ELGIN AFB, FLORIDA
SPONSOR -
AIR FORCE ARMAMENT LAB.
CONTRACT NUMBER -
CONTRACT NO. F08635-71-C-0083//PROJECT NO. 2513// TASK NO. 07//WORK UNIT NO. 001//AFATL-TR-73-125
OTHER INFORMATION -
0154 PAGES, 0048 FIGURES, 0014 TABLES, 0014 REFERENCES

EVACUATION AREAS FOR TRANSPORTATION ACCIDENTS INVOLVING PROPELLANT TANK PRESSURE BURSTS

by

SIEWERT, R.D.

11/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Incremental	Good/Excel.

-ABSTRACT-

EVACUATION AREAS ARE DEFINED FOR THOSE TRANSPORTATION ACCIDENTS WHERE VOLATILE CHEMICAL PROPELLANT TANKS ARE EXPOSED TO FIRE IN THE WRECKAGE AND EVENTUALLY EXPLODE WITH CONSEQUENT RISKS FROM FRAGMENTS IN SURROUNDING POPULATED AREAS. AN EVACUATION AREA WITH A MINIMUM RADIUS OF 600 M (2000 FT) IS RECOMMENDED TO LIMIT THE STATISTICAL PROBABILITY OF FATALITY TO ONE IN 100 SUCH ACCIDENTS. THE RESULT OF THIS STUDY WAS MADE POSSIBLE BY THE DERIVATION OF A DISTRIBUTION FUNCTION OF DISTANCES REACHED BY FRAGMENTS FROM BURSTING CHEMICAL CAR TANKS. DATA CONCERNING FRAGMENTS WAS OBTAINED FROM REPORTS OF TANK CAR PRESSURE BURSTS BETWEEN 1958 AND 1971.

-PERTINENT FIGURES-

FIG.2 DENSITY FRAGMENTS - DISTANCE TRAVEL, PAGE 14//FIG.4 FATALITY PER ACCIDENT - RADIUS OF EVACUATION, PAGE 16.

-BIBLIOGRAPHY-

1. LEVINE, D.; AND DANCER, D.M., FIRE PROTECTION OF RAILROAD TANK CARS CARRYING HAZARDOUS MATERIALS - ANALYTICAL CALCULATIONS AND LABORATORY SCREENING OF THERMAL INSULATION CANDIDATES. REP. NOLTR-72-142, NAVAL ORDNANCE LAB., JULY 21, 1972//2. O'DRISCOLL, J.J., METHODS FOR PREVENTION OF SPILLS IN THE RAIL TRANSPORTATION OF HAZARDOUS MATERIALS, CONTROL OF HAZARDOUS MATERIAL SPILLS. PRESENTED AT THE 1972 NATIONAL CONFERENCE ON CONTROL OF HAZARDOUS MATERIAL SPILLS, HOUSTON, TEX., MAR. 21-23, 1972//3. SIEWERT, R.D., A METHOD FOR DEFINING DOWN-WIND EVACUATION AREAS FOR TRANSPORTATION ACCIDENTS INVOLVING TOXIC PROPELLANT SPILLS. NASA TM X-68188, 1972// 4. STREHLOW, R.A., UNCONFINED VAPOR CLOUD EXPLOSIONS - AN OVERVIEW. PRESENTED AT FOURTEENTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, PENNSYLVANIA STATE UNIV., UNIVERSITY PARK, PA., AUG. 20-25, 1972.

-SOURCE INFORMATION-

CORPORATE SOURCE -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO
REPORT NUMBER -
NASA TMX-68277
PUBLISHER -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SPONSOR -
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO
CONTRACT NUMBER -
NASA TMX-68277
OTHER INFORMATION -
0019 PAGES, 0005 FIGURES, 0001 TABLES, 0008 REFERENCES

FAILURE RATES OF AUTOMATIC FIRE DETECTION AND ALARM SYSTEMS

by

CHAMBERS, E.D.

03/00/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Govt. Only	Summary	Acceptable

-ABSTRACT-

In 1968, a survey was made on all fires starting in premises equipped with automatic fire detection systems. All reports were examined to establish how often a fire occurred and either (1) there was a complete failure of the automatic system because it was not in a serviceable condition (Total Failure); (2) there was a local alarm indication provided by the system, but a failure in the brigade connection because the connection was not in a serviceable condition (Brigade Connection Failure); (3) the system operated, or would have done so if the fire had not been discovered at an early stage by a person. In about 460 fires reported in protected premises, it seemed that the automatic detection and alarm system installed was incapable of warning the public fire department in only about 16 (3.5 percent) and (included in the above) incapable of warning anyone at all in only about eight (1.7 percent). Although the reasons for unserviceability were varied, it appeared that direct human failures, particularly failing to take adequate precautions over disconnection, were about as common as failures of a technical nature.

-SOURCE INFORMATION-

CORPORATE SOURCE -
FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
REPORT NUMBER -
FR NOTE NO. 932
OTHER INFORMATION -
0005 PAGES, 0000 FIGURES, 0003 TABLES, 0001 REFERENCES

THE ASSESSMENT OF AMBIENT CONDITIONS TO WHICH FIRE DETECTORS ARE EXPOSED

by

KENNEDY, R.H.

03/18/72

SECURITY CLASS	ACCESS LEVEL	REPORT CLASS	ENTRY EVAL.
U/Unrestricted	Unlimited	Summary	Acceptable

-ABSTRACT-

IN ORDER TO REDUCE THE FALSE ALARM RATE OF FIRE DETECTORS, DATA ON AMBIENT CONDITIONS INCLUDING MEASUREMENTS OF SMOKE, TEMPERATURE, RADIATION, AIR VELOCITY, HUMIDITY AND VIBRATION, ARE ESSENTIAL. THE DATA MAY BE COLLECTED ON PORTABLE DATA LOGGING MAGNETIC TAPE RECORDERS IN COMPUTER-COMPATIBLE FORM. IT IS EXPECTED TO REDUCE THE PRESENT FALSE ALARM RATE BY A FACTOR OF 3 BY USING DETECTION CRITERIA THAT MORE CLEARLY DISCRIMINATE THE DEVELOPING FIRE CONDITIONS FROM THE AMBIENT. MEASURING SITES SELECTED FOR DATA GATHERING WERE IN OFFICES, HOTELS, SHOPS (AVERAGE NOISE LEVELS), WORKSHOPS, TEXTILE MILLS, PRODUCTION LINES (NOISY ENVIRONMENTS), AND HOSPITALS AND LIBRARIES (QUIET ENVIRONMENTS). THE INSTRUMENTS USED FOR SMOKE LEVEL MEASUREMENTS CONSIST OF AN OPTICAL OBSCURATION MEASURING DEVICE, AN OPTICAL SCATTER MEASURING DEVICE, AND AN IONIZATION DEVICE. RECORDING RATES OF ONE SAMPLE PER 15 SEC. ARE FAST ENOUGH FOR TEMPERATURE RISES OF 30 DEG. C./MIN. AIR VELOCITIES FOR SWIFT CURRENTS MIXED WITH MEAN DRIFTS ARE MEASURED WITH SEPARATE ANEMOMETERS OF DIFFERENT SENSITIVITY. VIBRATION MEASUREMENTS REQUIRE A GREAT DEAL OF SPACE FOR INSTRUMENTATION AND RECORDING EQUIPMENT.

-PERTINENT FIGURES-

SMOKE MEASURING SENSOR PAGE 9

-BIBLIOGRAPHY-

FRY, J.F., AND EVELEIGH, C.: THE BEHAVIOR OF AUTOMATIC FIRE DETECTION SYSTEMS. FIRE RES. NOTE NO. 810, H.M. STATIONERY OFFICE, ENGLAND, MAR. 1970//PICKARD, R.W.: THE FUNDAMENTALS OF AUTOMATIC HEAT-SENSITIVE FIRE DETECTION: PART 1. THE PERFORMANCE OF FIRE DETECTORS. SDIR AND JOFRO AUTUMN SYMP., 1962

-SOURCE INFORMATION-

CORPORATE SOURCE -

FIRE RESEARCH STATION, BOREHAM WOOD (ENGLAND).
JOURNAL PROCEEDINGS -
IN: SYMP ON AUTOMATIC FIRE DETECTION, LONDON (MAR. 8-18, 1972)
OTHER INFORMATION -
0011 PAGES, 0002 FIGURES, 0000 TABLES, 0004 REFERENCES

INDEX OF DESCRIPTORS

INDEX OF AUTHORS

☆USGPO: 1976 — 660-432/63 Region 5-11