

CONTENTS

	Page
FOREWORD	III
PREFACE	V
AUTHOR'S INTRODUCTION	VII

Chapter I. AT THE TURN OF THE CENTURY

MAIN STREET, 1900	1
"A national standardizing bureau"—America in 1900— A century of science and invention—The new electrical world—Business, industry, and laissez-faire govern- ment—Cost of living—Wealth and the industrial potential.	
THE SHAPE OF THINGS TO COME	9
The promise in science and technology—The prophets of the new century—Advance of physics, 1900–1925— Edison as symbol of the age of electricity—Rise of industrial research laboratories—Role of the Bureau.	
GOVERNMENT, SCIENCE, AND THE GENERAL WELFARE	16
Federal role in the promotion of science and the useful arts—Early scientific agencies in the Government— Proposal for a Department of Science (1884)—Federal attitude toward science and industry.	
LOOKING BACK	20
Charles S. Peirce and the Office of Weights and Meas- ures in the Coast Survey—Jefferson and Adams on weights and measures—Hassler and his standards (1832)—The metric system legalized (1866)—Menden- hall's fundamental standards of 1893—Makeshift standards of the 19th century—Adoption by Congress of electrical standards (1894).	

**Chapter I. AT THE TURN OF THE CENTURY—
Continued**

LAISSEZ-FAIRE STANDARDS

Page
33

Conflicts among "authoritative" standards—The system of weights and measures in ordinary use—Federal and State standards and commercial weights and measures—The proliferation of local arbitrary standards.

**"A NATIONAL NEED * * * A NATIONAL
HUMILIATION"**

38

The establishment of European standards laboratories since 1870—Secretary of Treasury Gage proposes a U.S. standardizing laboratory (1900)—Professor Stratton brought to Washington as "Inspector of Standards"—Nationwide endorsement of the proposed laboratory—Establishment of the Bureau.

**Chapter II. FOUNDING THE NATIONAL BUREAU OF
STANDARDS (1901-10)**

SAMUEL WESLEY STRATTON

49

Stratton's background and association with Michelson at Chicago—Pritchett's, Stratton's and Vanderlip's accounts of the founding of the Bureau—Stratton in the Office of Weights and Measures—Goes to Europe for ideas and instruments—The Reichsanstalt as model—Selecting the Visiting Committee—Choosing a site for the Bureau.

EDWARD B. ROSA

62

Rosa called to head electrical research—Building a staff and planning a program—Expansion of temporary facilities and operations in downtown Washington.

Chapter II. FOUNDING THE NATIONAL BUREAU OF STANDARDS—Continued

	Page
THE NEW BUREAU LABORATORIES	68
Transfer of the Bureau from the Treasury Department to Commerce and Labor—Constructing the laboratories on Connecticut Avenue—Rosa's description of North and South buildings—The electrical group moves in.	
ACQUIRING NATIONAL STANDARDS	73
The Bureau in 1904—Classes of standards—Status of standards in the new Bureau divisions and planned programs of work.	
AN AUTUMN FIRE AND A CONSUMERS' CRUSADE	82
The Bureau exhibits its wares at the St. Louis Fair and buys Dewar's liquid hydrogen plant—An autumn leaf fire and hoses that could not be coupled—The Bureau holds its first conference on weights and measures—The national reform movement against commercial and political knavery—Stratton puts weights and measures into the crusade.	
THE BEGINNING OF GOVERNMENT TESTING	90
The Government discovers it is a consumer—Congress worries about the growth of the Bureau—Industry seeks Bureau help and "consumer" research at the Bureau expands—Preparation of standard samples—Transfer of Geological Survey laboratories to the Bureau—West building—Personnel problems—Note on NBS scientists starred in <i>American Men of Science</i> —The graduate study program at the Bureau—Rosa's group becomes the premier division at the Bureau.	

**Chapter III. ELECTRICITY, RAILROADS, AND RADIO
(1911-16)**

	Page
STANDARDS FOR THE AGE OF ELECTRICITY	103
Progress in electrical measurements between 1903 and 1910—International agreement on new values for the ampere, ohm, and volt—Congress feels that Bureau's electrical research is completed—Construction of East building—A program of electrical measurement research.	
 STANDARDS FOR PUBLIC UTILITIES	 110
Need for standards of quality, of safety, and of service in public utilities—Rise of the public service commissions—Waidner and Burgess' standard of light—Specifications for incandescent lamps—Standards of gas service—Resistance of the public utilities—Bureau track scales and test cars—Railway accidents—The trolley car, electrolysis, and underground corrosion—NBS as clearinghouse for scientific and technical problems of public utilities.	
 TESTING GOVERNMENT MATERIALS	 124
Rapid growth of Government testing—The cement testing program—Cooperation with industry—Metallurgical research—Electroplating and electrodeposition—Burrows' permeameter—Physical constants—Fire resistance properties of materials—Materials testing and the consumer.	
 STANDARDS FOR THE CONSUMER	 133
The problem of Bureau testing and the ultimate consumer—Three circulars for the homemaker: "Measurements for the household," "Safety in the household," "Materials for the household"—Thomas Edison discovers the Bureau.	

**Chapter III. ELECTRICITY, RAILROADS, AND RADIO—
Continued**

	Page
RADIO, RADIUM, AND X RAYS	138
"Radio telegraphy and radio activity"—Austin's early radio research for the Navy—Dellinger and radio measurements—Kolster's decremeter and radio direction finder—Radium research in Europe—The International Radium Standard—Dorsey's "X-ray hands."	
"REVISING" THE ORGANIC ACT	147
The Bureau's 200 projects and its vast testing program exceed intention of organic act—Stratton and the Congress—The device of special appropriations—Criticism of Bureau expansion—Congress makes testing and research of materials a specific Bureau function—Secretary of Commerce Redfield and the Bureau—Stratton's restatement of Bureau functions.	

Chapter IV. THE WAR YEARS

(1917-19)

THE BUREAU TURNS TO WAR RESEARCH	159
The war in Europe—Planning for war—The Bureau organizes a gage laboratory and a series of experimental "factories"—Wartime expansion—From peacetime to military research.	
NEW SOURCES, RESOURCES, AND SUBSTITUTES	171
Allied scientific missions—National shortages—Toluol extraction—Coke and natural gas investigations—Alloy and other metallurgical studies—Concrete ships—Leather, paper, and textile substitutes—The War Industries Board and the drive for standardization, substitution, and conservation of resources.	

Chapter IV. THE WAR YEARS—
Continued

	Page
THE AIRPLANE IN THE LABORATORY	179
<p>The status of aviation here and abroad—Spark plug, fuel, and oil problems—Development of aeronautical instruments—Dr. Briggs and the wind tunnel—The Liberty engine—The dynamometer and altitude laboratories—New sources and substitutes in airplane materials.</p>	
OPTICAL GLASS AND OPTICAL INSTRUMENTS	186
<p>Shortage of high-grade optical glass—Bleininger's crucible—Glass production—Optical instrument development—Military photography.</p>	
"NEW THINGS IN RADIO COMMUNICATION"	191
<p>The Navy takes over radio for the duration—Wartime radio requirements—Bureau publications on radio measurements and radio principles—Kolster's radio compass—Note on Bureau patents and patent policy—Bureau work on vacuum tubes—Resumption of patent litigation at the end of the war.</p>	
FROM GAGES TO GAS MASKS	199
<p>The gage and mass production—The Johansson and Hoke gages—Standardization of screw threads and other investigations—Gas warfare—Submarine detection—Goddard and his rocket weapons—The Garand rifle—Life at the Bureau during the war.</p>	
THE BUREAU AND THE METRIC SYSTEM	207
<p>The metric controversy—The AEF adopts the metric system—Bureau support of metric legislation—The antimetric American Institute of Weights and Measures—The legislative failure.</p>	

**Chapter IV. THE WAR YEARS—
Continued**

	Page
“THE LEGACY LEFT TO US”	212
<p>The war ends abruptly—Peacetime applications of war research—The device of transferred funds—The new alliance of science and industry—“Is the Bureau of Standards capable of extension into a national research institution?”—The Bureau’s Industrial building as its war legacy—The Bureau plan to become the national research laboratory for industry.</p>	

**Chapter V. THE TIDE OF COMMERCE AND INDUSTRY
(1920–30)**

THE POSTWAR WORLD	221
<p>Growth of new and old industries in the 1920’s—The new cost of living—Research associates—The depression of 1920–21—Rosa’s study of Federal expenditures and of Government research—The Republican ascendancy.</p>	
HERBERT HOOVER AND THE BUREAU OF STANDARDS	229
<p>Hoover’s plans for the Department of Commerce—Note on a comparison of NBS with NPL—The Bureau comes under Hoover’s wing—Deaths of Rosa, Fischer, and Waidner—Dr. Stratton leaves the Bureau.</p>	
GEORGE KIMBALL BURGESS	237
<p>Burgess as administrator—New limitations on his freedom of action—Continuation of Stratton policies—Bureau program for postwar research—Fundamental research during and after the war.</p>	

Chapter V. THE TIDE OF COMMERCE AND INDUSTRY—
Continued

	Page
BUILDING AND HOUSING	249
Hoover's plans for recovery and reconstruction— Better homes—Bureau publications on home owner- ship and care and repair of the home—Note on NBS Letter Circulars.	
"THE CRUSADE FOR STANDARDIZATION"	253
Reconstruction through elimination of waste—Stand- ardization, specifications, and simplification—The AESC and trade associations as agencies of standardization— <i>NBS Standards Yearbook</i> —The Federal Specifications Board—Obstacles in the standardization program and the end of the crusade.	
RESEARCH FOR INDUSTRY	263
Conservation of raw materials, elimination of waste, and assistance to new industries—Household gas, gas appliances, and so-called "gas-savers"—Rare sugar research—Utilization of waste products from the land— Industrial and scientific instruments—Standardization of color—Dental research—Building research—Screw- thread standardization—Optical glass—The Bureau standard of planeness.	
AUTOMOBILES AND AIRCRAFT	276
Automotive engine research—Brakes and braking dis- tances—Rubber research—Storage batteries—Battery additives—Airplane engine research—The helicopter and jet propulsion—Lighter than air craft—The new aeronautical division in the Department of Com- merce.	

**Chapter V. THE TIDE OF COMMERCE AND INDUSTRY—
Continued**

	Page
"POLICING THE ETHER"	286

The radio boom—Bureau publications for making simple radio sets—The Federal Radio Commission—Problems of radio reception—Frequency studies—Radio wave propagation and fading phenomena—New radio equipment—Harry Diamond and an instrument landing system for blind flying—The tide of industry and commerce at the flood.

**Chapter VI. THE TIME OF THE GREAT DEPRESSION
(1931-40)**

THE BUREAU IN THE PUBLIC VIEW	299
-------------------------------	-----

The Bureau and the public press—The Bureau and the consumer—Criticism of the Bureau by private industry—The NBS-American Standards Association quarrel—Increasing criticism of the Bureau's "paladins of precision"—Congressional investigation into Government competition with private industry.

LYMAN JAMES BRIGGS	308
--------------------	-----

Onset of the depression—The Bureau's "banner year"—Note on a comparison of PTR and NBS—Death of Dr. Burgess—Selection of Dr. Briggs—His paper on the curve of a baseball—Dr. Briggs as Director—Attitude of the New Deal toward business and industry.

TOWARD A REDEFINITION OF BUREAU FUNCTIONS	320
--	-----

The New Deal attack on the depression—The Science Advisory Board—The slash in Bureau appropriations—The Science Advisory Board and Government research—The depression at midcareer—Rise of the consumer movement—Life at the Bureau during the depression—New Bureau facilities, branch laboratories, and new programs.

**Chapter VI. THE TIME OF THE GREAT DEPRESSION—
Continued**

	Page
SOME FUNDAMENTAL WORK ON STANDARDS	335
<p>A new international meter—Absolute electrical units— Practical photometric units—Standard of ultraviolet radiation—Color temperature standards—Standardiza- tion of X-ray dosages—Radioactive luminous com- pounds—New spectrochemical measurements—The Mathematical Tables Project—Physical constants of pure substances.</p>	
“CURTAILMENT BY LIMITATION OF FUNDS”	344
<p>Photographic emulsion research—Other research ter- minated in the 1930's—New NBS-ASA agreement— Note on Bureau patent litigation and policy—New standards in radio—NBS radio prediction service— Radiotelemetry and cosmic ray research—Telemete- orography and the radiosonde—“Laboratories in the stratosphere.”</p>	
HEAVY WATER	357
<p>Atomic and nuclear research—Urey and the discovery of deuterium—Note on German attitude toward atomic research—Dr. Briggs and the Advisory Committee on Uranium—Status of atomic research in the spring of 1940—Transfer of the Committee to NDRC and OSRD.</p>	
Chapter VII. WORLD WAR II RESEARCH	
(1941-45)	
“IN THE EVENT OF WAR”	365
<p>The Bureau offers its services—Educational orders— Cautious preparations for defense—NDRC and OSRD—The Bureau reports its eve-of-war research— Strategic materials studies—Civilian defense investi- gations—Petroleum conservation and gas rationing— Synthetic rubber—Quartz crystal—Optical glass— Bureau organization for war.</p>	

**Chapter VII. WORLD WAR II RESEARCH—
Continued**

	Page
THE BUREAU AND THE ATOMIC BOMB	377
Degree of Bureau participation—Heavy water research—Bureau purification of graphite and uranium—Dr. Briggs and the Uranium Advisory Committee— Status of project in June 1941—The Bureau takes over analytical procedures—Fermi produces the first nuclear chain reaction—"The Los Alamos Primer"—Detonation.	
THE RADIO PROXIMITY FUZE	388
Theory of the proximity fuze—The Bureau undertakes development of fuzes for nonrotating projectiles—Development of the fuze for rockets—The photoelectric fuze—Ordnance Development Division—Requirement for a bomb fuze—Bomb director mechanism—The mortar shell fuze—Printed circuits—Restricted use of the proximity fuze.	
A GUIDED MISSILE CALLED THE BAT	399
NDRC seeks a winged bomb—The TV-guided "Robin"—Radar-guided missiles—The "Pelican"—The "Bat"—Flight tests in 1944—Use in the Pacific theater.	
RADIO AND RADIO-WEATHER PREDICTING	403
The high-frequency direction finder—Fundamental work of Diamond and Norton—Military value of radio weather predictions—Formation of IRPL—Problems in radio weather predicting—Forecasting mvf, luhf, terrestrial and ionospheric storm effects—The Bureau's short-time warning system— <i>IRPL Radio Propagation Handbook</i> —The quartz crystal stockpile project.	
RESEARCH IN CRITICAL MATERIALS	410
Shortages in raw material resources—Synthetic rubber—Dr. Briggs and the Truman Committee—Steel alloys—Protective coatings and electroplating as steel	

**Chapter VII. WORLD WAR II RESEARCH—
Continued**

	Page
RESEARCH IN CRITICAL MATERIALS—Continued substitutes—The copper and aluminum pinch—Optical glass production—Petroleum hydrocarbons and fuel research—High-precision wear gage—Carbon monoxide indicator—Plastics research—New demands in textiles—Wartime simplified practices and commercial standards—The beginning of reconversion—Reconversion at the Bureau.	

**Chapter VIII. THE NEW WORLD OF SCIENCE
(1946–51)**

“THE PECULIAR PEACE” The postwar scene and the cold war—Transfer of OSRD projects to NBS—NBS and transferred funds—Postwar plans for the Bureau.	427
EDWARD UHLER CONDON Dr. Briggs retires—H. A. Wallace and Dr. Condon—Dr. Condon at the Bureau—Before the House Appropriations Subcommittee—Dr. Condon’s plans—Need for redirection at the Bureau—Reorganization—The Corona and Boulder Laboratories.	434
TECHNOLOGICAL VS. BASIC RESEARCH Dr. Condon presents a program to Congress—Plans to free the Bureau from excessive industrial and technological research—Termination of Bureau membership in ASA—The new fields of electronics and nuclear energy—New tools of research—Research in electronic components—The Bureau as “the centralized national computer facility”—Fundamental research—Standard samples—Superconductivity—The isotopic effect.	446

**Chapter VIII. THE NEW WORLD OF SCIENCE—
Continued**

	Page
NUCLEAR PHYSICS AND RADIO PROPAGATION	467
<p>Program of the atomic physics division—A complete set of atomic standards?—Radioactive tracer studies—<i>Atomic Energy Levels</i>—<i>Nuclear Data</i>—“Thermal properties of hydrogen”—Cryogenic operations at Boulder—New research in radio propagation—Broadcasting standard time—Microwave spectroscopy and the atomic clock.</p>	
HIGH POLYMERS AND BUILDING RESEARCH	477
<p>Note on guest lecturers and consultants at the Bureau—High polymers—The Bureau as the national agency for rubber research, mathematics, and radio propagation—The building technology division—“Care and repair of the house” again—“Aquila”—AD-X2.</p>	
GOLDEN ANNIVERSARY	487
<p>Dr. Condon’s handbook of physics—Amendment to the organic act of 1901—Restatement of Bureau activities—Semicentennial of the Bureau’s founding—Dr. Condon and the House Un-American Activities Committee—Dr. Condon resigns.</p>	
THE CRUCIAL DECADE—AN ENVOI	
AN AD HOC COMMITTEE REPORTS	495
<p>The Kelly (Ad Hoc) Committee and its recommendations—A personnel survey—Readjustments in the Bureau testing program—“Proper functions of the Bureau.”</p>	

**THE CRUCIAL DECADE—AN ENVOI—
Continued**

GAITHERSBURG

Page
503

The 50-year-old Bureau plant—To reconstruct or rebuild?—Gaithersburg plans—New guidelines—Science and the Federal Government—The measurement pinch—The Bureau's central, continuing mission.

RETROSPECT AND PROSPECT

509

The Bureau in its first five decades—The Bureau as a focal point in the Federal science program—A regrouping of Bureau programs—An envoi.

APPENDICES

- | | |
|--|-----|
| A. FERDINAND RUDOLPH HASSLER: First Superintendent of the Coast Survey and of Weights and Measures. | 515 |
| B. THE METRIC SYSTEM IN THE UNITED STATES | 527 |
| C. BASIC LEGISLATION relating to Standard Weights and Measures and to the Organization, Functions, and Activities of the National Bureau of Standards. | 537 |
| D. THE NATIONAL BUREAU OF STANDARDS IN THE FEDERAL ADMINISTRATION | 555 |
| E. MEMBERS OF THE VISITING COMMITTEE of the Secretary of Commerce to the National Bureau of Standards. | 557 |
| F. NBS APPROPRIATIONS and other Supporting Funds, 1902-1955. | 559 |

CONTENTS XXV

APPENDICES—Continued

	Page
G. NBS SPECIAL APPROPRIATIONS, 1910-1935	561
H. NBS AUTHORIZED PERSONNEL	563
I. PUBLICATIONS by the Staff of the National Bureau of Standards.	565
J. NBS ADMINISTRATIVE, SCIENTIFIC, AND TECHNICAL STAFF CHIEFS, 1905-1960	569
K. NBS PUBLICATIONS representing RESEARCH HIGHLIGHTS in SCIENCE AND TECHNOLOGY, 1901-1951	631
L. LAND PURCHASES for the National Bureau of Standards.	649
M. SAMUEL WESLEY STRATTON: Founder and First Director of the National Bureau of Standards.	651
N. BOOKS by Staff Members of the National Bureau of Standards.	663
O. BUILDINGS AND STRUCTURES of the National Bureau of Standards.	669
BIBLIOGRAPHIC NOTE	673
INDEX	683