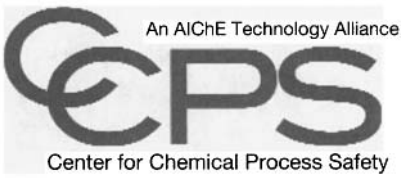
Guidelines for Process Safety in Bioprocess Manufacturing Facilities

Center for Chemical Process Safety
New York, New York



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This book is one in a series of process safety guideline and concept books published by the Center for Chemical Process Safety (CCPS). Please go to www.wiley.com/go/ccps for a full list of titles in this series.

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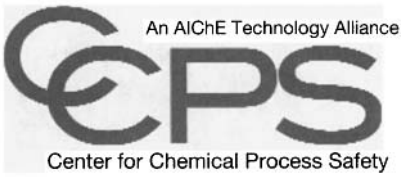

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FILES ON THE WEB ACCOMPANYING THIS BOOK

Biological Assessment Questionnaire

Bioprocess Facility Audit Checklist

You can access these files by going to the site:

www.aiche.org/ccps/publications/bioprocess.aspx

To access the files, download the zipped folder and extract all of the files. You will be asked for a password, enter the password:

CCPSBio2010

If you have difficulty accessing the files, contact CCPS at ccps@aiche.org or +1.646.495.1371

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PREFACE

The American Institute of Chemical Engineers (AIChE) has been closely involved with process safety and loss control issues in the chemical and allied industries for more than four decades. Through its strong ties with process designers, constructors, operators, safety professionals, and members of academia, AIChE has enhanced communications and fostered continuous improvement of the industry's high safety standards. AIChE publications and symposia have become information resources for those devoted to process safety and environmental protection.

AIChE created the Center for Chemical Process Safety (CCPS) in 1985 after the chemical disasters in Mexico City, Mexico, and Bhopal, India. The CCPS is chartered to develop and disseminate technical information for use in the prevention of major chemical accidents. The center is supported by more than 80 chemical process industries (CPI) sponsors who provide the necessary funding and professional guidance to its technical committees. The major product of CCPS activities has been a series of guidelines to assist those implementing various elements of a process safety and risk management system. This book is part of that series.

AIChE recognized a significant increase in members' bioprocess related needs in the early 1990s. Some of these members' processes benefit from traditional process safety techniques, others present different challenges for managing the biological nature of their hazards and associated risks, and still others combine both categories of hazards. Bioprocess safety management meshes the lessons learned from over 24 years of chemical process safety management with the unique approaches demanded by the widening variety of bioprocessing safety challenges. The CCPS Technical Steering Committee initiated the creation of these guidelines to assist bioprocessing facilities in meeting these challenges. This book contains approaches for designing, developing, implementing, and continually improving a bioprocess safety management system. The website accompanying this book contains resource materials and support information.

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INTRODUCTION

The following definition sets the scope of our discussion of process safety management in the bioprocess manufacturing industry:

> *Bioprocess—A process that makes use of microorganisms, cells in culture, or enzymes to manufacture products or complete a chemical transformation.*

Humans have been using such processes for baking bread, making cheese and fermenting alcoholic beverages since prehistoric times. Advances in commercializing recombinant DNA technology allow the production of an enormous variety of protein-based therapeutic drugs that is having a profound impact on the quality of life for severely ill patients. Bioprocessing is also essential to several emerging industries and technologies, including the production of biofuels from renewable biomass feedstocks such as ethanol biodiesel, and for the production of polymeric materials. Therapeutic stem cells, gene therapy vectors, and new vaccines are all the results of bioprocessing technology.

Effective process safety management in bioprocess manufacturing is essential to the growth of an already booming segment of global manufacturing. In the past few decades, leaps in basic science, new bioprocessing discoveries, technological methods, and equipment design have created a vibrant and creative business segment. Bioprocessing is a business segment that, like any other, has traditional fiscal risks but then adds unique chemical and biological hazard-based risks related to

- the raw materials involved,
- the products made,
- the processes used,
- the waste streams involved, and
- unique end user considerations.

Effective process safety management is viewed worldwide by leaders in the chemical process industries, government regulatory agencies, and non-governmental public advocacy groups concerned with public safety and environmental protection as a business philosophy that supports safe, efficient, and reliable operation of manufacturing facilities. An increased emphasis on process safety management across many segments of the process industries during the last several decades is widely credited for reducing the risks of catastrophic accidents in facilities worldwide.

While process safety management has traditionally been focused upon large facilities in the petroleum, natural gas and chemicals and polymers production sectors, other facilities in the process industries have also widely used and benefited from the basic concepts of process safety. Examples include facilities that may not be required by regulations to adopt formal process safety management systems such as biopharmaceutical industry facilities for production of biological drug substances and vaccines.

This book addresses process safety management practices for manufacturing facilities that use bioprocesses. For the purposes of this guideline, the reader should expand the traditional scope of the definition of hazardous materials to include chemicals, biological agents, and intermediates and derivatives generated during manufacture.

Owners of bioprocessing facilities must manage a variety of process safety related hazards, not just biohazards. These include a variety of chemical hazards and physical hazards (for example, stored energy in pressure vessels located in utility supply and process areas, asphyxiant gases, hot acidic and caustic cleaning solutions). While biohazards may in some instances be very significant and perhaps of primary importance from a risk perspective, in many cases chemical and physical hazards will present the more significant risk exposures to workers, neighbors, the environment, and property.

This book is a survey of the present guidance and experience from industry, professional organizations, and governmental research to encourage and support the use of systematic and self-directed design for success in

- safety (including bioprocess safety, personnel safety, and chemical process safety),
- environmental responsibility,
- quality, and
- the business case for your organization to embrace a rigorous management system to support all of the above as they apply to your organization.

1.1 BIOPROCESS ENGINEERING INFORMATION TRANSFER AND MANAGEMENT PRACTICES

A smooth interface between bioprocess scientists, bioprocessing engineers, biosafety specialists, and technical and support professionals demands a management system to address the transfer and consistent application of technology—both process technology and safety technology—from the laboratory to the production floor. Success in achieving this goal depends upon the combination of well understood bioprocessing guidelines and regulatory compliance methods with proven safety management, bioprocessing management, and business management best practices. These include, but are not limited to:

- Occupational Safety and Health Administration (OSHA) process safety management techniques
- Food and Drug Administration (FDA) Good Manufacturing Practice guidelines
- National Institutes of Health (NIH) guidance for facility design and specific bioactive and biological material use
- Center for Disease Control (CDC) and World Health Organization (WHO) laboratory safety management guidance
- Organisation for Economic Co-operation and Development (OECD) Directive on the protection of workers from risks related to exposure to biological agents at work
- United States Department of Agriculture (USDA) facility design standards
- Environmental Protection Agency (EPA) risk management program techniques
- International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH).
- Professional society standards and practices, such as the International Society for Pharmaceutical Engineering (ISPE), American Society for Microbiology (ASM), American Society for Mechanical Engineers (ASME), American Biological Safety Association (ABSA)
- Integrated operational excellence business management system techniques

This book presents the concept of process safety for bioprocesses as a branch within a total business management system. Operational excellence is supported when the various arms of the business all follow similarly detailed management systems.