

# Extractables, Leachables, & Elemental Impurities 2018— West Coast

Ensuring Quality, Safety, and Regulatory  
Compliance for Drugs & Biologics  
November 13–14, 2018, Sheraton La Jolla, CA

*Featuring Lessons Learned and Case Studies from Industry Experts:*



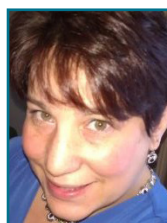
**Timothy Shelbourn**  
Research Scientist  
Innovation and  
Quality Consortium



**Ping Wang**  
Sr. Manager  
J&J



**Dennis Jenke**  
Chief Executive  
Triad



**Bobbijo Redler**  
Principal Scientist  
Merck



**William Beierschmitt**  
Research Fellow  
Pfizer



**Ken Wong**  
Deputy Director  
Sanofi Pasteur

*And Comprehensive Coverage On:*

- Implementing USP <232> and <233> and ICH Q3D: Updates and Case Studies
- The Ongoing Development of USP Chapters <665> and <1665> Dealing with Materials and Components Used in Pharmaceutical Manufacturing Systems
- Injectables Drug Product Long Term Leachable Study Approaches and Regulatory Expectations – an Industry-wide Survey
- Case Study and Experience on Sanofi's implementation of BPOG's Leachable Risk Assessment Model
- Toxicology Issues in Extractables and Leachables
- Analytical Challenges in E/L Studies of Pre-Filled Syringes for Oil-Based Drug Formulations
- Extractables & Leachables Studies on Single-Use Components in Biomanufacturing
- Advanced Identification Methods for E/L from Packaging & Manufacturing Components
- Streamlining GC/MS and LC/MS Workflows for Extractables Profiling and Leachables Testing
- USP <661>, USP <661.1>/<661.2> : A Review of Compendia Based Polymer Extractable and Chemical Safety Assessment
- Use of Chemical Characterization and Risk Assessment of Medical Devices to Design Biocompatibility Testing Plans and Explain Test Results
- And Much More!

*With Representation From:*



**Tuesday, November 13**

7:45

*Registration & Complimentary Breakfast  
& Chairperson's Welcome***Critical Issues – Updates & Case Studies  
on the Latest Compliance Implications  
of USP <232> and <233> and ICH Q3D  
Guidelines for Elemental Impurities**

8:15

**ICH Q3D Compliance Strategy: Elemental  
Impurities Risk Assessment Documentation***Timothy Shelbourn, Research Scientist,  
Innovation and Quality Consortium*

The final deliverable for an elemental impurities control/compliance strategy is the risk assessment document. While the scope of ICH Q3D and USP <232> is commercial drug product, an elemental impurities risk assessment for drug products in development is a recommended practice. This presentation will provide guidance for documentation of the EI risk assessment including where testing is required, where literature information can be applied and when it is appropriate to use a written assessment in lieu of analytical testing. A review of training modules and regulatory guidance documents with respect to the EI risk assessment documentation will also be conducted.

8:50

**Determination of Metal Impurities—  
A Practical Approach from the  
Perspective of A Contract Laboratory***Samina Hussain, Senior Chemist/  
Metal Group Leader, Exova*

There are several challenges a contract lab faces with the determination of elemental impurities in finished drug products, APIs, and excipients. Due to the expense and complexity of inductively coupled plasma instrumentation, a contract lab is often contacted by manufacturers to implement compliance with the new elemental impurities chapters, such as USP <232>, USP <233>, EP 5.20, and ICH Q3D. A common issue arising during the method development and validation process concerns setting appropriate specifications for a particular material. An evaluation of the specifications and how they relate to each and every drug product, raw material, and the manufacturing process as a whole is required. In addition, mastering sample preparation and analysis methods for a wide range of materials and specifications requires experience. An understanding of potential interferences associated with the instrumentation and specific analytical approach is essential. A risk-based approach to method validation will be presented.

9:25

**ICH Q3D: Application to Legacy Products***Jonathan Petersen, Senior Scientist, Merck*

The ICH Q3D Guideline for Elemental Impurities defines a scientific, risk-based approach to limit patient exposure

to elemental impurities in pharmaceutical drug products. This approach includes evaluating the most significant potential sources of elemental impurities: the drug substance(s), excipients, utilities, manufacturing equipment, and container closure systems. Legacy products present a unique challenge, and those risk assessments needed to be completed by the beginning of 2018. This presentation will discuss how one company met that challenge. Implementation timelines, tools, and specific strategies will be discussed.

10:00

*Coffee & Networking Break*

10:25

**Elemental Impurities: Not Just a Safety Issue***Daniel Norwood, Executive  
Partner, Scio Analytical, LLC*

ICH Q3D and USP<232> create acceptance criteria for certain specific elemental impurities potentially present in drug product. Each of the specified elemental impurities has been determined to have patient safety implications, and therefore Permissible Daily Exposures (PDEs) for each of these "toxic" elements have been determined. However, it is well documented that certain potential elemental impurities not specified in either ICH Q3D or USP<232> can have significant deleterious effects on the quality of certain drug products. It is also well documented that elemental impurities with drug product quality impact can leach from components of container closure/delivery systems. This presentation will describe specific case study examples of leached elemental impurity quality impacts. Data on extractable elemental impurities from container closure system raw materials, components, final packaging systems and manufacturing components will be presented. A case will be made that all container closure/delivery system components and appropriate manufacturing system components should be screened for potential elemental impurity leachables during the component selection process. This screening should not be limited to the list of toxic elements presented in ICH Q3D and USP<232>.

**E&L Risk Assessment—  
A Toxicological Perspective**

11:00

**Toxicology Issues in Extractables  
and Leachables***William P. Beierschmitt, Ph.D., D.A.B.T.,  
F.A.T.S., Research Fellow, Drug Safety  
Research and Development, Pfizer, Inc.*

An essential, critical component of the registration package for a parenteral product that is addressed by the toxicologist is the risk assessment of leachables and extractables. From a toxicology perspective, while extractable data can provide valuable information (i.e. what chemicals might migrate into the drug during storage), formal risk assessments are typically only performed on leachables (i.e. what chemicals did migrate into the drug during storage). The basic premise of this

procedure is to assess the potential risk to humans resulting from unintentional exposure to the chemicals that migrate into drug product from packaging. For each chemical, after determining the maximum potential dose a human might receive, the toxicologist uses available toxicology data, including experimentation if needed, to assess the potential risk. The route of administration and duration of potential exposure are just two of many factors taken into consideration when a risk assessment is performed. Overall, early involvement of the toxicologist in leachable and extractable studies from the earliest experimental planning stage through the data collection greatly facilitates arriving at a timely and successful assessment of these chemical impurities. Moreover, continued improvement in communication and information exchange with manufacturers regarding constituents/chemical make up of packaging components would also facilitate the risk assessment process.

### **Regulatory Spotlight—Long-term Leachable Study Approaches & Regulatory Expectations**

11:40

#### **Injectables Drug Product Long Term Leachable Study Approaches and Regulatory Expectations: An Industry-wide Survey**

**Ping Wang, Senior Manager, Ph.D. Janssen R&D**

Biologics Drug Product (injectables) long-term leachable studies are must-have in regulatory filings. However, there is no specific leachable study guidance and the study approaches vary from company to company. Inconsistent health authority inquiries also indicate that there is an urgent need for the industry to find a common ground, and have a unified voice to communicate with regulators.

As a 2018 initiative of ELSIE, an industry-wide survey will be conducted to understand the breadth and variety of the DP leachable study approaches. The survey will be focused on long term leachable studies of injectables in primary container closure systems. This interactive presentation will discuss the questionnaire and the goal of the survey. The final deliverable of this initiative (the survey results, and possible best practice recommendations) would help ELSIE members, pharma industry, and health authorities to ensure the leachable risks are properly evaluated.

12:20

#### **Complimentary Networking Lunch**

1:20

#### **Building a Bridge to Leachable Assessment**

**Diego Zurbriggen, Technical Account Manager, West Pharmaceutical Services**

Extractable data is a practical guide to support selection of components used in drug product container closure systems and to understand potential for leachables.

Standardization of extractables testing is a topic of interest in the pharmaceutical industry and debate in the scientific community, however; the challenge for standardized tests is to verify the extent of data and type of extractions needed to drive the best decisions. As a starting point, comparative extractable data can indicate differences but this may not be relevant to end use application. According to USP <1663> informational chapter on extractables assessment, the design of an extraction study is dictated by the purpose of the extractables assessment. This presentation will put into practice the overarching principles of USP <1663> for developing extractable study designs. Three case studies will be given representing risk of leachables across product lifecycle. Data will be shown related to the selection process, post approval changes, and considerations for biologic product quality.

### **Regulatory Spotlight—Implications of USP Chapter Revisions Pertaining to Pharmaceutical Manufacturing Systems**

2:00

#### **The Ongoing Development of USP Chapters <665> and <1665> Dealing with Materials and Components Used in Pharmaceutical Manufacturing Systems**

**Dennis Jenke, President, Triad Scientific Solutions**

Polymeric components of drug product manufacturing systems will contact the manufacturing process stream, including process solutions, production intermediates, or the API, DS, or DP themselves, during manufacturing. During contact, process equipment-related leachables (PERLs) could leach from the component and accumulate in the process stream, potentially impacting a quality attribute of the process stream and affecting manufacturing process efficiency. If the PERLs persist through manufacturing, they could accumulate in the pharmaceutical product, potentially affecting product quality attributes such as stability and patient safety.

USP Chapter <665>, Polymeric Components and Systems Used in the Manufacturing of Pharmaceutical and Biopharmaceutical Drug Products addresses this situation via a risk-based approach for chemically characterizing polymeric materials and components used to manufacture pharmaceuticals/ biopharmaceuticals. USP chapter <1665>, Characterization of Polymeric Components and Systems used to Manufacture Pharmaceutical and Biopharmaceutical Drug Products) communicates the key concepts behind <665> and addresses the applicability and the application of <665>.

This presentation discusses the continuing evolution of <665> and <1665> as it makes its way through its third round of revision.

2:40

## USP <661>, USP <661.1>/<661.2>: A Review of Compendia Based Polymer Extractable and Chemical Safety Assessment

**Allen Kesselring, Ph.D.,  
Chief Science Officer, EKG Labs**

While USP <661> has been a foundation point of product container safety, it has long been acknowledged to have several insufficiencies, particularly regarding the testing of final product containers. Due to these insufficiencies, the industry welcomed the concept of dividing Plastic (Raw) Materials of Construction (<661.1>) from (Final) Plastic Packaging Systems (<661.2>). Unfortunately, as illustrated in the to be presented case study, even before formal implementation of USP <661.1> & <661.2>, it was discovered that certain gaps existed which would allow a material to easily pass USP <661.1>, but fail USP <661.2>. For these and other reasons, the "Packaging and Distribution Expert Committee" has put forth an accepted recommendation of the immediate reinstatement of <661> and a 3 year implementation of <661.1>/<661.2>. In addition to this case study and general commentary, several recommendations of <661.1>/<661.2> implementation will be presented along with discussion of industry impact of Chemical Safety Assessment expectations.

3:20

*Coffee & Networking Break*

3:45

## Case Study and Experience on Sanofi's implementation of BPOG's Leachable Risk Assessment Model

**Ken Wong, Deputy Director, Sanofi Pasteur**

Brief reviewed of the BPOG's Leachable Risk Ranking model. A case study of the leachable risk model implementation into Sanofi will be presented. All changes to specific risk factors and weights changes will be discussed. Finally, the lesson learns and experiences of the risk model performance on several projects will be shared.

## Q&A Forum

4:15

### Topic: Harmonizing Industry E&L Approaches and Regulatory Expectations

#### Panelists:

- Dennis Jenke, President, Triad Scientific Solutions
- Ken Wong, Deputy Director, Sanofi Pasteur
- Ping Wang, Senior Manager, Ph.D. Janssen R&D

5:00

*End of Day One*

## Wednesday, November 14

7:45

*Complimentary Breakfast*

## Research Spotlight— Considering Thermal Kinetics

8:15

### Can an internally generated E&L database cure the common cold associated with E&L screening?

**Dennis Jenke, President,  
Triad Scientific Solutions**

If there is such a thing as a standard practice in extractables and leachables testing, it is the screening of extracts for organic extractables and/or drug product for organic leachables. Generally, researchers invariably use orthogonal and overlapping chromatographic methods to:

1. Uncover those substances present in a test sample at levels above a defined threshold
2. Estimate the concentration of the uncovered substances in the test sample
3. Produce information which leads to the identification of the uncovered substances

This information is required as it is the basis for assessing the impact of the uncovered substances on the drug product and its users.

Given the enormity of the task of screening, it is understood that the screening approach, no matter how technically optimized and how diligently pursued, is an exercise of compromise. Specifically, while the orthogonal and over-lapping approach provides good coverage of the universe of extractables and leachables, we know there are substances that slip through the cracks and go unreported (error of omission). Furthermore, while chemical substances are "quantified" via the normalization of responses to internal standards, we acknowledge the significant errors involved as response functions can vary widely between substances (error of inaccurate quantitation). Lastly, while many substances can be tentatively identified based on mass spectral matching to externally generated databases, we accept that such a practice is prone to errors (e.g., the highest match score isn't always the right ID) and produces, after all, only a tentative identity (error of inexact identification).

This presentation discusses these three critical errors and considers how they can be mitigated by an internally generated extractables and leachables database which contains the necessary information to:

1. Fill in the gaps
2. Make the concentration estimates more accurate
3. Confirm the identities.

8:55

### Extractables and Leachables Assessment for Cyrostore Cell and Gene Therapy Containers

*Raymond Colton, President, VR Analytical  
(Co-Authors: Sarah Brophy, Trent Volz,  
Ashley Boeckx, VR Analytical)*

Cell and gene therapy products are primarily made in small-scale bioprocess systems using single use systems. Products are then stored frozen in bags until they are needed by the patient. A large body of work has studied how elevated temperatures affect extractable migration and thereby influence the extractables profiles of single-use systems. However, there is relatively little information available on how lowered temperatures may affect extractables profiles. This is particularly pertinent to the bio-container bags used for cryogenic storage of drug products in the growing field of regenerative medicine. To address this issue, polyolefin-based bio-container bags were filled with an aqueous solution containing 10% IPA, 10% DMSO, and 1% NaCl that was designed to approximate the extraction propensity of common cell solutions that might be cryogenically stored in a bio-container bag. The bags were stored at  $-80^{\circ}\text{C}$  for various time points and the extracts were analyzed by GC-MS/FID, headspace HS-GC-MS/FID, LC-UV-MS, and ICP-MS. The resulting data provide a unique insight into the effects of cold storage on the inorganic and organic extractables profiles of a bio-container bag.

9:35

*Coffee & Networking Break*

### Critical Issues— Materials Characterization

10:00

### Implementation of a Material Based Approach for Managing the Risk of Leachables from Manufacturing Equipment

*Michael A. Ruberto, President,  
Material Needs Consulting*

The characterization, qualification, and control of leachables from manufacturing equipment can be a daunting task for pharmaceutical companies. "Best practices" have been established by BPSA, BPOG, and USP <1665> / <665> for the initial evaluation of polymer based manufacturing equipment. However it is often unclear how this information can be effectively utilized for qualifying the individual components for use in the production of a particular drug product. This presentation will describe a practical, materials based approach that has worked in meeting the FDA's expectations for manufacturing equipment leachables risk assessments. Topics discussed will include:

- A proactive selection process for manufacturing equipment
- The role and utilization of vendor generated extractables testing
- A systematic testing plan for qualifying processing components for use in the manufacturing of multiple drug products using one set of simulation studies
- Examples of the strategic elements necessary for successful E&L risk assessment reports

10:40

### Use of Chemical Characterization and Risk Assessment of Medical Devices to Design Biocompatibility Testing Plans and Explain Test Results

*Steven Doherty, Associate Director,  
Analytical Chemistry, Toxikon*

Recent regulatory guidance updates have highlighted the need to conduct material characterization as a critical step in the evaluation of the safety of medical devices. Initial comprehensive chemical characterization of devices can provide the basis to help guide necessary biocompatibility testing. The presence, or lack, of certain types of chemical compounds can support a rationale as to why some types of testing may, or may not, be necessary. Further, chemical characterization data can help to explain the results observed during biological testing. The data can provide context for the results and/or suggest means of mitigating the observed effect in a final product.

11:20

### Application of the BPOG Standard Extraction Protocol to Multiple Component Types and the Lessons Learned

*Bobbi Redler, Principal Scientist, Merck*

The BioPhorum Operations Group (BPOG), of which Merck & Co., Inc. is an active member, published a standardized extractables protocol for evaluating the polymeric materials used during the manufacture of biopharmaceuticals. Recognizing that a period of time would be needed before suppliers would be able to provide extractables data generated using this protocol, Merck & Co., Inc. opted to evaluate several materials commonly used in our manufacturing processes. We have currently tested more than 20 components including connectors, filters, diaphragms, and others. This presentation will share our experiences with the protocol as well as some recommendations for the BPOG E&L team to consider.

12:00

*Complimentary Networking Lunch*

1:00

### Advanced Identification Methods for Extractables and Leachables from Packaging and Components Used in Manufacturing Pharmaceuticals and the Effect of Analytical Methodology on the Number and Type of Compounds Identified

*Kevin Roland, Manager, Jordi Labs*

The process of Extractables and Leachables (E&Ls) identification requires screening extracts for components of wide chemical diversity. E&Ls have highly varied properties including widely ranging polarity, volatility and molecular weight. Identification of leachables in drug product matrices is made even more difficult by the fact that many drug products contain significant levels of background interferences. These interferences can suppress ionization in LCMS analysis or conceal signals from individual leachables. The FDA and USP have issued guidance and draft guidance on E&L analyses for products used in the manufacturing or packaging of pharmaceuti-

icals. These documents provide recommendations regarding methods of identification but leave decisions as to the exact analytical methodology that should be applied to the sponsor. The types of analytical instrumentation and conditions used when conducting the E&L analyses affect the completeness and accuracy of E&L identification. In this presentation, we will demonstrate the effect of changes in sample work up prior to instrumental analysis on the number and type of E&Ls identified from a pharmaceutical packaging material and a component used in the manufacturing of a pharmaceutical following guidance from USP 1663, 1664 and the draft guidance from USP 665. Parameters which will be examined include changes in surface area to solvent volume ratio and associated sample concentration, methods of solvent transfer procedures prior to GCMS and LCMS analysis such as liquid-liquid extraction, and storage conditions and age of extracts (extract stability). Variations in instrumental methods will also be examined including the use of traditional gas chromatography mass spectroscopy instrumentation versus more advanced systems such as Soft Ionization Quadrupole Time of Flight Mass Spectrometers. An advanced method of data reduction will be demonstrated comparing the use of differential analysis software to manual data-reduction. The presentation will then summarize the combined effect of changes in these parameters on the number and type of compounds detected and the accuracy of identification.

1:40

### Streamlining GC/MS and LC/MS Workflows for Extractables Profiling and Leachables Testing

*Smriti Khera, Strategic Marketing Manager, Agilent*

When it comes to Extractables and Leachables (E&L) analysis, there are at least two critical analytical workflows involved, each with its own unique requirements. The first is extractables profiling which provides the first pass assessment and profiling of the worst-case leachables that may be encountered in the final dosage form or manufacturing process. The second is the actual testing of the final drug product or bioprocessing/manufacturing steps for targeted leachables or to identify any new leachables that weren't previously expected. Both these workflows involve extensive use of LC/MS and GC/MS technologies to get a complete picture of volatile, semi-volatile and non-volatile organics in the extracts and samples. In this seminar, we will present how you can streamline your GC/MS and LC/MS workflows leading to overall laboratory efficiencies and the ability to gain greater insights from the analytical data you have collected.

2:20

*Coffee & Networking Break*

2:35

### Component Identification Beyond "El Library search": USP <1663> in Practice

*Gyorgy Vas, Scientific Liaison, Intertek Pharmaceutical Services*

Component identification is one of the most difficult, and in the meantime, one of the least discussed analytical activities related to extractable and leachable testing. Tox-

icological risk assessment requires reliable and highly confident component identification. Over the past couple of years, multiple studies were presented and discussed focusing on the extraction part of the data packages, and multiple case studies were presented with little or no focus on the component identification part. Many of the presentation indicated that it is an acceptable practice for volatile component identification to be completed using only the NIST based library search or using client developed proprietary library databases.

The introduction of high resolution accurate mass instrumentation (HRAM), hyphenated with GC-MS opens new possibilities beyond the unit resolution based identification workflow.

USP <1663> provides an excellent, practical, and science based approach for component identification, listing three level of identification (tentative, confident and confirmed).

This presentation will focus on case studies for the identification part of extractable-leachable testing, providing a state of the art workflow. Analytical data packages will be presented to compare unit resolution data vs. HRAM data sets.

3:15

### How understanding the Chemistry and Reactivity of Halogenated Rubber Oligomers can help in Identifying Unknowns in Rubber Extraction Profiles of Exhaustive Controlled Extraction Studies

*Dr. Piet Christiaens, Scientific Director, NELSON LABS NV*

It is commonly known that halogenated rubber oligomers are a group of compounds which are often observed, both as extractables, in controlled extraction studies, as well as – in certain cases - as leachables in some drug products. Although there is an ongoing debate upon the toxicity of this group of compounds, it is a fact that these compounds are alkylating agents with a high reactivity for certain functional groups. These interactions have been widely observed – forming adducts with components of the drug products (API, Peptides, proteins, excipients).

A second observation is that, when performing a controlled extraction study on rubbers with more aggressive solvents (like IPA, Hexane), a potentially longer list of "Unknowns" is generated, both in GC/MS and LC/MS, of which the origin is not always very clear. The question now arises: knowing and understanding the high reactivity of these halogenated rubber oligomers, would it be possible that a group of these reported unknowns could be linked to reaction products of the oligomers with other rubber ingredients, such as curing agents, activators, and accelerators.

Nelson Labs ran an R&D programme to systematically allow the halo rubber oligomers – compounds that are available at Nelson Labs NV as analytical standards –

3:45

### Successes and Ongoing Challenges with Implementation of Single Use Extractables Datasets

*Chien-Ju (Cherry) Shih, PhD, Senior Scientist and James Hathcock, PhD, Sr. Director, Regulatory and Validation Consulting, Pall Life Sciences*

Establishing consistent, high caliber expectations for component extractables data has been a major industry focus intended to streamline and accelerate the adoption of single use components. In this overview we will share lessons learned in execution of more than 17 studies using the BPOG protocol as well as limited studies using the USP <665> draft protocol. In addition, we review current challenges and potential solutions associated with compiling extractables datasets from multiple suppliers to perform comprehensive risk assessments on single use processes, as well as approaches to risk assess low to medium risk components for which detailed extractables studies are not available. The aim of this review of experiences to date is to drive further industry alignment among suppliers, end users and regulators that accelerates the adoption of single use technologies and serve the public good.

4:25

### Analytical Challenges in Extractable and Leachable Studies of Pre-Filled Syringes (PFS) for an Oil-Based Drug Formulation

*Dujuan Lu, Ph.D. Technical Client Manager-E&L, SGS*

Pre-filled syringes (PFS) are increasingly becoming a container of choice for storing and administering pharmaceutical products. PFS components and residues from processing tools may leach organic and inorganic chemicals into formulated drugs, as extractable and leachable compounds. As part of safety risk assessment, it is very important to identify and quantify those extractables and leachables as they may pose safety risks to patients and/or change the efficacy of the medical products.

This presentation will focus on a case study regarding the extractable and leachable testing of PFS for a drug formulation containing high content of castor oil. The choice of the extraction solvent systems and study design to bracket and mimic hydrophobicity and administration of oil based drug formulation will be discussed. In order to obtain a comprehensive extractable profile, multiple analytical techniques were used to identify and quantify the extractables, including Headspace (HS)-GC-MS/FID analysis for volatile organic compounds, GC-MS/

FID analysis for semi-volatile organic compounds, LC-MS/UV analysis for non-volatile organic compounds, and ICP-OES analysis for trace elements. This presentation will show that internal database and High Resolution Accurate Mass (HRAM) data facilitate confident compound identification and unknown compound structure elucidation. Analytical challenges associated with the drug formulation containing high amount of castor oil during the leachable testing will also be discussed.

4:50

### Close of Program

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