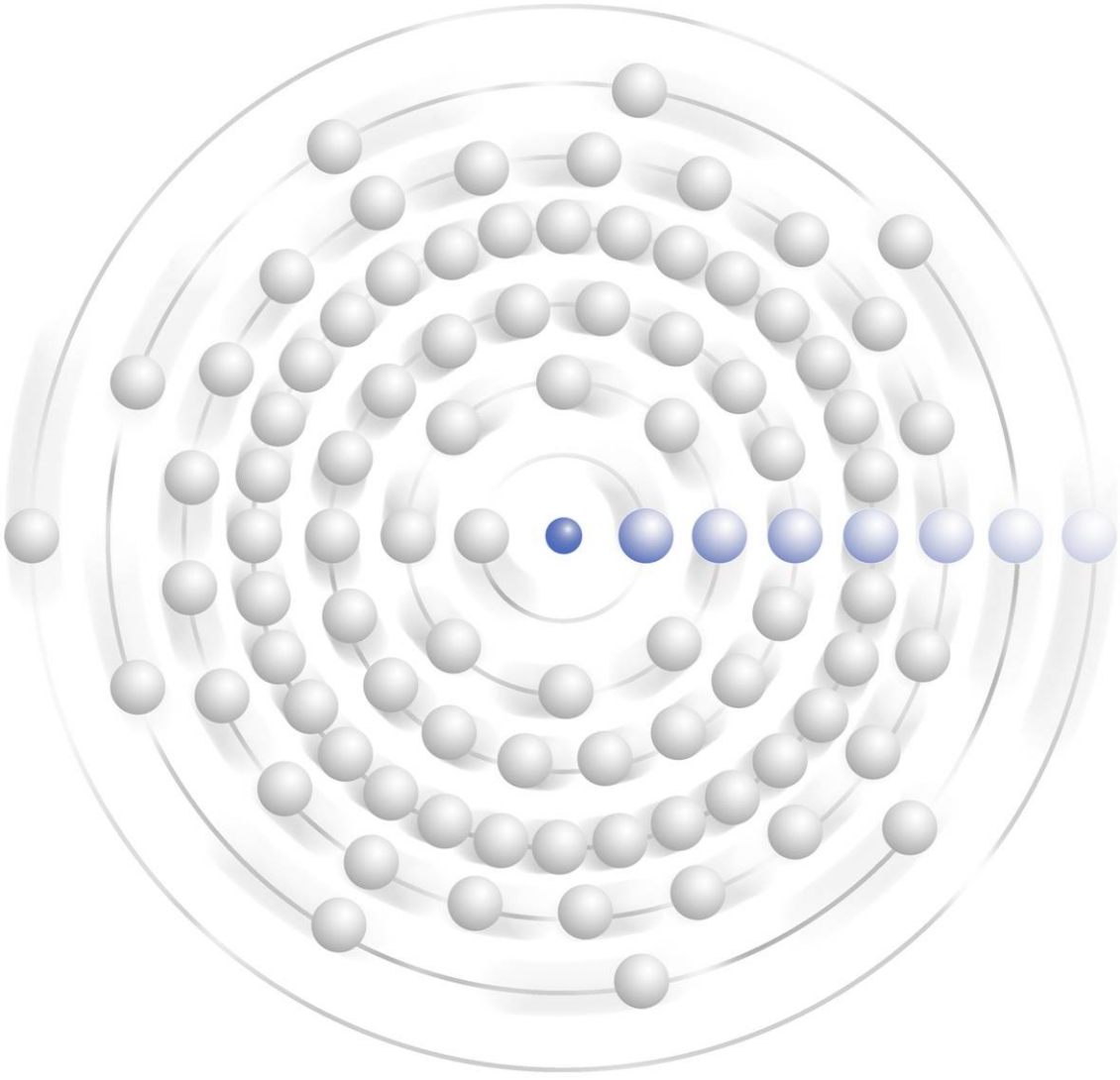
**Ux Consulting Services** **November 2011**

# Nuclear Zirconium Alloy Market



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# Introduction & Overview

The Ux Consulting Company, LLC (UxC), is pleased to present the third edition in its report series, *Nuclear Zirconium Alloy Market*.

The initial report, issued in November 2008, was intended to be a one-of-a-kind snapshot of the then-contemporary zirconium alloy industry. However, the highly favorable response to that original report, and to the April 2010 report update, convinced us that there is an ongoing need and desire for current information on this important topic. Thus, we have added the *Nuclear Zirconium Alloy Market* to our list of periodic reports, and our latest findings and conclusions are presented herein.

Nuclear-grade zirconium alloys and components are employed in the fabrication of fuel assemblies used in the vast majority of nuclear reactors currently operating, under construction, and planned around the world. Even as the nuclear renaissance has been derailed in many countries, at least temporarily, by the Fukushima accident, many aspects of the international nuclear fuel supply chain continue to be of concern.

The supply of nuclear-grade zirconium alloys – from the mining of zircon mineral sand through the manufacture of cladding and components used in finished fuel assemblies – has not escaped this scrutiny. Therefore, the primary objective of this report is to factually and analytically approach the current and expected future direction of the nuclear-grade zirconium alloy market to help arrive at some clear conclusions about how producers of fuel assemblies for nuclear reactors will obtain the necessary zirconium alloys for their finished products.

This up-to-date report offers UxC's most recent analyses and opinions of the various sectors that make up the nuclear-grade zirconium sponge, alloy, materials and tubing markets. Additional details are included on the interplay of the nuclear fuel fabrication and zirconium alloy supply markets and of the fabrication process itself. We then assess major trends in this unique industry by analyzing the global and regional supply and demand balances for nuclear-grade zirconium alloy and tubing as well as the supply and demand situation based on reactor fuel types. We conclude with some final observations on the global market as well as the current status and expectations for future price developments for the related zirconium alloys and tubing.

## Availability of Data

During the preparation of the original report, it became evident that many of the various processors and fabricators of nuclear-grade zirconium sponge, alloys, and fuel assembly components were reluctant to publish or even discuss the details of their businesses. Much of their data are considered proprietary and thus restricted from inclusion in reports such as this. Consequently, in the first report in this series, there were some gaps in the data.

 

When developing the 2010 report, we were able to identify additional sources of information and to fill in a number of the blanks. Further sources have since been developed for the current 2011 effort. Thus, we believe that this report provides a significantly more comprehensive and more accurate picture of the industry than the earlier documents.

To supplement our own data collection process, we provided each of the principal processors and producers with a draft of the portion of the report that described its operations. If corrections were received, the appropriate changes were made in the text. If our data were confirmed, or if no response was forthcoming, the original language, based on the best information available from public and private sources, was used. Where possible, we confirmed data from one source with a second, independent source. We would like to express our sincere appreciation to all of those companies who responded to our inquiries.

We believe that the information contained herein is accurate or, as a minimum, representative of the operations, production levels, etc. of the companies discussed in the succeeding chapters of the report. However, the possibility still exists that there may be a few errors or that the information has changed since the data were obtained. In a couple of instances, there were no available non-proprietary data, and, therefore, the missing information is listed as "not available" in the affected data tables.

## What's New in the 2011 Report?

In this November 2011 edition of the *Nuclear Zirconium Alloy Market* report, we have continued to employ the format and content of the previous document, but have updated all of the relevant information to reflect current circumstances. But other improvements have been made as well.

Beginning about two years ago, the markets for zircon sand and some of the downstream zirconium products entered a period a great volatility. Shortages of zircon led to explosive increases in prices for raw materials and created substantial uncertainty as to the future performance of these markets. Consequently, we have substantially expanded our analysis of this market from that in the previous report and highlighted the role of China, both as the world's largest importer of zircon sand and the largest exporter of processed zirconium products. That discussion also contains a much more detailed description of the zircon mining and refining process.

No report on any aspect of the nuclear industry can ignore the impact of the massive March 11, 2011 earthquake and tsunami in Japan, which devastated the Fukushima Daiichi Nuclear Power Plant. All of the analyses in this report have taken account of the implications of the Fukushima accident on the current status and future prospects of the industry.

Perhaps Fukushima's greatest impact is on the future growth of nuclear power around the world and, therefore, the demand for nuclear fuel assemblies and the zirconium alloy components which comprise them. The demand projections for alloys and tub-

 

ing described herein have taken specific account of the post-Fukushima world, which looks quite different from what we and others anticipated before that accident.

The current demand projection incorporates detailed UxC calculations of the zirconium weight and tube content in all the major nuclear fuel assemblies in the world, including improved estimates of the quantities of material used in various assembly designs. Moreover, the forecasts make use of UxC's recently refined *UxC Requirements Model* (URM) to forecast global reactor fuel loading requirements and the resulting demand for zirconium alloy materials and products. The URM projects demand on a reactor by reactor basis taking account of each plant's refueling schedule (and/or construction schedule for new plants), the specific fuel assembly design used in that plant, the size of the reload batch (or initial core) and the zirconium-alloy content of the fuel assemblies. This has resulted in a far more accurate presentation than that used previously.

We also noted that many of the subscribers to the previous reports represented organizations which did not participate directly in the fuel fabrication market. Thus, for those not familiar with the technical aspects of the fabrication industry, we have added a discussion of the design of BWR and PWR fuel assemblies, the zirconium alloy components of which they are constructed, and the fuel fabrication process itself.

## Structure of the Report

This report includes separate chapters for various aspects of the nuclear-grade zirconium alloy market, supply and demand, and other related areas. Following this **Introduction & Overview**, the report includes:

**Chapter 1 – General Zirconium Overview** provides a broad summary of the zirconium mineral occurrence, resource base and industrial applications, including the role of zirconium alloy production in the nuclear fuel industry. It describes the mining and refining of zircon sand and, most importantly, it addresses, in some detail, the current and projected supply, demand and price of zircon in the international marketplace with emphasis on China's critical role.

The General Zirconium Overview discussion helps to put the specific nuclear-grade zirconium alloy market analysis in better perspective, as there are numerous applications for the zirconium mineral beyond nuclear reactor fuel. Additional discussion is provided on the broader global market for zircon and how this impacts the specific nuclear-grade zirconium alloy market.

**Chapter 2 – Manufacturing Processes for Nuclear Fuel Cladding** discusses the manufacturing processes and the overall "nuclear zirconium cycle" for production of the materials and components used in nuclear fuel assemblies.

**Chapter 3 – Nuclear Zirconium Alloy Materials & Product Suppliers** offers a profile of each of the companies involved in nuclear-grade zirconium alloy materials and product supply. This includes all the companies in the world involved in zirconi-

 

um sponge and alloy production and processing through manufacture of sheet, plate, bar stock and tube-reduced extrusions (TREX), as well as tubing and other component manufacture.

**Chapter 4 – Nuclear Fuel Fabricators & Zirconium Components Supply** provides a brief overview of the global nuclear fuel fabrication industry and indicates the source of each fabricator's fuel assembly tubing and other components. It also includes a discussion of the individual components which make up fuel assemblies and describes the fuel fabrication process.

**Chapter 5 – Nuclear Zirconium Supply & Demand Analysis** offers UxC's most recent analysis of the global supply and demand balance for nuclear fuel-related zirconium alloy products. In addition, this chapter includes analysis of the zirconium supply and demand on the basis of regional breakdowns as well as on the basis of the different reactor types installed around the world.

**Chapter 6 – Overall Conclusions and Market Analysis** summarizes our findings on the nuclear-grade zirconium market analysis and offers some final thoughts on the current situation and forecast of future trends. This chapter also provides UxC's analysis of the current nuclear-grade zirconium alloy prices and expectations for future price developments.

Finally, the attached **Appendices** include the data and assumptions used in many of the analyses discussed in the body of the report.

 