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OAK RIDGE NATIONAL LABORATORY
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GEN IV MATERIALS HANDBOOK BETA RELEASE FOR STRUCTURAL AND FUNCTIONAL EVALUATION

Weiju Ren and Claire Luttrell

September 12, 2006

UT-BATTELLE
OAK RIDGE NATIONAL LABORATORY

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Prepared for

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ABTRACT

Development of the *Gen IV Materials Handbook* is briefly summarized up to date. Current status of the *Handbook* website construction is described. The developed *Handbook* components and access control of the beta version are discussed for the present evaluation release. Detailed instructions and examples are given to provide guidance for evaluators to browse the constructed parts and use all the currently developed functionalities of the *Handbook* in evaluation.

CONTENTS

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1. BACKGROUND

To manage materials property data and provide an authoritative single source as well as a powerful data analytical tool for the development of Gen IV Nuclear Reactor Systems, a task was defined under the Gen IV Nuclear Reactor Materials Program to develop a web-accessible database named the *Gen IV Materials Handbook*. The *Handbook* will be used by US stake holders in the Gen IV Nuclear Reactor development, with the potential of international acceptance by member countries of the Gen IV International Forum (GIF).

To prepare for the *Handbook*, a "*Gen IV Materials Handbook* Implementation Plan" was written in March 2005 to provide guidelines and directions for the development [1]. A "*Gen IV Materials Handbook* Advisory Committee Charter" was also drafted in April 2005 for organizing expertise and support from candidate *Handbook* users. Meanwhile, initial collection of data for the *Handbook* content was vigorously conducted, which yielded a report "Assessment of Existing Alloy 617 Data for *Gen IV Materials Handbook*" in June 2005 [2]. Advancement was also quickly made in *Handbook* software and hardware preparation, and the progress was summarized in the report "Initial Development of the *Gen IV Materials Handbook*" in September 2005 [3]. In October 2005, hardware and the software were acquired and assembled for evaluation. In the same month, the *Handbook* task officially joined the Material Data Management Consortium (MDMC). Also, the "*Gen IV Materials Handbook* Advisory Committee Charter" was revised [4] and sent to candidate Advisory Committee members with an invitation to an inaugural Advisory Committee Meeting. By the end of February 2006, the first *Handbook* Advisory Committee Meeting was convened. At the same time, a report "*Gen IV Materials Handbook* Architecture and System Design" was completed [5]. The document has since been serving as a blueprint for the construction of the *Handbook*. A detailed summary of the *Handbook* development is listed in the Appendix.

In compliance with the "piecewise construction strategy" stipulated in the "*Gen IV Materials Handbook* Implementation Plan" [1], the *Handbook* is being developed piece by piece over time. Technically, it is much easier to debug and fix problems in a relatively small piece of a large database than to find problems and try to fix them when the entire system has already been built up. This usually proves very difficult, if not impossible, or leads to a disastrous collapse of the whole system. Financially, the piecewise strategy may better fit into the profile of Gen IV Materials Program funding. With the available funds of a given fiscal year, development may cover certain data and functionalities based on user demands and priorities.

The present report introduces the first piece of the *Handbook* construction completed and released as planned for FY06. This is a beta version release of the web-accessible *Handbook* for preliminary user evaluation. The release consists of the basic structure of the *Handbook* data management schema, foundations of several *Handbook* parts (or chapters), the most important functionalities for data management and analysis, and limited amount of data loaded for Alloy 617. A group of selected potential *Handbook* users, Gen IV Program task leaders, as well as Gen IV program managers and relevant personnel, has been invited to participate in the evaluation. Selection of the evaluators has been considered with mainly three particular focuses: 1) Potential *Handbook* users for reactor design and construction are invited mainly for them to provide feedback in *Handbook* functionality requirements and future data needs; 2) Gen IV Program task

leaders are invited mainly for them to become familiar with the *Handbook* structure so they can provide input for constructing parts and chapters in their particular research area (e. g., what attributes should be included in the chapters for graphite materials?); 3) The Gen IV program managers and relevant personnel are invited mainly for them to understand the status of the *Handbook* development and provide programmatic directions. Of course, any comments, suggestions and criticisms will be greatly appreciated. All the feedbacks will be documented, analyzed, discussed, and considered for incorporation into the future *Handbook* construction plans.

2. STATUS OF *HANDBOOK* CONSTRUCTION

2.1 *Handbook* Data Management Schema Overview

As stipulated in "*Gen IV Materials Handbook* Architecture and System Design" [5], the *Handbook* is designed with Part A through Part J as shown in Fig 1. Each part is equivalent to a chapter of a hardcopy book. However, the parts in the *Handbook* are internally connected to each other through hypertext links. User can jump from a page in, for example, Part A, directly to another related page in Part B by a simple click on a link. These interconnections are symbolically indicated in Fig. 1 by the black lines connecting each part. More detailed structures within each part are schematically shown in Fig 2.

Part A (Materials) is for general or generic materials information. It is composed of sections for metals, ceramics, graphite, and composites, respectively. Part B (Pedigree) is for detailed batch/heat specific information on materials including specification, supplier, and processing. It is divided into Part B1 for base materials and Part B2 for joints, each composed of several sections. Part C (Test and Data Management) is divided into Part C1 for test data; Part C2 for testing definition, which contains the nominal testing conditions and parameters of the test data in Part C1; Part C3 for test information, which holds records for testing machines, calibrations, specimen and important equipment that were used to generate the data in Part C1; and Part C4 for test requirements, which specifies the data needs. Future functionality development will enable the *Handbook* to suggest test matrices for filling data gaps by comparing information contained in Part C2 and Part C4. Part D (Statistical Data) is for statistical summaries of the raw test data in Part C1. Part E (Microstructure) is for detailed, heat-, product- or batch-, and process-specific microstructure information. Part F (Design Data) is for data processed from Part C and Part C1 that can be used for design but is not yet accepted into ASME Codes and Standards. Part G (Application) is for reactor component cartoons and schematics to provide graphical concepts for users to understand the material applications. Part H (Comments) and Analyses is for *Handbook* users to share their thoughts and analyses about the data contained in the *Handbook*. Part I (Reports) is for storage of R&D results generated for the Gen IV Program. Part J (References) is for literature that are relevant to the information contained in the other parts of the *Handbook.*

It should be noted that the present design of the Parts and Sections are not final. As the *Handbook* is developed, comments from users will be considered during each revision. The

present beta version evaluation will be the first occasion that feedback can be collected from evaluators.

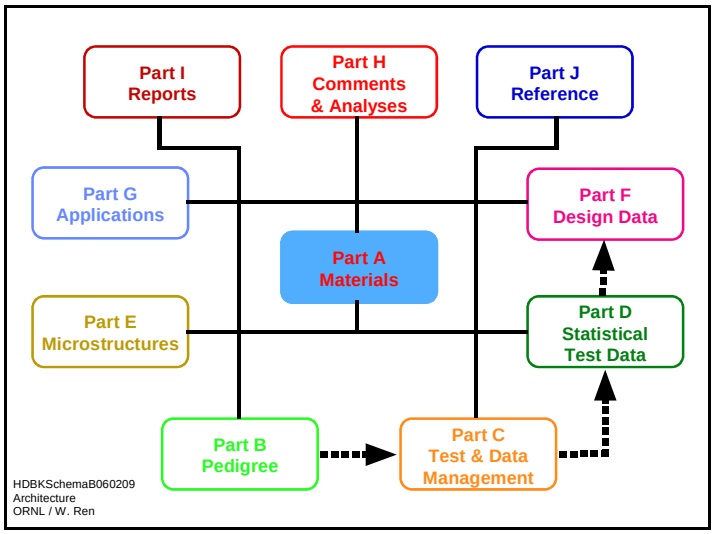

Fig. 1: Overview of *Gen IV Materials Handbook* database schema

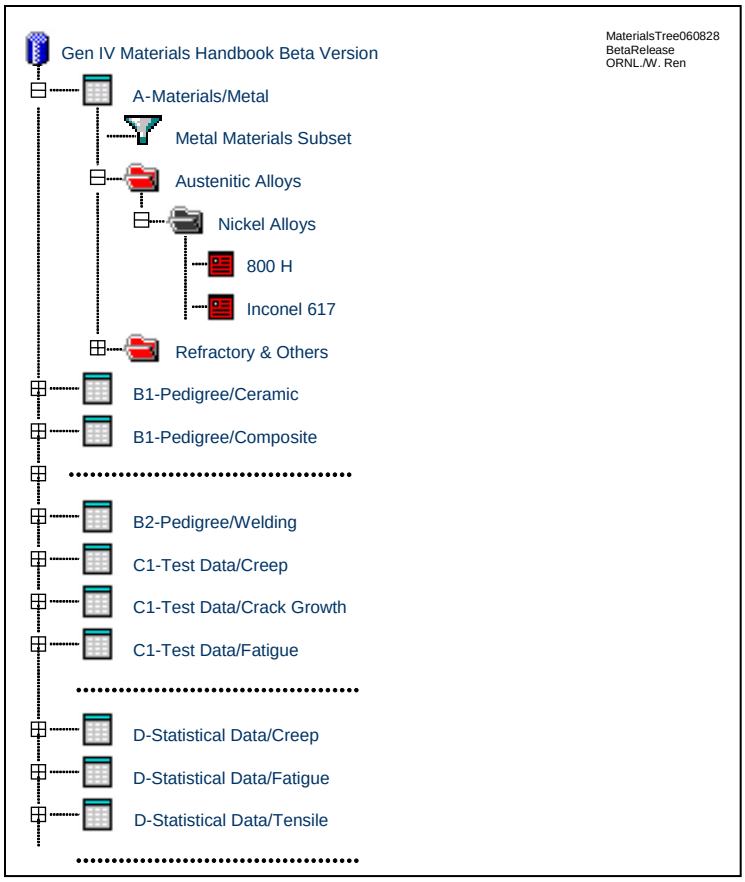

Fig. 2: Schematic of *Gen IV Materials Handbook* Materials *Tree*

2.2 Components for Beta Version Release

The construction work started in March of this year after the completion of the "*Gen IV Materials Handbook* Architecture and System Design" document [5]. This beta version release is focused on demonstration of the base software functionalities, the basic *Handbook* structure, and the completed components with loaded Alloy 617 data. These components include the following: A-Materials/Metal with several metallic materials loaded with their data; B1-Pedigree/Metal with several metallic materials but only Alloy 617 loaded with pedigree data for several heats; C1-Test Data/Creep with Alloy 617 loaded with creep test data at various temperatures and test loads in both air and helium environments; C3-Test Information with specimen information for creep test data of Alloy 617 contained in C1-Test Data/Creep; E1-Microstructure with optical and scanning electronic micrographs of Alloy 617 from the heats contained in B1-Pedigree/Metal. With all these constructed components and loaded data, the functionalities of the *Handbook* can be fully evaluated. Problems in the system, if any are identified, can be addressed without causing a large system disturbance.

2.3 Access Control of the *Handbook*

Detailed description of the access control system is described in the "*Gen IV Materials Handbook* Architecture and System Design" document [5]. A user's access privileges are determined by a combination of his/her Application Access Control privilege and the Database Access Control setting on the *Handbook* content on which he/she is viewing. With different access privileges, two users can see completely different appearances and contents of the *Handbook*.

During the construction for the present beta version release, the personnel involved in the construction were granted the ADMIN privilege to all components of the *Handbook*. The *Handbook* task leader played the role of Manager of Operations (see description in the "*Gen IV Materials Handbook* Implementation Plan" [1]) and approved all the construction activities and access privileges. For the present beta version evaluation, all the invited evaluators are granted the USER privilege to all Parts of the *Handbook*. With the USER privilege to all Parts, an evaluator can use all the functionalities in Read Mode of the VIEWER component to browse every Part of the *Handbook*. When the *Handbook* website is officially launched for Gen IV Program use, most users will be granted the USER privilege to use these functionalities evaluated in the present beta version release, but their access to particular Parts or contents will be restricted based on negotiated agreements.

It should be pointed out that Manager of Operations only has the authority to approve, not the technical mechanism to execute, granting the access to a user including the Manager of Operations himself. Granting any approved access privilege has to be executed by the *Handbook* software and hardware maintenance personnel. All the granted access will be documented and periodically audited. To prevent unethical use of the access privilege and protect proprietary information, every user will be asked to sign an agreement to use the *Handbook* for the Gen IV Program only. Abuse of the access privilege and misuse of the *Handbook* information will be prosecuted as a violation of the agreement.

3. BROWSING THE *HANDBOOK*

3.1 Definitions

To browse the *Handbook*, the basic definitions listed below should first be reviewed and understood.

Database: A database contains one or more *Tables* which can be linked together. Database Symbol: 

Tree: A database is organized in a hierarchical tree structure. The highest level of the *Tree* is the *Table*. Below this are branches made up of *Folders* and individual *Records* as leaves located within the *Folders* or branches. Within the *Records* are *Attributes* as cells of the leaves.

Table: A collection of information relevant to a specific entity (e.g., Materials *Tables,* Creep Test Data *Tables,* Tensile Test *Data Tables*). *Table* Symbol: 

Folder: A *Folder* is used to group *Records* together. A *Folder* normally does not have data directly associated with it, but contains *Records*. *Folder* Symbol: 

Record: A *Record* in the database contains the actual data within the *Table*. The type of information contained in a *Record* will vary from *Table* to *Table*. *Record* Symbol: 

Attribute: Each *Record* contains *Attributes* which specify what type of data the *Record* will hold. There is an *Attribute* defined for every data type represented in the database (e.g., Creep Rupture Time, Tensile Stress, etc.).

3.2 Getting Started

The *Gen IV Materials Handbook* database can be remotely viewed through the internet. For ORNL internal users, the website is http://gen4www.ornl.gov/. For external users, the website is https://gen4www.ornl.gov/. The following steps are used to enter the database.

1. Enter the above link in the web browser address bar. The cover page of the *Gen IV Materials Handbook* will show up.
2. To enter the web site, left click with mouse at the bottom of the cover page where it says “Click here to enter”.
3. A pop-up log on screen will appear that requires a User Name and Password.
4. After entering the User Name and Password, the database VIEWER opens in the web browser.

When the VIEWER opens, a screen is displayed with a toolbar across the top containing several options, a left window pane, and a right window pane. Clicking on the first icon **Mi** in the toolbar resets the left and right window panes to their default contents. If you get lost during your browsing, you can always click the **Mi** icon to get back to the starting page. The contents of the left and right window panes are controlled by the **browse**, **select**, **search**, and **report** icons. The **matdat.net** icon links to a large external material data network. The **preferences** link on the right side of the toolbar will open a preferences window in the right pane. The preference link allows one to change the database viewed, the unit system, and the display format.

3.3 Getting Around in the *Handbook*

Before doing the exercises, change the database units by following the steps below.

1. Select the **preferences** link found on the right side of the database top toolbar. You will see the preferences window in the right pane. Make sure you see "*Gen IV Materials Handbook* Beta Version [Default]" under "Database Preferences". If not, select "*Gen IV Materials Handbook* Beta Version [Default]" using the drop down menu and click with left mouse on **Change Database**.
2. Under "Application Preferences**"** select "-Database-" from the drop down menu next to "Unit System". Then click with left mouse on **Save Options.**

3.3.1 Using the browse icon

The **browse** icon is used to view or edit the database *Tables*. The editing tools are only available if you have access privileges allowing this option, which is not granted for the present beta version evaluation. By clicking on **browse**, the database *Tree* structure will be displayed in the left window pane (This is the default left window pane display). The *Tree* shows all the available *Tables* in the current database. After evaluation, please email your recommendations of the *Tree* structures of the *Handbook*.

The following actions allow you to navigate the database. Examples are given in the following tables.

1. Click with the left mouse button **browse** on the toolbar.
2. If the left window pane title bar says "Switch to Read Mode", click the link to switch modes.
3. Expand a *Table* by clicking on the **+** icon beside the *Table* name.
4. Expand the levels of the *Tree* by clicking the **+** icon beside the *Folders* in the *Tree*.
5. Click on a *Record* name to display the data in the right window pane. The *Records* do not have a **+** beside them and are underlined if they contain data.
6. The right window pane can either display only the *Attributes* that contain data, or all *Attributes*. To toggle between these options, click **Show All Attributes** or **Hide Empty Attributes** (depending on which is currently displayed) in the top of the right window pane.

7. Inside a *Record*, *Attributes* are grouped under headings such as "General Information", "Chemical Composition" etc. Clicking on the double triangle icon on the right in a heading row hides or displays the *Attributes* under that heading.
8. Links can be used to navigate between *Tables* directly from the *Record*. These links are found at the bottom of the *Record* under "Further Information".

Table 1: Examples for using the browse icon

Example 1:	To find general material information on Inconel 617 and review its thermal expansion coefficient data and all the constructed *Attributes*, and close the composition *Attributes*. 1. Open the "A-Materials/Metal" *Tree* by clicking on the + icon beside the *Table* name. 2. Click the + icon beside the Austenitic Alloys *Folder*. 3. Click on Inconel 617 to view the *Record* for Alloy 617 (do not click on the  icon.). 4. Under the Thermal Properties heading, find *Attribute* "Thermal Expansion Coefficient with Temperature" and click on the  icon. The plot of Thermal Expansion Coefficient versus Temperature curve appears. 5. Click on the **View Data** link at the top of the right window pane. The table of Thermal Expansion Coefficient versus Temperature data appears. 6. Click on the **Save As CSV** link at the top of the right window pane, you can save the table in Excel file for further processing. 7. Click on the **Back To Datasheet** link at the top of the right window pane to get back to the *Record* page. 8. Click on the **Show All Attributes** link at the top of the right window pane (you may need to use the scroll bar on you right to see the link at the top). All the constructed *Attributes* appear. 9. To hide the composition Attributes, click on the "Chemical Composition" heading. Click again to unhide.
Example 2:	To find pedigree information on a specific heat of Inconel 617 plate, Heat XX01A3US, there are two options. Option 1 - At the bottom of the Inconel 617 *Record* found in Example 1, click on the [See Related Records] link beside "Metal Pedigree". Then click on XX01A3US in the left window pane to display the *Record*. Option 2 - Click the **browse** icon in the top toolbar to refresh the database *Tree* structure in the left window pane. Open the "B1-Pedigree/Metal" *Tree* by clicking on the + beside the *Table* name and then follow the branches: Austenitic Alloys > Inconel 617 > Plate, and click on "XX01A3US".

	This pedigree information can also be accessed from links in the "C3-Test Information" *Table* and "E1-Microstructure" *Table*, where test information and microstructures, respectively, of Heat XX01A3US are stored. This allows user to easily get pedigree information of the test information and microstructures he/she is viewing.
Example 3:	To find microstructure data on Inconel 617 hot rolled plate Heat XX01A3US, there are two options. Option 1 - At the bottom of the Inconel 617 Heat XX01A3US *Record* found in Example 2, click on the [See Related Records] link beside "Microstructure". Then click on "OP-XX01A3US" in the left window pane to display the *Record*. Option 2 - Click the **browse** icon in the top toolbar to refresh the database *Tree* structure in the left window pane. Open the "E1-Microstructure" *Tree* and then follow the branches: Austenitic Alloys > Inconel 617 > Plate > Hot Rolled > Batch XX01A3US > OP Micrograph *Records* and click on "OP-XX01A3US".
Example 4:	To find creep test data on Inconel 617 Heat XX01A3US, there are three options. Option 1 - At the bottom of the batch specific "Pedigree" information for Inconel 617 Heat XX01A3US found in Example 2, click on the [See Related Records] link beside "Creep Test Data". A list of creep tests on Heat XX01A3US should appear in the left window pane. If the first page appears blank, go forward through the pages by selecting the numbers or the >> symbol to see the list of tests. Select any of the test data *Record* to see the creep test result. Option 2 - At the bottom of the Inconel 617 "Materials" *Record* found in Example 1, click on the [See Related Records] link beside "Creep Test Data". A list of all creep tests on Inconel 617 should appear in the left window pane. If the first page appears blank, go forward through the pages by selecting the numbers or the >> symbol to see the list of tests. Select any of the test data *Record* to see the creep test result and find out whether it is for Heat XX01A3US. Option 3 - Use this option when you want to review a *Record* of creep test data on Heat XX01A3US under a particular testing temperature and stress (e.g., 760ºC and 138 MPa) if it exists in the Handbook. Click the **browse** icon in the top toolbar to refresh the database *Tree* structure in the left window pane. Open the "C1-Test Data/Creep" *Tree* and then follow the branches:

	Austenitic Alloys > Inconel 617 > 760 °C > 138 MPa > Heat XX01A3US Base Metal Air Tests and click on "Air760C138MPa_C1-C2-N06617-0025". The creep data can also be accessed from links in the "E1-Microstructure" *Table* and "C3- Test Information" *Table*.
Example 5:	To find test information on a creep test specimen there are two options. Option 1 - At the bottom of the creep test data Record found in Example 4, click on the [See Related Records] link beside "Test Specimen". Select the Record for "Tensile&Creep C3-S-0001" shown in the left window pane, you will see the information on the specimen used for generating the data in the Record you are viewing in Example 4. Option 2 - Click the browse icon in the top toolbar to refresh the database Tree structure in the left window pane. Open the C3-Test Information Tree and then open the Folder: Test Specimen and click on "Tensile&Creep C3-S-0001". (Currently there is only one entry. More specimen Records will be input and linked to respective test data Record in future development.)

3.3.2 Using the select icon

The **select** icon is used to find *Records* based on their *Attribute* data. By clicking on **select,** the selection page will be displayed in the right window pane. The selection page shows all the possible *Attributes* that can be used to perform a selection. The criteria displayed are *Table* dependent. The *Table* used for selection can be changed by clicking the "Change Selection Table" link found in the title bar of the right window pane. More than one *Attribute* can be selected and the resulting list will display the *Records* that include the intersection of the selected criteria. A cross-tabular selection can be made by clicking on the "Advance Selection" link at the top of the window. Please note that not all *Attributes* are listed selectable. After evaluation, please send your recommendations for the *Attributes* that should become selectable for each *Table*.

To perform a selection

1. Click **select** on the toolbar.
2. The selection criteria displayed will depend on the *Table* last selected in the browse window. To change this selection to a specific *Table* select the **Change Selection Table** link at the top of the right window pane and select the desired *Table* from the list.
3. Discrete data types can be selected by clicking on the desired value (e. g. select **Ruptured** or **Discontinued** under "How did test end?"). Numerical values can be

selected by entering the desired numerical range in the boxes next to the *Attribute*. To reset the selections click the **Reset** button at the top of the right window pane.

4. After selecting all the desired criteria, scroll to the top of the right window pane and click the rectangular **Select** button found near the top right corner next to the **Reset** button.
5. A list of *Records* matching the criteria is shown in the left window pane.
6. To view one of the *Records*, click on the *Record* name.

Table 2: Examples for using the select icon

Example 1:	To find all creep test data from tests in helium environment at temperatures between 590°C and 750°C that ruptured, follow the following steps: 10. Click **select** on the top toolbar. 11. Click the **Change Selection Table** link at the top of the right window pane. 12. Select "C1-Test Data/Creep" 13. If the units are not in metric, change the unit system preference as discussed in the beginning of Section 1.3. 14. Click on "Ruptured" beside the *Attribute* "How Did Test End?" under "General Information" heading. 15. Scroll down to the "Test Parameters" heading and type in 590 and 750 in the blanks beside "Test Temperature". (To deselect selections click on the "Reset" button.) 16. Select "Helium" beside the "Test Environment" *Attribute*. 17. Scroll back to the top of the right pane and click on the **Select** button next to the **Reset** button. 18. All tests with these parameters are displayed in the left window pane. To view the data click on one of the *Records*.

3.3.3 Using the search icon

The **search** icon is used to search the database for *Records* containing specific words or phrases. The text input can consist of any number of words, separated by spaces. The results will return all *Records* containing all the words in the list. It is also possible to perform searches based on search operators. The available search operators are:

AND - Finds all *Records* containing both terms.

OR - Finds *Records* containing either term.

NOT - Finds *Records* that contain the first term, but not the second.

Phrase - Finds all *Records* containing the phrase enclosed in double quotes.

Wildcard operators ***** and **? –** The wildcard is used by entering some text string followed by * or **?**. The ***** sign matches the entered text followed by any sequence of zero or more characters and the **?** sign matches the entered text followed by zero or one single character. They cannot be used on their own or as the first character of a word.

Parentheses - Groups terms together. Parentheses cannot be empty.

The search can be narrowed to a specific *Table* by selecting the desired *Table* from the drop down menu below the **Search** button.

To perform a selection:

1. Click **search** on the toolbar.
2. Enter the desired text in the search box found in the left window pane.
3. To limit the *Table* searched, select the desired *Table* from the drop down menu.
4. Hit return or click the rectangular **Search** button in the left window pane. A list of *Records* that meets your search criterion appears in the left window pane.
5. Select the *Record* to view by clicking the *Record* name.

Table 3: Examples for using the search icon

Example 1:	To find *Records* related to Inconel 617, heat number starting with XX09, that do not include the word "Air", follow the steps below: 1. Click **search** on the top toolbar. 2. Enter the text: **XX09* NOT Air** in the search criterion box in the left window pane. 3. Hit return or click the rectangular **Search** button in the left window pane. 4. A list of *Records* containing the text "XX09A4UK" but not "Air" will appear in the left window pane. 5. To view any of the *Records*, click on the *Record* name.

3.3.4 Using the report icon

The **report** icon can be used to create a comparison table showing selected properties of several *Records*, make an X-Y chart showing the relationship between two *Attributes* for a set of *Records*, or to export data in a specified format.

To create a comparison table:

1. Use the **browse** icon, the **select** icon, or the **search** icon in the top toolbar as described above to display a list of *Records* in the left window pane to choose from for creating your comparison table.
2. Click **report** on the toolbar to display the Report window pane on right.

3. If there are already *Records* in the large rectangular box in the right window pane, click on the **Clear List** tab found below the rectangular box to reset the record list.
4. Add *Records* from the left window pane to the right window pane by clicking on the icon next to the *Record* name. If the icon beside a *Folder* is chosen, all the *Records* in the *Folder* and sub-*Folders* will be added.
5. Select **Comparison Table** found in the right window pane below the *Records* list.
6. Select *Attributes* to compare by either choosing a report template from the drop down menu in the right window pane, or by clicking on the **+** beside the headings and selecting the desired *Attributes* from the left window pane.
7. Click the **Generate Report** button.

Table 4: Examples for using the report icon to create a comparison table

Example 1:	Compare the time to 1%, 2%, and 5% creep strain under various loads for Inconel 617 tested at 1050°C. Use the **browse** icon to list the *Records* to choose from. 1. Click **browse** on the top toolbar to display the database *Tables* in the left window pane. 2. Open the C1-Test Data/Creep *Tree* and then open the branches: Austenitic Alloys > Inconel 617 3. Click **report** on the top toolbar. 4. If there are *Records* already in the large rectangular box in the right window pane, click on the **Clear List** tab found below the rectangular box to reset the record list. 5. Click on the icon beside the 1050 °C *Folder* to add all the *Records* at 1050ºC to the right window pane. 6. Select **Comparison Table** by either clicking on the Icon or the text. 7. If there already are *Attributes* listed in the lower **Choose attributes** box, clear the list in the lower **Choose attributes** box by clicking on the **Clear List** tab. 8. Click on the **+** beside the "Test Parameters" heading in the left window pane. 9. Select **Test Load**. 10. Click on the **+** beside the "Raw Data" heading in the left window pane. 11. Select **Time to 1% Strain**, **Time to 2% Strain**, and **Time to 5% Strain**. 12. Click the **Generate Report** button under the **Choose attribute** box, a comparison table appears. 13. To sort the data by the "Test Load" click on the "Test Load" column heading in the table. You can sort the data by other *Attributes* by clicking the column heading. 14. The data can be exported to a text file and Excel by clicking on the **Save As CSV** tab below the report. 15. To add other *Attributes* for comparison (e. g. start times of secondary and tertiary creep), click on the **Modify Report** link at the upper right corner. 16. Click on the **+** beside the "Secondary Zone" heading in the left window

	pane. 17. Select **Secondary Zone - Start Time**. 18. Click on the + beside the "Tertiary Zone" heading in the left window pane. 19. Select **Tertiary Zone - Start Time**. 20. Both secondary and tertiary creep start times have been added to the list. You need to use the scroll bar in the box to see the newly added *Attributes*. 21. Click the **Generate Report** button under the **Choose attribute** box. A new comparison table appears with the added *Attributes* columns. 22. To delete the secondary creep start time column, click on **Modify Report** link at the upper right corner. 23. Click on the x icon in the "Secondary Zone - Start Time" row in the box to delete the *Attribute*. 24. Click the **Generate Report**.
Example 2:	Compare the test load, test temperature, minimum creep rate, creep rupture strain and time to rupture for creep data from tests performed between 700 and 750 °C. Use the **select** option to list *Records* to choose from. 1. Click **select** on the top toolbar. 2. Clear any previous selection by clicking on the rectangular **Reset** button in the right window pane. 3. Scroll down to "Test Parameters" heading and enter 700 and 750 in the blanks beside "Test Temperature". 4. Scroll back to the top and click the rectangular **Select** button next to the **Reset** button. 5. Click on the **report** icon on the top toolbar. 6. If there are already *Records* in the large rectangular box in the right window pane, click on the **Clear List** tab found below the rectangular box to reset the record list. 7. Click on the  icon beside **Add all results to list** in the left window pane. All the listed *Records* should appear in the right window pane. 8. Select **Comparison Table** by either clicking on the Icon or the text. 9. Clear the list in the lower "Choose attributes" box by clicking on the **Clear List** tab. 10. Click on the + beside the "Test Parameters" heading in the left window pane. 11. Select **Test Load** and Test **Temperature**. 12. Click on the + beside the "Raw Data" heading in the left window pane. 13. Select **Minimum Creep Rate**, **Creep Rupture Strain**, and **Time to Rupture**. 14. Click the **Generate Report** button. 15. To move load to the first column, click on **Modify Report** link at the upper right corner. You are back on the Report page. 16. Click on the up arrow in the "Test Load" row in the "Choose attributes" box to move the "Test Load row" to the top. 17. Click the **Generate Report** button.

To create an X-Y chart:

1. Use the **browse** icon, the **select** icon, or the **search** icon in the top toolbar as described above to display a list of *Records* in the left window pane to choose from for creating your X-Y chart.
2. Click **report** on the toolbar to display the Report window pane on right.
3. If there are already *Records* in the large rectangular box in the right window pane, click on the **Clear List** tab found below the rectangular box to reset the record list.
4. Add *Records* from the left window pane to the right window pane by clicking on the icon next to the *Record* name. If the icon beside a *Folder* is chosen, all the *Records* in the *Folder* and sub-*Folders* will be added.
5. Select **X-Y Chart** found in the right window pane below the *Records* list.
6. Select *Attributes* to plot by either choosing a report template from the drop down menu in the right window pane, or by first clicking the **Select X-Axis Attribute** button, clicking on the **+** beside the headings in the left window pane and selecting the desired *Attribute* for the X-Axis, and then clicking the **Select Y-Axis Attribute** button, clicking on the **+** beside the headings and selecting the desired *Attribute* for the Y-Axis.
7. Click the **Plot Chart** button.

Table 5: Examples for using the report icon to create an X-Y chart

Example 1:	Plot a graph showing the "Time to 5% Strain" vs. "Test Load" for Inconel 617, Heat XX63A8UK. Use the **search** icon to list *Records* to choose from. 1. Click **search** on the top toolbar. 2. Enter XX63A8UK in the search box in the top of the left window pane. 3. Click **report** on the top toolbar. 4. If *Records* already appear in the *Record* list in the right window pane hit **Clear List** tab found below the rectangular box to reset the record list. 5. Click on the icon beside "13 *Records* from table C1-Test Data/Creep" in the left window pane. 6. Select **X-Y Chart** by either clicking on the Icon or the text. 7. Click on the **Select X-Axis Attribute** button. 8. Click on the + beside the "Test Parameters" heading. 9. Select the "Test Load" *Attribute*. You should see the words "Test Load" to appear under the **Select X-Axis Attribute** button. You may choose "Linear" for X-axis scale. 10. Click on the **Select Y-Axis Attribute** button. 11. Click on the + beside the "Raw Data" heading in the left window pane. 12. Select the "Time to 5% Strain" *Attribute*. You should see the words "Time to 5% Strain" to appear under the **Select Y-Axis Attribute** button. You may choose "Linear" for Y-axis scale.

	13. Click the **Plot Chart** button. The legends are listed under the plot. 14. If you are interested in a particular data point in the plot, click on that data point, its legend will appear at the top of the legend list, and you can click on the legend name to view its *Record*. 15. Or if you are interested in all the data when viewing the plot, click the **View Data** link in the top of the right window pane.

3.3.5 Using the matdat.net icon

The "**matdat.net**" icon links to a large external material data network including the following sites:

ASM Handbook
ASM Alloy Center
ASM Micrograph Center
ASM Failure Analysis Center, MatWeb
NIMS Materials Database, NPL MIDAS
The PGM Database
SteelSpec II
TWI JoinIT

This link is provided as a benefit of the MDMC membership for the *Handbook*. *Handbook* users can take full advantage of the information from these external sites during their use of the *Handbook*.

4. SUMMARY AND EVALUATION REQUESTS

The present beta version release is the first piece of the *Handbook* completed in compliance with the "piecewise construction strategy" stipulated in the "*Gen IV Materials Handbook* Implementation Plan" [1]. The release includes limited generic, pedigree, creep test, test specimen, and microscopic information on Alloy 617, as well as all the currently developed functionalities. Selected evaluators are being invited to browse the *Handbook* website and provide feedback about the *Handbook* structure, contents, and functionalities for future development. All the feedback should be sent to *Handbook* task personnel[*] at Oak Ridge National Laboratory with the sender's contact information.

5. REFERENCES

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[*] Weiju Ren, email: renw@ornl.gov, Phone: 865-576-6402

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[13] "Application of the MI System to *Gen IV Materials Handbook* Development at ORNL", 2006 Material Data Management Consortium 2nd Semiannual Meeting, July 31 - August 2, 2006, Los Alamos, MN, Weiju Ren.

APPENDIX

GEN IV MATERIALS HANDBOOK DEVELOPMENT CHRONICLE

DEVELOPMENT CHRONICLE

July 2004 — The First *Gen IV Materials Handbook* Workshop was held in La Jolla, California attended by the principal stakeholders of the *Handbook* including senior materials managers/experts from the reactor vendor community (General Atomic, General Electric, Areva, and Pebble Bed Modular Reactor), representatives from relevant American Society of Mechanical Engineers (ASME)/American Society of Testing and Materials (ASTM) standards and code committees, the Section Head for the Nuclear Regulatory Commission (NRC) Office of Nuclear Regulatory Research, the Department of Energy (DOE) Gen IV Program manager, Gen IV System Integration Managers (SIMs), and materials experts and managers from Oak Ridge National Laboratory (ORNL). The participants were unanimous in strongly supporting a DOE-led materials handbook/database activity with particular initial focus on Next Generation Nuclear Plant (NGNP) materials.

October 2004 — Collection and evaluation of existing data for future *Handbook* population were initiated. The collection was first focused on existing data of Alloy 617, the leading candidate material for reactor internals and heat exchangers.

March 2005 — "*Gen IV Materials Handbook* Implementation Plan" was completed [1]. The purpose, rationale, attributes, and benefits of the *Handbook* were addressed. The *Handbook* content, format, quality assurance, applicability, and access were detailed. An overview of the organizational structure of the *Handbook* and details of *Handbook* preparation, publication, and distribution was provided.

An AFCI-Gen IV Materials Working Group Meeting was held in Albuquerque, NM to prepare for collaboration in materials database development between the Advanced Fuel Cycle Initiative (AFCI) and the Gen IV Programs. Presentations on "An Interactive Materials Database for the Generation IV Nuclear Reactors" [6], and "Comments on the Scope, Applicability, Organizational Structure, and Preparation of the *Gen IV Materials Handbook*" [7] were given by *Handbook* personnel.

April 2005 — A presentation on "Development of *Gen IV Materials Handbook*" was given at the first 2005 semiannual Generation IV International Forum Provisional Management Board Meeting to prepare for proposing the *Handbook* for GIF adoption [8]. It is envisioned that the GIF adoption can bring in significant existing data from international sources and save U. S. research funds and time.

Search was initiated for software developers, and investigation also followed on existing and customizable software product to support the *Handbook*.

"Purpose and Role of the *Gen IV Materials Handbook* Advisory Committee" [4] was drafted for organizing expertise from potential *Handbook* users to provide support to the development of the *Handbook*.

May 2005 — "*Gen IV Nuclear Reactor Materials Handbook* Product Requirements Template" [9] was developed to provide guidance for *Handbook* software design.

June 2005 — Report "Assessment of Existing Alloy 617 Data for *Gen IV Materials Handbook*" was completed [2]. Major sources of existing data of Alloy 617 were identified. The collected data were analyzed and compiled for *Handbook* input.

July 2005 — A panel discussion was organized at 2005 ASME Pressure Vessels and Piping Conference in Denver, CO to obtain ASME support and information for *Handbook* development. A technical paper "Construction of Web-Accessible Materials *Handbook* for Generation IV Nuclear Reactors" was published in the conference proceedings with a presentation on the topic at the panel session [10]. The publication drew great interest from industries and ASME. ASME personnel were assigned to contact *Handbook* personnel and monitor the *Handbook* development.

August 2005 — *Handbook* personnel attended Materials Data Management Consortium Invitational Workshop to evaluate possibility of using Granta MI System as *Handbook* base software.

Assessment of candidate companies and proposals for *Handbook* software development was completed.

The conclusion for *Handbook* software preparation was reached that Granta MI System could provide desired basic functionalities and flexibility, and could be used as the base software for *Handbook* development.

September 2005 — Video conference was held between ORNL and Joint Research Centre of European Commission to discuss possibility of collaboration in database development for the Gen IV Program.

Report on "Initial Development of the *Gen IV Materials Handbook*" was completed [3]. Choices for software and hardware development were analyzed, and status of the *Handbook* development was summarized.

October 2005 — The document of "Purpose and Role of the *Gen IV Materials Handbook* Advisory Committee" [4] was revised and distributed to candidate Advisory Committee members with an invitation for Committee participation.

Handbook task joined the Materials Data Management Consortium (MDMC) to obtain experience and technical support for *Handbook* software development. Main Consortium members include ASM International, Granta Design, aerospace companies and US government research institutes.

Handbook hardware and base software system was assembled at ORNL for initial evaluation.

November 2005 — To reassure the collaboration in materials database development between the AFCI and the Gen IV programs, a presentation on "Development and Status of *Gen IV Materials Handbook*" [11] was given at AFCI-Gen IV Materials Working Group Meeting in Washington, DC. Agreement was reached to incorporate applicable AFCI Handbook data (in a static PDF file database) into *Gen IV Materials Handbook* (a web-accessible dynamic database with analytical functionalities).

February 2006 — Inaugural *Gen IV Materials Handbook* Advisory Committee Meeting was held in Santa Fe, NM. The *Handbook* development was fully discussed, and inputs from the members were documented for development consideration.

"*Gen IV Materials Handbook* Architecture and System Design" was completed. This document provides a detailed blueprint for *Handbook* construction [5]. The *Handbook* structure, data management schema and access control were fully addressed.

May 2006 — *Handbook* personnel met with head of the European Union materials database (Mat-DB) to discuss collaborations in database development for Gen IV Nuclear Reactor Materials Program. Mutual understanding and initial agreement in collaboration were established [12].

July 2006 — Two panel sessions on Gen IV materials database development were organized to discuss international collaborations in existing data sharing and exchange. Materials database leaders from the Japan, European Union,

Korea, and U. S. introduced their database respectively. It was suggested and unanimously agreed that a working group should be established to address technical issues in data sharing and exchange, but political and proprietary issues should be negotiated by Gen IV program managements or governments of GIF member countries.

August 2006 — *Handbook* personnel attended the second semiannual MDMC meeting. A presentation on "Application of the MI System to *Gen IV Materials Handbook* Development at ORNL" was given [13]. Future *Handbook* software functionality enhancement was discussed and planned.

September 2006 — *Gen IV Materials Handbook* beta version is launched for initial structural and functional evaluation.

Distribution

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