Enclosure Design Documents
for New Construction

Brad Carmichael, PE
and
José Estrada, PE

JRS Engineering LLC
12721 30th Ave. NE, 2nd Floor, Seattle, WA 98125
Phone: 206-728-2358
Email: bcarmichael@jrsengineering.com and jestrada@jrsengineering.com

Nonpresenting Coauthors
Han Salzmann and Jeff Speert, AIA

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ABSTRACT

Construction documents for the building enclosure are commonly prepared by the architect of record, often with peer review by a building enclosure consultant. We ask a great deal from enclosures today—complexity, performance, efficiency—yet detail work often only concentrates toward the end of the construction document preparation process, and the risks related to rushing details can be high.

Many other design disciplines produce construction documents complementary to an architect’s set. Perhaps it is coming time for the building enclosure discipline to do the same.

In Washington State, legislation requires enclosure consultants to effectively act as designers of record and produce stand-alone documents for condominium projects. This has led to the growing adoption of a stand-alone set of building-enclosure-related construction documents (herein referred to as a “BE set”) for mid- and high-rise multifamily condo and apartment design, and increasingly for commercial and institutional design as well.

This paper intends to provide a process overview and guidance for efficiently incorporating a BE set into construction documents, including lessons learned and benefits for broader adoption in construction beyond Washington State.

SPEAKERS

Brad Carmichael  
JRS Engineering, Seattle, WA  
Carmichael has been consulting on building enclosures throughout North America for over 15 years. He is passionate about good design and the role it can play in social and environmental stewardship. He believes that durable and efficient building enclosures are critical for a built environment that is low consumption and long lasting. Carmichael has consulted on a wide array of different project types and sectors, including high rises, healthcare facilities, cultural institutions, workspaces, affordable housing, and historic landmarks.

José Estrada  
JRS Engineering, Seattle, WA  
Estrada is a consulting engineer with more than a decade of experience in providing advice on building enclosures for projects of varying size, scope, and location. His project portfolio includes a range of project types, from high-end homes, to affordable housing, to medical facilities, to military barracks, to multi-billion-dollar super-tall commercial developments. He has also had the opportunity to work on projects throughout North America and China. Estrada is passionate about building science and about the role that the building enclosure must play in helping us build a sustainable world.

Nonpresenting Coauthors  
Han Salzmann  
Jeff Speer, AIA
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INTRODUCTION
The history of design subconsulting in North America follows the transformation of the construction industry by industrialization, technological advances, and the global trend toward specialization. It is also tightly bound with the role calamity has played in creating a demand for governmental regulation and professional accountability from architects and engineers.

In the design and construction of buildings in present day, it is common for a design team to be led by an architect and consist of numerous specialized subconsulting disciplines that contribute to the design of a building for different systems. Many subconsulting design disciplines have established independent design practices for the development of construction documents on building projects for their respective systems, yet by contrast, the discipline of building enclosure design remains tightly bound to architecture. In this paper we explore the potential for building enclosure design documentation on new construction projects, using regional practices in Washington State as a case example.

BACKGROUND

Brief History of Design Subconsulting
In Europe and across the United States, the nineteenth century saw an increase in the number of construction projects compared to previous centuries, and an increase in the complexity of the buildings themselves, as well as material technologies that required a greater understanding of science (Wilton-Ely, 1977). The building boom meant that material suppliers and trades could simultaneously work on more than one project while increasing specialization in their respective areas of expertise. This division of labor and trend toward specialization in the construction industry was not completely new, however, as its roots in the economic and organizational developments began in medieval Europe.

Architect–From Master Builder to Designer

Master builders in medieval Europe were traditionally tied to the supervision of one building project at a time. However, as the volume of projects increased in the Middle Ages and new construction methods (such as the availability of ready-made components) became more prevalent, construction of public projects increasingly became awarded to private contractors, and the gap between the planning and construction of building projects widened. As a result, the tasks of building design and preparing and assembling the building parts were no longer carried out by a single organization onsite. Instead, these tasks were divided up between a designer and one or more contractors, all working on multiple smaller parts of the project at one given time.

The distinction between the master builder and the architect began to emerge at this time, as the architect became less a master of the works and more a liaison between the client and the contractor (Kostof, 1977).

Standardizing Professional Practice

While the industrial building boom and technological advances in the nineteenth century were important factors in the professionalization of architects and engineers in the United States, of equal importance was the emerging need for standardization and regulation within the professions and within the industry. In response to widespread deregulation in the 1820s in the United States, the middle of the nineteenth century saw the rise of professional associations with the goals of standardizing practice such as the American Society of Civil Engineers (ASCE, 1852), the American Institute of Architects (AIA, 1857), and the American Society of Mechanical Engineers (ASME, 1880). The development of a standardized theoretical education for architects in North America (among them the MIT School of Architecture and Planning [1865], the Illinois School of Architecture [1867], University of Michigan Taubman College [1876], University of Toronto [1890], and UC Berkeley College of Architecture [1903]), as well as the government requirement for inclusion of engineering education for all land grant universities in the Morrill Act of 1862, led to the broadening of architectural and engineering education. Universities in Canada also established schools of engineering throughout the nineteenth century, with professional organizations for architects and engineers following in the twentieth century. These are examples of steps taken in standardizing and stratifying the labor performed by architects and engineers.

Regulation and Licensure of Engineering and Architectural Practice

The turn of the century saw an increasing role by the state in the regulation of architectural and engineering practice, largely in response to devastating failures of buildings due to building technology rapidly advancing in a largely unchecked manner and the tragic loss of life and the property damage that occurred as a result. California land disputes in the nineteenth century, the Great Chicago Fire of 1871, the deadly Chicago Iroquois Theater fire in 1903, devastation and damage caused by the 1906 San Francisco earthquake, and the catastrophic collapses of the Quebec Bridge in 1907 and 1916, the Washington, DC Knickerbocker Theater in 1922, and the St. Francis Dam outside Los Angeles in 1928 are all examples of events that sparked changes in building codes in North America and further codified the fields of architecture and engineering. In an attempt to bring uniform regulations to professional practices, licensure was required of land surveyors as early as 1891 in California, and architects as early as 1897 in Illinois and 1907 in Canada, while regulation of engineers in the U.S. began in Wyoming in 1907 and in Canada in 1919 with the Engineering Profession Act. By the mid-1930s, more than half of the states in the U.S. required licensure of architects and engineers, and in Canada, the Dominion of Canada Council of Professional Engineers required registration.
of engineers in eight provinces (NCARB, 2019; Rogers, 2020; and Simas, 2020).

This division of labor between engineering and architectural disciplines in building design and construction became further established throughout the twentieth century, with design teams continuing to expand and more specialized consultants becoming utilized. The design practice of respective engineering subconsulting disciplines today is much more than a peer review of the architectural design in search of potential problems for any given building. Rather, it is a fully developed practice of designing the systems and producing the construction documents for which each respective discipline is responsible.

Building Enclosure Design Consulting

The history of enclosure consulting and the discipline of building science does not reach as far back as other engineering and architectural disciplines, but the discipline traces a similar path through a course that is marked by technological advances, calamity, government regulation, and the division of labor due to increasing complexity and specialization.

In design, the broader practice of building enclosure design consulting generally involves either peer review of construction documents produced by an architect for new construction or the production of construction documents when acting as lead designer on rehabilitation projects. In North America—with the exception of Washington State—building enclosure consultants do not commonly produce stand-alone construction document packages, which is in contrast to the practices of other design subconsulting disciplines. Perhaps it is inherent to the nature of the discipline, though it may also be that the discipline is still emerging as a design practice and may eventually have a similar role in the design process.

Available professional practice guidelines reflect this relationship between the building science and architectural disciplines. In the International Institute of Building Enclosure Consultants (IIBEC) Manual of Practice, for example, construction document preparation is primarily referred to in the context of either existing buildings or as a design peer reviewer for new construction (IIBEC, 2010). In British Columbia, where enclosure consulting on new construction is a well-established practice, the Engineers and Geoscientists BC Professional Practice Guidelines for building enclosure engineering services note that the architect is to act as the registered professional of record and produce the construction documents, while the building enclosure engineer acts as a supporting registered professional (EGBC, 2020).

In Washington State, however, laws were passed in 2004 in response to a rise in regional construction defect claims and premature building enclosure failures that had somewhat different requirements than in other areas. These laws are known as the Revised Code of Washington (RCW). Specifically, RCW 64.55 requires that building permit applications for multi-unit residential buildings have building enclosure design documents stamped by a registered design professional unless a covenant is signed prohibiting the sale of the units as part of a condominium for five years (Washington, 2005). It also requires such buildings to have an accompanying statement indicating that the submitted design is appropriate to protect the building or its components from water or moisture intrusion. As a result of this law, building enclosure design consultants are required to act as the designers of record in responsible control of the building enclosure systems.

While acting as designer of record for the building enclosure on new construction has become common practice in Washington State due to this legislation, it has been our experience that such has not been common practice elsewhere in North America.

NEW CONSTRUCTION ENCLOSURE DESIGN DOCUMENTS

The construction documents of other engineering disciplines have developed over time to become distinct from architecture. The construction documents and detailing for a given project are complementary to, but somewhat separate from, the architectural construction documents for the same project.

The next few sections of this paper trace some of the development of enclosure construction documents over time, providing a look at how they can be made distinct from architecture and how they can be improved.

The Role of a Designer of Record in New Construction

Much of the practice for the preparation of construction document packages by enclosure consultants originates from rehabilitation work related to existing buildings. As enclosure consultants, we have unique roles, expectations, and design constraints that differ between new construction and rehabilitation work. Some roles, expectations, and design constraints are also shared between the two classes of work.

For example, in enclosure rehabilitation, the enclosure consultant is often in the role of designer of record for the overall project—we are in charge of establishing the overall rehabilitation scope, coordinating subconsultants, managing the overall construction budget within the design, and having design responsibility for architectural materials and elements. Additionally, because much of the building already exists, our documents reflect elements such as demolition scopes, repairs to structures and substrates, integrations with existing materials, and architectural finishes that may need to complement existing work.

On a new construction design team, however, much of this responsibility is divided up, with the enclosure consultant acting as a subconsultant. As such, we have a different role within a larger group. The architect of record will coordinate the full construction document package and produce the primary architectural set, with subconsultant sets coordinated into that larger package.

In contrast to the scope of rehabilitation, the overall project scopes and budgets on a new construction project do not fall entirely within the purview of the enclosure consultant, and so the need to integrate, trade off with, and complement all of the other disciplines is essential. Additionally, the building typically does not yet exist, thus enclosure design documentation is tasked less with reflecting existing physical conditions and more with reflecting conditions that exist only as designs.

The Progression of BE Sets Since 2005

The passing of RCW 64.55 in 2005 subsequently led to the quick adoption of the building enclosure “BE” set, and many of the early components and approaches to constructing a BE set are still part of common regional practice today. The nomenclature of a “BE” numbering series (e.g., BE-2.1) goes back to 2007 at our firm, and possibly earlier with some of our peers. In 2006 and prior, sets often used
a “W” numbering series denoting waterproofing, since, at the time, the focus of enclosure detailing tended to be more on moisture management than on airtightness and thermal continuity.

Sets often consisted of stand-alone assembly sheets, combined with individual details at 3- or 1½-in. scales. Information between the architectural set and the enclosure set was often duplicated, though greater level of detail would be shown with respect to the components of each respective discipline. The details in the BE set were generally referenced on the architectural plans and elevations.

Early BE sets from our Seattle team also incorporated some axonometric and sequence details intended to clarify system components and sequencing (Figure 1).

Following the adoption of more stringent airtightness standards and whole-building air leakage testing requirements in Seattle and throughout Washington State in 2009, the components of BE sets were further developed. At our office, BE sets began to incorporate more general notes, as well as diagrams outlining the path of the air barrier and thermal boundary through building sections and plans (Figures 2 and 3).

Additional components were incorporated as project needs became more complex and BE sets more commonplace in the overall set of construction documents, including material extents pages, building models, and more notes.

Some of the challenges, feedback, and lessons learned that we have determined internally and received anecdotally from the industry include the following:

- **Series Design Process:** Prior to the wide availability of BIM/Revit models, the enclosure consultant would have to wait until much of the architectural design was established before commencing detail work, resulting in a series design process rather than a parallel one. This series design process is also the case in design peer review. Overcoming this series process is becoming more essential to achieving efficient and lean project delivery—particularly as it

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**Figure 1 – Axonometric detail of typical wall construction.**

**Figure 2 – Air barrier diagram building section.**

**Figure 3 – Air barrier diagram plan.**
Missing Details or Conditions: In a series design process, enclosure consultants often rely on the architects to develop details first in order to spur the development of corresponding enclosure details. Since there are sometimes details that are more important for building enclosure but less so for architectural design, they may not be readily apparent through review of plans, elevations, and details alone, and as a result can easily be missed.

Inconsistency or Duplication: Duplication of information between the architectural detailing, manufacturers’ standard details, and enclosure details can often occur if too much information from one discipline or area of responsibility is shown in the design documentation of another. Inconsistencies can arise if duplicate information is not closely coordinated on a continual basis during design, which can result in confusion among the builders.

One approach to addressing some of this feedback is to begin decoupling the design of building enclosure systems from the architectural elements in a manner that still allows for the two designs to be mutually complementary in a similar fashion to the design of systems by other design subconsultants.

Disentangling the Discipline
Since production of enclosure design documents is an emerging practice for subconsultants in new construction, it can be challenging to set expectations as to what enclosure documents should and should not include. In established design disciplines, such as structural, MEP, and landscaping, for example, the division of responsibility is more widely understood. It has typically been clear in the industry that the structural drawings should not be precise with respect to interior finishes, the MEP drawings do not need to identify the rise and run of the stair treads, and that landscaping drawings should not be responsible for the layout of the windows. By this measure, if the enclosure subconsultant is to provide a stand-alone set of construction documents, it becomes important for clarity that the enclosure design be disentangled from architecture and other disciplines. Once achieved, it starts becoming possible to design the enclosure systems in parallel, rather than series, with the architecture, and provide a more efficient design delivery process.

System-Level Design
The design of a building enclosure is closely related not only to architecture, but also to each manufacturer’s installation requirements, means and methods, and sequencing. These can also be difficult to disentangle in order to clearly demonstrate an intention for the design of the enclosure without supplanting the responsibilities of other parties. That doesn’t have to be the case. By looking at other disciplines, there is clear industry understanding with MEP sets, for example, between the design intent for a mechanical system outlined in the construction documents contrasted with the particular installation requirements for a specified heat recovery ventilator. The same follows for other design disciplines with their respective trades and manufacturers, and the same should follow for the enclosure discipline.

In other disciplines, much of the design is expressed at the level of each system. One way to look at building enclosure design documentation as a system is through the lens of building science control layer continuity. Effective building enclosure details should demonstrate how the different control layers interact throughout the building and how continuity is achieved. This means that the enclosure documents should focus largely on the air barrier system, water control layers, vapor control, and insulation continuity, and define how these objectives are achieved.

Other than low-slope roof membranes, control layers are often hidden by the architectural elements. While architectural elements such as cladding and other important water-shedding features serve an important function in the building enclosure, they are not typically acting as control layers. As such, maintaining the primacy of the architectural drawings in that regard by peer reviewing those elements can be more important than accurately displaying them in a BE set. By maintaining these architectural elements in diagrammatic form on BE details and focusing on the performance parameters of concealed control layers, the BE set can help avoid confusion while providing important discipline-specific information to the builder. In fact, we have found that trying to match cladding or overburden components with architectural details too closely has often resulted in trade confusion when these duplicate details inevitably do not match perfectly.

With respect to manufacturer installation requirements or means and methods, the level of detail shown in a BE set can be a bit of a grey area. In essence, portions of an installation particular to a specified manufacturer’s system could be considered delegated design unless the design aspires to exceed the manufacturer’s standard requirements. With a system such as a mechanically fastened water-resistant barrier, for example, the manufacturer outlines parameters such as lap lengths and fastening requirements within their own system. As a result, that information does not necessarily need to be shown on a BE set, and to repeat it in construction documents may result in confusion if there are eventual discrepancies or if multiple product lines with different requirements are specified.

In order to disentangle the enclosure design detailing from architectural details and a manufacturer’s standard details, some elements that have become important to show in a BE set include the following:
• Overall extents for different systems and assembly definitions that clarify the building science role of different components
• Conditions critical to the control layers and their continuity that are not necessarily shown in manufacturers’ standard details or architectural details
• Conditions where requirements above and beyond a given manufacturer’s standard are intended
• Interfaces between systems and how they relate to one another
• Interfaces where two dissimilar assemblies come together that do not benefit from an industry standard approach and that may have high-cost impacts to the project (disproportionate to their size) if not included in initial pricing

Finding the right level of detail in a BE set is a difficult process. For practical purposes, some degree of duplication is almost inevitable, and details can often be somewhat replicative of the corresponding architectural details or manufacturer
details. Therefore, the more we can disentangle the discipline, the better equipped we will be to send more signal than noise. As the practice continues to evolve, unique characteristics and components of a BE set have also started to emerge that are worth reporting on.

**CONSTRUCTING A BE SET**

**Background**

For the past 15 years, our Seattle office has been practicing a process of continual improvement with respect to our BE sets, as have our peers in the region. In this section we hope to outline a snapshot of what we consider to be the anatomy of a BE set at the current state of practice, with the understanding that this practice is not as commonplace in different regions and is widely variable, even within our own region. The intent here is to start a discussion regarding the practice that may eventually set the groundwork for a standard of care and a broader improvement to the practice.

**Levels of Design**

In a practical sense, design across disciplines progresses from the broadly general to the more specific and detailed. In terms of the design process, this is commonly broken down into the schematic design, design development, and construction documents phases. In terms of goals for development of a BE set, in these phases we look to incorporate a hierarchy of the following levels of design:

- **Project-Level Design:** These are the schematic levels of the design, which we generally reflect in a general notes page. They are broad expressions of the overall design intent and apply across the entire project, including project-specific owner requirements, code requirements, performance targets, and global design requirements.

- **System-Level Design:** These levels are typically fleshted out during design development, or even earlier in some cases. The system-level design establishes assemblies with respect to their control layer components and the extents of those assemblies. The system-level characteristics of design are typically reflected in assembly sheets, extents pages, and air barrier diagrams.

- **Detail-Level Design:** This level of detail generally occurs during the construction documents phase and involves the detailed demonstration of conditions on the building at larger scale (1½ to 3 in.), as well as axonometric and installation sequence details.

**Anatomy of a BE Set**

Some of the core components of a BE set can be broken up into sections, which include the following:

- **Project-Level Design**
  - General notes
  - Air barrier and thermal boundary diagrams
  - Waterproofing extents

- **System-Level Design**
  - Enclosure assemblies

- **Detail-Level Design**
  - Enclosure details
    - Below-grade foundation details
    - Above-grade wall details
    - Fenestration details
    - Horizontal deck waterproofing details
    - Roofing details
    - Interior air barrier details

We understand that the organization of these BE sets varies within the industry, but generally they are current common component parts. Within our practice, sheet numbering generally follows the order above and uses the series BE0XX for notes through assemblies and BE1XX for below-grade foundation details through BE6XX for interior air barrier details, respectively. A brief description of each section follows.

**General Notes**

Similar to other design disciplines, the general notes page consists of global design requirements. Specific to enclosure, these include general notes with respect to the use of the documents and their limitations. Additionally, this page summarizes the overall code, performance, mock-up, and testing requirements for the whole building, as well as enclosure subsystems.

Additionally, there are architectural requirements that require global parameters for building science purposes; thus, the parameters should be included on the notes page. A good example is sheet metal flashings at rainscreen walls—the profile and shape should be determined by the architect on their drawings—but parameters such as minimum slope, cladding overlap, and vent clearance are global parameters that should be included in the notes page.

We have also found it useful to state a project design intent for the various enclosure systems on this page, which describes in point form some of the project-wide design requirements that may not easily be expressed in detail form.
Air Barrier and Thermal Boundary Diagrams

The requirement for project-specific air barrier diagrams arose with the 2009 Washington State Energy Code. By code, the air barrier diagram (Figures 4 and 5) also outlines the thermal boundary of the building. Typically, these air barrier diagrams will outline the delineation between conditioned and unconditioned space for both commercial and residential occupancies. This is particularly important at back-of-house spaces, and at areas of mixed occupancy.

The diagrams consist of overall building plans and sections, as well as calculations of the enclosure volume. These diagrams are used to convey the intent of the air barrier pathway for construction and to provide the extents and quantities for the whole-building air leakage test.

Waterproofing Extents Diagrams

It is often not feasible to use a one-size-fits-all approach to waterproofing a building. Waterproofing extents pages (Figures 6 and 7) are helpful when a variety of different approaches to waterproofing are used on the same project. This helps clarify where different systems are to be used throughout. For example, there may be areas below grade where hydrostatic conditions necessitate different waterproofing approaches, and approaches to waterproofing throughout may differ based on overburden, traffic, exposure, etc. As such, the waterproofing extents pages can help clarify the design intent of “what goes where.”

Enclosure Assemblies

Assemblies play a critical role within the design of a building enclosure, as each one is a composite element consisting of several subsystems designed by multiple disciplines. Within the assemblies, there are components that perform different functions, including not only the various control layers, but also structure, fire, acoustics, aesthetics, and other architectural elements. The assembly sheets in a set of enclosure documents should primarily identify the elements specific to the enclosure systems, including the control layers. Items that fall within the purview of the architect are referenced here as “Per Arch.” We generally try to show items such as cladding or overburden as a generic item with the understanding that the architect may change or redefine it as needed, but for the purposes of the enclosure performance it may only be necessary to generically note BE details coupled with peer review of the architectural details (Figures 8A and 8B).

Enclosure Details

Our sets for new construction are divided into the following series:

- BE100 Series – Below-Grade Waterproofing
- BE200 Series – Above-Grade Walls
- BE300 Series – Fenestrations
- BE400 Series – Horizontal Waterproofing Systems
- BE500 Series – Roofing
- BE600 Series – Interior Air Barriers

Within these sets, details generally fall within a few categories: plans, sections, single axonometric details, and axonometric sequence details. There are plan and section details, which generally follow specific architectural details and are
cross referenced as such; the focus on these details is to show the layering and interfacing of different enclosure control layer components—specifically those that are required to be continuous. To avoid confusion, less focus is given to the architectural elements and elements by other disciplines, except as needed for coordination and unless there is conflict between other disciplines and the enclosure systems. Details coordinated with the architectural drawings have the corresponding detail identified (Figure 9).

Axonometric details are often generated independently of the architectural details and demonstrate the important three-dimensional interfaces of the enclosure. For these details, cladding and other architectural elements are generally not shown in order to focus primarily on the control layer components. Establishing the relationships between inter-
secting structural substrates and enclosure system layers is the key to providing value with these details (Figure 10).

It is often the case that these details are demonstrated in sequences of multiple details and, in some cases, with the assistance of 3-D graphic programs for proper clarity (Figure 11).

**CONCLUSION**

When a set of enclosure design documents is not required by regulation, it can still be viable and straightforward for enclosure consultants to work successfully in a peer review capacity on new construction design where the construction documents for the enclosure elements are prepared by the architect of record.

However, the increasing complexity and performance demands of new building enclosures, along with the increasing need for design teams to deliver documents more leanly and efficiently, renders the peer review process worthy of re-examination. Other disciplines, for example, do much of their design work in parallel with the architectural design—especially as part of integrated design. Enclosure consulting on new construction via the peer review model tends to be more of a series process, requiring some detail-level construction documentation production prior to review by the consultant. Additionally, the architectural design process can’t be expected to freeze without changing in order for the peer review to be completed.

The ultimate aim should be to make the overall design process more efficient and reliable by having a specialist produce complementary construction documents for the building enclosure systems in parallel with, yet distinct from, the architecture itself, which would be similar to the design processes of other subconsulting disciplines.

To achieve the most value out of a BE set as part of a broader set of construction documents, the aims of designing a BE set should strive toward the following goals:

- Provide a design of the building enclosure as a system or set of systems.
- Provide relevant information on the design intent of the building enclosure systems in a manner that is complementary to the architecture, without necessarily reproducing or overlaying architectural detailing in a manner that produces “double effort.”
- Provide information and a level of detail that reduces the amount of specific building enclosure information required by the architect to place into their construction documents and details, thus aiming to reduce the architect’s overall effort.
- Address challenging conditions not typically covered by architectural details.
• Whenever possible, progress the design in parallel with the rest of the design team rather than in series.

With the above goals kept in mind, there is opportunity for a BE set to provide value to the broader design team and delivery process beyond the current applications within Washington State.

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REFERENCES


