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SUBTASK 4.8 REPORT

EVALUATION OF THE INTERNAL CONSISTENCY AND EASE OF IMPLEMENTATION OF MODIFICATIONS TO PIMS

One of Three 18-Month Reports

IN-DEPTH TECHNICAL REVIEW OF THE PENSION BENEFIT GUARANTY CORPORATION'S
MULTIEMPLOYER AND SINGLE-EMPLOYER PENSION MODELS

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Introduction

In July 2015, the Social Security Administration (SSA) engaged the FTI Consulting team (FTI) to conduct an 18-month, in-depth technical review of the Pension Benefit Guaranty Corporation's (PBGC) single-employer (SE) and multiemployer (ME) Pension Insurance Modeling System (PIMS). Task 4 of the Statement of Work (SOW) consists of 10 subtasks required for this in depth review - nine specific areas of review and a final report.¹ Three of the subtask reports are due at the end of each of the six-, 12- and 18-month periods. This report for Subtask 4.8, along with those for Subtasks 4.4 and 4.6, is due at the end of the 18-month period (with approved extension). As a part of our review of PIMS, this report documents our evaluation of the internal consistency and ease of implementation of modifications to PIMS.

The PIMS models undergo continual modification as new proposals are simulated, data are updated, and ERISA and the Internal Revenue Code are amended by Congress. It is important that changes due to various sources, such as data updates, model improvements, assumption changes, and changes in law can be distinguished within the resulting output and that the results are consistent from one run to another. The process of looking at changes one at a time is known as "reconciliation of changes" and is an important part of confirming the effects of newly implemented changes. Furthermore, ad hoc requests, which are frequently made by various parts of the government to model the impacts of potential policy changes and are layered on top of the PIMS models used for the prior year's reports (the "baseline model"), add an extra layer of change management. Thirdly, the processes used to transfer the PIMS output into reports or other means of communication must be designed to minimize the potential for errors that could undermine the public's confidence in PBGC.

The quality assurance processes involved in the ad hoc requests and the analysis of PIMS output are reviewed in this report wherein we address the following key questions raised in Subtask 4.8:

- Are model results consistent from one run to another?
- If a policy lever is changed between one simulation and the next, can all the changes in results be reliably attributed to the policy change?
- Are these procedures adequate and clearly documented? What are the quality control/quality assurance procedures? Are the procedures adequate or simply need to be made more transparent?
- What should PBGC learn from best practices used with comparable models?

¹ Social Security Administration, Evaluation of the Pension Benefit Guaranty Corporation's Pension Models, Description/Specification/Work Statement, page 14.

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Findings

Based on our review of the documentation provided and our interviews with PBGC personnel, the procedures and policies in place provide a reasonable level of assurance that when changes are made to a policy lever, the resulting changes between one simulation and the next can be attributed to that change. In our opinion, the level of consistency currently achieved is reasonable for the type of modeling involved.

The previously submitted report for Subtask 4.7 reviewed the change management and quality assurance processes used for PIMS and our findings/recommendations from that report would also apply here. In addition to what was covered in the Subtask 4.7 report, we have also reviewed the quality assurance processes used when transferring a model run's output into a report or communication. While we found the documentation and support is less than ideal, it is consistent with the level of documentation supplied for other parts of PIMS.² In addition to the recommendations from our previous subtask reports that are applicable to this topic, we would recommend that PBGC consider:

1. Tracking, non-confidential ad hoc requests as some previously fulfilled requests may be applicable to future requests and should be consistent with related requests.
2. Updating quality assurance procedures³ to explicitly require a comparison with previously communicated results and act as a consistency check.
3. Updating the quality assurance manual for ad hoc requests to require that communications back to the requestor comply with Actuarial Standards of Practice Number 41, Actuarial Communications, when the communication could be considered an actuarial opinion.⁴
4. Appropriately capturing institutional knowledge documentation at the functional level, such as detailed documentation on the structure of PIMS code, or process memos on how to review PIMS results.
5. Accounting for potential policy lever changes in the system design of future PIMS updates and implementing design features that will lead to easier implementation of future policy lever changes.⁵

As was noted in our previous subtask reports, FTI found that there is little publicly available information regarding the quality assurance procedures used for other microsimulation models. In the absence of information on comparable models, we have used as a proxy best practices from our extensive experience conducting and reporting on data intensive analysis and have made recommendations where appropriate. These best practices are applicable to microsimulation models as well.

² See the Subtask 4.5 report for our assessment of the documentation for PIMS as a whole.

³ Quality Assurance Procedures for Formal PRAD Reports Utilizing the Pension Insurance Modeling System (PIMS), Version 5.0, August 25, 2015 and Quality Assurance Procedures for Ad Hoc Requests (PRAD), July 26, 2016.

⁴ Quality Assurance Procedures for Ad Hoc Requests (PRAD), July 26, 2016.

⁵ As described in Subtask 4.6 report, PIMS models should be designed to minimize the use of hard-coded values.

Documents Reviewed

PBGC's Policy, Research, and Analysis Department (PRAD) has established a quality assurance manual for formal PRAD reports and ad hoc requests. The following two documents are the main documents governing the review process to ensure PIMS results are consistent and reasonable.

1. Quality Assurance Procedures for Formal PRAD Reports Utilizing the Pension Insurance Modeling System (PIMS), Version 5.0, August 25, 2015
2. Quality Assurance Procedures for Ad Hoc Requests (PRAD), July 26, 2016

As an example of how the review process is implemented for Projections Reports and ad hoc requests, PRAD provided the following documents for reviewing the 2015 Projections Report and one sample ad hoc request.

File Name	Description
3. FY15 SE-ME System Test.pdf	A file showing that various SE- and ME-PIMS runs from the quality assurance (QA) environment and the production environment produce the same results
4. FY15 PR Checks.pdf	An email documenting the completion of checking PIMS output in the 2015 Projections Report
5. ME Templates for FY15 PR.pdf	A file showing various ME-PIMS runs considered in the 2015 Projections Report, including basic runs descriptions, data sources, results directories, environments, and the run parameters
6. CMJ review_1.pdf	A quality control checklist for PIMS output
7. NRAD Review.pdf	An email indicating the review of the 2015 Projections Report from an actuary from the Negotiations and Restructuring Actuarial Division (NRAD)
8. FW_ collar proposal.pdf	An email request for an analysis of a funding proposal for SE plans
9. RE_ Draft output for JCT.pdf	An email documenting the review of PIMS output for this ad hoc request
10. Preliminary Results.pdf	An email communicating the results of this ad hoc request
11. Report #'s with MPRA 2017 2017 - 0-30-10 QA.xlsx	A spreadsheet that processes ME-PIMS output into graphs in the 2015 Projections Report (QA environment)
12. Report #'s with MPRA 2017 2017 - 0-30-10 PROD.xlsx	A spreadsheet that processes ME-PIMS output into graphs in the 2015 Projections Report (production environment)

Overview of Quality Assurance Procedures

This section provides an overview of how PIMS quality assurance procedures are applied to ensure that model results are reviewed for consistency from one run to another, including changes due to modeling different policy options coming from various ad hoc requests. PRAD's document, *Quality Assurance Procedures for Formal PRAD Reports Utilizing the Pension Insurance Modeling System (PIMS)*, sets out procedures for reviewing PIMS input, coding changes, PIMS output, and final reports. With regards to ensuring the model results are consistent from one run to another, there are two main aspects to PBGC quality assurance procedures. The first is the PIMS program change management process and the second is PRAD's review process for assessing the reasonableness of the results.

PIMS Program Change Management Process

The first aspect is the PIMS program change management process, which governs how changes to PIMS are initiated, developed, tested, and migrated from the QA environment to the production environment. Since annual updates to PBGC's Projections Report require multiple runs and each run may require a different PIMS set up, the change process provides procedures for reviewing and testing the changes from one run to another before they are finally put into production to verify the changes are operating as intended. Once finalized, the version of the PIMS models used for the most recent Projections Report becomes the baseline models for subsequent ad hoc requests that use PIMS models for analysis. Therefore, PBGC recognizes the importance of thoroughly testing the baseline model and fully documenting the changes from prior versions of PIMS. For a detailed discussion and evaluation of the PIMS program change management process, see our Subtask 4.7 report, *Evaluation of PIMS Model Development, Modification and Refinement*.

Ad hoc requests to analyze different policy options are handled throughout the year and the quality assurance procedures are governed by the document, *Quality Assurance Procedures for Ad Hoc Requests (PRAD)*. The following aspects of ad hoc requests create a need to have a different change procedure for ad hoc requests than for annual PIMS updates:

1. The request may come from different mechanisms (e.g., assigned in meetings, phone calls, email, or letters) and from different sources (internal PBGC staff or other external parties, such as congressional or administration staff), and may require a timely response.⁶
2. The request may become a recurring project.⁷ Additionally, policy options analyzed via ad hoc requests may be enacted and be incorporated into future PIMS updates.
3. Some requests can be highly confidential and may not be records of PBGC. Therefore, "PRAD will generally avoid compiling lists of requests which commingle requests from various parties, so as not to increase the risk of inadvertent disclosure of confidential requests. Instead PRAD managers are responsible for assigning and tracking ad hoc requests individually until the request has been answered or otherwise resolved and for managing any resulting records relating to the request in accordance with PRAD and PBGC policy."⁸

⁶ PBGC, *Quality Assurance Procedures for Ad Hoc Requests (PRAD)*, page 2.

⁷ *Ibid*, page 3.

⁸ *Ibid*, page 3.

When responding to an ad hoc request, a member of PRAD or contractor will check out the copy of the appropriate PIMS code into the QA environment and work on the request. Reviews of ad hoc requests will typically involve assessment of programming specifications, unit tests, and code by contractors and PRAD's review staff. The PRAD reviewer conducting a test review or code review will send an email to formally approve the changes and save backup files to the appropriate location.⁹ Once the request is completed, results are reviewed by the Director of PRAD and Division Manager of the Pension Insurance Modeling Division before being communicated to the requestor. The documentation of the request, code updates, and results are maintained on an internal PBGC network folder in the event they receive a similar request in the future.¹⁰

Assessing the Consistency of the Results

The second aspect of the quality assurance is the assessment of consistency of the results relative to the results from prior model runs.¹¹ This requires professional judgment on the part of the reviewer. Nevertheless, PRAD's quality assurance procedures provide that certain procedures should be followed:

1. The appropriate PBGC staff should review the assumptions, results, and final reports. For example, a Chief Actuary and/or PRAD Director will review and either revise as appropriate or confirm the specific assumptions on an annual basis.¹² A draft of the Projections Report will be reviewed by, among others, the PRAD Director and/or a PBGC Chief Actuary, the Director of Communications and Legislative Affairs Department (COLA), and peer reviewed by actuaries appointed by the Chief Negotiating Actuary, NRAD or the Chief Valuation Actuary, ASD.¹³
2. A consistency review should include certain items:
 - a. The growth of liabilities over the projection period, and its distribution over the plans in the sample.
 - b. Distributions of actual contributions among plans and across years in the projection.
 - c. Distributions of funding levels and of actuarial charges and credits.
 - d. Examination of plans with results showing strong deviation from average patterns ("outliers") to justify unusual results for specific plans where appropriate. Exceptions are noted, and corrections made, where appropriate.¹⁴

Although not explicitly mentioned in the quality assurance manual, the Projections Report also provides reconciliations of changes in PIMS results and various sensitivity analyses, which are indispensable for the assessment of the consistency of results across runs. For both ME- and SE-PIMS, the Projections Report shows the reconciliation of the present value of the 10-year projected net deficit from the prior year's Projections Report to the current year's Projections Report. The current Projections Report

⁹ PBGC, Quality Assurance Procedures for Ad Hoc Requests (PRAD), page 4.

¹⁰ Subtask 4.7 report, Evaluation of PIMS Model Development, Modification and Refinement, page 10.

¹¹ A related issue is assessment of the reasonableness of the assumptions. We have extensively commented on the reasonableness of various assumptions that PIMS makes and therefore do not address this here. In this report, we only discuss model results.

¹² PBGC, Quality Assurance Procedures for Ad Hoc Requests (PRAD), page 12.

¹³ PBGC, Quality Assurance Procedures for Ad Hoc Requests (PRAD), pages 20-21.

¹⁴ PBGC, Quality Assurance Procedures for Ad Hoc Requests (PRAD), pages 16, 18.

attributes changes due to data updates, the passage of time, change in economy and economic assumptions, changes in other assumptions (e.g., in recent reports, mortality), model updates, and legislative changes.¹⁵ The Projections Report displays changes in these categories and briefly explains changes in each category. Additionally the Projections Report provides various sensitivity analyses. For example, showing the results relative to different Multiemployer Pension Reform Act (MPRA) assumptions allows one to better understand the potential impact of the new legislation.¹⁶

Reconciliation and sensitivity analysis performed by PBGC are useful in assessing the consistency of the results relative to those from prior model runs in light of policy lever changes introduced; however, professional judgment on the part of actuaries and economists are still needed. Because policy changes often impact different elements of the pension insurance system simultaneously, experts need to understand how the policy changes impact different items separately and in combination. For example, a change to ERISA funding rules may impact the plan funded statuses, potential PBGC claims, PBGC premium collection and bankruptcy probability. The combination of these impacts might not be evident.

Recommendations on Quality Assurance Procedures to Ensure the Consistency of the Models' Results from One Run to Another

On the change management process, as noted in the Subtask 4.7 report, the documentation to support the requirements, development and testing individual change is robust and clear. Formal tracking for all ad hoc requests should be considered although we understand that the confidentiality of certain requests would make tracking them difficult. However, a tracking of related, non-confidential, requests would be useful to assess the changes from one request to the next.

With respect to assessing the consistency of PIMS results relative to previous model runs, we make the following recommendations:

1. In the quality assurance manual for the annual PIMS update and ad hoc requests, explicitly require the reviewer to compare current results with previously communicated results as part of the reasonableness check. We believe this is something PBGC reviewers are currently doing, and that this is an aspect of the quality assurance process that should be made explicit. Professional judgment is still required in terms of the scope and depth of the results comparison.
2. In the quality assurance manual for ad hoc requests, require that the communication of actuarial opinions back to the requestor comply with Actuarial Standards of Practice Number 41, Actuarial Communications. If the responses to ad hoc requests are actuarial opinions issued by qualified actuaries, actuarial communication should follow the relevant Actuarial Standards of Practice. It is recommended that this requirement be made explicit in the quality assurance manual for ad hoc requests. The elements of such communication include the identification of the responsible actuary, a reference to applicable actuarial assumptions and methods and the extent this work can be relied upon. Such information is not only useful for communicating actuarial results, but also useful for documenting the review of the consistency and reasonableness of the results.

¹⁵ 2014 Projections Report, pages 22, 35.

¹⁶ 2014 Projections Report, pages 18 – 20.

Additionally, the following two areas should be considered because they can significantly impact the consistency and ease of PIMS implementation.

3. The proper working of the quality assurance procedures depends on the institutional knowledge, experience and expertise of key PBGC personnel. Appropriately capturing such institutional knowledge should be a high priority for PBGC. This may require documentation on a functional level, such as a detailed documentation on the structure of PIMS codes, or process memos on how to review PIMS results.
4. The system design for future PIMS updates should take into account potential policy lever changes. The current PIMS models involve a multitude of input tables and object-oriented code organized from the macroeconomic level down to the plan level and to the benefit formula level. Under current PIMS, a policy lever change may require code modification in different areas; however, when PIMS models are re-designed, the experience of how PIMS models are actually used should be part of the system re-design process. This should lead to easier implementation of future policy lever changes.

Overview of Process to Transfer PIMS Output to Reports and the Quality Control Checklist

This section provides an overview of how PIMS outputs are transferred to reports and the quality assurance procedures in place to ensure the completeness and accuracy of the Projection Reports. PRAD's document, Quality Assurance Procedures for Formal PRAD Reports Utilizing the Pension Insurance Modeling System (PIMS), sets out procedures for reviewing PIMS input, coding changes, PIMS output, and final reports. PRAD utilizes PIMS data for a variety of purposes but most notably the PBGC annual Projections Report which provides an actuarial evaluation of the distribution of possible future outcomes and the net position. The report includes projections for both single-employer and multiemployer programs.

Transferring PIMS Output to Reports

The actual output produced by PIMS is a set of text files. There is a summary report generated by PIMS for each data-producing run which indicates the unique identifier for a run, time, and the user who executed the run, the run name, the data sources, input tables, and the output file.

For SE-PIMS, those text files are initially analyzed using Statistical Analysis System (SAS) which produces output reports based on the parameters set by the PRAD user. The SAS output report is copied to a spreadsheet template which is used to transform the resulting data into graphs, charts and summary tables for the Projection Reports. Below is an overview of the SAS output files and the data contained within each:

- **FYXX_AR_SE_SASOUT_ANNUAL_CHARTS_DATA** – Contains the 10-year projected SE statistics (e.g., mean, median, and mode, 15th percentile, 85th percentile) on program net position, investment income, and net new claims
- **Distribution_Stats_2022_Financial_Balance** – High and low range of SE financial position
- **FYXX_AR_10yr_SE_SASOUT_SLB_Added_FYXX_sasout_tablevalues** - Contains the 10-year projected SE statistics (e.g., mean, median, and mode, 15th percentile, 85th percentile) on

program projected liabilities, asset investment, returns on invested assets, premiums, and benefit payments

When transferring the SAS output to a spreadsheet, PRAD documents the specific source (i.e., SAS output report location) for all graphs, figures or summary tables. This is done so that the reviewer can revert back to the source information for quality control procedures and reconciliation. Other data sources used to create the Projections Report include the PBGC Annual Report, Pension Insurance Data Book, and previous years' Projections Reports.

For ME-PIMS, data extracted from the PIMS output text files are transferred to a spreadsheet-based tool (referred to as the VBA Toolkit) which is used to analyze the output data (SAS is not used for ME). The VBA toolkit utilizes a series of macros to produce aggregated data results and graphs for a user-specified number of years. Below is an overview of the output created by the spreadsheet tool.

- **FYXX Preliminary Results 11-01-2012** – Contains statistics (e.g., mean, median, and mode, 15th percentile, 85th percentile) on program net position, value of new claims, financial assistance payments, and present value of multiemployer premiums

The spreadsheet files used to summarize PIMS outputs for both SE and ME are maintained on a network folder. These files are only updated when there is a new field produced by PIMS or change to a macro is required, which is rare based on discussions with PRAD. When a spreadsheet file does require a change, there is a peer review performed by another PRAD team member. Additionally all changes require final approval from the Director of PRAD.

The aggregated data tables, figures and graphs in the Projections Report are created using output from the PIMS QA environment, as opposed to the production environment. This is done because the production run only occurs once per year and that run happens at the end of period after all program changes have been made to PIMS. Given the time it takes to create the output, the PRAD team starts producing the Projections Report using output from the QA run, operating under the assumption that the output will be identical to the production run. Once the production run is complete, PRAD will perform a reconciliation to ensure the output from QA is identical to the output produced by the production run.

Quality Control Review Checklist

The annual Projections Report is reviewed by multiple groups before being published. Below is an overview of the review steps:

- PRAD Review: The Director of PRAD and Division Manager of the Pension Insurance Modeling Division
 - Reviews the draft Projections Report for accuracy, actuarial reasonableness and policy considerations, and
 - Notifies the Office of Inspector General of issuance date and coordinates review.
- Chief Policy Officer: Reviews for policy considerations
- NRAD Review: This independent group at PBGC appoints an actuary to review. The appointed actuary
 - Tracks PIMS results and other numerical data contained in the report to a verifiable source and confirms accuracy, and

- Confirms that the Projections Report complies with the requirements in the Actuarial Standards of Practice.
- PRAD Independent Review: The Projections Report is reviewed by a team member within PRAD who was not involved in generating the output or creating the report.
- PBGC Director, Board of Directors, and OMB: Reviews the Projections Report and provides any necessary feedback prior to issuance of the Report to Congress.

The quality control procedures including checklists and templates are defined in PRAD's document, Quality Assurance Procedures for Formal PRAD Reports Utilizing the Pension Insurance Modeling System (PIMS). Email is used to track all communication and approval related to reviews and those emails are stored in a secure network folder.

Recommendations on Quality Assurance Procedures to Ensure Accuracy of Output Communication

Overall, we found that PBGC's processes for ensuring that the communicated results match the model's output are sufficient. However, we recommend that PBGC formalize these procedures in written form to help ensure they are consistently applied. A greater concern, and one which is more difficult to address, is ensuring consistency across multiple ad hoc requests. PBGC should consider developing a method to record ad hoc requests and identify requests that have a similar basis and should therefore have outputs that are consistent. Once this recording system has been implemented, the communicated results from each new ad hoc request should be compared to the communicated results of other similar requests. This is a common industry practice which helps to ensure user confidence.

In particular, PBGC should focus on documenting the methodology and rationale behind certain key algorithms, such as mass withdrawal probability and the sampling process. Documentation of the logic behind their creation is important for preserving institutional knowledge.

Additionally, given the reliance on institutional knowledge, a process should be adopted to create a summary memo for all ad hoc requests. These memos should capture the original request, PIMS code change(s), results, response and any other relevant information. By using a narrative form to summarize how the ad hoc request was addressed, PBGC will be able to capture and preserve the institutional knowledge required which can then be applied to future requests or used to help train personnel moving into new roles. This is a common best practice in data science, complex modeling and analytics.