



US Department of Energy

IAC ASSESSMENT DATABASE MANUAL

Version 10.2

<http://iac.rutgers.edu/database/>

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Disclaimer

This document is intended to supplement the DOE sponsored Industrial Assessment Center database (IAC) located at <http://iac.rutgers.edu/database/>. The IAC database is fully available for public access and distribution online through the IAC field manager's website (www.iac.rutgers.edu) managed by Center for Advanced Energy Systems (www.caes.rutgers.edu) located at the School of Engineering, Rutgers University. CAES maintains this database under contract with the U.S. DOE. This data is available at no charge and no warranty with respect to the accuracy, completeness, or usefulness of the data as expressed or implied. Company names and street addresses are removed from the database for confidentiality reasons. The database will be updated regularly as additional data becomes available. This document may be reproduced and freely distributed.

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Introduction

The US Department of Energy (DOE) Industrial Assessments Centers (IAC) program tracks and analyzes its assessment results and related data with a web-based database management system commonly known as the IAC database. It contains the results of over 14,000 assessments with more than 100,000 recommendations ranging in dates from 1981 to present. All of this is publically available with only limited confidential information redacted. For details of the IAC program see “Appendix I: IAC Program Details”.

Origin and Historical Development

While the DOE ultimately manages the IAC program, day to day field management has always been provided by a university based team with extensive industry assessment experience. Currently, Rutgers University serves as IAC field manager.

The IAC database was originally created as a basic tracking and monitoring tool for the IAC field management. The field management team manually handled all data entry and analysis internally.

As technology evolved, so did the capabilities of the IAC database. Soon the centers were using spreadsheets to submit assessment data. With the use of the internet becoming widespread, unrestricted portions of the assessment data were put online, though initially they could only be accessed using the specific assessment ID.

In 2001, the database took several large steps forward by allowing the centers to directly upload assessment data into the database, adding a series of search and analysis features to the public side of the database, and providing the DOE with real-time reports of program activity and metrics.

Since then various additional features and functions continue to be added to database.

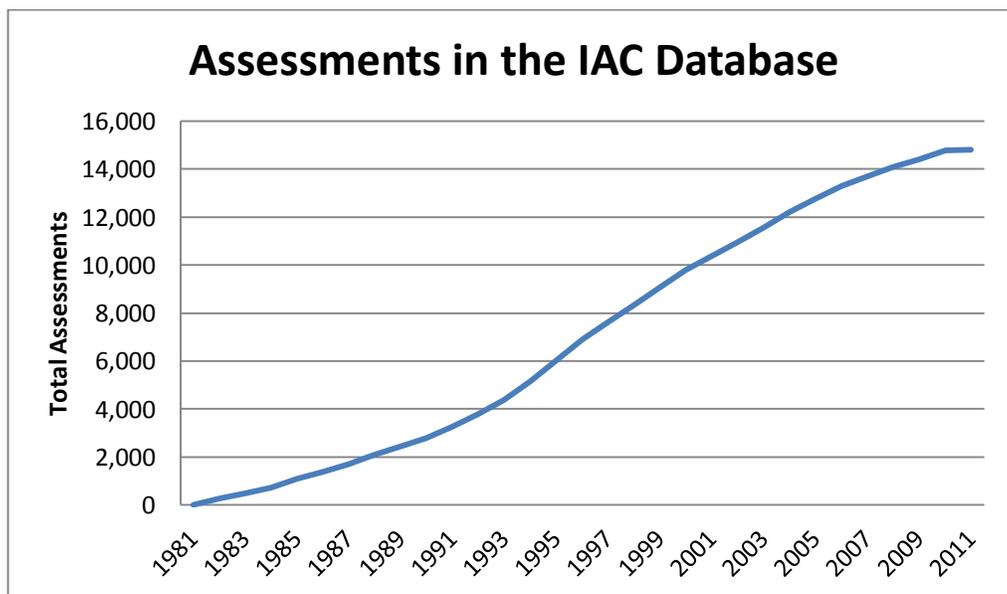


Figure 1: Total Assessment in the IAC Database by Year

Primary Database User Types

The database was, originally, only designed for use by the IAC field management. As its scope and capabilities broadened, so did its user base. Currently, the primary user types fall into 4 categories:

- IAC Field Management
- U.S. DOE
- IAC Centers
- The General Public

IAC Field Management

Initially, the database was developed only as a tool for the IAC field management (FM). The FM operates and maintains the database and has full administrative access.

U.S. Department of Energy

The DOE is primarily interested in the overall program status, results, and miscellaneous metrics. While they have unlimited access to most of the program data, they are restricted from accessing data that could connect the assessments results with the clients names.

IAC Center

The centers are required to upload their activities, assessment results, and center specific information into the database. They also can view reports on various performance factors for their center compared with the overall program.

The General Public

The public has access to almost all assessment results. The only restricted information includes the company's name, plant contact information, and reasons for rejection of a recommendation¹.

The public can look at the assessment data through a variety of customizable online forms and tables. They can also download the entire database in an Excel Spreadsheet if they want to further analyze the data.

¹ Reasons for rejection can provide insight into a plant's internal decision making which many companies are very sensitive about. While the public data is striped of company identification, this data is still considered too sensitive to distribute publicly.

IAC Database Website Interface

The IAC database is setup with three distinct sections. Each section is designed to meet the needs of a specific user type. The following chart illustrates this breakdown:

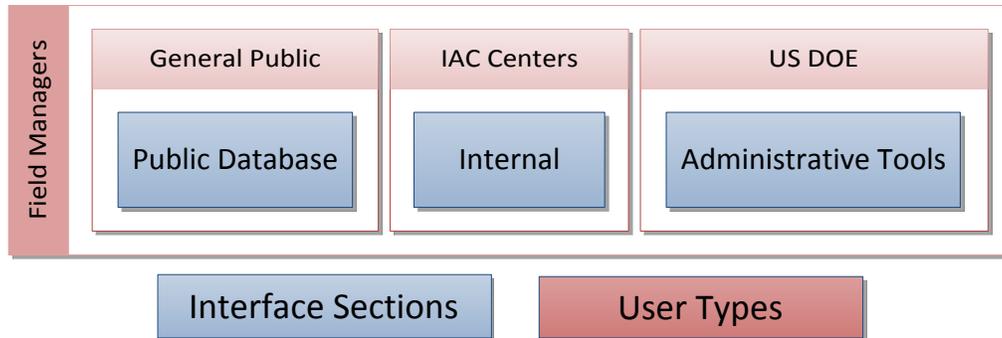


Figure 2: Website Interface Sections

Internal Section

All assessment data first enters the system through the internal section, which is customized to the specific center accessing it.

The key forms used by the centers to upload and modify data are:

- **Activity Log (ActLog):** Logs scheduled assessments into the database. This is the first time an entry is created for an assessment in the system.
- **Activity Log Plus (ActLog Plus):** Logs non-assessment activities into the system.
- **Assessment Upload Forms:** Takes in all tracked assessment data.
- **Implementation Upload Forms:** Updates assessment data with implementation status.
- **Center Contact Information Update:** Updates center personnel contact information.

Centers also have access to program resource materials including manuals, guidelines, press/publication materials and links to related sites.

Public Database

The public section of the database provides access to all publically available data. To simplify analysis and evaluation of the assessment data for interested users, several search features and analysis tools are available.

Assessments can be searched by:

- **Industry Types:** Either SIC or NAICS
- **Assessments Specifics:** Year, Plant Size, Energy Usage Levels, Employees, Production Levels, Location, Assessment Center, etc.
- **Recommendation Types:** ARC Codes
- **Recommendation Specific:** Implementation Status, Energy Savings, Cost Savings, Implementation Cost, etc.

Analysis tools include:

- **Assessment Statistics:** Statistics of assessments matching search criteria.
- **Top Ten Recommendations:** Top ten recommendations matching search criteria.
- **Geographic Map:** Map of assessments and recommendations matching search criteria. Allows for regional comparisons of recommendations and implementation.
- **Downloadable Database:** The entire public database is also available for download in both full and filtered versions.

Each assessment can be viewed individually on the assessment details page. This page displays all related assessment data, as well as the breakdown and summary of the individual recommendation resource stream impacts.



Figure 3: Assessment Details

In addition to the assessment data, the public database includes a variety of other supporting resources. These include:

- **Find a Center:** Allows users to locate the closest centers and evaluate their assessment results.
- **Industrial Code Indexes:** Includes all manufacturing related industrial codes for both the SIC and NAICS systems.
- **Recommendation Code Index:** Includes the full IAC Assessment Recommendation Code (ARC) list
- **Technical Manuals, Case Studies, and Instructional Webcasts**

Administrative Section (for US DOE and IAC Field Management)

The administrative section provides the US DOE with reports and summaries of the programs activities. These reports and summaries are generated in real-time when requested to provide the most current information. If new reports, metrics, and summaries become needed on a regular basis they are also added to this section.

Reports, metrics and summaries include:

- **IAC Executive Summary:** A high-level breakdown of program savings by year and for the overall program
- **SAVE ENERGY NOW Weekly Report:** A weekly medium level breakdown
- **Quarterly Goals:** Summarizes various metrics that are used to set quarterly goals.
- **IAC Requirements:** Lists assessments required from centers and the current progress of those centers.
- **Program Metrics:** Detailed spreadsheets of the IAC program's recommended and implemented energy and cost savings.
- **Report Card:** A ranking and rating of centers and their relative performances as compared with the program overall.
- **Calendar of Activities:** Provides a calendar of all activities currently logged in the database

- **Total IAC Savings:** Summarizes the total program savings since the beginning of the program.
- **Assessment Counts:** Total number of assessments by calendar year, fiscal year, quarter, and month.
- **Center Alerts:** List of currently active issues with various centers.
- **Student Counts:** Counts of students active in the program overall and by center.
- **Quarterly Reports:** All submitted quarterly reports are available for review.

Many of the reports, metrics, and summaries can also be filtered by funding sources, time frames, and locations.

The Data

The data contained within the IAC database can be broken down into several categories based on importance and usage.

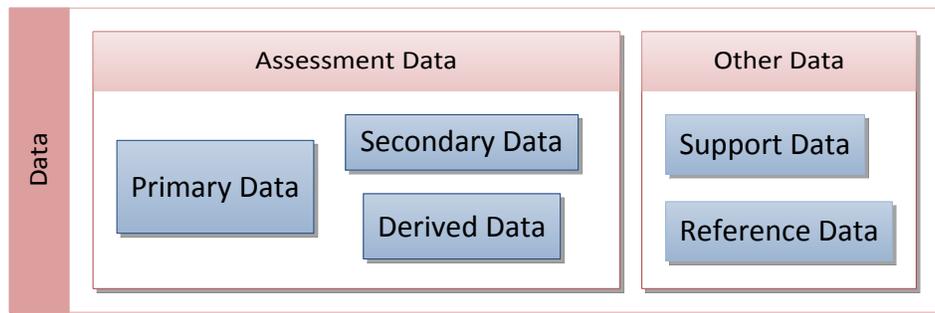


Figure 4: Database Data Classifications

Assessment Data

The assessment data collected from the IAC centers can be broken into two distinct categories; primary and secondary. There is a third category for assessment data referred to a “derived” data which is generated from the primary and secondary assessment data, as well as the support and reference data.

Primary Data

The primary purpose of the assessment data is to quantify the impact of an assessment in the form of recommended and implemented energy and cost savings. This requires details of both the recommendation savings and plant energy usage to determine the specific and percent impact.

This primary data is mainly used to report the impact of the IAC program and the performance and effectiveness of the centers.

Secondary Data

The secondary purpose of the collected data is to define a profile of both the plant and recommendations. For the plant, this includes the industry type, size, production levels, operating hours, and location. For recommendations, this includes the recommendation type, application, support tools used, and whether a rebate was involved.

These profiles are also a key feature of the public access website. Users can filter all of the assessments to match a specific profile type and determine potential savings ranges for most effective recommendations for the given profile.

Derived Data

The derived data consists of data calculated from the raw assessment data once it has been uploaded. This includes source energy savings for electricity and total energy savings. These derived values are calculated and stored, with the primary and secondary assessment data, when it is originally uploaded. Updates are made whenever any assessment data is modified.

Support/Reference Data

The IAC database also stores extensive support and reference data. This information is used to support the analysis and evaluation of the assessment data. It includes both common and program specific reference data.

Examples of common reference data includes:

- Industry Classifications: Both SIC and NAICS
- Historical National Climate Data: Degree Heating and Cooling Days
- U.S. Zip Codes

Examples of program specific reference data includes

- IAC Centers
- Assessment Recommendation Codes
- IAC Faculty/Staff
- IAC Students

Table Structure

The IAC database started as two data tables with restrictions on data types and available memory, given the technological limitations of the time. Since then, it has grown to over 50 tables, with 5 representing the “core” data.

Core Tables

These “core” tables include:

Table Name	Description
ActLog²	The activity log that tracks dates, contact information, and types of activities.
ASSESS	The assessment table that contains entries of the public data specific to each assessment. This includes plant size, plant energy usage, plant operating hours, etc.
ASSESSP	The assessment table that contains entries of the private data specific to each assessment.
RECC	The recommendation table that contains entries of the public data specific to each recommendation.
RECCP	The recommendation table that contains entries of the private data specific to each assessment.

When a center first schedules and enters an assessment into the system, an entry is created in the ActLog. When the assessment has been completed and the assessment data is uploaded, associated entries are then created in the ASSESS, ASSESSP, RECC, and RECCP tables.

Support Tables

There are several support tables that contain specific types of reference data including:

- SIC: Standard Industrial Code
- NAICS: North American Industry Code System
- ARC: Assessment Recommendation Code
- CENTER: Contains specific contact information and other details

² “ActLog” is the title of the table in the database. Many table and column names were abbreviated due to old restriction on the table and column title length. While the database no longer has any of these restrictions many of the old abbreviated names remain in use.

Data Flow

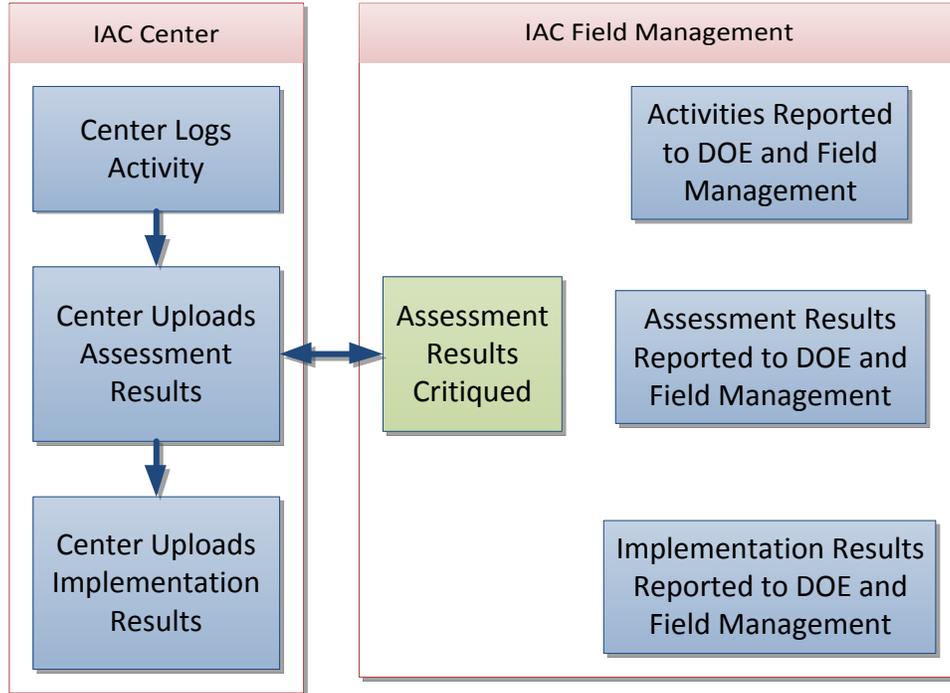


Figure 5: Basic IAC Database Data Flow

Assessment results are critiqued by the field management. If issues or errors are identified, the centers are notified and corrections are made.

Implementation data is not critiqued as it does not consist of any data that can be independently evaluated outside of contacting the plant directly.

Technical Details

The IAC database has been developed with MySQL database server and PHP scripting language. It uses the Apache web server and a Linux based operating system. This configuration is often referred to as LAMP.

Additionally, it incorporates a variety of add-on software packages that provide the capabilities to generate PDF, Excel, Word, and image files dynamically.

Appendix I: IAC Program Details

The IAC

The U.S. Department of Energy (DOE) has been funding industrial energy assessments for small and medium sized manufacturing firms under the auspices of the Energy Analysis and Diagnostic Center/Industrial Assessment Center (EADC/IAC) program since 1974. In October 1995, the centers were tasked to perform only industrial assessments and the name of the program officially changed to the Industrial Assessment Centers. The IAC is managed by the Center for Advanced Energy Systems at Rutgers University. The assessments are performed by teams of faculty and students from accredited engineering schools and universities and have resulted in more than 12,000 assessments and 87,500 recommendations. “Industrial Assessment” centers now target waste streams and productivity improvements in addition to the traditional energy streams.

The IAC program not only benefits the manufacturers served, but it also provides a unique opportunity for the students involved in the program to see a range of manufacturing processes. The government also is able to provide direct support to small and medium sized manufacturers, which in turn potentially become more profitable through increased energy efficiency and pollution prevention measures and therefore increase tax review, and in the process, underwrite the program.

The program is very specific about what plants qualify for these assessments; it is directed at small and medium size manufacturers. Large manufacturers are expected to be able to fund such studies independently through the consulting industry. The scope of the assessments would also be limited by the size resulting in an unacceptably spotty review of plant operations. The audit is available for all types of manufacturing provided the plant's products are within the standard industrial classification codes 20 through 39 and the facility is located within a reasonable distance of the host campus. Generally, a plant must also meet the following criteria:

- Have gross annual sales of \$100 million or less
- Consume energy at a cost greater than \$100,000 and less than \$2.5 million per year
- Employ no more than 500 people
- Have no technical staff whose primary duty is energy analysis

The current IACs are located strategically around the country.

The Centers

Currently, there are a total of 26 IAC centers made up of 31 universities. Schools become active participants via response to an open solicitation of all ABET accredited universities with engineering programs. A complete list of past and presently participating schools is included in “Appendix V: Active and Former Centers”.

Rutgers CAES

Rutgers, the State University of New Jersey participated directly in the Energy Analysis and Diagnostic Center Program as an EADC (IAC) from 1987-92. Professor Michael Muller established this EADC (IAC) to provide mechanical engineering outreach to small and medium size industries within one hundred and fifty miles of Piscataway, NJ. One hundred and sixty five IAC assessments were performed by Rutgers.

The Office of Industrial Productivity and Energy Assessment was established by Rutgers University in 1992 as furtherance of the Universities' commitment to community service by helping the industry with energy, waste, pollution prevention and productivity issues. In 2002, OIPEA became "The Center for Advanced Energy Systems – CAES". Its mission is to provide a range of engineering extension services to the community through the creation and maintenance of partnerships among government, business, interest groups, and educational facilities. As a result of this effort, CAES now contracts with the DOE to participate in field management of the IAC program. Additionally, since 1992, management of the Industrial Assessment Database has been the responsibility of CAES. The CAES is part of the Department of Mechanical and Aerospace Engineering located in the School of Engineering on Busch Campus in Piscataway, New Jersey.

Under the direction of Dr. Michael R. Muller, database operations have been updated and automated to the point where information becomes available to the public within days of receipt by Rutgers. Data transfers are now handled electronically and the information contained within the database is the responsibility of the IAC which produced the report and associated data upload.

Some of the most important benefits of the program activities ongoing at CAES are harder to quantify, but define some of its unique benefits and provide a rationale for its existence at a major state university. In addition to the technology transfer, one of the major goals of the university based technical assistance programs, like those managed by the CAES, is to train students in practical aspects of mechanical engineering for manufacturing.

A major benefit of Rutgers' role in participating in various federal and state programs is the access it gives to policy makers on several levels. In the recent past, Professor Muller has testified before congress, worked with the Office of Technology Assessment (of the Congress) on technical assistance program issues, attended several White House Conferences, sat in on numerous government panels, addressed national meetings of state energy officials, and served as a member of the peer review group for EPRI's Industrial Programs.

Most state universities have, as part of their charter, a service mission to their states and communities. While service takes many forms, technical assistance is very common. Most schools also have an active program in continuing education. The development of agricultural extension services either located at or coordinated by the state university has also occurred in most states. Engineering extension services are less well developed. Some schools have adopted a model similar to the agricultural extension whereby an engineering extension faculty is identified, separate from the academic faculty, and charged with performing a variety of extension services.

The engineering extension model being adopted at Rutgers through the CAES is different. The faculty involved are normal tenured professors with active research programs, teaching and other normal duties. By devoting only part of their efforts to extension work, the impact is clearly reduced. However, the technical challenges of industry today are so sophisticated that it is necessary that such highly qualified people to staff the program. Critical, expensive decisions often result from recommendations made by university personnel and it is imperative that the university insure that the highest quality information is provided. This is requiring a change of attitudes at universities and Rutgers is leading the way. It is likely that accountability will become an important issue at state schools in the near future and operations like the CAES will add important contributions to the overall "deliverables" of the university.

For more information about CAES, please contact:

**The Center for Advanced Energy Systems
School of Engineering, Rutgers University
Piscataway, NJ 08854-8003
Voice: (732) 445-5540 Fax: (732) 445-0730
email: database@caes.rutgers.edu**

The Industrial Assessment Process

Industrial assessment clients may be located by a Center as a result of direct solicitation, client referral, or contact via business associations and trade groups. An extensive data gathering function ensues during which energy/waste bills are screened and the potential client is qualified. Clients must meet criteria concerning energy usage, plant size, geographical location, and number of employees. Next the University's professor led team normally performs a one day site visit at an industrial plant. The visit entails discussions with plant management, plant tours, and measurement of various operational parameters.

Following the site visit, the assessment team prepares a written report for the manufacturer which includes information about the plant's energy use, processes, waste handling and other operations. In addition, each report contains several specific recommendations (termed Assessment Recommendations or ARs) written up with sufficient engineering design to provide for anticipated savings, implementation costs, and simple payback. Data from this report is also formatted into a spreadsheet boilerplate that is uploaded to the database managers for inclusion in the program database.

Following an appropriate interval (usually between six and nine months) the IAC again contacts the manufacturer to follow up on the recommendations made in the report to determine the level of implementation. Implementation reports are also formatted to boilerplates and electronically transferred for inclusion in the program database (for more information regarding data uploads by centers, see the section entitled "The Data").

Appendix II: Core Table Structures

ASSESS Table (Assessments)

Field Name	Type	Description	
1	id	Character	Unique identifying number given to all records based on IAC Name and Report Number. This number is used when linking the two databases.
2	iac	Character	The identifier assigned to each IAC (see “University Contributions”).
3	repnum	Numeric	The number assigned by the IAC to their visit and subsequent report.
4	visitdate	Date	The date the assessment was performed.
5	sic	Numeric	The Standard Industrial Classification that represents the principle product manufactured by the plant.
6	sales	Numeric	The annual sales in dollars for the site reported by the client.
7	employees	Numeric	The total number of employees on the site as reported by the assessment client.
8	plant_area	Numeric	The total amount in square feet of area used for production and office support purposes.
9	products	Character	Principle products of the plant (in words).
10	resources	Numeric	Total number of resources tracked at the plant.
11	produnits	Numeric	The units of production for the principle product (see “Produnits Coding”).
12	prodlevel	Numeric	The total number of units produced annually as reported by the assessment client.
13	prodhours	Numeric	Client reported annual production hours.
14	numars	Numeric	The total number of ARs recommended in this report.
15	sourc_elec	Numeric	Energy consumed at source to produce consumed electricity at site.
16-42		Numeric	The annual usage and cost of electrical consumption, electrical demand, electrical fees, natural gas, L.P.G., fuel oil #2, fuel oil #4, fuel oil #6, coal, wood, paper, other gases and others – taken from actual bills provided by the client prior to the assessment (see “Resource Identification Code”).
43	nrgcosttot	Numeric	Total energy cost for this client. Figure is produced by summing energy costs reported in columns 15-38.
44-55		Numeric	The annual production and cost of waste: water disposal, non-hazardous liquid, hazardous liquid, non-hazardous solid, hazardous solid, and gaseous waste in dollars and waste stream units. (see “Resource Identification Code”).
56	wstcosttot	Numeric	Total waste cost for the client. Figure is produced by summing the waste costs reported in columns 40-51.
57	comments	Character	General comments about the assessment.
58	fy	Numeric	The fiscal year in which the assessment was performed.
59	state	Character	The state in which the assessment was performed.
60	tdays	Numeric	The amount of days spent on site doing assessment
61	NAICS	Numeric	The North American Industry Classification System
62	BPUSED	Boolean	Flagged if DOE-ITP Best Practice Tool Used
63	HP_CAP	Numeric	Total Facility HP of Motors
64	HP_MAX	Numeric	Maximum HP on single unit
65	STEAM_CAP	Numeric	Total Facility Steam Capacity
66	STEAM_MAX	Numeric	Maximum Steam Pressure
67	AIR_CAP	Numeric	Total Facility Compressed Air Capacity
68	AIR_MAX	Numeric	Maximum Air Pressure

RECC Table (Recommendations)

	Field Name	Description
1	superid	The unique identifying number given to all records based on IAC Name, Report Number and the Assessment Recommendation Number.
2	id	Unique identifying number given to all records based on IAC Name and Report Number. This number is used when linking the two databases
3	ar_number	The recommendation number as it appears in the report.
4	appcode	Application for recommendation (see ARC List).
5	arctype	Recommendation type (see ARC List).
6	arc	The code representing the specific recommendation made (see ARC List).
7	impdate	Client reported date of implementation of this Assessment Recommendation.
8	impstatus	Client reported implementation status of this Recommendation (see "Implementation Status").
9	impcost	Client reported implementation cost. (This cost may be estimated)
10	psourcode	The Primary Resource coded per "Resource Identification Code". This resource may not necessarily be the most important resource involved in the Assessment Recommendation, but it is usually chosen based on greatest usage before conservation measures are suggested.
11	pconserved	The amount of primary resource conserved (see "Resource Identification Code").
12	psourconsv	The primary energy consumed at the source needed to produce the consumed energy at site
13	psaved	The primary resource's dollar savings for this Assessment Recommendation.
14	ssourcode	The Secondary Resource involved in this Assessment Recommendation (see also "Resource Identification Code"). This resource is usually chosen based on second highest amount of usage before conservation measures are suggested.
15	sconserved	The amount of secondary resource conserved (see "Resource Identification Code" for units).
16	ssourconsv	The secondary energy consumed at the source needed to produce consumed energy at site
17	ssaved	The secondary resource's dollar savings for this Assessment Recommendation.
18	Tsourcode	The Tertiary Resource involved in this Assessment Recommendation (see "Resource Identification Code"). This resource is usually chosen based on second lowest amount of usage before conservation measures are suggested.
19	tconserved	The amount of tertiary resource conserved
20	tsourconsv	The tertiary energy consumed at the source needed to produce consumed electricity at site
21	tsaved	The tertiary resource's dollar savings for this Assessment Recommendation.
22	qsourcode	The Quaternary Resource involved in this Assessment Recommendation (see "Resource Identification Code"). This resource is usually chosen based on the least amount of usage before conservation measures are suggested
23	qconserved	The amount of quaternary resource conserved
24	qsourconsv	The Quaternary energy consumed at the source needed to produce consumed energy at site
25	qsaved	The quaternary resource's dollar savings for this Assessment Recommendation.
26	rebate	Indicative whether the Assessment Recommendation included a rebate for implementation.
27	incremental	Indicates if the Assessment Recommendation is to be implemented on an incremental basis. Incremental data is included in the database for the first two years only.
28	descript	Description in words of the individual Assessment Recommendation.
29	imp_comm	Description of any variation between suggested recommendation and actual implementation.
30	fy	The fiscal year in which the assessment was performed.
31	lc_capital	The capital (equip. & material) cost of a recommendation.
32	lc_other	Implementation costs that are not capital costs.
33	p3-ees	Effective energy savings resulting from an improvement in energy efficiency.
34	Payback	Payback period for recommendation.
35	BPTOOL	What DOE-ITP Best Practice Tool (if any) was used for the recommendation

Appendix III: Database Coding Systems

Implementation Status

The database uses a numerical code to represent the status of implementation. The following table provides details to the coding scheme:

Code	Implementation Status	
I	IMPLEMENTED	Was completely implemented at the time of the call, or plans were definitely made to complete implementation within 12 months of call (not to exceed 24 months from the assessment date)
P	PENDING	This status is for recommendations with implementation costs of \$10,000 or more. Delay in implementation should be attributable to large capital investment.
N	NOT IMPLEMENTED	
K	DATA EXCLUDED OR UNAVAILABLE	K status may be assigned ONLY by field managers.

Figure 6: Implementation Status Codes

- A list of “Pending” implementations will be kept for each center; for each Pending implementation, a yearly report will be required from the center until the implementation can be identified as either Implemented or Not Implemented.
- If, after 3 years, a Pending implementation cannot be identified as Implemented, it shall be changed to Not Implemented.
- Pending implementations will not be counted when determining which implementations are Implemented and Not Implemented

Production Units (Produnit) Coding

The database uses a numerical code to represent units of production. In some industries such units are not very informative and so in many cases this item is left out. The following table provides details to the coding scheme.

Code	Units
0	Not Available
1	Pieces
2	Pounds
3	Tons
4	BBL
5	Thousand Gallons
6	Thousand Feet or Thousand Square Feet
7	Bushels

Figure 7: Production Unit Codes

Rejection Codes³

When a recommendation is not adopted attempts are made to determine the reasons surrounding the negative decision. The database uses a numerical code to represent the reason for rejection. The following table provides details to the coding scheme.

Code	Reason
1	Unsuitable return on investment
2	Too expensive initially
3	Cash flow prevents implementation
4	Unacceptable operating changes
5	Impractical
6	Process and/or equipment changes
7	Facility change
8	Personnel changes
9	Production schedule changes
10	Material restrictions
11	Bureaucratic restrictions
12	To be implemented after 2 years⁴
13	Considering
14	Lack of staff for analysis and/or implementation
15	Not worthwhile
16	Disagree
17	Risk or inconvenience to personnel
18	Suspected risk or problem with equipment or product
19	Rejected after implementation failed
20	Unknown
21	Could not contact plant
22	Other

Figure 8: Rejection Codes

³ Currently, Rejection Codes are not publicly available due to confidentiality concerns

⁴ No longer used

Resource Identification Codes

The database uses a numerical code to represent the various resource streams tracked. The following table provides details to the coding scheme.

STREAM TYPE	STREAM	CODE	CONSUMPTION UNITS
ENERGY	Electrical Consumption	EC	KWH(site)
	Electrical Demand	ED	MMBtu(source) kW-months/year
	Other Electrical Fees	EF	n/a
	Electricity	E1 ⁵	KWH(site)
	Natural Gas	E2	MMBtu
	L.P.G	E3	MMBtu
	#1 Fuel Oil	E4	MMBtu
	#2 Fuel Oil	E5	MMBtu
	#4 Fuel Oil	E6	MMBtu
	#6 Fuel Oil	E7	MMBtu
	Coal	E8	MMBtu
	Wood	E9	MMBtu
	Paper	E10	MMBtu
	Other Gas	E11	MMBtu
Other Energy	E12	MMBtu	
WASTE REDUCTION	Water Disposal	W1	Gallons
	Other Liquid (non-haz)	W2	Gallons
	Other Liquid (haz)	W3	Gallons
	Solid Waste (non-haz)	W4	Pounds
	Solid Waste (haz)	W5	Pounds
	Gaseous Waste	W6	Pounds
RESOURCE COSTS	Personnel Changes	R1	n/a
	Administrative Costs	R2	n/a
	Primary Raw Material	R3	n/a
	Ancillary Material Cost	R4	n/a
	Water Consumption	R5	n/a
	One-time Revenue or Avoided Cost	R6	n/a
PRODUCTION	Primary Product	P1	n/a
	By-product Production	P2	n/a
	Increase in Production	P3	%

Figure 9: Resource Stream Codes

⁵ E1 was replaced with EC, ED, and EF as of FY 95 (9/30/95).

Appendix IV: Resource Streams

Energy Streams (E)

The energy streams, with the exception of electricity, remain unchanged in the data sets. All units are in MMBTU for comparison purposes. With quaternary data reporting and subsequent database inclusion, the possibility exists for recommendations to include four energy streams.

EC – Electrical Consumption

Electrical consumption, EC, refers to actual electric energy used in the facility. The units for this resource are in KWHs. On Version #8 the units were changed from MMBtus to KWHs for clarity.

Ex. Lighting throughout the plant is currently provided by conventional light bulbs. Recommended action is to replace existing bulbs with those of reduced wattage. There will be savings in electrical energy consumption (EC) and also in demand (ED) based on annual demand avoided which is calculated from the differential wattage of all bulbs in a given year.

ED – Electrical Demand

Electrical demand, ED, accounts for any charge applied by the utility company to serve peak loads. Demand should be reported in kilowatt-months /year.

Ex. Certain equipment in the plant is operated intermittently during an 18-hour period. Recommended action is to move all operations of the equipment to nighttime off-peak hours. Though there will be no energy savings (EC), the electrical demand (ED) will be reduced.

EF – Other Electrical Fees

Electrical fees are total electric billing less the consumption cost and the demand cost. Electric consumption, demand and fees must add up to the electric bill. There are no units associated with this stream.

Ex. The manufacturing company pays its electrical bills. Filing for sales tax credit for electricity used in manufacturing process is recommended. The total tax burden will be lowered (EF).

Ex. A company is operating an electric annealing furnace. Recommended action is to replace the electric furnace with a gas furnace. The electrical consumption charge (EC), demand charge (ED), and the electrical service fees (EF) will be lower, however there is an increase in gas usage (E2).

E2 – Natural Gas

Natural gas is a gas consisting primarily of methane and various other hydrocarbons or inert gases. Natural gas consumption is typically expressed in units of therms, where 1 therm =100,000 Btu.

E3 – Liquefied Petroleum Gas, L.P.G.

LPG is a mixture of hydrocarbon gases used as a fuel in heating appliances and vehicles. LPG includes mixes that are primarily propane, mixes that are primarily butane, and mixes including both propane and butane.

E4 – #1 Fuel Oil

Fuel Oil No. 1 is similar to kerosene and is the fraction that boils off right after gasoline during the distillation process.

E5 – #2 Fuel Oil

Fuel Oil No. 2 is diesel fuel, which is commonly used in trucks and cars. It is also referred to as heating oil.

E6 – #4 Fuel Oil

Fuel Oil No. 4 is a blend of distillate and residual fuel oils, such as Fuel Oils No. 2 and No. 6. Fuel Oil No. 4 may be classified as diesel, distillate or residual fuel oil.

E7 – #6 Fuel Oil

Fuel Oil No. 6 is called residual fuel oil or heavy fuel oil. Fuel Oil No. 6 is what remains of crude oil after gasoline and the other distillate fuels are extracted through distillation.

E8 – Coal

Coal is a fossil fuel which is composed primarily of carbon along with variable quantities of other elements. There are a variety of classifications of coal pertaining to its geological process of formation and molecular makeup. From hardest to softest or highest to lowest heating value, coal can be classified as: Anthracite, Bituminous, Sub-bituminous, Lignite and Peat.

E9 – Wood

Burning of wood is currently the largest use of energy derived from a solid fuel biomass. Wood fuel may be available as firewood, charcoal, or by-products of industrial processes such as: wood chips, pellets and sawdust.

E10 – Paper

Paper is a thin material mainly used for writing and printing upon. It is produced by pressing together moist fibers, typically cellulose pulp derived from wood or grasses, and drying them into flexible sheets. Waste paper can be processed and burned as fuel for heating.

E11 – Other Gas

Other Gas includes the use of gaseous fuels as part of the energy streams that do not fall into the previous categories such as: gasoline used for transportation.

E12 – Other Energy

Other Energy includes any energy source, whether it is solid, liquid or gaseous, as part of the energy streams that do not fall into any of the previous categories.

Waste Streams (W)

Waste stream tracking is integral to pollution prevention and waste minimization opportunity analysis. Waste stream classification is by physical properties such as liquid, solid, or gas and capability for causing harm (hazardous versus non-hazardous). A brief description of each waste stream type and a brief example illustrating the application of each classification follows:

W1 – Water Disposal

Water disposal, W1, refers simply to any water-based solution leaving the plant through the public sewage system for treatment. The units associated with water disposal are gallons.

Ex. Water used as process coolant is currently dumped into the manufacturers' metered sewage system in large quantity. The recommended IAC measure includes the installation of a heat exchanger and water circulator. Water disposal cost and volume reductions are coded as W1. Additional savings relate to energy cost reduction coded in a similar fashion (electrical consumption, EC, in this case) and water purchase reductions (R5).

W2 – Other Liquid (non-hazardous)

Waste Stream, W2, applies to liquid waste leaving the facility by means other than the public sewer. This liquid is classified as non-hazardous. The units for the stream are in gallons.

Ex. Ethylene glycol is used in a plant to cool equipment. The recommended action specifies the collection of the used liquid as opposed to the prior practice of waste disposal into the sewer. The ethylene glycol collected (liquid nonhazardous, W2) is to be sold to an outside recycling firm.

W3 – Other Liquid (hazardous)

Other liquid (hazardous), W3, refers to hazardous liquid material requiring treatment before disposal. The units are in gallons.

Ex. A plant uses trichloroethane-1, 1, 1 for cleaning process material before painting. Currently, the company pays an outside firm to dispose of this liquid hazardous waste. A still is recommended to recycle the polluted solvent. The resulting reduction in the amount of liquid waste produced (W3) from the cleaning process lowers the disposal cost of the trichloroethane-1, 1, 1 liquid. Additional savings will be realized from smaller purchase needs of cleaning fluid (not coded) while new expenses accrue from still bottom disposal (solid hazardous waste, W5).

W4 – Solid Waste (non-hazardous)

Waste stream, W4, refers to solid materials classified as non-hazardous. The waste units are pounds.

Ex. Raw materials are shipped into a plant in bags stacked on wood pallets for easy forklift handling. Currently the company personnel are disposing of the pallets in the dumpster. The recommendation presented suggests burning the pallets to provide process heat. Solid non-hazardous waste volume (W4) decreases along with energy purchases, in this case natural gas (E2).

W5 – Solid Waste (hazardous)

In contrast to waste stream, W4, the waste stream, W5, refers to those substances which are classified as hazardous solid waste. The units for this waste stream are also in pounds.

Ex. Energy efficient lighting measures are currently being implemented by a manufacturer to save electricity costs. Changing out the light bulbs also requires replacement of the old ballasts. These older model ballasts contain hazardous PCBs. When these ballasts are removed, the plant is charged for disposal based on the combined total weight of the ballasts (approximately 3 pounds each) and the PCB containing capacitor (approximately 1 ounce each). If the contaminated capacitor is removed and disposed of separately as hazardous waste (W4), the remaining portion of the ballast can be recycled. Hazardous waste volume and associated cost decreases substantially and are partially offset by the recycling income (not coded).

W6 – Gaseous Waste

The waste stream, W6, refers to gases emitted into the atmosphere. The units for this stream are pounds.

Ex. A metal separation and recycling plant pays permitting fees and heavy emission fines as a function of the amount of cyanide fumes released into the atmosphere. These emissions result from uncovered liquid vats losing product to evaporation. The recommendation for the installation of fume collection and condensation units for each vat will result in gaseous waste (W6) savings, ancillary material (R4) purchase savings, administrative cost reductions (R2), and a slight increase in electricity usage (not coded).

Resource Costs (R)

Resources other than energy are directly tracked in the IAC program database. Important matters such as personnel changes, material costs, water costs and administrative considerations can be broken down into separate recommendations.

R1 – Personnel Changes

For many Assessment Recommendations an additional amount of work may result (the opposite may also be true). Thus, personnel changes (R1) must be considered.

Ex. For a natural gas refinery, the installation of a cogeneration system is recommended for in-house electricity generation and the sale of excess energy production. To manage the system properly, a skilled professional must be added to the payroll as a recurring cost. This is not a one-time cost. This personnel cost (R1) is tracked along with electricity production (EC) and natural gas usage (E2).

R2 – Administrative Costs

Administrative costs (R2) represent any fees or charges which are not directly related to the production process. These costs include taxes, inventory control, and late fees on billing.

Ex. The purchase of a manufacturing facility's process equipment is recommended in lieu of current leasing agreements. In this instance, there are greater tax deductions allowed for equipment depreciation with ownership compared to the benefits of leasing. A net decrease in tax payments (administrative costs, R2) helps improve the payback of the process machinery purchases.

R3 – Primary Raw Material

Many process changes may result in the savings of a primary raw material. Therefore, raw material costs (R3) can be considered while assessing recommendations.

Ex. A plastics plant rejects deformed bottles as part of the quality control process. If these bottles can be reground and reused in the process as recommended, the primary raw material (R3) cost can be reduced. Additional savings will result from decreased non-hazardous solid waste disposal (W4) and electricity costs (EC) will increase.

R4 – Ancillary Material Cost

As with the cost of primary raw materials, a cost savings may result from a decrease in the use of an ancillary material. An ancillary material is any additional material other than the primary materials.

Ex. A children's furniture manufacturer uses standard spray guns to paint the exterior of each item. Overspray reduction recommendations require installation of high volume, low pressure paint nozzles. The ancillary cost (R4) for paint will decrease. There will also be a reduction in gaseous waste (W6) for environmental losses and reduced electrical usage (EC) due to the lower compressed air pressure.

R5 – Water Consumption

Although water consumption (R5) is usually overlooked when assessing utility bills, it is usually a large cost to the plant. This consumption is recorded in dollars.

Ex. A chemical plant currently ships their product as an aqueous based solution. Process alterations are recommended by the IAC allowing the company to package the product in bulk powder form. Savings result from water consumption (R5) reductions and decreased transportation costs (Fuel E11). Additional cost accrues from increased product handling requirements (Personnel changes R1).

R6 – One-time Revenue or Avoided Cost

There are times when a recommendation not only includes annualized savings, but also a one-time cost savings or increase in revenue. A new resource stream, R6, has been introduced in the database for such cases of one-time savings. In the past, these types of cost benefits were included in the implementation cost and should now be reported as their own resource streams.

Ex. A facility is in the process of replacing an old 100 hp compressor with a new, more efficient 100 hp compressor. The IAC has determined that this unit is oversized and that a new and efficient 80 hp unit should be purchased instead. Since the facility already budgeted for the 100 hp unit and since the 80 hp unit is cheaper and will consume less energy, there will be a yearly electricity consumption (EC) savings as well as a one-time avoided cost (R6) by purchasing the smaller compressor. The AR will also reflect a \$0 implementation cost.

Ex. A glass company produces both clear and colored glass. The clear glass can be re-melted in the furnaces as cullet, but the colored glass cannot. 1,500 tons per year of colored glass is rejected and over the years, the company has acquired many tons of the rejected glass and has stored it outside of the facility. A recycler has been located which will come and haul away the scrap and will also contract with the glass manufacturer to buy the yearly production of rejected colored glass. There will be a yearly income from the recycler (P2) and also one-time revenue for the initial sale of the “alps” to the recycler (R6).

Production Streams (P)

Production stream tracking will allow data analysis of recommendations involving productivity methods such as Total Quality Management initiatives and other innovative strategies.

P1 – Primary Product without improvement in energy efficiency

The primary product stream (P1) refers to anything which directly effects cost of production but not energy efficiency. This may include any changes which affect production cost per unit or the amount of time needed for production.

Ex. The manufacturer should improve packaging of the product to prevent damage in shipment. Previously a number of products shipped to customers were damaged in transit and had to be shipped back to the manufacturer for repair. Improved packaging has reduced the number of products damaged in shipping.

P2 – By-product Production

By-products (P2) are salable items which are secondary results of the primary product. It is anticipated that markets can be found for these items, thereby improving the profits of the plant.

Ex. A furniture maker is currently burning sawdust produced and collected by his main process. A local horse breeder is found who can purchase the sawdust. Increased income due to sale of the sawdust appears as increased by-product production (P2). There would also be an increase in energy costs due to the reduction in wood burning (E9).

P3 – Primary Product with improvement in energy efficiency

The primary product stream (P3) refers to anything which directly effects energy needed to produce a given number of products. This may include any changes which affect production cost per unit or the amount of time needed for production.

Ex. A manufacturer currently produces 100 garbage cans in 1 hour of which 5 are rejected by plant inspection personnel. The quality control problems are linked to unreadable instruments on key machinery. This situation was rectified through the recommended instrument cleaning program resulting in a usable production of 99 cans per hour, an increase of 4% (P3). The result of this is an increase in production of garbage cans without the need for additional energy.

Appendix V: Active and Former Centers

P = Primary Center Location, S = Satellite Center attached to Primary Center

Active IAC Centers

Abbr.	University	First FY	First Report #	Level
AM	Texas A&M - College Station	87	1	P
BS	Boise State University	12	1	P
BS	University of Idaho	12		S - BS
BS	Idaho State University	12		S - BS
BD	Bradley University	94	1	P
CO	Colorado State University	84	1	P
IA	Iowa State University	91	1	P
IP	Indiana University – Purdue University	12	1	P
LE	Lehigh University	01	101	P
MA	University of Massachusetts	84	1	P
MI	University of Miami	01	101	P
MZ	University of Missouri – Columbia	07	1	P
MZ	Southeast Missouri State	12		S -MZ
NC	North Carolina State University	93	1	P
OK	Oklahoma State University	82	17	P
OR	Oregon State University	87	1	P
SD	San Diego State University	91	1	P
SF	San Francisco State University	93	1	P
SU	Syracuse University	01	101	P
TN	University of Tennessee	81	102	P
TT	Tennessee Tech	07	1	P
TT	University of Memphis	07		S - TT
TT	East Tennessee State	07		S - TT
UA	University of Alabama	07	1	P
UD	University of Dayton	81	16	P
UK	University of Kentucky	12	1	P
UM	University of Michigan - Ann Arbor	94	1	P
WM	Univ. of Wisconsin - Milwaukee	12	1	P
WV	West Virginia University	93	1	P

Figure 10: Active IAC Centers

Former IAC Centers

Abbr.	University	First FY	Last FY	First Report #	Last Report #	Level
AR	Univ. of Arkansas - Little Rock	93	0	1	197	P
AS	Arizona State University	90	6	1	390	P
DS	South Dakota State University	94	0	1	175	P
GT	Georgia Tech Research Institute	82	12	110	n/a	P
HO	Hofstra University	91	0	1	238	P
IC	University of Illinois - Chicago	01	12	1	n/a	P
KG	Texas A&M - Kingsville	94	97	1	100	P
KU	Kansas University	81	0	16	554	P
LL	Louisiana University - Lafayette	01	12	101	n/a	P
LT	Louisiana Tech	84	89	1	144	P
LM	Loyola Marymount University	01	07	1	125	P
ME	University of Maine	93	0	101	305	P
MO	University of Missouri - Rolla	90	0	1	295	P
MS	Mississippi State University	94	12	1	n/a	P
ND	Notre Dame University	91	0	1	366	P
NV	University of Nevada	94	0	1	170	P
OD	Old Dominion University	94	0	1	175	P
TP	Prairie View A&M	99	0	1	19	P
RU	Rutgers, The State Univ. of NJ	87	92	1	165	P
ST	Stevens Institute of Technology	84	86	1	80	P
TA	University of Texas - Arlington	1	6	1	87	P
TS	Tri-Cities University	84	85	1	33	P
UL	University of Louisville	94	0	101	249	P
UF	University of Florida	91	12	1	n/a	P
UU	University of Utah	1	6	1	67	P
UW	University of Washington	07	11	1	54	P
WI	Univ. of Wisconsin - Milwaukee	87	6	1	480	P

Figure 11: Former IAC Centers