Indoor Environment Quality + Workplace Environment Hennepin Energy Recovery Center (HERC) Administration Building, Report 1

June 2014, Minneapolis, MN
Sustainable Post-Occupancy Evaluation Survey (SPOES)
B3 Guidelines

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1.0 Overview

The purpose of this report is to examine the connection between sustainable design criteria used in the design of the Hennepin Energy Recovery Center (HERC) Administration Building (hereafter referred to as HERC) and employees' satisfaction with their work environments. HERC was designed using the B3 Guidelines (formerly known as the Minnesota Sustainability Guidelines or MSBG) and completed for occupancy in 2013. The B3 Guidelines track specific state-funded buildings as a means of demonstrating real outcomes aimed at the conservation of energy resources, creation and maintenance of healthy environments, and occupants' satisfaction with their work environments. The Sustainable Post-Occupancy Evaluation Survey (SPOES) was developed to assess human outcomes in classroom and workplace settings in compliance with the project tracking requirements for the B3 Guidelines. The survey was conducted in June 2014 and serves as the first of two required POE events.

This SPOES report focuses on employees' satisfaction with the physical environment as related to 15 indoor environment quality (IEQ) criteria such as lighting, thermal, and acoustic conditions in their primary workspaces, i.e., offices. Employees' satisfaction with the facility (site, building, and interior) and the effect of the facility's physical environment on employees' perceptions of their work performance and health are included. The report provides descriptive information about employees' perceptions of the IEQ with their primary workspace. This information serves the broader development of knowledge regarding the influence of IEQ on employees. Finally, a brief look at employees' commuting and physical activities within the building are also reported.

2.0 Method

SPOES consists of a self-administered, Internet-based, questionnaire submitted to and completed by employees. The SPOES questionnaire has been tested for **validity (**measures what it is intended to measure) and **reliability (**repeatability or replicability of findings) in studies involving similar facilities and employees. Employees rate their level of satisfaction on a **Likert-type scale** (measurement scale) from 1 (very dissatisfied) to 7 (very satisfied) with IEQ of the facility and their primary workspaces. They also rate the influence of their physical environment on their perception of their work performance and health on a scale from 1 (hinders) to 7 (enhances). There were no physical measurements taken of environmental conditions such as temperature or acoustic level. This study is limited to employees' perceptions.

The report provides a descriptive summary of the results stated as a **mean** (M) (average of all responses), **standard deviation** (SD) (how different scores are from each other and the mean), and **number of responses** (N) for questions analyzed. The mean for a 7-point scale is 4.00. Lower or higher means reflect stronger tendencies towards dissatisfaction/satisfaction and hinders/enhances. Means that are close to the center of the scale (4) are considered to be neither dissatisfied/hinders or satisfied/enhances.

When interpreting **mean** responses, the following labels were used:

- 1-3.99 dissatisfied (hinders)
- 4-4.49 neither satisfied (enhances) or dissatisfied (hinders)
- 4.5-7 satisfied (enhances)

An IEQ Satisfaction Score is also calculated for employees' satisfaction with IEQ in their primary workspaces. This is a statistical combination of all IEQ scores for selected 'overall' criterion, which results in a single IEQ Satisfaction Score for all employees on all IEQ criteria and is reported in an IEQ Scorecard.

2.1 Description of the Questionnaire

Employees first rate their level of satisfaction with the facility and the influence of their physical environment on their perception of their work performance and health. Then they respond to questions about their satisfaction with their primary workspaces in relation to the IEQ criteria. The questionnaire uses IEQ criteria from the B3 Guidelines and relates each of them to employees' satisfaction with their physical environment.

Criteria include (in alphabetical order):

1. Acoustic Conditions
2. Appearance
3. Cleaning and Maintenance
4. Daylighting Conditions
5. Electric Lighting Conditions
6. Function
7. Furnishings
8. Indoor Air Quality
9. Lighting Conditions
10. Personal Adjustability Conditions
11. Privacy
12. Technology
13. Thermal Conditions
14. Vibration and Movement
15. View Conditions

However, there are about 25 IEQ (see Table 3) questions that represent the IEQ criteria. Some of the criteria are broader such as Function or Indoor Air Quality, and there is only one 'overall' question about it to which employees respond. Other criteria have additional questions to provide greater detail about the condition. For example, Thermal Conditions has an 'overall' question and three other questions related to temperature, humidity, and air velocity (draft). Acoustic Conditions is also an 'overall' question with others related to employees' ability to hear desired sounds and ability to limit undesired sounds. Lighting Conditions has questions related to Daylighting Conditions and Electric Lighting conditions and the quantity and control of each.

2.2 Limitations

Employees' participation is voluntary, and responses are self-reported. As is true with all survey research, the responses indicate employees' perceptions. There were no physical measurements of the environment taken, e.g., temperature, humidity, or lighting levels.

3.0 Sample Description

3.1 Building Description

The HERC facility is located at 417 North Fifth Street, Minneapolis, Minnesota, and was developed in tandem with a multi-faceted project involving a community plaza, transportation center, parking facility,

and office space (See Figure 1). The site is located in the North Loop area, adjacent to the warehouse district and Minneapolis downtown business environment. The building complex is near Target Field, home of the Minnesota Twins® and adjacent to Target Center, home of the Minnesota Timberwolves. Target Field Station (formerly referred to as the Interchange building) serves as a central hub for of the Metropolitan Transit public bus service, the Blue Line LRT (Hiawatha Light Rail Transit), Northstar Commuter Rail, and the Green Line (Central Corridor Line). Future expansions of the LRT are proposed into the Southwest and Northwest communities around the metropolitan area (http://www.hennepin.us/your-government/facilities/hennepin-energy-recovery-center).

Figure 1. HERC main facility and adjacent spaces (Photo credit http://www.covanta.com/en/facilities/facility-by-location/hennepin/about.aspx)

The HERC facility is owned by Hennepin County and operated by Covanta Energy, Inc. The building includes 15,000 square feet (sf) of parking on the ground level and 15,000 sf of office space on the 2nd floor. It stands adjacent to the main HERC building, which serves as a waste-to-energy facility and converts disposable waste to a renewable energy for the adjacent North Loop area and downtown district business environment (http://www.hennepin.us/your-government/facilities/hennepin-energy-recovery-center). In addition to pursuing the B3 Guidelines, the HERC facility received LEED Certification as a BD+C: New Construction V3 facility in 2014. This report contains the results of the SPOES issued to employees having workspace in the HERC.

3.2 Description of Respondents

The HERC facility has approximately 46 employees at this location. The response rate to the questionnaire was approximately 33% (N=15). Of those responding, 93% were male and 7% were female. The mean age of respondents was slightly over 46 years, with a range of 27 to 64 years.

Prior to relocating to the current site in 2013, employees working in the new HERC facility had office space in the main HERC building since 1989. All but 13% of the respondents had worked at the new site since it opened in 2013. Relating to hours worked during a typical week at the HERC facility, 86% of the employees reported they spend 40+ hours a week in the facility, 7% spend 30-40 hours in the facility,

and 7% spend less than 20 hours in the facility. Relating to the percentage of time employees spend per week in their primary workspace, 37% of the employees reported they spend more than 75% of their time per week in their primary workspace, 47% spend 51-75% of their time per week in their primary workspace, 7% spend 25-50% of their time per week in their primary workspace, and 19% spend less than 25% of their time per week in their primary workspace.

The HERC facility provides private offices, shared offices, and desks in open office environments serving as primary workspaces. Results indicated 53% of the employees had private offices, 7% share private offices with others, 7% worked at a desk in an open office area, and 33% worked in other areas throughout out the building or from home. Employees also indicated that 60% of their primary workspaces were located within 15 feet of an exterior window and 40% of the employees were not.

4.0 Findings and Discussion

4.1 HERC Facility (Site, Building, and Interior): Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning their overall satisfaction with the HERC facility (site, building, and interior) as related to their work performance and their health. Results indicated that employees were **satisfied** (**M= 6.07**) with the HERC facility (building, site, and interior). They also reported that their overall **work performance** was **enhance**d (**M = 5.8**), and their overall **health** was **enhanced** (**M = 5.67**) by the facility. Table 1 and Figure 2 show a summary and interpretation of their responses.

Table 1 Overall satisfaction, work performance, and health related to the HERC facility

HERC facility (site, building, and interior)	N	Mean (1-7)	SD	Interpretation
Overall satisfaction	15	6.07	1.33	Satisfied
Overall work performance	15	5.80	1.15	Enhances
Overall health	15	5.67	0.98	Enhances

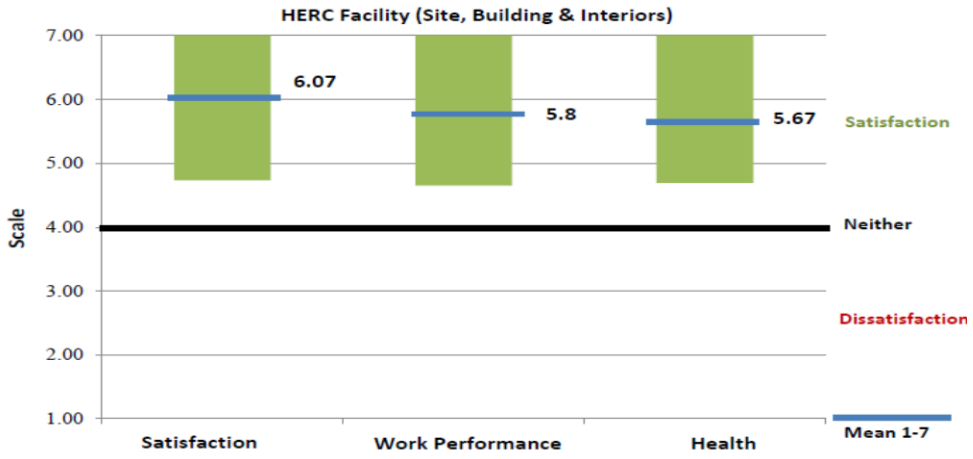

Figure 2 Overall satisfaction, work performance, and health related to the HERC facility

4.2 Primary Workspace: Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning their overall satisfaction and overall perceptions of their work performance and health related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 2 and Figure 3 show a summary and interpretation of their responses. Results indicated that employees were **satisfied** (**M = 5.60**) with their primary workspace, their overall **work performance** was **enhanced** (**M = 5.73**) by their primary workspace, and their overall **health** was **enhanced** (**M = 5.40**) by their primary workspace.

Table 2 Overall satisfaction, work performance, and health related to primary workspace

Primary Workspace	N	Mean (1-7)	SD	Interpretation
Overall satisfaction	15	5.60	1.72	Satisfied
Overall work performance	15	5.73	1.44	Enhances
Overall health	15	5.40	1.12	Enhances

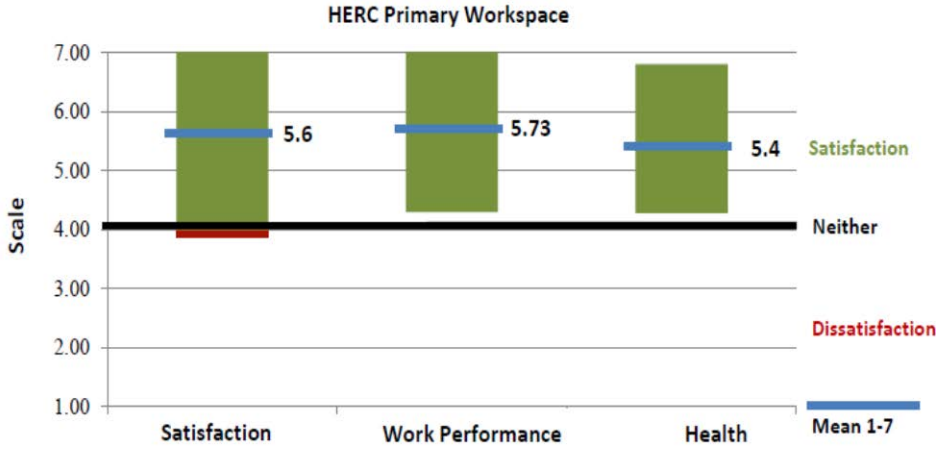

Figure 3 Overall satisfaction, work performance, and health related to primary workspace

4.3 Primary Workspace: Satisfaction with Indoor Environment Quality (IEQ)

Employees responded to questions concerning their satisfaction with IEQ criteria (function, thermal conditions, indoor air quality, acoustic conditions, etc.) related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 3 and Figure 4 show a summary of the means, the standard deviation, and interpretation of their responses.

Results indicate that employees were satisfied with all IEQ criteria associated with their primary workspaces except three: adjustability of thermal conditions, humidity, and overall thermal conditions, with which they were neither satisfied nor dissatisfied.

Table 3 Satisfaction related to IEQ criterions in primary workspace

#	IEQ Criterions	N	Mean (1-7)	SD	Interpretation
1.	**The overall electric lighting**	15	6.00	1.00	Satisfied
2.	**The overall lighting conditions**	15	5.93	1.16	Satisfied
3.	**The amount of electric lighting**	15	5.87	1.19	Satisfied

4.	**The overall cleaning and maintenance**	15	5.73	1.28	Satisfied
5.	**The overall daylighting conditions**	15	5.67	1.63	Satisfied
6.	**The overall technology**	15	5.60	1.64	Satisfied
7.	**The adjustability of your task lighting**	15	5.60	1.55	Satisfied
8.	**The overall furnishings**	15	5.60	1.72	Satisfied
9.	**The amount of daylighting**	15	5.60	1.59	Satisfied
10.	**The overall view conditions**	15	5.47	1.77	Satisfied
11.	**The overall appearance (aesthetics)**	15	5.40	1.88	Satisfied
12.	**The overall function**	15	5.40	1.72	Satisfied
13.	**The overall privacy**	15	5.20	1.42	Satisfied
14.	**The ability to hear desired sounds**	15	5.20	1.52	Satisfied
15.	**The adjustability of the daylighting**	15	5.13	1.88	Satisfied
16.	**The adjustability of the electric lighting**	15	5.07	1.62	Satisfied
17.	**The overall indoor air quality**	15	4.93	1.87	Satisfied
18.	**The air velocity (drafty or stagnant)**	15	4.87	1.73	Satisfied
19.	**The overall vibration and movement**	15	4.73	1.83	Satisfied
20.	**The temperature (hot or cold)**	15	4.53	1.30	Satisfied
21.	**The ability to limit undesired sounds**	15	4.53	2.03	Satisfied
22.	**The overall acoustic quality**	15	4.53	1.92	Satisfied
23.	**The adjustability of the thermal conditions**	15	4.40	2.03	Neither S or D
24.	**The humidity (dry or moist)**	15	4.33	1.80	Neither S or D
25.	**The overall thermal conditions**	15	4.33	1.45	Neither S or D

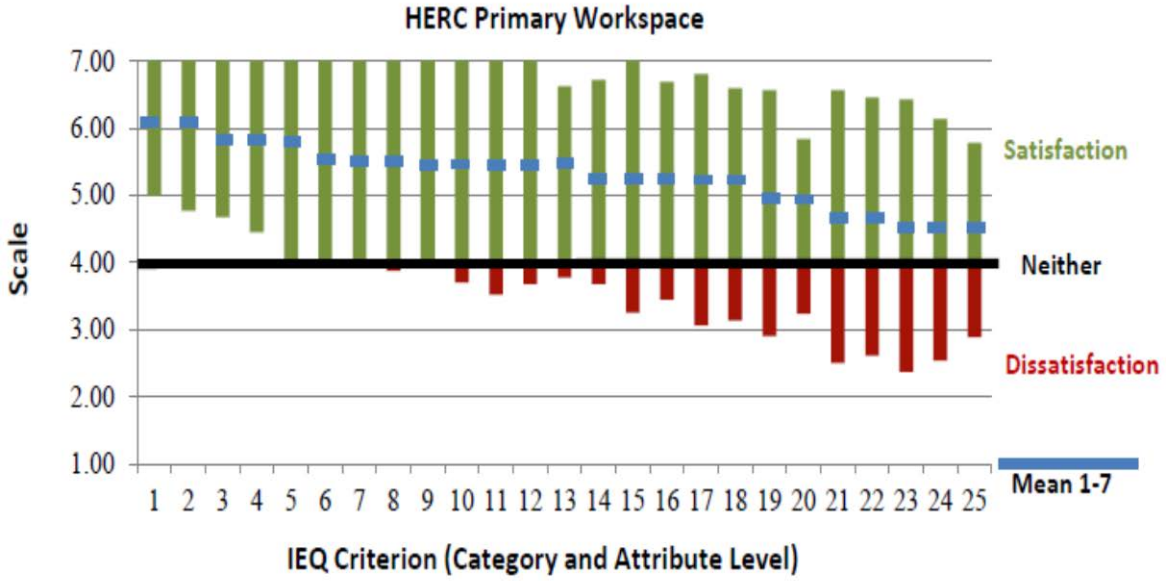

Figure 4 Satisfaction with individual IEQ criterion associated with employees' primary workspace. The numbers (1-25) on the bottom refer to the IEQ criteria included in Table 3.

4.4 IEQ Satisfaction Scorecard

The IEQ Satisfaction Score is determined by developing weighted factors of all categories, which is more representative of a fair overall IEQ score. For example, it might be more important for an employee to have satisfying thermal conditions than to have satisfying indoor air quality. Thus, if the employee gives

a high thermal satisfaction score and a lower indoor air quality satisfaction score, the overall IEQ satisfaction will be scored much higher than one with the inverse statistics.

The weighted scoring system was developed by employing the following procedures:

1. Factor analysis (a multivariate statistical procedure) was conducted to determine the importance of various IEQ categories.
2. The factor loading of selected IEQ criteria was regarded as the individual weight.
3. The weighted sum score was used to calculate the final mean score illustrating how well a particular building performed in terms of satisfying its occupants' IEQ needs. This becomes the IEQ Satisfaction Score.

As shown in Figure 5, the IEQ Score for HERC is **5.30 (mean score)**.

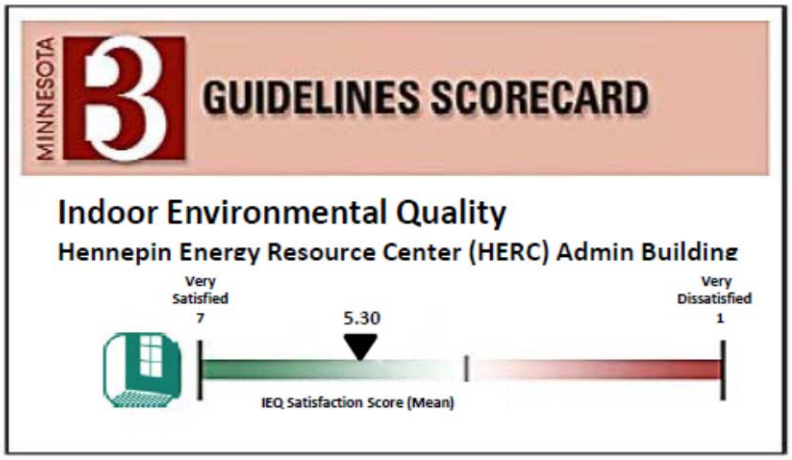

Figure 5 Employees' IEQ Satisfaction Score for the primary workspace in the HERC facility

Overall, employees showed a positive but moderately low level of satisfaction with the overall IEQ score, as indicated by the weighted **mean score** of **5.30**. Results indicated that the overall **appearance (aesthetics)** was the criterion that contributed most to the IEQ Satisfaction Score, followed by **function**, and **privacy (sound and visual privacy)**. They determine IEQ satisfaction more strongly than other categories. Overall **thermal conditions, vibration and movement,** and **acoustical conditions** were the least contributing categories to the IEQ Satisfaction Score.

The **IEQ Satisfaction Score** of **5.30** validates the overall satisfaction (**Error! Reference source not found.**) **mean score** of **5.60** with the primary workspace. Both scores indicate levels of satisfaction with the primary workspace, however, the IEQ Score is lower as it may reflect some other factors beyond IEQ such as satisfaction or dissatisfaction with other considerations, e.g., the location or size of primary workspace. The IEQ Satisfaction Score gives us more refined knowledge.

5.0 Physical Activity Engagement and Commuting Practices

In the final section of the survey, employees responded to questions regarding their overall physical activity while at HERC facility (site, building, and interior) and their commuting practices.

5.1 Physical Activity Engagement

Providing employees with opportunities for alternative paths of travel around the workplace, e.g., taking stairs as opposed to the elevator provides opportunities to engage in additional types of physical activities. Engaging in physical travel throughout the work environment can be associated with healthier lifestyles. Results for the employees' physical activity are included in Table 4.

Table 4 Overall physical activity (walking, stair use, etc.) affected by the HERC facility

HERC facility (site, building, and interior)	Mean (1-7)	SD	N	Interpretation
Overall physical activity (walking, stair use, etc.)	5.48	1.18	15	Enhances

Results indicated that employees felt that the HERC facility enhanced (**M = 5.40**) their physical activities (walking, stair use, etc.). Further, of the 15 respondents to this set of questions, 33% said the facility enhanced their overall physical activity; 40% said the facility neither enhanced or their overall physical activity and 27% indicated that the facility hindered their ability for physical activity.

5.2 Commuting Practices

Employees' commuting practices examine primary modes of travel, commuting distance one-way, and the ability to use alternative modes of commuting. Alternative modes of commuting are available and responses provide insight into employees' commuting behaviors. These data provide researchers, building owners, and employers with information related to employees' commuting practices and the impact on the carbon footprint These data, while not specific to the IEQ data, are addressed in the B3 guidelines.

The HERC facility is located adjacent to Target Field Station, a central public transit hub for busses, light rail, commuter rail, and public parking. Table 5 provides results on employees' primary mode of transportation. Table 6 summarizes commuting distances between home and the HERC facility. Table 7 summarizes employees' ability to commute using alternative choices (walk, public transit, bike, van or carpool, etc.) between home and the HERC facility.

Table 5 Commuting Practices - Primary mode of transportation for daily commute

Commuting Transportation Mode	Drive alone (or with children < 16)	Carpool or van
Primary mode of transportation	80%	20%

Related to primary modes of transportation, 80% of the employees drove alone (or with children under 16), followed by 13% who used a van or carpooled, and 7% used some other form of transportation.

Table 6 Commuting Practices – Distance traveled to HERC facility one way

Commuting distance: miles one-way	6-15 miles	16-30 miles	31-45 miles	46-60 miles	61-75 miles	76+ miles
Home-to-HERC	7%	46%	26%	7%	7%	7%

Results indicated that 7% of the employees commuted 6-15 miles one-way between home and the HERC, followed by 46% who commuted 16-30 miles, 26% commuted between 31-45 miles, 7% commuted between 46-60 miles, 7% commuted between 61-75 miles, and 7% commuted 76 or more miles.

Table 7 Commuting practices – HERC location and commuting in an alternative way

Alternative commuting	Mean (1-7)	SD	N	Interpretation
Ability to commute in an alternative way	3.90	1.18	32	Hinders

Results indicated that employees were **hindered** (**M = 3.9**) by the location of the HERC in their ability to commute to work in alternative ways, e.g., walk, bicycle, public transit, van or carpool, etc. Further, of the 15 respondents to this set of questions, 27% said the location **hindered** their commuting options,40% indicated the location **enhanced** their ability for alternative commuting, and 33% indicated the location **neither hindered or enhanced** their ability to commute in alternative ways.

6.0 Conclusions

6.1 Summary

A post-occupancy evaluation was conducted of employees of HERC approximately three years after it was first occupied. Of the 46 employees at HERC, approximately 33% of the staff responded to the survey.

The survey included questions related to employees' overall satisfaction with the facility (site, building, and interior) and influence of the facility on their overall work performance and health. Employees were satisfied with the facility (**M = 6.07**); they found the facility enhances their overall work performance (**M = 5.80)** and enhances their overall health (**M = 5.67**). In addition, similar results were noted when employees were asked these same questions about their primary workspaces (private office, shared office, laboratory, etc.). Employees indicated an overall satisfaction (**M = 5.60**) with their primary workspaces and that their overall work performance (**M = 5.73**) and health (**M = 5.40**) were enhanced by their primary workspace. As the range of scores was from 1-7, satisfaction scores are in moderately high to mid-range and therefore, are considered positive.

Most of the survey questions related to employees' satisfaction with the IEQ criteria in their primary workspaces (private office, laboratory, etc.). Employees' responses showed they were satisfied with the majority of the IEQ criteria. The results indicate a moderately high level of satisfaction with some IEQ criteria **[electric lighting (M = 6.0)]** and a low level of satisfaction with other IEQ criteria [**ability to limit undesired sounds (M = 4.53)].** Employees responded that they were neither dissatisfied nor satisfied with the following IEQ criteria: **adjustability of thermal conditions** (**M = 4.40**), **humidity (dry or moist**) (**M = 4.33**), and **overall thermal conditions (M = 4.33).** Lastly, there were no IEQ criteria with satisfaction scores less than 4.0 resulting in dissatisfaction with their primary workspace.

From the employees' responses, an IEQ Score was developed and shows respondents' satisfaction with all criteria and the contribution of each criterion to the satisfaction score. For HERC, the IEQ Satisfaction Score was **5.30**, with satisfaction with **appearance (aesthetics)**, **function,** and **privacy (sound and visual)** of their workspaces as the three categories that influenced employees' satisfaction level most. Consistent with the IEQ criteria scores, overall thermal conditions, vibration and movement, and acoustical conditions contributed the least to the IEQ Satisfaction Score. Overall, this score reflects the moderate satisfaction level of the other categories.

Tne final section of the survey examines employees' physical activity and commuting practices. Employees reported that HERC enhances (**M = 5.40**) their **physical activity**, which is one of the sustainable design criteria that influence occupant behavior. Employees' commuting practices showed a **strong preference for driving alone** (or with children under 16) (**80%**) and **46%** of the employees commuted between 16-30 miles one way. Lastly, although the HERC facility location is adjacent to a central mass transit facility, employees indicated that the location of the HERC facility hindered (**M = 3.90**) their ability to commute in alternative ways.

6.2 Recommendations

The satisfaction scores are certainly in the positive direction, however, improvement may be possible. It is also notable that for those criteria that most influence positive satisfaction, **appearance, function,** and **privacy,** attention can continue to be paid to these criteria. For IEQ categories that have physical measurement possible, e.g., thermal, acoustic, and lighting, it is recommended that these measurements be taken in both overall workspaces and primary, individual workspaces. Recommendations follow:

There are several strategies that can be used as a follow-up to this survey that will help dig deeper into the criteria that showed low satisfaction or dissatisfaction.

- Determine if any task areas differ now from original intent.
- Identify employees' specific concerns via focus groups
- Log complaints and sort into areas of concern that can be acted upon. For any criteria/complaints that are measurable, e.g., thermal conditions, lighting conditions, conduct onsite measurements using Illuminating Engineering Society standards for employees' tasks.

Acoustic Conditions

- Identify acoustic criteria for overall requirements.
- Develop any additional special acoustical performance requirements to support functional programming of building, e.g., sources of recurrent noise that need to be controlled, special user populations that may have distinct auditory performance limitations, or multiple uses of building spaces that may have different acoustic criteria. Investigate and choose appropriate acoustics modeling software for the project.
- Measure acoustic performance onsite with full systems running. Log noise and other sonic environment complaints.

Lighting Conditions

- Identify performance criteria that are to be met to achieve goals.
- Develop additional quality lighting criteria as needed for special facility issues such as employees' ages, duration of task, influence of daylight quality or quantity.

Personal Adjustability

- Determine if adjustability issues arise with temperature, lighting, or furnishings via focus group.
- Identify personal, individual problem areas and relate to other IEQ issues via log of complaints.
- Provide education to employees about adjustability of any applicable adjustment options, e.g., furnishings, air diffusers, lighting, temperature control, etc.

Privacy Conditions

- Consider adding noise masking equipment and/or visual screening depending on nature of complaints.
- Compare acoustic privacy problem areas with acoustic measurements to pinpoint specific problem areas.

Thermal Conditions

- Determine special thermal comfort requirements or problems that may be encountered in the building due to work activities, sitting, or design considerations.
- Review conditions that affect thermal comfort using ASHRAE Standard 55-2004 or Human Factors Design Handbook.
- Log complaints related to thermal conditions.

It seems obvious that employees' satisfaction can be improved by addressing the criteria that had 'dissatisfied' or 'neither dissatisfied nor satisfied' scores. The above recommendations can help address change in these criteria. The areas employees were dissatisfied with **(overall thermal conditions, humidity, and adjustability of thermal conditions)** are all in the thermal arena can all be addressed by the above recommendations. Exploring these areas in more detail and making adjustments may increase overall satisfaction at the primary workspace.

This study investigated employees' satisfaction with the facility and primary workspaces. IEQ satisfaction is individual, but the results of the survey show a central tendency of moderate satisfaction to satisfaction with the facility and most of the IEQ criteria. The results can be used as a diagnostic tool to aid in improving IEQ conditions for employees and to set the benchmarks from which improvement can be measured in the future.

Appendix A. Open-Ended Responses

Employees had the opportunity to raise specific concerns on the overall facility and their primary workspaces. Important information can be gleaned from the open-ended responses. Qualitative responses can appear as the employees are satisfied or dissatisfied; it does not mean they represent the overall sentiment from employees.

For example thermal conditions, appearance, IAQ, vibrations/movement, and function reflected positive employees' satisfaction in their primary workspaces making the case that the open-ended responses reflect a small sample of the population.

HERC Facility (Site, Building, Interior)
Building Services Amenities

- Very nice facility
- The lunchroom sink needs a garbage disposal
- Very nice environment

HERC Primary Workspace
Overall satisfaction

- The new admin building is very much appreciated; so much better than what we had
- Very satisfied

Acoustic Concerns

- The noise level at times is very disruptive
- The train noise is much louder than I expected, I cannot be on a conference call (speaker) while the train is going by my office.
- Due to the large office space, you can often hear others phone conversations in neighboring offices. Either through the walls, or the sound echoing down the hallway.
- Sound quality limits internal conversations above a very low tone

Thermal Conditions

- The locker room and lunchroom are a bit warm and very humid
- The humidity seems a bit high also. Any papers/documents that you have in your office seem flimsy and damp due to the high humidity levels in the workspace.

Furnishings

- Ergonomic desks are great!

Appendix B. Glossary

Descriptive statistics
Statistics used to summarize large sets of data (i.e., means, frequencies, medians). Descriptive statistics describe only the sample under consideration and are not intended to infer results to the larger population.

Factor analysis
A multivariate statistical procedure that is used to identify and group together general dimensions or factors that underlie a large number of variables in a set of data. The procedure transforms the variables into new principal components or orthogonal factors. Variables within each factor are related to each other but have no relationship to variables in other factors.

Frequency
A descriptive statistic provides information about how many of a particular response or measurement is observed.

Likert-type scale
A measurement technique, employed in questionnaires and interviews, that utilizes a range of standardized response categories such as strongly agree, agree, etc.

Mean
The average score of a set of data is calculated by adding all scores together, then dividing by the number of scores.

N
The number of subjects or participants responding to the questions in the study

Reliability
The repeatability or replicability of findings; the same results are produced each time. Instruments and procedures should produce the same results when applied to similar people in similar situations, or on a second occasion.

Standard deviation
A statistic used to measure the variability of a group of scores (how different scores are from each other and the mean). For example, if the range of scores is 1-7 and the mean (average) is 5.0 with a standard deviation of 1.0, then the scores are closely clustered around the mean, i.e., there is one unit of variation among all scores. If the mean was 5.0 and the SD was 3.0, there is a broader range of variation among the scores…a smaller SD means the scores are similar and the mean score is likely to be more accurate and more useful (this is better!).

Validity
The extent to which an instrument or procedure measures what it is intended to measure (internal validity). The generalizability of results to another population (external validity).