The C-2000 Program for Advanced Commercial Buildings

Buildings Group
CANMET
Energy Mines and Resources
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Background

C-2000 is a small-scale initiative to promote the adoption of advanced technologies and innovative management in commercial buildings through pilot projects, monitoring and information transfer. The immediate goal of the Program is to achieve high performance goals in a small number of pilot project buildings and to transfer the information gained to the industry.

The program is being developed by CANMET (Canada Centre for Mineral and Energy Technology), a branch of Energy Mines and Resources Canada. The program, a part of Canada's Green Plan activities, is expected to influence the next generation of commercial buildings.

The participation of key industry groups is being encouraged to ensure wide support and acceptability for the Program. Electric utilities are also being approached for technical and financial participation. It is likely that no more than six to ten buildings will take part in the program, and much of the program's value to the industry will be in technology development related to these projects and in a concurrent information program.

Approach to performance

C-2000 is more than an energy conservation program. It will demand a very high level of energy performance, minimal adverse environmental impacts, an exceptional indoor environment for occupants and high levels of functional performance. This whole-building performance structure is based on CANMET's experience that energy and environmental agendas will be most effectively adopted by the industry if a broad approach is taken.

A relatively unique requirement of C-2000 is that initial performance levels will have to be maintained over a long period. Full commissioning will ensure that the intended performance levels are reached, and on-going monitoring will ensure that they are maintained. The development of management plans, training for building operators and the long-term participation of tenants will therefore be important features of all C-2000 projects.

A partnership approach

CANMET's available funding and human resources for the program are modest, so an emphasis is being placed on developing technical and financial partnerships with provincial governments and utilities, professional associations, suppliers and private-sector firms.

Building types

Our initial approach is to focus on office and multi-unit residential buildings under approximately 150,000 square feet in area. It is expected that retail commercial buildings will be included in the program by 1994.

What's in it for developers?

Although high performance costs money, developers of projects that meet the technical criteria will gain in several ways by participating in the program. During the design development process, the designers of the project will have access to specialized expertise at no cost, and funds will be available to help cover the costs of additional time to explore design alternatives and to undertake analysis of energy performance.

If the project is eligible to participate in further stages, funds will be provided to cover part of the capital costs of mutually-agreed upon system upgrades, such as a switch to high-performance windows, high-performance lighting, the installation of thermal storage tanks, low-emissivity interior finishes or individual control of ventilation and temperature conditions. These are only examples, and specific system upgrades will depend on the exact fit between the building's function and the technical criteria.

Another benefit to developers of qualifying projects is that they will be eligible to use the C-2000 designation in their marketing programs and will benefit from CANMET's program marketing. Assuming that the program is successful in reaching its objectives, such a designation should have considerable marketing value towards the end of the program's five-year life span. In keeping with the emphasis on long-term performance, designated buildings will be subject to periodic re-assessments to ensure that initial performance levels are being maintained.

How the process will work

Concurrent with the completion of our technical criteria by the Summer of 1993, eligible developers and projects will be selected through a negotiation process. We will be identifying owner/developers with a demonstrated commitment to high performance, especially in the area of energy efficiency and environmental sensistivity. Another requirement will be that the owner/developer is intending to develop a project which falls within our area of interest and which has not yet entered the design process.

Design Brief

When a project is selected for participation, C-2000 staff will designate a technical representative to work with the design team during the design brief and preliminary design phase. During this stage the developer will be expected to prepare a design brief which outlines the functional requirements of the project and also reflects the performance

requirements of the C-2000 Technical Criteria. The intent of this phase is to prepare a document that will present the design team with all requirements in an unambiguous way.

Design phase

Industry experience indicates that it will be very difficult to reach the high performance requirements of the C-2000 Program using the traditional sequential procedure of architects preparing a schematic design, followed by engineers who are expected to implement this design. The design phase is therefore structured around the assumption that there will be a design team working together in an integrated way from Day One.

The C-2000 liaison person will act as a link between CANMET and the development team during the design phase, providing interpretation of the specific application of the technical criteria and supplying the design team with assistance at critical stages, such as bringing in a subject expert for consultation (eg. a daylighting or an environmental specialist) or by providing specialized technical reference materials. To facilitate this, CANMET is selecting a roster of up to 100 subject experts across Canada.

The design team will be expected to explore several design upgrade options including simulations of energy performance.

At the end of the design development phase, and before contract documentation is prepared, both parties will consider whether the project will go ahead with some or all of the performance upgrade options. From CANMET's point of view, the decision will be based on the projected performance of the building and the expected technology transfer benefits.

Construction, commissioning and monitoring

If the project enters the construction stage, CANMET and funding partners will provide contributions to cover part of the incremental costs of construction and commissioning. If commissioning indicates that the building's performance is consistent with the technical criteria the building will be certified as a C-2000 building and final contributions will be provided. CANMET will undertake non-intrusive monitoring of the building's performance for a multi-year period.

Activity to date

Preliminary activities began in the summer of 1991, with a series of interviews on the concept of the program with architects, engineers and utility representatives across the country. The response indicated a high degree of interest, mingled with the reservation that the program would only be successful if it was treated as part of a long-term involvement in the commercial buildings sector. The field interviews led to the preparation

of a discussion paper which developed the initial ideas in a more concrete form. One-day workshops were then held to obtain feedback on the discussion paper and to obtain further input into the design of the program.

The Program is now entering its second year of development, which will see three or four C-2000 projects begin the design and development process. Current activities are focused in two areas: development of technical criteria, technology assessments and the development of a few preliminary projects.

Development of Technical Criteria

Technical criteria which specify the performance requirements of C-2000 buildings were outlined by C-2000 staff and are now being developed in detail by a consortium of specialized consultants. This work, to which Ontario Hydro, Ontario Ministry of Energy and CMHC have also contributed, is expected to be completed by the end of July, 1993. Criteria are being developed by consultants and in-house staff in each of the four designated long-term performance areas: energy, environmental impact, indoor environment and functionality. The latter category covers several sub-issues, including adaptability, durability and access for disabled persons.

Technical criteria are being developed in the form of performance targets and prescriptive requirements. All performance targets will be matched with a specific test to ensure that the target has been met. Criteria for energy performance are being designed to be compatible with the widely adopted ASHRAE 90.1 Standard "Energy Efficient Design of New Buildings Except Low-rise Residential Buildings". Our initial energy performance target is to exceed ASHRAE 90.1 requirements by 50%.

Several parallel efforts are being carefully studied for relevance, including the work being carried out by Dr. Ray Cole at the University of British Columbia to develop a variant of the British BREEAM system (British Research Establishment Environmental Assessment Method) for application in Canada. Dr. Cole's system, called BEPAC (Building Environmental Performance Assessment and Certification Program) is even more ambitious, and EMR is studying ways of assisting in its widespread acceptance across the country.

Precursor projects

We have already decided to participate in two projects and are actively working on them. One of these studies concerns the design of a standard design for a fast-food chain and we are now in negotiations with a major grocery chain to cooperate in the development of a "Store of the Future", which will follow the C-2000 concept of whole-building performance. Participation in these projects was not anticipated, but the potential for technology transfer to the industry is sufficiently attractive that we will be developing technical criteria suited to these building types in a parallel process.

Other Research

Several research projects are underway that underpin and complement the development of the field trial projects. One modest project, now completed, provided a design history of the retrofit of a 1950's warehouse to serve as a "green" office and distribution centre for a national cosmetics company. This project provided an indication of how difficult it is, even with the best of intent, to insert ideas for achieving very high performance levels into a design process that has already begun.

A second project involves the development of design criteria for a specific high-rise apartment building that was already in the design stage. This project focussed on energy and building envelope issues and has served as useful input into the development of the main technical criteria.

Another research contract was awarded for the development work of an innovative 100% fresh air, chilled-air distribution system for office buildings. The system consists of a closely-spaced network of small diffusers blowing chilled air at high speed, and is based on a previously proven residential system. The system is intended to provide a displacement effect, with colder air at the floor level slowly pushing warmer air up and out the exhaust system. It is anticipated that the greater ventilation effectiveness of the system should make a 100% fresh air system economical.

Finally, the C-2000 group is working with Ontario Hydro and Hydro-Québec to update the BESA energy simulation program so that it can serve the needs of the three organisations.

Training

Although the architects and engineers involved in C-2000 projects are likely to be highly skilled professionals, some may lack specific skills required for the Program. A knowledge of embodied energy issues of building materials, for example, is not common and there is also a need to ensure consistency among participants in activities such as energy analysis or interpretation of ASHRAE 90.1. Given these conditions, there will be a need for professional-level training for design teams at the early stages of the program. We also anticipate a need to provide certain trades with special skills during construction and to engineers for commissioning, and the emphasis on long-term performance means that we must ensure that building operators and managers are fully familiar with advanced systems.

Given the small scale of the program it will not be possible to establish training programs to meet these needs, so we will initially have to content ourselves with providing these groups with access to our pool of subject-area specialists. At a later stage, deficiencies in skills may result in formal training programs to be delivered in cooperation with existing industry groups.

Technical Criteria in the C-2000 Program

The following section was provided to the consultants who are now developing a revised and more detailed version for implementation in the summer of 1993.

The Program is intended to result in the construction or refit of office and multi-unit residential buildings that will:

* consume significantly less energy than current construction,
* reduce adverse environmental impacts
* create a more comfortable and healthy indoor environment and,
* reach a higher level of functional performance.

One of the most important immediate tasks is to develop technical criteria, including performance targets and prescriptive requirements. The technical criteria will guide development teams in the design and development process and will be used by those monitoring actual building performance to determine the degree to which buildings have conformed to the criteria.

We are defining "technical criteria" as consisting of two sub-categories: performance targets and prescriptive requirements. In general terms, performance goals provide more flexibility for the designer, but require a test of performance to be meaningful. Prescriptive requirements are simpler to implement but require supporting evidence to ensure acceptability by the industry.

The technical criteria will be applied to the assessment of projects during the preliminary design phase and will be used to test whether performance has been reached when the completed building is monitored during operation. A purely energy-related program could solve the problem of how to implement these requirements relatively easily, as most energy-related parameters (whether performance or prescriptive type) are measurable. Technical criteria for the C-2000 program will extend over a relatively broad area, however, and this complicates the issue, especially when dealing with some of the softer issues (such as lighting quality or adaptability of space to new uses). Another issue is whether to have a pass/fail system or to have a graduated scale of performance. The former approach has the advantage of being clear and simple, but the combination of circumstances, functions and systems that may be found in C-2000 commercial buildings would make such a system difficult to implement.

An approach that may prove workable is to have a combined system, wherein each criterion has a minimum pass/fail point that is based on current best practice, but where requirements exist for higher aggregate performance. Such an arrangement would ensure a minimum level of performance in each criterion (which could still be quite demanding), while ensuring that aggregate performance has to be still higher -- but the choice of which specific areas have ultra-high performance would be up to the proponent. The system

could be further elaborated by placing more weight on areas that appear to be of special importance, such as (for example) criterion (7).

The 47 criteria that are listed under the performance headings below are intended to provide some illustrations of advanced specific systems or processes that should be considered. *Those criteria that we suggest should have mandatory prescriptive requirements or performance levels are shown in italics.* Proposed criteria shown without italics are proposed to be treated as optional with bonus points. It is recognized that some criteria may not be applicable in retrofit projects because of limitations such as floor-to-floor heights, orientation etc.

With respect to Section A, Energy performance, because of the probable wide-spread adoption and influence of the ASHRAE publication 90.1-1989 "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings", it is desirable that the methodology and approach used in that document should be followed to the extent possible in formulating criteria that are relevant to that document.

A. Energy Performance Issues

1. *Reduce dependence on access by auto*
   - locate in proximity to public transport
   - *provide bicycle racks & changing rooms*
   - staff busing schemes (office)
2. *Site the building to maximize passive solar potential*
3. *Control summer solar gain from exterior (where not useful)*
   - *vegetation or external screens*
4. *Minimize winter wind velocities near building*
   - *building relationships, landscaping*
5. Provide multiple uses in project
   - where shared uses results in efficiencies
6. Maximize energy efficiency of building shape
   - ratio of envelope area to interior area or volume
7. *Minimize infiltration/exfiltration through the envelope.*
8. *No simultaneous heating and cooling in building.*
9. *Minimize annual energy consumption*
   - *ASHRAE 90.1 + 50% ekWhr/sf*yr*
10. *Minimize peak electric demand, summer*
    - *reduce electric cooling loads*
11. *Minimize peak electric demand, winter*
    - *reduce electric heating loads*
12. *Minimize plug loads (office)*
    - *limits on plug load capacities*
    - *occupants selection of efficient equipment*
    - *plug load shifting*

13. *Minimize total peak and annual lighting load (office)*
    - *high efficiency lighting systems*
    - *low ambient lighting levels + task lights*
14. *Maximize use of free energy*
    - *minimum proportion of free cooling (incl. GSHP?)*
15. *Minimize use of electricity (annual)*
    - *depending on mode of utility generation thermal or hydro*
16. *Provide decentralized metering & control*
    - *individual tenant electrical meters*
    - *perimeter zone light controls (office)*
17. *Provide DDC HVAC controls (office)*
18. *Provide EMCS system*
    - *for buildings > 25,000 sf in area*
    - real-time performance analysis
    - dynamic/anticipatory control
    - *user interface for ease of use*
19. *Maintain long-term energy performance*
    - *commission HVAC, control systems and envelope*
    - *requirement to maintain x% of initial performance*
    - *reliability, MTBF of equipment*
    - training and skills required for maintenance
    - *easy access to HVAC systems for maintenance*

B. Environmental Impact Performance Issues

20. Minimize the embodied energy of construction materials.
    - materials not requiring a complex production process
    - minimize building mass
21. *Eliminate CFC use*
22. Maximize re-use of materials
    - design and build so that components with a short lifespan can be easily changed (without destruction) and re-used or re-cycled.
23. Use materials that are easy to re-use or re-cycle
    - avoid the use of composite materials
    - use durable materials with high potential for re-use
24. Minimize use of construction materials
    - efficient structure
25. Minimize waste of construction materials
    - during construction process
26. *Minimize use of water*
    - *reduce water use*
    - *recycle storm/grey water*
27. *Minimize liquid pollutants*
    - consider on-site waste-water treatment

28. *Minimize atmospheric pollutants emitted by active systems*
    thermal, CO2, NOX
29. Minimize solid wastes during operations
    technical and management solutions
30. *Minimize neighbourhood noise disturbance*
    from HVAC system, loading bays
31. *Maintain long-term environmental performance*
    requirement to maintain x% of initial performance
    management & maintenance policies
    easy access to relevant systems for maintenance
    training of operating staff, tenants and occupants

C. Indoor Environment Performance Issues

32. *Minimize indoor material emissions*
    during construction
    during operations
33. *Maximize air quality*
    min/max.ventilation rate of supply air (office)
    min. ventilation effectiveness (office)
    min. percent fresh air provision (office)
    min. 25% relative humidity, winter
    max. 50% relative humidity, summer
    olfactory quality
    minimum indoor pollutants
        C02, C0, VOC's, Formaldehyde, Ozone,
34. *Provide appropriate thermal quality*
    minimal thermal gradients, 0 to 5 ft. (office)
    limit temperature swings
    provide differential temperature regimes for varying user needs (office)
    limit differential thermal radiation
35. *Provide appropriate acoustic quality*
    minimize noise intrusion from exterior
    minimize noise levels in workstations (office)
    provide masking noise where appropriate (office)
36. *Maximize use of natural light*
    minimum requirement for daylighting as percent of total illumination at 5 m from glazing (office)
37. *Provide appropriate artificial light*
    minimize ambient light levels (office)
    design for task lighting (office)
    maximize colour rendition quality (office)
    minimize glare at work surfaces (office)

38. *Maximize individual control over indoor environment*
    - *individual control of lighting*
    - *individual control of temperature*
    - *individual control of ventilation rates*
    - possibility of operable windows w. HVAC interlock (office, low-rise)
    - individual control over ambient noise (office)
39. *Maintain long-term indoor environment performance*
    - *commission HVAC, control systems and envelope*
    - *requirement to maintain x% of initial performance*
    - EMCS with diagnostics
    - *documentation of HVAC and control systems*
    - *maintenance plans*
    - staff and tenant training (office)
    - management policies
    - *easy access to HVAC, lights etc. for maintenance*

D. Functional Performance Issues

40. Provide suitable ancillary facilities
    - social spaces, cafeteria, fitness facilities, day care etc.
41. Maximize adaptability of building
    - for new uses of building
    - for changes in closed/open offices (office)
42. Maximize adaptability of spaces
    - for new uses on floor (office)
    - use of residential space as home office (MUR)
    - ability to customize office/workstation (office)
    - ability to personalize residential environment (MUR)
43. Maximize adaptability of components and materials
    - for new functions (eg. add/delete window in a wall)
    - for new uses/locations (eg. partitions or cabling changes)
44. *Provide barrier-free design*
    - *re. locomotion disabilities*
    - *re. auditory handicaps*
    - *re. visual handicaps*
45. *Maximize security of occupants*
    - *physical security of occupants*
    - *security of communications*
46. *Maximize physical durability*
    - *durability of materials and assemblies*
    - *detailing*
    - *commissioning procedures & tests for envelope*
47. *Maintain functional performance over the long term*
    - management/maintenance policies
    - *easy access for maintenance*