ONTARIO RECREATION
FACILITIES ASSOCIATION INC.

Guidelines For Facility Planning: Design & Construction Methods

The Arena

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ONTARIO RECREATION FACILITIES ASSOCIATION INC.

GUIDELINES FOR FACILITY PLANNING:

DESIGN & CONSTRUCTION METHODS

THE ARENA

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Guidelines for Facility Planning:
Suggested Design & Construction Methods
The Arena

Introduction to Building a Recreation Facility

The purpose of this document is to provide guidance to recreation staff in assisting them with the various steps and planning required to design and to construct a functional recreation facility.

This booklet will provide you with a better understanding of the planning stages, the various types of design methods, community, user and staff involvement, various methods of construction, the space, design, programming and operation requirements for your new or renovated facility.

Do your homework and complete the proper planning in advance. Most of all, be prepared.

Building a recreation facility is a project many communities throughout Ontario will undertake.

However, many may not realize the implications of constructing a building that facilitates recreation and community events. What steps must be taken when beginning such a major project? What are the considerations when contracting an architect? What are the risks involved with building this type of facility?

The first step to building a vibrant community recreation facility is finding a competent architect. A credible and reputable architect is essential to the success of any project.

Once a community has consulted with an architect, it is important that those overseeing the project understand the over all concept of the construction process. This understanding includes knowing the responsibilities of each party involved, as the architect is not the only instrumental part of the project.

An architect is a tool to help clients achieve their goals. However, it is important to know that there are obligations for both the architect and the client who is hiring the architect.

When building a recreation centre, the client must appoint a knowledgeable and experienced person to be their key representative and they must be an integral part of the design and construction process. The concept of the facility's functions and needs must be conveyed to the architect who, in turn, translates these needs into three-dimensional space that supports client programs.

It is important at the planning stage that the design space be suited to the client's intended use. Only then can the building be expected to function properly and adequately to the purpose of its construction.

The Functional Program

The client must develop a written document (functional program) stating specific functions of the building, listing all spaces required and detailing the purpose of all spaces; including mechanical and electrical requirements and necessary features for each room. The architect will use the functional program throughout the entire design phase as a reference to guide all design actions and decisions in order to achieve the type of facility that will benefit the community.

Design Phase
Architects who specialize in sports facility architecture say that the process of design goes through various steps – from the general to the specific.

The design stage has three steps:
⇨The first is developing the schematic design where the architect looks at how the building can be assembled. The schematic gives a general understanding of the site, suitability, function, and operations of the building;

⇨The second is developing the design where the architect begins introducing more detail to the schematic designs as he gains an understanding of the building and its operations;

⇨The third stage involves finalizing the scheme, the design and preparing working drawings and specifications. This step is the most time extensive and labour intensive part of the project for any architect.

Municipalities must now consider the type of contracting method that will work for them.

Contracting Methods:

Design/Build
Private or Public owners may reduce their costs by as much as 20 per cent using this method compared to the traditional design-bid-build scenarios. In Design/Build there are four stages:

- Contractor negotiates a fee with the design consultant for preliminary drawings
- Preliminary sketches are produced and the contractor submits a tender for the job. Usually the tender guarantees a maximum price for Design/Build projects.
- Contract is awarded and a final detailed design is then completed.
- Contractor completes the job.

Changes in Design/Build can be very expensive. The owner has little control over the process once the contract is awarded.

Potential problems can arise for the contractor because he guarantees a maximum price prior to the final detailed designs. One consequence of this may be that the contractor can cut corners on the job. For example, the design consultant makes decisions based on quality, including long-term performance, durability and lower maintenance objectives.

The contractor may opt for minimum standards that won't necessarily offer the best result because he has to keep within his guaranteed maximum price.

Traditional, Stipulated or Lump Sum

This is the most common method used in Ontario in contracting municipal facilities – it has a long history and is well understood. In this design-bid-build method, the contractor gives a fixed price for the construction of the building, excluding change orders. The owner has input throughout this process. This method provides the most accountability to the taxpayer.

Construction or Project Management

In this process, there is no general contractor but a Construction Manager who works under contract to the owner for a fixed fee, which is independent of the construction, cost. The construction manager issues trade contract tenders. Therefore, the total cost of the project is not fixed at the outset, as the entire project is not tendered at once. This process can be faster than traditional lump sum process and, depending on the skill of the Construction Manager, may be less expensive.

This person (project manager) whether an experienced architect, contractor or facility staff member must have construction experience, recreation facility experience, HVAC and mechanical equipment experience. They should also have a good knowledge of the Ontario building code and the Ontario fire code. They must have project management experience.

Whatever process is selected, contracts must be clearly worded and specific in detail and everything must be stated in order to avoid misunderstandings.

The implications of not issuing clear documents can be substantial. It can increase your costs drastically.

As financial issues become apparent in this phase, it is important for municipalities to remember that the project cost and construction cost are two separate figures. The project cost will be the cost of construction plus additional amounts for fees, project management, furniture, equipment, etc. The total project cost is typically about 20 per cent more than the construction cost. The construction cost is the cost of the building and its built-in components only.

In any construction project there will always be change orders so money should be set aside to deal with such changes. This is called Contingency expenses. It is recommended to budget 6 to 8% of the project costs for contingencies.

Field Services

Once construction starts, the architect will provide administration support and field services- observing the construction process and making sure everything conforms to the design and contract documents. (Observation: Architects will only provide the services they are contracted for – in some cases, overseeing the project directly is not included, however, they will consult with the on site (inspector or manager) representative for the client, and assist in settling disputes.)

Architects allow that expectations of perfection are unrealistic. Unforeseen problems with the conditions of the site, the performance of one contractor influencing the work of another, design changes and the inability to complete work within expected time-frames are other problems that may arise during the construction process.

For some municipalities, an architect who specializes in sports facilities may be the best place to start. It is strongly recommended that you pre-qualify your architect, general contractor and project manager depending on the construction method you use.

Sport architects have specialized expertise (such as what kind and size of ventilation you need for an ice arena, aquatic facility, or what makes a good gym surface) that a general architect may not have. Although architecture, as a profession, generally has not traditionally specialized, if the building is sufficiently demanding (as recreation facilities sometimes are), specialization may be required. Specialists better understand appropriate building responses (such as bio-mechanic of sport surfaces) and the strengths and weaknesses of specific solutions. A general architect may not necessarily know those things.

In the case of recreational facilities, sport architects spend most of their life working on one building type. Understanding the design and technique of a sport facility is very important, as not all buildings are created equally.

Municipalities are well advised to take advantage of the benefits of hiring an architect who specializes in sport and recreation facilities.

When a project becomes a successful reality, the community, contractors and architect have worked together with clear communication and a common vision of the building’s purpose. In order to achieve this success, it is very important that the client be very clear in describing their needs right from the beginning. Only then will the results be a facility of the best design and construction to meet the needs of the client and patrons.

The Planning Process

An increased emphasis on leisure services has created demands for more and better recreation facilities. Every recreation department, faced with decisions about the number, type, location and design of facilities recognizes the importance of a recreation master plan and facilities needs study. This plan is a written document that identifies the facilities, services desired and states a course of action to follow that will meet these requirements. The owner or Recreation Department can ill afford mistakes, the cost of which continue to rise in direct proportion to increasing land and building costs.

Each municipality, large or small, needs a recreation master plan or a facility needs study. It is often a part of the Official Plan for the municipality. When it is a part of the Official Plan, the citizens have not only Council's acceptance for the policies stated but also the protection of the Planning Act that no public action will be taken contrary to the policy. In addition, the statement may be used so that residential development or redevelopment will provide parkland, open space or cash –in-lieu of this land.

This plan will assist the municipality in future planning by:

- Deciding about future financial requirements, staff additions, life cycle planning and land acquisitions
- Coordinating of all recreation programs and services, i.e. public, private and commercial
- Communication with citizens to determine their expectations, and to encourage their involvement and participation
- Recognizing the recreation potential within the community, thus providing a wider range of opportunities
- Cooperating of the recreation authorities, local developers, institutions, private agencies local service clubs and community organizations.
- Enhancing the recreation experience for the members of your community.
- Utilizing facilities to their full capacity.

Following this planning process is not easy, but it is important. There are no short cuts. It provides the key to understanding what facilities are needed, when, how and by whom they should be built or developed and where they should be located. Once the plan is developed it is relatively easy to revise as needed, keeping it accurate and relevant.

Approaches to Planning

Planning for recreation facilities involves much more than applying recommended standards. It requires, in fact, the development of a set of standards that are sensitive to the requirements of each specific community. Each community's approach to planning will be different. What is effective for one community may not work for another. The approach will depend on the size and stage of development of the community, available resources (financial, personnel, and time), the philosophy and sophistication of the authority doing the planning and the political climate of the community.

There are five approaches that may be used:

- Planning buildings or structures, such as pools, arenas or tennis courts, on a short-term basis.

- Planning parks and open space based on current needs.

- A combination of these two – short – term recreation facility planning.

- Comprehensive planning for recreation facilities, which includes capital budget scheduling, staff requirements, operational costs, life cycle planning – all staged over five, ten or 20 years.

- Integrated or systems planning -- a multiple approach requiring the integration of the services provided by all municipal departments, i.e. public works, building, planning, recreation and parks.

- Systems planning, a complex and difficult procedure requires the involvement and cooperation of all municipal departments. Each department must consider the function of all other departments and how they inter-relate.

Regardless of the approach taken, some common principles of recreation facility planning should be followed:

- All people should have access to activities and facilities regardless of interest, age, sex, income, cultural background, housing environment or disability.
-
- Public recreation should be coordinated with other community recreation opportunities to avoid duplication and encourage innovation.

- Public recreation must be integrated with all other public services.

- Facilities should be adaptable to future requirements.

- Facilities and programs should be financially feasible at all stages of development; the operation and maintenance places a greater financial burden on the municipality than the initial cost; more facilities require more staff.

- Citizens should be involved in this planning process throughout all stages.

- Recreation and parks staff including facility staff should be involved in the planning process from design through to construction.

- Planning should be a continuous process, involving constant evaluation of the recommendations.

- Local, regional and provincial plans should be integrated.

Common Elements of Recreation Planning

Although approaches to planning recreation facilities may vary, the components of the process do not. Headings used may differ but the general intent of each phase has common acceptance. As well, the sequence of these components is not standardized and may change.

The following eight steps are involved in facility planning:

1. Background or preliminary analysis

Review all relevant background information in order to:

- Avoid duplication of studies or reports already done and to use these to best advantages

- Ensure that the plan is compatible with other municipal services

- Identify constraints and limits to the plan; issues that must be considered

The information reviewed can be secured from the municipal clerk's office, the building department, planning department, university studies or regional offices of the Ministry of Tourism, Culture and Recreation and should include:

- Existing policy statements for the recreation authority, local by-laws, official plans or provincial regulations

- Financial resources, i.e., provincial grants, and operational budgets – as found in similar plans for other municipalities.

- All related studies or surveys, i.e. census data and population trends, from past studies and regional reports

- Availability of required services, i.e. employment levels, ethnic background and neighborhood structures

- Political opinions, as expressed by councilors, authority members and civic officials

2. Inventory analysis

Inventory can range from a broad; general overview to very detailed accounts of specific areas. There is a danger of collecting too much information. Therefore, understand why any information is necessary and how it can be used before collecting it.

There are four basic types of inventories:

- Physical characteristic, such as climate, soils, plants, wildlife geology, physiography and hydrology, will assist in identifying areas that might be best developed for facilities or as open space or parkland or that should be left undeveloped (flood plains) or that have some unique quality (bogs or swamps) with natural habitats; if this information is not available, expert assistance from an outside ecologist or an environmental specialist should be contracted.

- Social characteristics, such as population density and distribution, age-sex profiles, types of housing, cultural and economic backgrounds, community preferences and recreation patterns, will assist in understanding the potential users of facilities and the levels of use of current facilities. This demographic information is usually available from the school system; behavioural data can be acquired through participation reports, onsite surveys, household surveys, community conferences and workshops. (Info available from census as well?)

- Existing public and private facilities should be listed and described in terms of type, ownership, availability for use, location, dimensions, state of repair, who uses them, where the users come from and parking capacity; this information will indicate levels of service throughout the community.

- Potential recreation opportunities will indicate the possibilities for future development and should include an assessment of undeveloped land within the municipal boundaries (i.e. vacant lots, conservation lands); of places commonly used for some other purposes (i.e. schools, institutions, parking lots, streets, alleys, medians, rooftops); and of areas not presently accessible to the public (i.e. hydro rights of way, abandoned railway lines, private clubs, high-rise complex, industrial facilities). These should be mapped to indicate their location in relation to population, current facilities and proposed new facilities.

3. Evaluation of current systems

Once information has been compiled outlining existing opportunities and community preferences, it is necessary to assess current levels of use. This can be handled in a number of ways. A combination of the following techniques will give the most accurate picture:

Analyze program statistics – program attendance's, participation rate

- Encourage comments by all recreation staff, including volunteers, full-time and part-time programmers and facility operators
- Review the application of past guidelines and standards to indicate accuracy and effectiveness of past policies
- Consider special requests from community interest groups neighborhood associations and local services clubs
- Invite citizen and user opinion through neighborhood and community meetings, representatives of interests groups community organizations and service clubs

Evaluation will depend on information obtained from all of these sources and should indicate the needs that are not being met as well as suggest reasons for deficiencies.

4. Formation of goals and objectives

Early in the planning process the recreation authority must reach an understanding of its capabilities, its resources and an awareness of community and users concerns. Based on this understanding, the authority can express its goals in providing recreation opportunities. These goals provide:

- An overall direction for the public program, i.e. how the plan is to be used

- The standards to be achieved, i.e. the number, size and general location of the facilities to be developed
- A rationale for the stated policies, i.e. why the plan was prepared
- A basis for the recommendations on future development, i.e. how it relates to other plans, such as the Official Plan, facilities needs study and the municipal capital budget

To be effective, these goals developed by the professional staff should relate to:

- The concerns expressed by local citizens, users and politicians
- Current political, economic and environmental constraints
- Future trends and conditions evident in the community

Goals should be fairly lengthy and well qualified in terms of cost and consequences.

Objectives are more explicit than goals and should:

- Fulfill the spirit and purpose of the stated goals
- Should be specific
- Suggest a means for attaining the goal
- Be responsible and feasible in terms of time and cost

This part of the plan is a management statement and may be formulated by the recreation staff or with direct assistance from interested citizens.

5. Developing alternate strategies -
A variety of techniques can be used to select alternate strategies for reaching stated goals and objectives. Three of these are:

- Community forums – present all relevant information, including financial limitations to community groups and they will generate ideas worth considering
- Staff discussion – brainstorming sessions are useful for creating new ideas; list the possible alternatives suggested and discuss the implications of each
- Questionnaires and surveys – incorporating information collected from community interviews

6. Selecting the preferred strategy
Select one alternative by reviewing all suggestions in terms of the:

- Financial feasibility; time constraints
- Relationship to stated goals and objectives
- Impact on total community services, i.e. roads, housing developments and private enterprise
- Meeting community preferences and needs
- Affect on the natural environment

This can be done through community groups with help and direction from the professional staff, by a planning committee of recreation and planning staff, or a combination of these methods.

7. Setting standards, planning guidelines and policies
Within the framework of the method or strategy selected, specific planning guidelines and standards can be set. These can be incorporated into overall planning policies to direct development over a specific period of time.

Standards can be stated in specific terms as to what type of development should take place and to what degree it will be carried out. Standards can be expressed in quantitative statements or as quantified objectives, such as population ratios (i.e. 1 arena ice pad per every 12,000 people or 20 acres of open space per thousand people). In either case, the standards that are set should be a direct reflection of community preferences and need. They should be reasonably attainable and reviewed regularly. Although these standards give direction and offer a means of evaluation, they should be treated as flexible guidelines.

Standards in use by other communities and agencies can be used as planning aids. Recreation departments, starting the task for the first time find other standards useful for comparison or as a starting point.

Policies should be aimed at fulfilling expressed objectives, in line with the planning guidelines and standards.

They should express action-oriented programs for each neighbourhood and community. Policies should relate to:

- The location of the facility – indicating the relationship of each development to the population it is to serve and to other uses

- The size of arenas, number of facilities, type of opportunities
- Site development standards
- Cooperation with other public bodies
- Coordination between public and private agencies
- Citizen involvement in site design and facility programming
- Evaluation techniques and criteria

These policy statements should be incorporated into the open space section of the Official Plan.

8. Recommendations for Action

Application of newly derived planning guidelines and policies will lead to recommendations focusing on:

- Targets for upgrading and rationalizing provision of recreation opportunities in developed communities
- Standards for planners and developers related to providing recreation opportunities in new subdivisions
- The design and location of major recreation facilities

The preservation of land outside the built-up area that is required for the proposed open space system

Priorities can be established and a schedule set for the staged implementation of all recommended facilities. These priorities will be based on economic constraints and the need for the recreation facilities, as verified through the involvement of community groups. The staging of the recommendations for action should be flexible enough that the schedule is responsive to changing priorities and financial conditions.

Architect / Consultant Selection

Goal:

The goal is to select the best possible architect/consultant team for your project having regard for budget, level of in-house expertise, experience related to project, experience of staff and how much time each staff member will be putting into this project.

Choosing the Right Architect/Consultant

- Completing a RFP – Request for Proposal

- RFPs provide valuable information to the client on the architect/consultants experience, and on their staff, and provides detailed information on what they can do for you
- Allows owners to hire an architect/consultant with experience in the related field
- Allows you to review who they have worked for in the past, what work they completed, what time frame the work was completed in, and the fees that they charged

The RFP allows you the opportunity to view and determine what the architect/ consultant will do for you as their client.

Architect/Consultant Selection

- Develop Advertisement
- Pre-Qualify Architect/Consultant
- Request for proposal
- Tender Call
- Detailed Proposal
- Short List
- Reference Check and Project Visits
- Interview
- Final Selection Process
- Fee Negotiation

Architect Selection Process

This is some information from the Ontario Association of Architects regarding suggested guidelines to be used in selecting an architectural firm. The information is provided to give background information and a starting point in tailoring the process we will ultimately be using for our project.

The short-listed firms (How did we arrive at a short list?) have been given additional details about the project and have been asked to include the following information in their detailed proposal:

- Detailed information on the similar projects indicated in your Expression of Interest in regards to arenas, seniors centres, community centres.
- Identify similar or comparable projects close to your Town. Each firm must complete a list of facilities they have worked on and must provide references.
- List the team player's to be used throughout the project and provide detailed information on their experience and qualifications (CV's). Include experience on their role being proposed for this project. Include the amount of time (man hours) that each member will be involved with this project and to what extent.
- Provide the approach your team will consider for pre-design phase, design development, tender and construction supervision to achieve the desired results.
- Description of project cost control mechanism
- Energy efficient equipment/design considerations
- Anticipated project schedule/time chart

- Any funding suggestions
- Any recommended or suggested partnerships

Interview only those architects who have been short-listed to ensure that all architects have had equal opportunity to prepare presentations.

As a rule of thumb, you should schedule approximately 45 minutes for each presentation, and 15 minutes between interviews. It is important to allow ample time for both the presentation and for the question and answer period, and also for the committee to discuss the presentation privately before beginning the next interview.

Schedule all interviews on the same day or consecutive days. This permits the committee to compare all of the interviewed architects while information is fresh in their minds, and ensures consistent interview scoring.

The evaluation and weighting criteria for interview scoring system should be communicated to all architects in advance.

While it is appropriate to question architects about their approach to the design of a specific project do not ask for or expect specific advice on an actual design solution during the interview. Appropriate and responsive designs require a great deal of interaction between owner and architect, considerably more than is possible during the selection phase. Preconceived design solutions brought to the table by either the architect or owner rarely address the true needs of the owner's program. Considerable time and effort may be subsequently expended trying to salvage those preconceived ideas and make them fit the program. This actually impedes the progress and prevents the exploration of more responsive solutions to identified design issues.

The interview provides an opportunity to explore issues such as design innovation and cost control and how these can be applied to your project.

Some clients may wish to explore how the architects plan to develop an appropriate level of compensation for their professional services. However, compensation amounts should be left to be resolved through detailed negotiations with the architect who is finally selected, and then only after there is a comprehensive and mutual understanding of the actual scope of services. Let all architects know when the selection decision will be made. It is ideal if the decision can be made and announced on the same date as the interviews, after the committee has had ample time to evaluate all short-listed architects. You are anxious to get underway, and the architects may be involved in a selection process for other projects to which they may be asked to commit.

THE INTERVIEW: QUESTIONS AND SCORE SHEETS

______________________________ (Owner)

______________________________ (Project)

Architects invited to interview for the captioned project should be prepared to address the following issues during the course of their interview. Questions can be expanded on as appropriate.

Criteria	Rating	Weight		Total
1. Related project experience.	X	________	=	______
2. Architect's ability and capacity to perform the work. Key personnel assigned to this project.	X	________	=	______
3. Grasp of the project requirements: • Studies • Design • Etc.	X	________	=	______
4. Methods to be used to fulfill the required services, including design phase.	X	________	=	______
5. Management approach for technical requirements. • Cost controls • Design/construction phase involvement • Etc.	X	________	=	______
6. Use of consultants that may work on the project: • Discuss in-house resources • Outside sources	X	________	=	______
7. Ability to meet time schedule planned for this project:	X	________	=	______
8. Architect's experience and methods used for: • Budgeting and financial controls (provide examples) • Determining fee and compensation	X	________	=	______
9. Other considerations: • Innovative design • Specialization applicable to this project • Design achievements/awards	X	________	=	______
GRAND TOTAL			=	______

Instruction for the Interviewers

Adapt this form to the specifics of your project, adding or deleting criteria that are important considerations in the selection process. Before sending this score sheet to short-listed architects, assign 'weights' to each of the criteria, indicating relative importance.

During the interview, rate each architect on a scale of 1-5 with 5 being the highest, in each of the criteria. Enter the number under "Rating". At the completion of the interview, multiply the rating by the predetermined weight for each criterion and enter the total. Add all totals to establish the grand total. The person in charge will combine all of the totals for those participating in the interview session. The pre-assigned weights are established with a maximum of 10 points for each of the criteria.

SELECTING THE ARCHITECT/CONSULTANT

Rating Scale for Expressions of Interest

1. Related project experience	10%
2. Key personnel (time on project)	15%
3. Arena design knowledge & Community Hall design knowledge	25%
4. Local Community/Town/Regional knowledge	15%
5. Cost Control	10%
6. Use of in-house consultants & outside sources	5 %
7. Time Schedule	10%
8. General Impressions	5 %
9. New initiatives/or ideas	5 %
TOTAL	100%

1. **Related Project/Arena Design Experience**
   - Performance of arena projects, emphasis on projects that are similar to your situation (eg. Small community), more recent projects should be rated higher than projects from the 1970's as technology has changed significantly.
   - Consideration to performance of an arena, community hall, community centre and aquatic facility projects.
   - Differentiate projects listed as Feasibility Studies or proposals only, rather than full project development and design.
   - Are personnel who worked on those previous projects being proposed for your facility? How much time will they be involved in your project?
   - Knowledge and experience working with Ministry of Consumer and Commercial Relations.
   - Ministry of Labour.
   - TSSA – Technical Standards and Safety Authority.

2. **Architects Ability and Capacity to Perform Work – Considerations:**
   - Completeness of team – are all areas covered.
   - Are consultants and sub-consultants going to be available to deal effectively with your issues in a timely manner?
   - Has architect established a working relationship with his proposed consultants?
   - Approach to quality of design package eg. % complete for tender and % complete at close of tender --- to minimize claims for extras.
   - Are drawings done on CAD – ease of change during design and construction?

3. **Ability To Work In Local Climate - Considerations**
   - This is a small community where the facility will be the major focus. There will be significant community input, financial donations and donated material and equipment which will need to be accommodated, large steering committee to work with.
   - Receptiveness to input from committee members, staff, user groups and the general public. Ability to recognize, consider and incorporate needs identified.
   - Local residential issues.

4. **Time Line Suitability – Considerations:**
   - The desired time frame for the project has been indicated to the proponents. The state of the existing facility has a bearing on our desire to have the ice facility operational within 10 months without compromising the end product or cost of project.
   - Firms have been asked to indicate major project aspects as to how they are planning to achieve the completion of the project with accompanying time lines.
   - What is architect's philosophy on project scheduling? Critical Path Method (CPM). Does his schedule include 'pre-design' and 'design development'? Do we receive timely (weekly) status reports re: schedule/progress.
   - Do we have weekly or monthly meetings?

5. **Ability To Deliver On Budget – Considerations:**

- The budget for this project has been established and approved by Council. Of interest is how the firms have performed on previous projects in meeting the project budget including references to confirm past budget performance. Have past projects been on budget?
- Are quality surveyors or construction consultants being proposed and what is their past record?
- How does the firm propose to address extras required through Construction?
- With donated items being included, has the firm addressed how these donated materials or items will be accommodated?

6. **Approaches to Pre-Design – Considerations:**

- A significant part of the project development is compilation of the program information that will include input from committee, staff, user groups and the general public. Of interest is the proposed approach of the firm to assemble this information prior to the schematic design phase.

7. **Key Personnel – Considerations:**

- This item is extremely important to aspects related to the smooth running of the project development.
- Focus on the experience of key personnel, such as Project Manager, Architectural Design, Mechanical, Electrical, Structural, Refrigeration Team Members, Landscape Design and Cost Consultants – specifically related to our situation.
- Are the same individuals being proposed for the entire project or is it to be handed to someone else through the project.
- How available will these individuals be?
- How much time will these key individuals be involved in this project
- Principals of firms – accountability.
- Any conflict of interest re: time spent on other projects by these 'key' people?
- How many other jobs are they working on during your project time frame?

8. **Ability To Communicate – Considerations:**

- This project will involve a number of meetings and presentations.
- Clear, concise correspondence will be of utmost importance.
- Impression of proposal – presentation.
- Capable of working with town staff.

9. **Working Knowledge In Town – Considerations:**

- Having previous experience in dealing with the various regional/local (Regional Government, Conservation Authorities, etc.) Authorities will aid the project development in achieving necessary approvals in a timely manner.
- Are they familiar or have previous experience with your local building and planning department?
- Local environmental groups, etc.

10. Overall Impression – Considerations:

- General feeling on proposal/interview.
- Impression of suitability for this particular job.
- Did they provide any suggestions on new initiatives or ideas?
- Did they impress you with other jobs they have completed?

Interviewing Short-Listed Architects

Excerpt from:
Architect Selection Guidelines developed by the Ontario Association of Architects.

Purpose

Interviews with the short-listed architects gives you the opportunity to compare the architects' different approaches to the design process, as well as their interpretations and understanding of the specific project requirements. You should not expect sketches or other design work for the project in the RFP. The design requirements for even simple projects can be quite complex. At this stage, the architects will not be sufficiently informed as to your needs and requirements to be able to develop a meaningful design solution.

In addition to providing an opportunity to review the architects' experience and expertise, the interviews allow you to evaluate the personal styles of each architect's management and key personnel, and their compatibility with the pre-identified criteria for the project. It is imperative that design personnel assigned to the project, as well as key representatives from the architect's consultants be present at the interview. It is essential that the project's intended users be involved in the interviews. Direct interaction between client/user and the architect is essential for the development of a design that truly meets the owner's needs. It is recommended that no more than 8 (eight) firms be interviewed. It is best to keep selection to 5 or under.

Set-up

The physical set-up for the interview should be comfortable, with good acoustics and ample room. A separate waiting area should be provided for others scheduled to be interviewed. Equipment such as blackboards, flip charts, and audio-visual screens may be useful if available, although many architects will bring the equipment they need. Advise the short-listed architects if you intend to have any equipment available, or of any restrictions (such as the room cannot be blacked out).

Interviews are held in closed sessions unless applicable statues or regulations require an open public meeting. In the latter case, the architects should be notified of this in advance.

Guidelines
If you have requested RFPs, carefully review and score them before the interview. While it is not usually an effective technique or efficient use of time to review the RFP in detail during the interview, the interview presents an opportunity to clarify or expand upon elements of the RFP.

Ranking the Short-Listed Architects
A score sheet that includes a weight and a score for each criteria and/or question is used for evaluating RFP's and interviews, ranking and finally, determining the most appropriate architect for your project.

Establish a weighting system that reflects the importance of each of the criteria. These weighting factors should be entered on the score sheets prior to circulating them to the short-listed architects. Each interviewer/reviewer then employs the same weighting system during the interviews or in evaluating the RFP. Each interviewer completes his/her own score sheet on each architect.

When all the interviews have been concluded, the individual score sheets are compiled. This system provides a documented record of the selection process as support for the decision. When a committee is involved, it is recommended that committee members take the time to achieve a consensus rather than just ranking and selecting by majority vote.

If RFPs are included in the process, the results of the RFP review are incorporated in the evaluation process.

FEES – Discussion of Establishing Compensation for Architect

Notifying all of the short-listed architects of the outcome of the selection process, advising the name of the first ranked architect, the reason for selecting that architect, and the ranking of all short-listed architects, completes the selection process.

Contractual Arrangement Options
There are three main entities in a building project: The client, the consultants (architects and engineers), and the contractor. In the traditional scheme of things, the client enters into separate agreements with both the contractor and consultants to construct a defined building at a predetermined price. This is known as the Stipulated Sum Contract (commonly known as the Lump Sum Contract) or Traditional Method.

An increasing length of time to obtain requirement approvals, the high cost of financing, and the increasing complexity of buildings are among the factors which have led to the creation of various alternate forms of contractual agreements. Each form has its pros and cons; also each is best suited to certain conditions.

The level of the client's in-house expertise, the amount of control he/she wishes to exercise, the degree of public accountability, and the rigidity of the construction budget and schedule are some of the factors to consider in selecting the form of agreement to enter into. In fact the type of contract selected may also affect maintenance and operations criteria.

The Traditional Method (Stipulated Sum, Cost Plus, and Management Contractual) agreements allow the client a high level of input and control over the project. The Design-Build Method sacrifices control and quality for cost and budget considerations.

Public accountability is best served in a Traditional Method (Stipulated Sum Agreement) but most undermined in the Cost Plus Agreement. The latter is favoured in cases in which there are many unknowns and changes are anticipated in the construction process.

An important decision must be made in selecting the type of contractual arrangement by which to build a recreational facility. Everything from concept to commissioning forms this decision. There are many intricacies to take into account.

Pre-Qualification of Contractors

In the best interest of your Municipality, you should give consideration to pre-qualify your contractors for your project. Understand your tendering process and the legalities of contract law, since the Owner is responsible to award the construction contract.

Pre-qualification enables you to have only qualified contractors to receive contract documents and bid on the project. The Pre-qualification Process is prepared by the owner and should include experience within the current five-year period, related experience to your project, related experience in constructing recreation facilities, key personnel, fee, health and safety record, references and banking information. The owner should not pre-qualify more than seven firms and should have a minimum of four to allow competitive bid submission.

Contact your local area Construction Association for assistance and to receive a list of potential considerations. At the end of the day, you want to award to the lowest qualified bid regardless if they are a local firm or a firm out of your area. Given the public nature of recreational building, it is important that the final selection is done in a fair and equitable way with NO outside interference. After all, you are accountable to your taxpayers for your decision.

Four Methods Of Contractual Agreements

Traditional Method Or Consultant/Contractor Method – Stipulated Sum

- This is the traditional form of contractual agreement, with the client entering into a contract with the general contractor or builder.

- The architect, engineers, and other consultants design and administer the project on behalf of the client.
- The general contractor, however, administers the actual construction of the work. Competitive bids for the completion of the project are called from general contractors, who are provided with detailed, completed final drawings and specifications.
- The general contractor, in turn, obtains prices form various sub-trades in order to compile an all-inclusive price.
- A winning bid is selected to construct the project.

ONE

Traditional Build or Consultant/Contractor Method

- This method is most commonly used in constructing municipal facilities
- The architect is usually the prime consultant and works closely with the owner/or owner reps
- They assist in design of facility and ensure project is tendered by experienced contractors
- The architect employs their sub-consultants such as structural engineers, mechanical engineers, electrical engineers, refrigeration engineers and landscape engineers. They all work together as a team in the best interest of their client. The project is then designed, detailed, cost analysis completed, approved and then tendered.
- This method is more time consuming, however, it gives the owner more flexibility in the design as the architect is involved at the early stages and remains in control with the owner though the project.

1. Advantages

(i) The design team, consisting of the architect and engineers, are retained by the client and are in close communication with a responsive to him/her.

(ii) This is a tried and proven arrangement in which the responsibilities of all parties are well defined.

(iii) Sequential phasing of design, tendering, and construction demands attention to detail. All design details must be completed before subsequent phases. This ensures the greatest client input and quality control.

(iv) As the scope of work is well defined, the lowest bid is easily identified and public tenders may be issued. This ensures public accountability.

(v) The Traditional Method (Stipulated Sum) ensures the best possible price at the time of tender and holds the contractor’s price to a well-defined entity.

(vi) Capital commitment is known in advance.

(vii) Competitive nature keeps prices low and demands efficiency in time management on the part of the contractor.

2. **Disadvantages**
   (i) Construction cannot begin until design development and construction documents are complete and tenders are called. Design and construction cannot overlap unless subsequent tenders are called.
   (ii) Revised client requirements are not as readily implement in both the tendering and the construction phases as they are in the cost plus contract.
   (iii) The progress payment procedure may slow down cash flow to the contractor and indirectly to the subs during the construction phase that may lead to potential delays and other costs to the client.

3. **Discussion**
   (i) If the quality of the bid package is high and if contract administration during the construction phase is tight, construction extras can be minimized.
   (ii) The general contractor is not party to the design development. While this may result in an uncompromised design, the general's knowledge and experience is not utilized.
   (iii) Rather than having to calculate the units of materials and hours of labour after the fact, as in the Cost Plus Contract, the contractor is required to calculate these before hand. This exposes the builder to financial risk, which may jeopardize the project mid-stream. It is important to investigate the general's and sub's financial position and obtain sufficient bonds.
   (iv) This type of contract is usually conducive to an on time, on budget, and low construction extras, if the project team is strong.

TWO

Cost Plus

The contractor is paid on the basis of actual cost of materials and labour, plus a fee to cover his/her overhead and profit. While these unit costs, including the mark up, may be determined before hand and included in the contract, the client faces a significant risk of increased financial exposure. An upset price may be included in the contract; however, this makes for difficult and litigious contract administration.

1. **Advantages**
   (i) This is a viable solution to a construction program with many unknowns or where it is not necessary or practical to document the exact scope and method of work.
   (ii) All problems need not have predetermined solutions; rather, the solutions may evolve.

(iii) Construction and design can overlap and therefore construction may be completed faster than in the Traditional Method (Stipulated Sum Arrangement).
(iv) The general contractor's knowledge can be utilized during the design stage.
(v) Changes to the work are easily implemented and the project can be stopped and re-started more easily than under other contract forms. Changes can even be implemented on site.
(vi) Cost Plus permits a situation where time and resources can be used to exact the highest quality of workmanship.
(vii) It provides a clear basis for assessing the contractor's and sub's progress claims.

2. Disadvantages

(i) Unless a guaranteed maximum is agreed upon, there is no contractor's commitment with regards to total price and time frame.
(ii) It is difficult to determine a fair guaranteed maximum price. A basis for adjusting the guaranteed maximum should be included in the contract to provide for changes in scope of work.
(iii) This method requires close control by the client, consultants, and the architect in order to verify extras and progress claims.
(iv) Public accountability of funds can be difficult.
(v) Unless there are incentive clauses in the contract, there is little financial motivation for the contractor to be efficient. The project can easily run over budget and behind schedule.
(vi) If the contractor is party to the contract, the added cost of incentives may become a built-in bonus for the successful contractor, especially if there is a guaranteed maximum.
(vii) It is possible that the client may pay for the contractor's errors.
(viii) Control of overtime cost claims by the consultants as well as cost of delay claims by the contractor may be difficult.

3. Discussion

(i) As the final cost of the project is rather nebulous, this form of contract permits little public accountability and is not common in the public sector.
(ii) A variable of the Cost Plus Contract is the Unit Price Contract. Each variable in the contract has a defined price (the unit price) and multiplying the unit price by the quantity of units arrives at the total price. This method is suitable for certain types of less complex or repetitive buildings and is more common for renovations type of projects. This form of contract is also best suited to certain clients who are involved with numerous structures of a defined type.
(iii) This is an extremely flexible form of contract but at the expense of maintaining a predetermined budget. One way to deal with this is to

include an incentive clause in the contract, which will encourage contractor's efficiency and accountability.

THREE

Management Contractual (Project or Construction Manager)
By this form of contractual arrangement a project or construction manager is appointed by the client to act as an extension of his own resources. The manager may manage the entire project form conception to commissioning (Project Management) or may manage only the construction phase (Construction Management). In both cases, the manager will, in fact, act as the general contractor obtaining bids from the subs and administering the project.

Project Manager

- Project Manager usually works on a fee basis of percentage of the construction costs.
- The project manager hires the design professionals architects, engineers, general contractor which allows the Project Manager to have full control of all aspects of design and construction including the building and professional services.
- Tenders out the sub-trades – structural steel – masonry/concrete work.
- Compiles and completes project sub-contractors and consultants.

Advantage – the actual tender process is shortened due to the fact that the Project Management team is involved with the owner form the initial concept of the project and the construction costs are negotiated while a "fast-track" method of construction is under way.

1. Advantages

(i) Provides for effective communications.
(ii) If the client has low expertise in the design phase, a reputable manager will be invaluable. This will allow the client to take the hand-off approach. This approach is similar to design-build except with the potential for more client control.
(iii) Allows for flexibility during design and construction to overcome the unexpected.
(iv) Provides for efficient use of joint expertise in all phases of work.
(v) Construction may begin before completion of the final design for the project.
(vi) Work can be tendered sequentially, allowing flexibility in controlling costs.
(vii) Ensures disclosure of all sub-contractors' prices to the client. Also, trades may be selected on an individual basis.
(viii) Possible savings in carrying costs may be realized if subs trades are paid directly after their contract is fulfilled.
(ix) If the manager is diligent, the construction extras may be minimized.

2. **Disadvantages**
   (i) There is a limited pool of qualified persons with experience in managing these types of projects.
   (ii) The client is seldom willing to give the manager total responsibility and conflicts may result.
   (iii) There is an additional potential for conflict of interest between the manager and the subs, and between the manager and consultants.
   (iv) This necessitates mutual respect for each other's abilities.

3. **Discussion**
   (i) The Management Contract usually involves overlap between the design and construction phases. Construction work is tendered in sequential packages by means of competitive bidding as the relative design documents are completed.
   (ii) The manager may be compensated on a lump sum or salary basis. For large complex projects, both a project and a construction manager may be hired separately.
   (iii) Under other contractual arrangements, a single general contractor may not be able to assemble the team with all the strongest parts. In theory this may be achieved under a managed contract. This same argument has parallels, in the design development, cost control and administration aspects of the project.
   (iv) The manager must be removed from the various interests. At the same time, the manager must be given sufficient authority, in other words "walk a fine line."
   (v) Architects, engineers, and general contractors are experienced in managing their own responsibilities in most projects. To involve a separate project and/or construction manager is usually appropriate in the case of large, complex projects.
   (vi) If the client has little expertise in design, he/she may hire a reputable manager and take a hands-off approach, with the option to input when required.

FOUR

Design Build
This form of contractual agreement is popular for building types that are characterized as being simple and repetitive in nature. Under this form of agreement, the client with the help of consultants develops comprehensive set of performance requirements (conceptual drawings and specifications). This package is then tendered. The successful design builders will then further develop the detailed design documents for construction.

The professionals completing the construction documents and performing the field reviews are retained or employed by the design builder rather than the client.

- The client would employ a General Contractor who would be in charge of the project.
- They would be contracted to construct the facility project for an agreed upon maximum amount of money
- This agreed upon fee would included all consultants and fees who would have to work within the limits of the contract price
- Some people in the industry feel that the flexibility and design requirements of the owner are compromised due to the control of the project being in the hands of the contractor and not the consultants

1. Advantages

(i) Particularly suitable for standard and repetitive buildings.
(ii) The client is free from administrative work after the conceptual design stage and award of design-build contract.
(iii) The total initial project cost commitment is known in advance.
(iv) Extremely competitive as one entity manages all aspects of cost control, including detailed design and construction.
(v) One party, the design builder, has full control over the design and construction schedule.
(vi) This provides a good framework for rapid decision making an implementation.
(vii) Construction can begin before all design work is complete.
(viii) Once the clients' requirements have been formulated, the design builder is responsible for all errors.
(ix) The procedure favours established firms with experience financial stability, and bonding capacity.
(x) The client will have a good idea of what to expect form the design builder by examining similar and previously executed projects.
(xi) In most cases, the client may receive several proposals with different approaches form which to choose.

2. Disadvantages

(i) Not suited to complex or unique building types.
(ii) The client must develop a well-defined set of performance requirements for the design, spatial relationships, circulation (performance specs, schematic drawings), etc., in addition to materials and workmanship.
(iii) Over emphasis on cost versus other considerations as a criterion in building, e.g. maintenance and operation cost (life-cycle cost).
(iv) The detailed design professionals (architects and engineers) are retained or employed by the design-builder and thus their role in representing the best interest of the client may be suspect.
(v) The client's consultants' (architect and engineers) role, if any, is restricted and the design-builder tends not to acknowledge it. The

client's consultant's design philosophy may conflict with those of the design-builder's consultants and often a compromise is reached.

(vi) Final design professionals are not in close contact with the client.

(vii) The cost of preparing a contract proposal is high and discourages many competent builders.

(viii) Objective comparison of proposals becomes difficult because of different approaches by different design-builders.

(ix) It is difficult to reject low but unsatisfactory proposals.

(x) The design and construction technique could be repeated too often resulting in a nondescript building.

(xi) High cost of construction extras may be incurred if the client's performance criteria are not well defined or if the client wishes to implement changes to the project subsequent to contract issue.

2. Discussion

(i) Success of the project depends greatly on a well-defined performance requirements/specifications.

(ii) The client is dealing with a single entity. This does not necessarily mean that the individual components of that entity are the best available.

(iii) The package contractor is sometimes able to get better and more consistent performance form trades because of an ongoing relationship with them. However, especially in a depressed economy, this may not hold true as competitive trades may be excluded.

(iv) Low client involvement is required and the project may "slip away" from the client.

Pre - Construction Investigation

Picking the site for an arena is very important. Soil tests must be completed to determine the type of soil the facility will be constructed on and to determine the depth of the water table below the surface. Water can be a dangerous product to have in the sub-foundation below your ice surface. You must choose a site that has the least possible water in the ground beneath, and take preventive measures to keep this sub-foundation well drained.

Before Purchasing a Site or Considering Construction

We recommend that an adequate number of test holes be made over the site to determine the nature of the subsoil and water level. Apart from high water table, or heavy clay strata close to the ground level (which can present drainage problems) underground springs or quicksand can cause problems that are costly to overcome. The money spent on adequate soil testing is a good investment. It may be wise to spend more money on an alternate site that has less construction problems (as far as water and ground strata are concerned). The construction savings and dependability of the ice surface could outweigh the initial desire to purchase the cheaper site.

High Water Table
Many sites, because of a high water level, are just unsuitable for a conventional rink. Satisfactory ice can be assured only by use of an elevated floor. There are several installations where rinks are built beside rivers or lakes, in which case the ice surface is supported a few feet above water level by concrete piers.

Run-Off Pattern
Water must be prevented from entering the subsoil under the ice surface. This is accomplished in many cases by means of weeping tiles around the building, which are led off into a drainage system, away from the building foundation.

Drainage & Sewage Facilities
Obviously, the drainage tiles under the floor must drain away to a lower system. Ridiculous as it seems, we know of installations where the weeping tiles were connected to a storm sewer system, and during storms the water actually backed up into the subsoil under the ice surface.

Septic tanks and rock beds, etc. must not be located where they can weep into the soil under the ice surface.

Soil Composition
The composition of the soil is important, and any possible areas of clay or non-porous material must be removed so that there is no possibility of holding water pockets under the ice surface. Generally speaking, all material under the ice surface must be completely porous for a minimum of four feet down. If the material under the four feet is non-porous, the surface of this material must be graded and drained, the water collected, run off, and disposed of.

Capillary Effect
The underside of an ice sheet is cold. This attracts moisture in much the same way a glass container does when it is removed from the refrigerator and placed at normal room temperature. Because of this capillary action of the surface, any moisture below will eventually become ice itself. A combination of several construction methods is required to address this problem, including:
Ensure that minimal moisture is permitted to remain in or enter into the soil under the ice.

Stop the cold of the ice pad from descending into the soil beneath, either by using insulation and/or heating through pipes or conduit.
Install the ice surface so that it is raised above the ground level, thereby eliminating the freezing action entirely.

Cost of Various Materials at Site
Any porous material should be satisfactory for the intended use. For a proper job, the existing clay or similar material is removed to a depth of at least four feet and the top of the remaining clay is terrace into drainage tiles that are connected to the drainage system,

leading the waterway from the building. Three feet of coarse gravel, or crushed stone, is placed above the tiles. Finally, for the top 10" or so, sharp sand is used, which can then be rolled smooth, and on which the insulation can be laid level.

Insulation

Insulation below the ice rink refrigeration piping system is important. Under floor insulation below the ice rink refrigeration system is strongly recommended. Care must be taken to use insulation that is non-absorbent. Remember that insulation does not stop the flow of cold, but simply slows it down. 2 layers of 2" rigid Styrofoam insulation or 1 layer of 4" rigid insulation is recommended. Some companies have published brochures on the use of insulation under ice rink floors that we suggest are worth reading.

Ice Rink Under-Floor Heating System

Under floor heating is a must in arena construction. Circulation of a warm brine or glycol solution through air pipe grad under the floor. Ventilation tiles under the floor, possibly with a connected forced air-heating system.

At first glance, the introduction of heat under the floor appears to be expensive, but upon closer examination it is found that the heating system, if designed properly, can be installed in such a way that it is not as costly as would be anticipated. In most cases, heat can be recovered from the refrigeration system and used for this purpose.

Summary of Steps in Arena Planning

- Decision that an arena facility needs to be built.
- Review and study needs – What other facilities are needed in the community? How important is an arena in meeting the community's recreation needs? Must involve the community and facility users in this process. Do you have a recreation master plan or a facility needs study in place?
- Committee structure – Arena committee chosen to represent a cross section of community leader and groups. Suggest 2 members of Council, 2 members from the public, 2 from the user groups and 2 from facility staff or recreation department.
- Co-operative planning and citizen participation – involve as many persons as possible – inform people and discuss the project as widely as possible.
- Preparation of arena objectives – A statement in writing to explain and clearly state the purpose and activities intended in the arena project. Must ensure that the facility is operational and functional. Ensure all people understand how important function of the building is.
- Preliminary design and cost estimates – schematic and preliminary plans – capital and annual budget projections. At this stage you find out whether all users needs have been met and whether all the needs meet the approved budget. It is at this stage items may have to be deleted or scaled down to stay within approved budget. Everyone must clearly understand the importance of this stage.
- Approval of final plans – by committee and local elected council or owner (if necessary).
- Fund raising (if necessary) and promotion.

- Working plans and specifications.
- Final check on plans and specifications – especially as to overall layout, material, traffic circulation, operational and maintenance efficiencies.
- Tenders, bids, contract letting.
- Construction and supervision.
- Dedication ceremony.

Important Questions That Must be Determined Before the Project Starts
To prepare the base for a good design and a good plan, there are many questions to which the committee must supply precise and adequate answers.

- What is the basic purpose of the arena?
- Will it be used mainly for spectator sports, or mainly for participation sports? Or a combination?
- Will it be used for summer activities, as well as winter sports? Will some years require ice to be kept in all summer?
- Will community want ice installed in summer months to hold hockey and skating schools?
- Is the arena to be part of a larger complex of recreation facilities that may include a community center, playing fields, swimming pool, auditorium, and so on?
- Will the arena building be expected to provide for activities that require a stage and auditorium seating?
- What population will be served? What distances will people travel? How will the arena relate to existing recreation facilities?
- What sites are available? Are all the facts needed for the selection gathered together – land cost, drainage, utilities, and zoning regulations, adjacent parking, etc.?
- What financial resources are available?
- Will it be necessary to build in stages?
- How will the arena be managed once the building is complete? What staff will be available for maintenance and programming? Is the facility being constructed in a residential area or an industrial area? What are the impacts with traffic and noise? Does the facility structure and landscape have to blend in with existing buildings etc?

Type of Structure
The type of structure to be built will be one of the first discussion points and should receive serious deliberation. This decision will establish the anticipated activities and programs for the arena. While this might appear obvious, there will be major differences in sizes of dressing rooms, seating, heating, and so on, according to the type of program in minor or senior hockey, and depending on whether events other than hockey will be promoted, whether winter or summer. Is lacrosse, in-line hockey, ball hockey or skateboarding being considered as summer activities? There is also a fundamental policy that must be determined at this stage: whether the arena is to be a commercial type revenue – first operation or whether it is to be used for public recreation purposes and profit only a

secondary consideration. Is the arena to be subsidized by the municipality, break even, or is it to make a profit? Are debenture charges to be paid out of gross revenues or charged against the current municipal tax levy? Is the community interested in public/private partnerships? The answers to these questions may have considerable effect on actual architectural design and layout, and should be thoroughly discussed and decided upon at the very outset of the planning process. To sidestep these issues may eventually prove most embarrassing to the arena managing authority or community and can become worthy.

Promotion
Proper use of various promotional techniques is necessary for the success of an arena building campaign. Local newspapers, radio and television can be a real asset, as can a local service club. The arena committee can utilize a scale model of the arena and adjacent property to great advantage, as it provides people with a better understanding of the proposed facility. Having a model constructed by the architect and used as an aid in the promotional campaign is really helpful. A model can be costly, depending upon your desired quality, but this device is an extremely wise investment to assist in fundraising and for getting the community on board with the project.

Arena Location and Site Considerations
Once the types of facility and its key operations and functions have been decided, the matter of relating the intended uses to the design is now the responsibility of the architect or contractor. Many people assume that their lack of knowledge of architectural design should absolve them from any responsibility in the design stage. A qualified architect will insist upon a close liaison with the arena owner and its staff in the interest of the best possible end product. It is very important that facility staff have input into the design as they have good knowledge in relation to the operation requirements of the building and design. This is not to suggest that every detail of the design must be approved in the initial stages, but that at each logical stage of development the owner must be given an opportunity to discuss the details and the implications of the design. The following should be discussed:

- The overall site plan and the relationship to the adjacent site and facilities.
- The actual building layout as to overall size and dimensions showing relationship of entrances and exits to the parking lot and public transportation.
- Zoning – Ensure that any existing zoning by-laws are adhered to, or any regulations as to type and size of building, height of building, amount of parking, and so on, have been approved by proper municipal officials. Often proper and attractive design features will overcome many of the objections to such a large facility being placed in certain areas. The old traditional steel-roofed barn-like building is understandably objectionable in an area of good quality housing, as opposed to some finer architectural renditions that have been designed and constructed in recent years, and built in proximity to residential areas. It should be recognized, however, that proper zoning regulations will by and large prevent conflicts in this

matter, as zoning is intended to promote the highest and best land use of the various sections of the municipality, taking into account all these delimiting factors.

- Parking lot – surfacing and drainage.
- Snow dumping area (ice from ice surface).
- Utilities (sewers, water, electricity, natural gas etc. outside the building).
- Landscaping of property.
- Extra and miscellaneous items (from 10-15 % as a safe estimate).

Building Regulations

The architect, contractor and owner have an obligation to ensure that and all local municipal building, fire and health regulations are adhered to. This is a customary procedure involved in any building construction project and is intended as a protection to the safety and health of the citizens, users and staff using the facility. These regulations vary depending upon the size of the community, and upon the criteria such as number of seats, type of intended uses of the arena, i.e. If facility use intends to have trade fairs or home shows will affect the type and numbers of sprinkler heads required, proximity to other structures, water outlets for fire protection, and so on. The type of regulations may have a considerable bearing upon the final overall construction costs and are a key factor in the determination of the final anticipated arena cost. The regulations could well affect the type of materials and fixtures, and hence require a much higher quality for such items.

Drainage Factors

The drainage of the overall site, including the parking lot and adjacent amenities, has been neglected in the construction of many arenas. Often there are no local regulations of by-laws pertaining to surface run-off. It is strongly recommended that a storm water management study be completed. In the final section of the building site, every precaution should be taken to ensure that both the arena site and the adjacent grounds receive sufficient drainage treatment. Standard site feasibility requires two approaches.

- Soil testing of the building site to determine the soil conditions and sub-drainage. These indicate the type of footings or structural support that will be required, and will also determine any source of underground water that could result in future problems.
- Surface drainage considered in terms of existing grade of the overall site. Any necessary changes in grade are to be indicated on the site plan, along with necessary storm sewers and catch basins. This precaution could prevent costly flooding problems, especially during the spring season.

Utilities And Services

The proximity of utilities and services (water, electricity, storm and sewer lines, telephone, natural gas lines, cable TV, etc.) may be a determining factor in final site selection. Water and electricity must be available near the intended arena location. Bringing services to the building can be expensive if the source in not located within a reasonable distance. A drilled well in rural area may prove to be a low cost feature.

The cost of municipal water and sewer can also influence the design selections of the refrigeration equipment. If water costs are anticipated to be high, alternate selections may be possible to reduce operating costs. If a septic tank sewage disposal or septic bed system is required, it is essential to ensure proper effluent carry-off. Also ensure that no rock outcrops or similar condition can create costly excavation problems.

Direction of Building
For natural ice arenas or outdoor artificial ice surfaces, climatic factors will dictate the orientation of the ice surface on the site. The direction of the sun and prevailing winds must be considered.

In a modern, well-insulated facility, these factors are not as critical. The building can be situated to accommodate access to parking and general aesthetics.

Special consideration should be made for smaller, low cost arenas that have limited or no seating along the south side of the building. A corridor or concourse between the rink boards and the exterior south wall will reduce radiation of the sun, thereby preventing soft spots or water occurring against the boards. This can also be overcome by planting a row of coniferous (evergreen) trees four or five feet from the building. In areas with considerable snowfall, the snow can also act as an insulating medium, but one should not depend on snow to alleviate the problem.

The major entrance and foyer may have to be located to suit strong prevalent winds. If possible, try to locate the building exits in a north-south direction. This will limit potential problems due to freezing and thawing along southern exposed areas and entrances, especially during the early and late season periods.

Parking
The amount of parking spaces required will, to a large degree, depend upon the type and number of activities and events that occur in the arena. Other related activities or facilities that take advantage of a common parking area should also be considered. To provide an unusually large amount of parking space for events that draw large crowds only occasionally is, of course unrealistic. However, the site must provide sufficient or reasonable space for normal activities with some measure of anticipated special event demands reflected in space used occasionally to full capacity. Other factors influencing parking demands are cost of land, related recreational facilities, public transportation, adjacent parking facilities for use at peak or over flow periods (such as shopping centers, public parking areas, etc.) to mention a few.
General Rules for Vehicular Parking:
- allow one parking space for every four patrons (for normal attendance)
- allow 400-450 sq.ft. per vehicle for each parking space, which provides parking for over 100 cars per acre.

You must check with your municipality regarding local parking regulations.

Public And Service Entrances

It is important that the entrance and service areas relate to the general site in terms of accessibility and convenience. The main entrance creates the first impression on the general public, and a poorly located entrance is not conducive to a positive initial response by the visitor. An entrance oriented to the parking area provides for more efficient arrival and departure of the arena patrons.

The service entrances should be designed to accommodate the delivery of items for normal operation. Besides ample room for trucks and large vehicles such as buses, there should also be sufficient surrounding area provided to receive material for special shows or events. There are many examples of large service doors opening into a corridor in which it is too small to maneuver a large truck.

Landscaping

Unfortunately, landscaping of an arena is often treated as a consideration only if there are a few spare dollars remaining after the building is completed and someone thinks that a sidewalk or some grass might improve the main entrance. Rarely is the overall appearance considered in terms of aesthetic qualities of the total site. When this has been considered, along with the sitting of the building, appearance and quality of building materials, easy access to the entrance and exits, and necessary landscape materials placed in respect to the total site, then a favorable overall quality is portrayed. Attendance and local public support, provided there are reasonable attractions, cannot be excluded from the subject of overall landscape and site quality.

Arena landscaping is not merely the growing of grass and the placement of a few shrubs and trees at the entrance to the building. Arena landscaping is the enhancement of the total area by strategically placing landscape materials that may include turf, plant materials, paving, exterior lighting, parking, benches and fencing, etc., all in conjunction with, and complimentary to, the sitting of the arena itself. The building and the overall site should be treated as a single design, relating the arena to parking, access, utilities, and final landscape improvements. Too often the grounds and the building are treated as separate entries when in fact, they are integral parts of the overall property and immediate surroundings.

The access and exit areas must be carefully considered with ample exit areas to prevent the use of turf areas, which can result in a run-down and neglected appearance. Carefully designed, a minimum amount of turf and plant materials can be tied in to the hard surfaced areas to create an attractive site. The arena should be considered in relation to other community recreational areas and facilities. A properly and well-designated site can add immensely to the overall appearance. Consideration must also be given for winter snow removal.

Designing the Building – Considerations and Precautions

We shall assume that the architectural design recognizes the intended activity and programmed use of the arena. We will deal in a general sense with the major arena design details that are not only important in the original layout and the construction, but are critical in the proper functioning and operation of the arena, as well as the maintenance and upkeep of the structure. Poorly designed structures are not only frustrating to the operator and its patrons, but also always expensive and often impossible to renovate or rectify. The planning committee has a major responsibility to screen out as many of these “bugs” as possible, prior to final approval of the building plans and prints. Operational concerns must be taken into consideration during the design stage. The facility must be functional for all users and for the facility operators of the building.

Type of Building Structure
The type of building design and main arena super-structure depends to a large degree upon the intended functions of the arena – the critical factor being the number of seats required in the main auditorium/seating area. Local demands vary greatly in every community. Many older arenas have been built, especially in many rural areas and small-to-medium size villages and towns. This particular style or design was very common, a laminated wood-truss, hip-roofed structure, and is suitable for capacity of up to several thousand seats. There have been many recent modifications to this basic unit, specifically to the entrance and foyer sections, which have been adopted to meet different needs of a particular community. This design has proven to be very satisfactory and structurally sound. In recent years, there have been many arenas built using pre-engineered metal buildings that are very practical. Depending on the ingenuity of the owner or contractor, these are aesthetically pleasing with the subtle use of masonry and shrubbery.

Type of Building
An Arena is normally a rectangular shape, having a rounded, flat or hip roof or a modification, or a combination of these three basic types. The crossbeams should be of steel structure. The walls can be concrete block with vertical concrete pillars as the major roof-bearing structure, or can be wood, sheet metal, brick or a combination of materials. This depends upon local building codes, type of building, capital funds available and the intended use for the building. The use of windows and/or skylights over the ice rink is not recommended as this will cause problems maintaining or installing your sheet of ice. This could also create sun glare affects to the participant. Having skylights can continue to create ice problems once your sheet of ice is in. During warmer days in the winter, the warmth of the sun can cause havoc to the surface temperature of the ice.

Glass is a dominant feature of some arenas, but its use on a large scale is discouraged to avoid costly maintenance in cleaning and replacement.

In the entranceways of many new arenas, concrete architectural block is now being used as an upgrade to replace the monotony of concrete block.

Main Entrance / Public Entrance
The main entrance can be located at one end of the arena or in a central location of your facility. In smaller, low capacity arenas, the main entrance is usually placed at one end of the building mainly as a lower cost factor.

The entrance must be accessible to all users, which should include handicap accessibility. Consultation with groups such as barrier free/special needs, in the planning stages can be beneficial to planning your recreation facility.

The main entrance is usually a common link to the dressing rooms. It is recommended that walkways, hallways or main lobby entrances should be twelve feet wide for a hallway and twenty feet wide for a lobby to allow for hockey equipment and spectators, with a double door access or more leading to the dressing rooms and exits.

Skylights are commonly used to upgrade the daytime lighting and are also used to conserve energy cost within your main entrance. The main entrance should have a vestibule type entrance to cut down loss of heat in the wintertime. The main doors should have wheelchair accessibility with push button doors or automatic sliders, with the push button located low enough for someone in a wheelchair to operate, as per building code. A slope over your main entrance door is not recommended, as it is a liability in the wintertime with snow building up on the slope and an avalanche of snow falling down on patrons. It is recommended that the roof is sloped away from the front doors when possible.

The main entrance should be heated to maintain a safe walkway leading to the main entrance of your facility. The control panel for the heat sensor should be within a reasonable distance to the front doors for easy management control. The ideal situation would be to have this tied into your energy management control system. Depending upon the intended capacity and type of activities, an entrance foyer should be of adequate dimensions to contain a minimum of 2% to 5% of the overall capacity at any one time. The larger the foyer that can be constructed, the more it will be appreciated by the patrons. Even in the case of a low seating capacity, participation-only type arena, a reasonable size foyer can be utilized as a control point.

Auditorium
In many front-entrance arenas, the area above the front foyer has been used for a medium size auditorium, and/or meeting and activity rooms. This has proven to be a multi-purpose room creating revenue for your recreation facility. In new larger facilities the auditorium has become open space overlooking your main entrance. This adds to an open concept, however it does create costly, high maintenance, low-income space.

Roofing Materials
Roofing materials are predominantly of rubber membrane, and or stone, asphalt or tar treatment. Ideally, the roof should be insulated and have a vapor barrier to help keep the heat out of your ice rink.

Exterior Wall Design
If concrete blocks are laid in an inset pattern, precaution should be exercised, so that the protrusions are not sufficient to allow a wall to be climbed. A 1/4" inset will provide the desired wall patterns and prevent climbing up the wall.

Icing Conditions
Eaves troughing is very important to help eliminate the problem of water running to outside doorways and freezing, thereby creating a risk management situation. Some arenas have installed an electrical heating cable in the bottom of the trough, as well as the down pipe, to prevent the build-up of ice. This has proven to be an excellent melting device. The down pipe should be installed directly into the storm sewer system eliminating possible flooding of your entrance and also freezing of your main walkway.

Heated Storage
Provisions should be made at one end, or at the side of the arena, for heated storage of mechanical ice-maintenance equipment. A hot water outlet is required in this storage area. The space should be a minimum of 200-sq. ft., and be protected from public areas. Equipment should be close to the ice surface but not located in the main resurfacer room.

Ticket Sales
The ideal entrance and foyer provide a direct and obvious path to one or more ticket sale windows. This should allow free access to the main arena after purchase, without having to cross through another line-up of people. This is accomplished by having two or more ticket windows that are side by side. Many larger arenas have two separate ticket outlets. Some have provided a ticket outlet for use on game or event nights in the central part of the foyer. This permits access from two sides, along with the regular window on one or both sides of the foyer. In many smaller arenas the ticket office is entirely separate from the manager's and facility staff office(s) and often doubles as storage space for sundry supplies. Ideally, the ticket and sales office connects to, or is part of the manager's and facility staff office. This provides considerable efficiency for the office personnel or the manager, who can handle advance ticket sales or provide information easily from a centralized location. Portable ticket booths can also be provided for special occasions.
A small foyer is often a very cold and drafty area since the exterior doors are held open to admit even a short line-up of patrons. This creates an unpleasant area for both the patron and the staff. The foyer should be heated in any type or size of arena.

Public Washrooms
Any arena, regardless of size, must provide washrooms for public use. These are normally located near or off the foyer in smaller capacity arenas. The medium and large arenas often provide washrooms on each side of the arena. The number of units for both the men's and women's rooms will depend upon the frequency of large crowds. Most smaller size arenas of low spectator frequency appear to require a minimum of two urinals, two toilets and one washbasin for men, and two toilets and one washbasin for women. Local building codes will dictate the number of fixtures required. In many medium and most large arenas, an anteroom is provided for the women's washroom with a very large mirror and shelf on one wall. Upright urinals are best in the men's room since the trough or horizontal floor type has not proven satisfactory or hygienic.

A handicapped/family washroom, separate from the public washrooms, is usually built to handle two or more wheelchairs depending on the size of the facility. Counters, sinks, taps, paper towel dispensers, baby change table, and toilet paper dispensers all should be located in a position to be handled from a wheelchair. A flashing light located outside the washroom, which would be operated from a pull switch or a switch near the toilet to indicate someone needs help, is always comforting to a person that may require help.

Accessories

Many newer arenas have installed factory type foot operated semi-circular washbasins that accommodate up to six or more people at one time. This type of basin stands up well to heavy usage, and considerably reduces the amount of space required for the standard-type washbasins.

It is also recommended, as an alternative measure would be to use washbasins with automatic sensors to turn the water on and off. These basins would be tempered water and can reduce potential lawsuits from small children being burnt by hot water. Automatic flushers on the toilets and urinals as well as the use of hand dryers are recommended as a money saving idea and also as a sanitary solution. In larger facilities, the use of a push-button type hot air hand dryer can slow crowds and cause line-ups. Paper towels are still the predominant hand-drying devices in many facilities, large or small. Paper towels can have drawbacks, such as, being a tool to cause blocked toilets, if the washrooms are not properly supervised and controlled.

Washroom Vandalism

Most public facilities succumb to a degree of vandalism in some form. The best form of prevention of vandalism is still considered to be well-designed, high quality fixtures within the washroom facilities. The design of washrooms, such as design brick and ceramic tiles can reduce long-term cost of vandalism within your facility. Having a closed circuit television (CCTV) system will cut the high cost of vandalism down within your facility. Having a camera just outside the main doors of your washrooms will deter vandals away from your facility.

It is highly recommended that the use of paint other than for your ceiling not be used in the washrooms, as painting can become expensive and time consuming.

Toilets should be wall hung when ever possible. Floor mount toilets become a custodian’s nightmare. If all toilets are off the floor it is easier to clean floors and makes for a cleaner looking facility. The toilet seat should be in the colour of white to show unwanted dirt. Washroom partitions should be a high durable plastic, approximately an inch thick. These partitions will last years and withstand all types of vandalism.

Counter tops should be made out of a one-piece hard marble/stone finish. Some counter tops and sinks can come as one piece, which is attractive and can make for easy cleaning.

Toilet bowl water closets should not be exposed. They are subject to damage if not placed behind the washroom wall in a maintenance area not open to the public. This maintenance door can have its own access entrance right from the washroom or from another area located in your facility.

Doors to washrooms should have a locking mechanism on them that can only lock with a key from the hallway or lobby only. Thumb latches should not be installed on any public doors as this can be a risk management situation. Heavy-duty washroom equipment in your facilities are advised whenever possible.

Outside doors to washrooms for summer use can present a real problem if not closely supervised. If your facility is considering washroom access to the outside then it is recommended that the washroom be made out of straight concrete block with latex painted walls. The use of latex paint allows a quick paint job to happen with very little drying time. Cutting out the use of tiles as suggested earlier will save major dollars on the replacement of broken tiles. The use of plastic partitions is still recommended. Other options to control outside doors would be the use of an electrical security system such as a meg locking device, key scan control that could unlock the doors at a certain time and lock your doors at night time. This becomes an effective way to monitor your washrooms, backed up by your CCTV system.

Concessions

Food and drink outlets are usually referred to as concessions, whether self-operated or leased to a private operator. Such an outlet is a normal part of every arena operation, large or small. In a small arena, the concession is often located in the main lobby in close proximity to the public washrooms. This area is heated for the comfort of patrons between periods. In a medium-size arena, there are usually two concession outlets, one on each side of the arena. A large arena may have 8 to 10 outlets, often located in the four corners of the building, as well as along each side of the corridors.

Vending machines can be used to alleviate crowded concession counters, as well as eliminate the need for staff personnel during off-peak or low attendance hours. Some arenas have special booths set up for a single purpose, such as popcorn sales. These outlets are strategically situated to best serve the arena patrons.

A well laid-out concession area can greatly increase food and drink net profits, as the time period for service to a large patronage is always at a minimum. The concession should be designed in such a manner that soft drink and food sections are convenient to each attendant, eliminating cross traffic and increasing efficiency. Excellent advice on this layout is available from any large-scale confectionery entrepreneur who leases and services outlets.

Electrical outlets should be GFI plugs. The main electrical panel for your concession stands should be located within the concession to allow quick access to the panel in the case of a tripped breaker.

The use of the local health department is recommended when you are in the planning stages. The health department will be willing to meet with you to discuss the locations of sinks and the amount of sinks required.

Public Telephones

Public telephones are usually required in any arena, and are best located in a prominent setting, either near an exit or in the foyer of the arena. A certain degree of vandalism occurs with public telephones unless there are good supervisory practices. Damage has been greatly reduced by eliminating the booth and leaving the telephone exposed near the front entrance and in full view of the manger's office, customer service desk, or ticket office. In only unusual situations are more than two or three public telephones required. Telephones should come with handicap options such as, lowered for wheelchair accessibility, hearing impaired and access to allow bell-prepaid cards or calling cards.

Check Rooms

Checkrooms are not usually included in smaller arenas, as most public skaters simply leave their shoes in a dressing room or concourse area. Exceptions to this often occur with summer roller-skating and ice skate rental operations where shoes are deposited with the rental operator. Coin operated lockers have been installed in some arenas for checking of paraphernalia while skating. Should a checkroom be in demand, a dressing room can be converted to this use by installing a "Dutch" door. Checkrooms are included as necessary in arenas promoting special events, dances, etc., on a year-round basis.

Supervisory Controls

The supervision and control of staff, patrons and participants are exceedingly important for a successful operation. Therefore, it follows that the locations of the manager's office, ticket office, the first aid room and the refrigeration and electrical control rooms are critical in the execution of proper arena management.

The managers and facility operators' office(s) should be located to provide ready access to the main arena and should ideally look out onto the ice area. This is a much greater necessity in a small arena operation, where the manager is more personally involved in the daily events and crowd control than in a multi-staffed operation. Many medium size arenas readily lend themselves to an excellent view of the arena, interior; especially those with a side entrance, and the concessions, washrooms and offices being located above the first floor dressing rooms. The worst possible location for the manager's or facility operator's office is one located well away from the main entrance. This is not only difficult for public access, but also extremely awkward for the manger to keep an eye on the day-to-day operations.

Bulletin Boards

An easily identified and well-placed bulletin board in the main foyer is helpful in indicating daily, weekly and coming special events. Consider locked glass doors for bulletin boards. Such a board is of good advertising value, and assists the arena staff in answering many inquiries. It is also a potential income source by selling advertising space to local merchants. The board should be posted with colorful, carefully lettered notices. Careless, misspelled, or out-of-date notices rob the bulleting board of its promotional value.

Circulation

Circulation of both the public and maintenance staff is of prime importance in the design of an arena. The main entrance should obviously lead to the seating areas. This is not difficult to achieve in a small arena, but can be confusing in a medium or large-scale building. The medium-size, side-entrance arena lends itself to a satisfactory solution to this problem when the stairs lead from the ticket windows in the foyer, directly to the second floor concourse and then to the seats. In large arena buildings, well-marked signs indicating the various sections, coupled with large arrows are extremely helpful. Some arenas use various colors on these arrows to assist the patrons (the arrow and ticket and seat color being identical).

Full circulation within the interior of the building is a definite asset. This may occur at the top or bottom of the seating. Smaller arenas tend to have a concourse running behind the top row of seats on both sides. It is important to have a substantial railing well above the height of the back row seats to prevent the standing spectators bothering the seated individuals. A very satisfactory design feature allows a full concourse around the entire lower level between the rink boards and the first row of seats. This is very helpful in the cleaning of the seat area, and also assists greatly in crowd departure and ease of exit. Not having this lower concourse can present cleaning problems, in that the debris must be carried back up to a higher concourse or carried across the ice for disposal.

Exits

Fire regulations demand that all exit doors be clearly marked by a red exit light that is always lighted. These doors are provided with hardware allowing the door to be opened outwards in an emergency. Exit doors should be unusually wide, allowing up to 4 people to exit simultaneously. These exit doors are of great assistance in facilitating crowd dispersal, especially if well located in relationship to the outside parking areas. The use of exits should be checked against local fire regulations.

Operational Services

The previous comments on circulation apply as well to the operational services, such as custodial, janitorial, maintenance and policing.

Easy access to all parts of the arena allows a much more efficient operation, hence service to the public. All areas should be well lighted at all times. Dead end corridors and hidden corridor areas are to be avoided in any design, as they will create problems for the supervisory and operating staff. Janitorial ease of upkeep and convenience depends to a large degree upon two factors:

(1) traffic flow and circulation
(2) type and quality of building materials

A good building design considers janitorial problems, and provides sufficient space in concourse and corridors to allow an efficient cleaning pattern. Of equal importance are the type and quality of materials used for walls and floors. A later section will deal with the general choices available.

The extent of policing, supervision and service will depend upon the number and type of activities and events. It is customary that the local police in smaller municipalities either assist directly or are paid for special service at the arena. Medium and larger arenas usually hire off-duty policemen or take advantage of private protection personnel on an hourly or contract basis. Some special activities may involve a greater proportion of policing than for typical events.

Some type of security protection may be required on a (24) twenty four-hour basis. A security system may be installed in certain areas such as the concession outlets and in the ticket, manager's and facility operator's offices. The use of CCTV security system allows (24) twenty four-hour security. Having this type of security tied in with your building alarm and a local Security Company that supplies guards will give you all the security your complex may require.

Storage

The one comment of virtually every arena operator in regard to storage is the same; "there can never be enough". Strangely enough this feature is often completely overlooked or neglected in arena design. While many smaller arenas have no need for large items such as stage equipment, scenery and various other pieces of equipment, as do larger operations, there is always a demand at an arena for storage of hockey equipment, summer playground equipment and similar apparatus. There is also a tendency to use the arena maintenance and repair room as the workshop for equipment (power equipment, etc.) This is usually quite unsatisfactory due to space limitations, unless consideration for this has been made in the original design. The tracking of wood shavings or metal shavings etc. from the work area by the ice resurfacer or other mechanical equipment can create bad ice conditions and other hazardous or dangerous matters.

The small arena may be limited in storage due to the seating areas being of insufficient depth or height to provide space beneath. Usually, in smaller rinks today a (200) two hundred square foot storage space is added within the construction and design of the dressing rooms. This design allows a privacy wall from your dressing room hallway and acts as part of your storage room wall. This type can allow up to five storage rooms on a six dressing room rink. Once you have included this in your plans you now have satisfied your arena operators with "enough storage". Usually, a workshop may be included within your plans that would include an electrical room, resurfacer room and your refrigeration room all tied into the same area, but the rooms are separate.

In larger arenas, where the seating may surround the rink, storage may then be available beneath the seating area. Special storage rooms may require a double door situation. If at all possible the cleaners room should have a double door on its storage room, this allows easy access of your floor machines, or other equipment. Be sure these rooms have good ventilation.

Press Box

In smaller arenas and in a larger arena the press box is located at the center ice section of the arena. It is usually built into the rafters or superstructure to allow as high and convenient an observation position as possible. The box should be divided into at least three sections or more, allowing for semi-private use by various personnel of the press and radio media. In a larger arena the press box area should be heated and closed off from any public access. A modern press box will have a washroom facility and some sort of kitchen facility.

Dressing Rooms

It is recommended that a minimum of six change rooms be constructed and larger arenas have eight to ten. One major factor in the need for extra space is the fact that one room is normally occupied at all times by the senior local team. Most municipalities now cater to an extremely active minor hockey league that imposes heavy demand on dressing room facilities.

Ideally these dressing rooms should be approximately 20' x 20', or the very minimum of 18' x 16' exclusive of shower and washroom area. The dressing room should be large enough to allow twenty players, coaches, trainers and other team personal. Ideally the room will hold up to twenty-four people comfortably.

If you are supplying a barrier free dressing room then you should be supplying lots of GFI plugs. All plugs should be GFI.

The barrier-free room should be a minimum 500 square feet excluding the washroom/shower space. This space should be another 200 square feet. All basins, toilet paper dispensers, hand dryers should be barrier free installed. A support bar should also be mounted to the wall near the toilet and another one added to the shower area.

All dressing rooms should have a rink chalk board installed in a location that is accessible to the coach and the players. All dressing rooms should include a metal stick rack.

A water bib outlet should be installed to be hooked up to a ½" hose for easy cleaning. The water bib should be located under each washroom sink away from the public's eye. A Plexiglas mirror should be installed over the washbasin.

Each dressing room should have a minimum of two floor drains, one in the dressing room and the other in the washroom area; both drains should be 6" in diameter. It is recommended a floor drain be installed just outside the shower entrance.

Showers

The ideal shower set up will have two showers in each room, both having there own push button and shower head. Their shower box should be of stainless steel. No piping should be exposed with the exception of the head and tap. These shower boxes have a 30-second or longer control tap to save water. Tempered water of about 110 degrees Fahrenheit assists in providing sufficient warm water for everyone.

The shower area should have the floor and walls tiled. Having an open ceiling to the dressing rooms saves on moisture and condensation on the walls and ceilings of the shower area. Other options for the shower area are the use of plastic tiling, painted concrete walls, or the use of spray-on epoxy paint. These options are cheaper in the short term, but are not recommended to use if a ceramic tile is in budget.

The use of an exhaust fan to the exterior will help provide adequate air ventilation by removing air moisture. Separating or dividing the shower room from the dressing room can provide a much-appreciated drying area. The complete shower room and drying area should have a minimum of 140 sq. ft. One toilet and washbasin, separate from the shower room, are sufficient for each dressing room. A water bottle fill up station over the washbasin is a nice luxury to have. If you are installing one of these stations, the tap should be a push button tap, hooked directly to cold water and should be located high enough to ensure the water spillage remains in the basin.

If your arena is committed to supplying a barrier free dressing room, then the washroom/shower area should be wheel chair accessible. The shower area should have a wash chair. The showerhead should be on an extended hose to allow a long reach. Each washroom/shower area should have an emergency switch, which should be hooked to a flashing light outside the dressing room area to notify staff that someone in the rooms needs assistance.

Benches

All benches should be supported by an angle iron that is secured by the block/brick. Having angle iron brackets bolted to the wall is a proven mistake to arenas, as the wall plugs lets go causing the bench to fall off the wall. Ideally, if your dressing rooms run back to back, the angle iron then can run through the wall and support both benches in each room.

Another system, which proves to have its benefits, is the block system. This is where the bench area is blocked to the floor and the wood benches sit on top of the concrete benches. Screws secure the benches and this system makes replacement easy. Having the block system makes maintenance cleaning easier because there is no need to get under the benches. The face of the block can be painted, or you can run your rubber flooring up the face of the block, which makes your dressing rooms more attractive.

Clothing Hooks
The type of clothing hooks is always a source of concern as they are very often pulled off the walls. The clothing hooks should be made of steel strapping or rods and secured to the wall directly or to a steel plate, which in turn is permanently bolted to the wall. Any other type of hook is only temporary. Normal screwed-on types or nails are unsatisfactory. A wooden shelf that is attached by angle iron to the wall is useful when placed above clothing hooks.

When installing the metal rod, the hooks should be high enough to ensure children standing on the bench will not hit their heads on the rods. The rods should be high enough for children to hang up their clothes but low enough for adults to reach from the floor. The hooks should be angled so clothes and coats do nut fall off hooks.

Floor
The floor materials for use in dressing rooms should be able to withstand skate wear. There are many manufactures of rubber flooring which can produce many different floor colours. Light coloured, good quality asphalt tile has proven to be a most economical floor surface and is able to withstand much abuse. Your rubber flooring should be installed wall to wall, which would expand right into the washroom area. Some arenas are now installing the rubber flooring on the floor of their shower stalls. Once the rubber flooring is installed the floor should be caulked around all floor drains and the base of the wall.

Bare concrete is unsuitable, being subject to damage, as well as being extremely damaging to skates.

Doors, Locks and Hardware
Public facilities require heavy-duty doors, locks and hardware to handle the abuse found in this environment.

It is recommended that the doors be of steel construction with weldless seams. The frames should be 16-gauge steel and doors are recommended at 18-gauge steel. Heavy-duty piano hinges should be installed on all change room doors and other doors in heavy used areas. Heavy-duty door closures should be installed.

A common problem with new construction is the contractor not putting in the proper cylinder for locks. It is recommended that specifications state that all locks in entry sets, storerooms, etc must be capable of handling universal lock cylinders.

All panic hardware should contain universal lock cylinders as well. Multi-door entrances should have the option of removable centre posts.

With a high volume of traffic in and out of dressing rooms, the problem of theft is also present.

If you are planning on installing a key system then you want to make sure that the key lock and the handle on the door does not interfere with each other. The key lock should be located over the push/pull handle on the door. The reasoning for this allows easy turning of the key and stops kids from jamming items into you key slot. If your arena has one dressing room that is committed to handicap accessibility then the key lock should be lower to allow someone in a wheel chair to open the door and should have the handle to the door away from the key tumbler. The door also should be on a push button.

Ceilings
New rinks have the ceilings made from concrete, which can be from the arena seating area if your dressing rooms are located under the stands. Some new rinks have either a lobby, work out area, or viewing area over the dressing rooms, this allows for a concrete slab as a ceiling.

Other durable material for ceilings that can be used is duro-rock and drywall, which provides adequate fire rated protection.

All ceiling lights should be flush with the ceiling and covered with a steel cage. There should be no exposed pipes, except for sprinkler pipes

Windows
Many newer arena designs are using acrylic type window structures that diffuse direct sunlight but allow daylight into the arena/ice area. The use of clear glass or skylights is not recommended in arena /ice areas due to high-energy costs and high heat transfers that this will put on the refrigeration system, not to mention the high costs of maintenance and cleaning. When one considers that the predominant activity takes place during evening hours, there is little justification for any windows. This eliminates many repairs and reduces the opportunity for vandalism from inside or outside the building. A Plexiglas skylight has been used in the dressing room areas where these rooms are part of a one-storey structure and daylight is considered essential. Should ventilation be desired, an exhaust fan can be easily installed. In some cases, glass windows have been replaced by Plexiglas, greatly reducing breakage while still allowing light penetration.

Equipment Drying Rooms
Most arena designs overlook an Equipment Drying Room. This area can be located adjacent to the locker room area, or another unused space. In modern arenas, using dehumidification systems, a small duct drop from the discharge of the system can provide warm dry air-stream to facilitate drying. This will dry the equipment before mold or odors set in. This provides good sanitary practice and promotes odor free equipment for the team. This area is also good for hockey bag storage for tournaments etc.

Referees' Room
The referees should have their own room. It is recommended that two rooms one for males and the other for females be constructed. Ideally, these rooms should be located in an area of the rink that is away from the change rooms. It should also be close to an exit that

would head to the parking lot. The referee's room should not flow out to the lobby of the arena. The size of the dressing rooms should be a minimum of (250) two hundred and fifty square feet, excluding the washroom/shower area. The shower area should have two showers, as described in the dressing rooms shower's paragraph. The shower area should have one washbasin, water bottle fill up station and a toilet.

The referee's room should have a bank of steel lockers to allow the referee's to lock up personal items. A bench with wall hooks, a Plexiglas mirror, and a chalkboard and a writing table should complete the requirements of the official's room.

First-Aid Room
A first-aid room is usually provided as a single purpose room. A table or bed, a chair, a first-aid kit, incident/accident reports, a washbasin, Plexiglas mirror and a stretcher are the basic requirements. This room should be kept in a sanitized manner at all times.

An arena having an active hockey and general skating program must consider the first-aid room as a basic requirement of the operation. The first-aid room is often placed near the front door or a major exit to allow quick and easy access for emergency purposes. This room should be a minimum (100) one hundred square feet.

Ice Resurfacer Room
The ice resurfacer room should be located at the end of the rink. In new rinks that may have twin pads, the ice resurfacer room is located between the two pads allowing easy access to both pads. The ice resurfacer room should allow room to hold a back up resurfacer, garbage storage, shipping and receiving, This room acts as a duel purpose room for your arena as most supplies for the arena are dropped off at this location.

The ice resurface room may house a snow pit for melting ice from floods or from ice maintenance. This room should have good lighting system and should also be equipped with a natural gas, propane and carbon monoxide detector to meet building code requirements.

There should not be a water heater nor a light sensor installed in this room. This could cause a spark if someone walks into the room, which could cause an explosion if you have a any type of gas leak.

Usually, the refrigeration room is attached to the ice resurfacer room. This means you should have an ammonia detector in this room.

The resurfacer room should have an overhead door that leads to the outside and another that leads to each ice surface. The room should have a man door that also leads to the outside and to each rink. This allows staff access to the rooms and the outside without opening the overhead door to get to the propane cages. This will save on your heat loss in the winter by not having to open the overhead doors.

Size of The Ice Surface
The ice surface dimensions should be a minimum of 190' long x 90'wide. Many communities now build Olympic size surfaces which are 200' x 100'. The larger ice surface allows the opportunity to divide the rink into 3 sections to allow greater use by the younger hockey groups. The big floor area will be useful for non-ice events such as trade shows, exhibits and special events.

Goal Judge Box
An enclosed box made of tempered safety glass of approximately 15 – 18 square feet protects and serves a goal judge. The goal light is suspended within the box to provide optimum viewing for the spectators. A blue or green light denoting the end of each period or game is placed adjacent to the red light. The score clock from the timekeeper's box controls the operation of the blue/green light.

Floor Drains
The main arena floor should have a drainage system to allow the water to drain away when the ice is removed. Four or more drains, connected to a sewer system, should be placed under the boards around the perimeter of the ice surface.

Lighting and Electrical Needs
The lighting systems for arenas have been improved and have become very energy efficient in the past few years. Various applications of these systems will be outlined and the preference of any particular type will be the choice of the operator. The major criteria or standard for lighting is measured in foot-candles, being a measurement of light intensity at a given point.

Ice Lights – The lighting over the ice area depends on the types of events and if TV cameras will be used. Consideration for any possible use in the future will help determine the selection of types of lighting used in a facility. The most common lights used in arenas today are metal halide. These lights come in 1000 or 750 Watt sizes. The 750W light bulbs provide almost the same light levels as a 1000W bulb does after its initial usage. The smaller bulb maintains a constant light level during its life where the 1000W diminish as its life extends. The installation of light dimmer systems for the ice area provides the owner with substantial energy savings. The reduction in light levels when various programs are taking place or maintenance is being carried out will result in less money spent for energy. Ontario Hydro has determined that reducing your light levels by 33% will realize savings of 40% in energy costs. Today, there are systems that provide four and two levels of lighting. The design of the lighting system should be done by an electrical lighting engineer to ensure that light levels are uniform over the entire ice area. The installation of remote ballasts for your ice lights is important to reduce maintenance costs and interruptions to ice programs. The painting of the ice white will also increase light levels as it aids greatly in light reflection.

Other choices for ice lights include mercury vapor. The control panel for ice lights should be placed so the operator can see the ice area from the room, if possible. This is important for events such as concerts and other events that require changes in light levels as dictated by the promoter. Control of lighting levels must be protected from public access and in many cases may be located in an office area.

Emergency and Exit Lighting – Fire regulations call for exit lights to be electrically illuminated at all times and clearly visible to the public to indicate the path of exit to the exterior. The installation of LED exit signs reduces energy consumption and maintenance. All exit lights require battery powered back up in the event of a power failure.

All emergency lighting must be connected to dedicated breakers for emergency lighting only. The direct hard wiring of these fixtures into the electrical source rather than being plugged is recommended. If emergency lights are plugged in adjacent receptacles, patrons may use the outlets and trip the breakers. Therefore, the back-up batteries will not work in the event of a power failure.
The locations of emergency and exit lights are determined by the Building Code and should be approved by the local Fire Inspector and Building Inspector.

Dressing Rooms – The use of occupancy sensors in change rooms and offices greatly reduces energy costs. Sensors must be located to activate lights upon entry into the room, but not to pick up motion from adjacent corridors if the doors are left open. The uses of occupancy sensors in ice resurfacer or refrigeration rooms are not recommended. The installation of receptacles in the dressing rooms will reduce the use of extension cords in the maintenance of these areas. It is imperative that these receptacles be ground fault protected (GFI).

Electrical outlets should be provided for various plug-in conveniences for patrons. All thermostats, switches, and electrical sub-panels should not be accessible by the public. Heavy-duty electrical outlets or sub panels should be placed on exterior side of the rink boards to supply power for trade shows and special events. The facility should have a minimum of a 400-amp service for the hook-ups for concert shows, trade shows, etc. if the facility is constructed to host these types of events.

Snow Removal
A snow pit to melt the ice and snow removed for the ice surface should be located close to the ice surface. The best location is adjacent to the service entry gate and ice resurfacer storage area. It should have a hot water inlet to quickly melt snow or a heating coil that utilizes heat recovered from the refrigeration system. The snow pit must be ventilated to the outside from a point above the high water level. The pit should be a large size and have protective grating to screen out debris. The pit should always be covered by a trap door when not in use.

Painting and Colour Schemes
The rink boards require greater upkeep and cleaning than other portions of the arena building. Rink boards are white with puck boards being a light yellow colour and top plates being of various light colours. It is recommended that the top cap is not the same colour as

the seating area immediately behind it. A contrast in colours provides an excellent background for players and spectators. A comprehensive cleaning and maintenance program is recommended to maintain a clean and neat appearance.

Heating
The decision to heat an arena, or portions of it, depends greatly on the nature and types of events that will take place in the facility.

Smaller facilities often choose to heat the dressing room areas, ticket booth, concessions and lobby areas. The arena design may incorporate a large auditorium type room above the front foyer area that is also heated. The heating plant in such cases may use forced hot air, hot water or steam system. Electrical heat may be used, or in conjunction with one of the mentioned systems.

Large facilities that are spectator oriented usually use an elaborate heating and air conditioning system. The seating area is kept at a comfortable temperature for spectators, using a forced air or hot water and blower system. The design of the refrigeration system should take into consideration the heat load from the heating system in these types of arenas.

In many small and medium sized rinks, spectator heating is desired. The use of gas infrared or radiant heaters provides heat over the desired locations of the seating area. The most efficient method of heating is the gas infrared heaters. These units are suspended over the entire seat area or portions of it. Installation should ensure that the infrared heat does not reach the ice surface. It is recommended the infrared heaters operate on a timer system. A mechanical engineer should be consulted to ensure proper application and locations. An infrared heating unit located above the area between the rink boards and the ice resurfacer room is recommended. This will prevent water freezing on concrete floor in this area.

The ice resurfacer room should be heated to facilitate starting of the engine and avoid freezing of the equipment. The heater should be located in an adjacent room and heat forced into the ice resurfacer room. Open flamed or electrical heaters should not be located in rooms where gas powered ice resurfacers are located.

Ventilation
Government regulations require a properly sized ventilation system to provide air changes to the arena and exhaust combustion gases from the ice resurfacer.

The *Ventilation System* must include intake louvers and large exhaust fans. Installation of electronically controlled louvers will reduce energy consumption during periods when outside air temperatures are above those in the ice area. Both fans and louvers should be automatically connected to a gas monitoring system for the arena ice area.

The *Ventilation System* should be capable of exchanging a minimum of 5,000 CFM during the ice resurfacing operation. A mechanical engineer should be consulted to determine the proper equipment and airflow requirements.

Ventilation in Ice Resurfacer Rooms – the installation of a gas monitoring device is required in a service garage are under the Ontario Building Code. Fossil-fuelled gas and carbon monoxide detectors are required as well as a fully automated exhaust ventilation system. The system will activate if any gas levels exceed acceptable levels. Generally speaking, all resurfacer rooms should be considered service garages for new construction to eliminate retrofits afterwards.

Hot Water Boilers
Hot water is required for washrooms, showers, ice flooding and in some cases, the heating system. It is recommended that separate hot water heaters or boilers be used for domestic hot water and for ice flooding purposes. If boilers are to be used for heating, then additional boilers and holding tanks should be installed for this system. The location of these boilers must be in a vented stand-alone room and not located in the ice resurfacer or refrigeration room.

Refrigeration
Proposed Activities

- non ice activities both winter and summer
- is brine heater required
- additional heat loads for TV, etc.

Ice Surface Dimensions

- the width and length of ice surface to determine piping and heat loads

Length of Season

- does season extend beyond average winter requirements
- do you require summer ice

Type of Building
is building and roof to be insulated or not.
vapour barriers properly installed
is low-e ceiling to be installed.

Electrical Requirements

- the source and type of power available is a factor in the equipment selection.

Refrigerants

- primary refrigerants such as ammonia and Freon
- glycol or brine are secondary refrigerants
- quick ice removal or installations for special events
- disposal of secondary refrigerant can be extremely costly

Under Floor Heating

- use of recovered heat from system to heat under floor and prevent permafrost.
- double glycol loop or electrical heating cables to be used.

Floor Materials

- type of materials to be used may vary from concrete, trap rock or trap rock shale.
- asphalt is not recommended
- plastic or steel piping in floor

All of the above mentioned factors should be considered in the design of the refrigeration system, so the mechanical and refrigeration engineer should be made aware of all of your requirements.

The refrigeration room requires that full schematic drawings be provided showing all valves labeled and numbered. This is a requirement for each local fire department in the event of a refrigerant leak or fire at the facility.

The Ice Making Process or Refrigeration

Refrigeration is the process of producing, within an insulated enclosure, temperature below that of the enclosure's surroundings. The process of refrigeration of an enclosure and it's contents consist of extracting heat from the space in which the temperature is to be lowered, and ejecting it into the surrounding (or some other external medium).

Annual Operating Costs

Every arena should consider the annual operating expenditures and revenues. There is a definite history of over-estimating potential revenues as well as under-estimating the annual expenditures. The depreciation of the debenture charges are often overlooked in the original estimates. It is also a wise decision to create a Facility Lifecycle Program from the outset, as this will assist in capital forecasts as well as operating costs over the life of the facility.

General Guidelines to Expenditures

As a general guide to annual operating costs, the following categories are usually calculated for any arena operation, large or small. The individual items may depend on local conditions.

Principal Annual Arena Expenditure Breakdown

- Salaries – Manager, Assistant, Office and Administration staff
- Wages – Permanent, Casual, Part-time
- Employee Benefits (Unemployment Insurance, Group Insurance, Workmen's Compensation, and Hospitalization)
- Insurance
- Office Supplies and Stationary
- Bank Charges and Interest

- Telephone and Cell Phone
- Water and Sewer
- Electricity
- Natural Gas or Oil
- Equipment Maintenance
- General Supplies
- Cleaning Supplies
- Maintenance and Building Repairs
- Advertising
- Sundry Expenses
- Debenture Charges
- Building and Equipment Depreciation Charges
- Bad Debts
- Accounting and Auditors
- Land and Corporate Business Tax (if not municipally owned)

Depending on local accounting practices and type of operation, reserves for building and equipment maintenance or purchases may be included as well.

Principal Annual Arena Revenue Sources

- Hockey – Professional, Semi – Pro, Junior “A”, College, Seniors, Minor Hockey (Boys and Girls)
- Ice Rentals – Hockey Practices and other uses
- Figure Skating
- Sledge Hockey
- Public Skating
- Parent and Tot Programs
- Skate Rentals
- Pro Shop
- Banquet and Receptions
- Special Events – Wrestling, Ice Shows, Dances, Carnivals, Bingo, Home Shows, Trade shows, etc
- Roller Skating, Inline Skating,
- Floor Hockey, Inline Hockey
- Skate Sharpening
- Bar and/or Restaurant
- Check Room
- Day Care
- Concessions
- Vending
- Video Arcade Room

Other possible sources of revenue may include bank machines, office, storage or equipment room space rentals, locker rentals, rink board, time clock, ice resurfacer, or other advertising options, bond interest, grants and donations, or in some arenas tax credit from the local municipality as a form of subsidy.

Maintenance and Upkeep

The ease and convenience of arena maintenance is a direct reflection upon the building design, type and quality of materials included in the construction. Substantial savings in annual upkeep are often a result of superior building materials. Costly renovations can be avoided by careful consideration of future arena activities, and the internal and external traffic flow generated by the arena program.

We discuss here only those aspects of maintenance that are directly affected by materials and/or design features. The total subject of maintenance and upkeep is too large a subject for inclusion in this booklet on arena planning and design. But as a general rule this is an area not to ignore, as your public image will greatly diminish.

Refrigeration System

Any mechanical system will require occasional maintenance to ensure it continues to operate reliably. The refrigeration system is obviously important to any arena operation and can represent significant operating costs. Therefore, system components should be properly maintained in accordance with manufacturers' recommendations so they continue to run at maximum efficiency. It is wise to establish an annual maintenance program for the refrigeration equipment and make this a top priority in your annual budget.

Painting

The uses of newer materials that do not require painting, or less frequent painting, have been of great interest in arena operation. The labor costs involved in painting application far exceed the actual cost of the paint materials. Materials that eliminate painting or other treatment as an ongoing cost are glazed tile, brick, trap-rock and terrazzo. While the initial cost of these materials is admittedly higher than more conventional materials, the upkeep costs are substantially lower and their life span can be much longer as well.

It is recommended that alkyd or epoxy paints be used in high traffic areas such as washrooms, lobby, change rooms, corridors, etc. Latex should only be used on exterior walls where breathing is necessary with temperature changes. It is recommended that you refer to the Master Painters Institute Manual called, Architectural Specification manual for new construction.

Floors

Concrete floors, if not painted or sealed and waxed, are a constant source of dust, as well as presenting a depressing appearance. Concrete can be covered with floor tile, trap-rock or terrazzo. It can also be finished with a colored additive, which can then be sealed and waxed. Floors must be cleaned frequently in order to present an inviting and clean appearance. Good quality flooring tile is increasing in arenas and appears to withstand severe use (ice skates) very well. When a tile is damaged it can be replaced. Rubber belting is often used on floors to protect skate blades. In areas with high skate traffic coloured rubber floor tile is a wonderful choice. Hardwood should never be used in general corridors and dressing rooms, as it is extremely expensive to maintain properly. If used, it can require sanding and refinishing every two years.

Walls
The walls of a public building, such as an arena, are subject to abuse and misuse. Walls can be constructed of glazed brick or tile, glass, concrete block, glass block, brick, as well as different types of wood or metal. Concrete block is most common and virtually indestructible. Glazed brick is expensive but used at the exterior entrance, is a superb appearing material. Concrete blocks can be painted with plastic type paints with good results. Wooden walls, especially on the interior of dressing rooms are subject to vandalism. Concrete blocks or bricks are the best materials for interior or exterior walls for most types of arenas because of their fire resistance qualities and durable character supplementing their primary purpose as a load-bearing wall.

Dasher Boards
In today's construction options in board design consist of many options. Some of these options consist of permanent as well as removable, but most construction is designed with permanent metal (aluminum) upright supports along with ½ in plastic boards. This combination reduces labour cost for maintenance. Glass will consist of herculite (tempered safety glass), with aluminum supports. Please refer to the O.R.F.A.'s "Suggested Guidelines For Evaluating Arena Boards and Glass".

Seats
There are several types of seating available for an arena facility. If the seating is merely planking secured to concrete or wood risers and therefore subject to considerable foot traffic, paint or sealers should be applied once a year. Seats can be subject to much abuse and wear if skaters are allowed to use them during Public Skating hours. Skaters should be limited to changing at ice level (in change rooms), as to eliminate any liability of skater climbing up and down steps. Strict control is necessary to enforce any ruling regarding skater using a general seating area. The best quality seats are flip-up molded plastic seat and back on a steel frame. These seats are available in single or sets of two per frame. Seat backs can be curved or straight. Medium quality seats are bench-like in character and do not flip or pivot. Molded plastic seats with no backs can also be purchased. The simplest type of seat is merely planking secured to a wooden or concrete riser with no backrest.

Showers And Washrooms
Shower rooms are difficult to maintain for good appearance. Ideally, shower room walls are constructed of ceramic or glazed tile. Many arenas use a plastic based paint on the concrete walls, and repaint as required.

Washrooms receive more than a normal amount of vandalism. Experience has shown that using durable tiles or metal walls and partitions reduces marks and writing on the wall or other abuses. If concrete block is used for walls, frequent painting to cover up any marks assists in keeping a clean and fresh appearance, reducing the tendency for vandalism and mould. One-inch plastic partitions can be used which reduces painting and can resist abuse.

General Maintenance Comments

Cleanliness and neatness are prime requisites to successful arena operation. An orderly and safe arena reduces the possibilities of personal injury and public liability damage claims, as well as presenting a pleasant appearance. A zero tolerance on violence policy that is community approved and that is properly enforced by staff and other user groups will help to greatly reduce vandalism in your facility.

It is highly recommended that a comprehensive and detailed maintenance schedule be set and enforced according to facility usage. The maintenance schedule should include daily, weekly, and yearly maintenance duties. Following this type of schedule and maintenance program will ensure that the building looks its best and will save operating dollars in the long term.

Paint should be applied whenever the appearance of an area shows obvious signs of wear and tear. The foyer and principal areas of use, such as corridors and dressing rooms should be painted once a year. If materials not requiring paint are used, then frequent washing is required to keep a neat appearance.

Counter tops in the concession areas should be covered with Formica or a hard durable water-impervious material, preferably of a cheerful colour.

Glass block is often used in walls to allow light penetration, but there is often light validity for its use. Glass windows are a severe detriment if placed in the main area, as the sunlight represents a heat load on the ice surface. If windows are used they should have a line of sight barrier to the ice surface, thus taking advantage of heat load in winter but not having a direct impact on the ice surface.

Types Of Refrigeration Systems

There are 2 types of refrigeration systems in use.

- *Ammonia/Brine/Glycol*
- *Freon/Brine*

Before we talk about items 1 and 2, we should define that the term “brine” could be any solution with a freezing point below 32’F (0’C). This could mean ethylene or propylene glycol, calcium chloride, sodium chloride or alcohol. We use an organic inhibitor to prevent any corrosion of steel components.

Some basic difference between the various types of systems available:

Ammonia Brine System

The most common refrigeration system in use for rinks is the Ammonia/Brine type of system. This system utilizes an ammonia refrigeration cycle, cooling the brine through pipes under the ice. The system has been used with standard steel pipe, wrought iron pipe, and plastic pipe under the ice surface. Most rinks use approved plastic rink floor piping.

Freon/Brine System

The Freon/Brine system is basically the same as the ammonia system, except that Freon is used as the refrigerant. The system is very common in smaller curling rinks. For ice surfaces up to 8,000 square feet capacity, either Freon or ammonia can be used; providing the ice surface is not used in the summer, it may be possible to utilize the refrigeration plant for air conditioning lounges, restaurants, meeting room, etc. through out the same facility.

Main Components of The Refrigeration System

Compressor

Every refrigeration system has one or more compressors. The size and type of compressor can vary depending on the refrigerant capacity required (measured in 'tons'), and the cost of installation versus operation. The two most common types of compressors for arena application are reciprocating (pr multi-cylinder), and screw compressor.

Screw compressors require minimal maintenance and are economical for selections of over 100 tons.

Reciprocating compressors usually require more maintenance, but have lower initial cost.

Either type of compressor can be used in a series to achieve the required refrigeration capacity. Detailed instructions on the operation of the compressor are available from the manufacturer. These instructions are generally complete, including pictures of the various components, and are all that is required for the operation of the machine. Gas driven compressors are a viable option in regions where electrical costs are high and natural gas is available as an alternative power source.

Condensers

In days gone by, refrigeration systems utilized city water for shell-and-tube condensers. This made for an inexpensive installation; however, as the cost of water and water disposal increased, this method became much less popular. Today we have variations on this, all of which reduce the amount of water required.

Water Cooled Condensers using re-circulated water from cooling towers; this method is quite acceptable in all but extremely cold climates.

Evaporative Condensers using re-circulated water; these are a combination cooling tower and water-cooled condenser all in one piece of equipment and are widely used.

Air Cooled Condensers use absolutely no water but have a higher initial cost than the above condenser options.

Climate and location play an important part in the choice of a condenser unit.

Chillers
The chiller facilitates heat transfer from the brine/glycol to the primary refrigerant. Chillers have been traditionally of the shell-and-tube type, but recent developments with plate-and-frame design have allowed this type of technology to be used in industrial refrigeration systems. The benefits of plate-and-frame system are; smaller refrigerant charge, higher thermal efficiency, longer life expectancy, and the ability to add plates to increase capacity in the future, have been rapidly redefining the industry standard. Plate-and-frame is considered a premium product and of course, price is always a factor. Plate-and-frame also takes up less space than a chiller shell-and-tube unit. Heat-and-plate frames can be used for ammonia and brine systems with plates being made from titanium and for ammonia and glycol systems stainless steel plates are used.

Control System
Traditionally, refrigeration systems for arenas have been operated based on the temperature of the concrete slab, or of the brine. The latest technology in the arena refrigeration system control is the ice surface temperature refrigeration system or infrared temperature control system. It responds faster to increased heat loads on the ice surface, and allows for better control of the ice surface temperature. Because the system is also controlled by your operating schedule, the refrigeration equipment usually runs less during non-used hours. This often translates to significant power savings, as well as reduced equipment maintenance costs.

How To Eliminate Fog And Condensation
Fog and Drip is only the visible evidence of water vapor in arenas. This moisture not only causes building deterioration but also increases the cost of maintaining the ice. Fog and Drip can be eliminated by the use of a properly designed dehumidification system.

These factors that contribute to this are as follows:

- Warm air holds more moisture than cold air. As the air is cooled by the arena or comes in contact with the ice surface, the relative humidity rises. The water vapor is then visible as fog, or it condenses as liquid vapor on cold surfaces.

- When an arena is maintained at a lower temperature and lower relative humidity, moisture tends to infiltrate to try to equalize the vapour pressure. A tightly constructed arena will minimize the moisture infiltration.

- Exhaust fans, air circulation and heat do not affect the moisture content of arena air.

- Refer to the section on Ventilation and determine the requirements for outside air or fresh air ventilation for your area. This will affect the size of the dehumidification equipment required. You will be required to investigate the standards of air movement for your area. A reliable mechanical engineer can assist you on this matter to ensure your unit is properly sized.

The only way to eliminate fog and condensation is with a dehumidification system to reduce the indoor moisture content. A properly designed system will provide the following benefits:

- No fog or condensation
- No dripping from the building structure
- No mushrooms/ice balls developing on the ice sheet
- No mold growth and reduced paint peeling
- Reduced operating costs of the refrigeration system
- Better quality ice sheet(s)
- Refrigeration contractor or qualified mechanical engineer can assist you with sizing a dehumidification system for your application, and can offer advice on the various types of dehumidification systems available, including mechanical and desiccant dehumidifiers.

Making The First Sheet Of Ice
We will assume that when the piping has been laid, the rink surface, as well as the header trench wall will be perfectly level, so that level ice can be secured and maintained. Varying ice thickness will produce differences in the ice surface temperature, which is detrimental to good skating or curling.

The following procedure is to be observed:

Preparation of a Sand Floor
- sand surface should be as level as possible.
- once the surface is smooth, saturate sand thoroughly using a 1" hose and put down light sprays of water, ensuring the sand is not disturbed. Water should be sprayed from outside the boards, directing the spray evenly over the sand.
- walking on the sand should be avoided.
- once you are nearing the point of saturation, the cooling of the floor can begin.
- when the sand is completely frozen, more leveling floods can be applied by walking on the surface.

- it is a good idea to place 2"x 2" metal plates throughout the sand surface to allow for ice measurements to take place safely once proper ice thickness is reached.
- once you have a smooth, flat sheet of ice, apply white paint according to manufacturer's instructions.

Preparation of a Concrete Floor

- concrete floor should be thoroughly cleaned and rinsed.
- ensure any trace of petroleum-based distillates has been removed.
- cool the rink floor to approximately 20'F, and frost shows through the floor.
- layer the ice with fine sprays until you have 1/8" to 1/4" of ice across the entire surface.
- water should freeze on contact or flash freeze.
- once you have a smooth, flat sheet of ice, apply white paint according to manufacturer's instructions.

Painting of the Ice Surface

Using a clean, ½" hose, seal in white paint with ¼" of ice using lights sprays of cold water. Increase water flow with each pass, but do not exceed freezing rate.
Apply and seal hockey lines, circles and logos.
Using light sprays of cold water, build an additional ½" to 1" of ice over the painted surface, again ensuring not to exceed the freezing rate. Once you have reached an overall ice thickness of 1½" use your ice resurfacer to top dress the ice surface with hot water. You may now raise your floor temperature to its optimum air/ice interface temperature, as your program dictates.

Total Ice Thickness

Thin ice will use less energy but can pose liability problems to the skaters. For this reason, the O.R.F.A. suggests that the recommended ice thickness should be 1" to1 ½" at all times where possible.

Ice Surface Maintenance

The quality of the ice and the ice surface is very important for a successful operation. Mechanical ice resurfacers are available to simplify the day-to-day task of maintaining a quality ice sheet. The ice resurfacing equipment is considered one of the most important and necessary items used in the arena. Ice resurfacing machines perform many different functions. The newer ice resurfacers are now equipped with a wash water system. This system places cold water on the surface to clean the ice and fill in holes and groves. A suction/vacuum like system sucks up the water, dirt, and debris leaving a nice clean ice surface. The water then goes through a filtering and recycling process and then is reused. The ice resurfacers are also equipped with a large blade, which shaves a thin layer of ice from existing ice sheet. The ice shavings are then removed from the surface to the rink by means of a conveyor system, which deposits the shavings into a large storage bin at the front of the resurfacing machine.

In addition to the shaving procedure, ice resurfacers are equipped with large water storage tanks. Hot water is laid behind the resurfacer to replace the thin layer of ice that has been removed from shaving, and to fill in grooves and cuts left behind by skate blades. A room must be provided for the storage of this equipment when it is not in use. The resurfacer room should be equipped with water taps supplying both hot and cold water. The hot water supply should be approximately 160 F and the heating/boiler units should be capable of replenishing itself at a rate of approximately 200 gallons or more per hour. Rooms must be equipped with floor drains. In many cases these rooms have pits that allow the ice shavings to be dumped inside, so this equipment never leaves the arena. However, in some cases the dumping of ice shavings outside works well. With the use of ice resurfacing equipment, properly trained operators will be able to maintain quality ice necessary for a successful arena operation.

ENERGY MANAGEMENT

Ice rink facilities use more energy than any other type of recreational facility. A typical hockey rink in Southern Ontario will use $3,000 to $5,000 per month in electrical energy costs in winter and $4,000 to $7,000 per month in warmer or summer months. These costs are primarily associated with ice refrigeration however other contributors to energy costs are lighting, space heating, water heating, and dehumidification. It follows then that any ice facility energy management program should be focused first on ice refrigeration costs and to a lesser extent on the others.

With the deregulation of electrical power in Ontario scheduled for November 2000, electrical costs could likely increase and are certainly expected to become more complicated. For this reason, this chapter devotes a section on electricity costs and various rate structures that apply to ice rink facilities in Ontario.

Although it is termed “Energy” Management, this topic really represents SAVING MONEY. Since it is every arena manager’s duty is to operate a cost efficient facility, arena staff should not only be interested in saving energy, but should be equally focused on the costs of energy. Although there are many different energy saving measures that can be incorporated into an ice rink, none of them can be properly evaluated without a clear understanding of electrical rates and what the electricity really costs. From this, one can estimate the potential energy cost savings and compare it to the capital costs of a particular measure. With this comparison the “simply pay back” can be calculated. This is the time in years that it takes to recover the capital cost of an energy saving measure. Then, knowing the energy savings and energy costs, rink management staff can make an informed decision about whether or not to invest into an energy saving product or service.

This chapter outlines various energy savings measures that can be incorporated into both new and existing ice facilities. Energy saving measures are divided into “Low or No Cost Measures” and “Capital Cost Measures”. Where possible, sample calculations are made to demonstrate the potential energy and dollar savings than can be achieved with the various energy saving measures.

ELECTRICAL RATES

Electrical utilities charge their commercial general service customers for two basic forms of electrical service. These are termed electrical energy consumption in kWh and electrical demand in kW. Most ice rink customers are charged for both of these. Therefore, an understanding of these two terms is essential in estimating energy cost savings.

Electrical Energy (kWh)

Electrical energy consumption is measures in kilowatt-hours (kWh). This measurement is a statement of how much electricity is consumed by a particular facility. It represents a running total of the electrical energy consumed during the billing period (approx 1 month). Electrical energy (kWh) generally becomes cheaper as a customer uses more. For example, a typical rate structure may have the first 250 kWh at a cost of $0.12/kWh but get progressively less at the consumption increases. A sample general service electricity rate is as follows.

First 250 kWh	$0.110 /kWh
Next 12,250 kWh	$0.063 /kWh
Next 100,000 kWh	$0.055 /kWh
Balance kWh	$0.040 /kWh

Of importance in evaluating energy saving measures is at which cost level or “tier” the energy savings will occur. For example, a rink that uses much more than 12,250 kWh per month but less than 100,000 kWh per month will save electrical energy (kWh) that costs $0.055/kWh. With the above example, it would be incorrect to calculate energy savings at $0.110/kWh or even at $0.063/kWh because the ice rink will most certainly use more than 12,250 kWh per month.

Electrical Peak Demand (kW)

Electrical Peak Demand is measured in kilowatts (kW). This measurement is a statement of the rate at which electricity is consumed. For each billing period (approx 1 month) a facility will be charged for the maximum one time rate it reached while using electricity in the period.

A common misconception of electrical peak demand is that customers are charged for the instantaneous spike that occurs when a motor is started. This is not true. Electrical demand meters actually work on a 15-minute ramp up time. For example, if a 10 kW heater is turned on for 7 ½ minutes and then shut off, it can only contribute 5 kW to the peak demand.

Another important aspect of peak demand is that customers are only billed for the one time peak that occurred in each month. If it occurred on Friday at 5pm, all the equipment that was operating at that time was contributing to the peak. It measures the one time coincidence of the maximum electricity rate the facility is operating at. If a piece of equipment was not operating during the peak, then it did not contribute to the peak demand for the month.

Where electrical *demand* is comparable to the speedometer in an automobile, the electrical *energy* is analogous to the odometer. That is electrical demand is like the speed at which electricity is used while electrical energy is like the total distance a car will drive, independent of its speed.

Electrical demand costs generally become more expensive with higher peak demand levels.
For example, the rate structure for a typical demand rate may be as follows.

First 50 kW of peak	no charge
Next 450 kW of peak	\$10.70 /kW
Balance of peak kW	\$14.00 /kW

Calculating the demand cost savings associated with energy savings measures can be difficult. Not all energy saving measures will save on electrical demand. For example, turning off the lights more will usually not reduce the demand but will save energy. This is because the monthly peak demand will likely be registered when the lights are on. Replacing lights with a lower wattage fixture, however, will likely reduce the electrical peak demand. This is because even if the lights are on when the monthly peak occurs, the actual total wattage of the lights will be less. Therefore, the peak demand will also be less.

Here are some useful tips for calculating and understanding rates.

1kW = the power needed to light a quantity of 10 (ten) 100 watt light bulbs
1kWh = the energy consumed when a 1 kW load operates for 1 hour
10 kWh = the energy consumed when a 1kW load operates for 10 hours
10 kWh = the energy consumed when a 10 kW load operates for 1 hour
1 hp = 0.746 kW of power
10 hp motor (bhp) = approximately equal to 7.46 kW of electrical demand or power
25 hp motor (bhp) = approximately equal to 18.6 kW of electrical demand or power
50 hp motor (bhp) = approximately equal to 37.2 kW of electrical demand or power

Sample energy cost calculation.
Using the above sample rates, what is the electrical cost to operate a 30 hp brine pump motor continuously for 1 year.

30 hp is approximately 30hp x.746 kW/hp = 22.38 kW of power

Number of hours in 1 year = 365 days x 24 hours/day = 8760 hours/year

kWh of energy consumption = kW load x hours of operation per year
= 22.38 kW x 8760 hours
= 196,049 kWh per year

Cost of electrical energy = Cost/kWh x kWh in year
= $0.055 x 196,049
=$10,783 per year

Next, assuming the rink peak demand is above 50 kW, the demand charges of the pump will be $10.70/kW and because the pump is running continuously for the year it will certainly contribute to the peak demand for each month.

Demand cost each month = Cost/kW x kW at peak
= $10.70/kW x 22.38 kW
= $240/ month
Demand cost for year = $240/month x 12 months per year
= $2,880 per year

Thus the total electrical costs to operate the 30 hp motor for the entire year is $10,783 (kWh energy cost) + $2880 (kW demand cost) = $13,663 per year.

Notes:

1. The monthly energy use will likely be less than 100,000 kWh/month so energy costs & savings will be at $0.055/kWh based on the sample rate above.
2. The kW values calculated from motor hp are only approximate because selection of motor hp will typically be greater than the actual bhp of the equipment and also due to equipment efficiencies of pump and motor)

LOW COST OR NO COST ENERGY CONSERVATION MEASURES

Many ice rink energy management efforts focus primarily on the implementation of high cost energy conservation measures. While it is true that many costly initiatives possess the greatest potential for reducing energy usage and operating costs, most rinks can still benefit from lower cost and no cost energy conservation measures. This section identifies

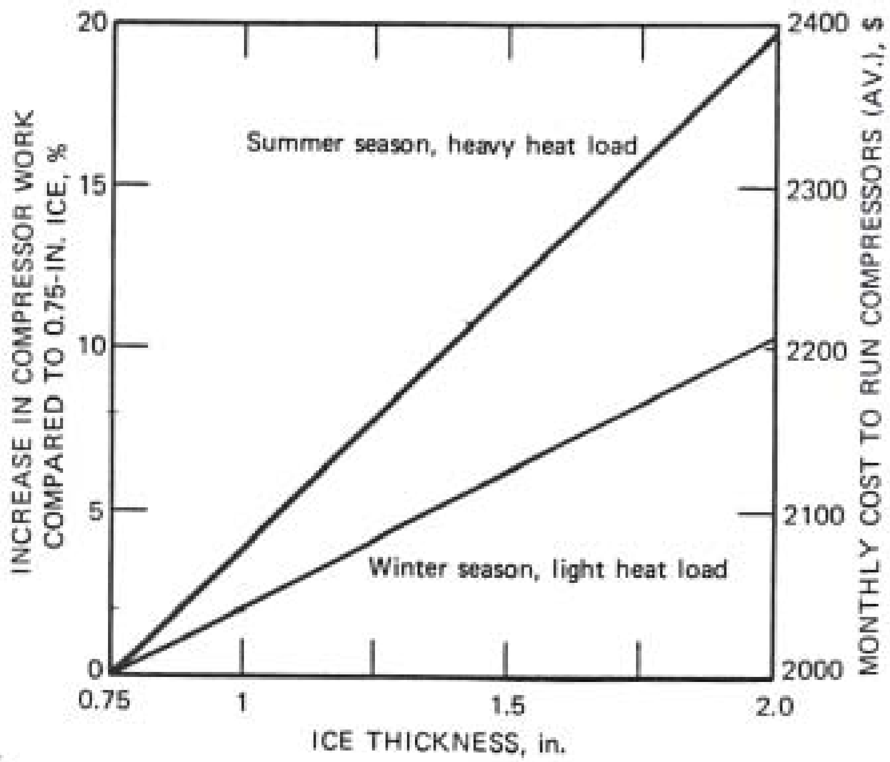

Fig. 5 Variation of compressor work with ice thickness.

various measures that can potentially save an ice rink as much as 15% in annual energy costs without the need for significant capital expenditures.

Resurfacing Water Temperatures

The third largest refrigeration heat load in an artificial ice arena is ice resurfacing. This load, imposed by the resurfacing of ice with flood water in the range of 140 F to 180 F, can account for as much as 12% of the total refrigeration requirements. A reduction in floodwater temperature will produce energy savings in two areas without adversely affecting ice quality. By reducing an arena's floodwater temperature from 160 F to 130 F (20% reduction), a 2.5% reduction in the annual refrigeration load and associated energy costs will be achieved. This reduction is achieved for two reasons.

First, the refrigeration system will have to absorb less heat to freeze the lower temperature floodwater. As long as the floodwater temperature is not set below 120 F or so, the ice quality should not suffer and the energy savings can be achieved.

Second, lower flood water temperatures will result in less operation of the water heating equipment. In a typical artificial ice arena, which operates eight months per year, approximately 250,000 to 500,000 gallons of water is used for flooding purposes. The ability to reduce floodwater temperatures by 20% will consequently reduce the applicable heating energy costs by the same percentage annually.

Ice Thickness

Maintaining ideal ice thickness (1" to 1-1/4") through a regular ice maintenance program will ensure a high standard of ice quality and help prevent ice refrigeration energy costs from rising.

Because ice acts as an insulator, the thicker the ice is, the colder the brine temperature must be in order to achieve the same ice surface temperature. Similarly, if the brine is maintained at a constant temperature, a thicker ice slab will result in a higher surface temperature resulting is softer ice and thereby making it more difficult to freeze the resurfacing water. Verifying ice slab thickness, on a weekly basis, in a recommended procedure that should be adopted in order to control energy costs.

The following chart shows how energy costs for a typical ice rink will vary with ice thickness. For example the additional cost to operate ice at 2” compared to ¾” can be as much as 20% more in refrigeration costs in summer and 10% more in winter months. In this chart, the additional costs are associated with having to run at colder brine temperatures to achieve the same ice surface temperature with thicker ice.

Night Set-Up of Ice or Brine Temperatures

One energy conservation measure that can be implemented with good success is the setting up of brine or ice temperatures at night and unoccupied periods on the ice. Where a typical rink may operate a brine temperature of 18F and ice surface temperature of 22 F during normal ice operation, the brine or ice temperature set points may be increased by 2 to 6 deg F and again reset back down prior to activities on the ice.

This simple yet effective measure can be easily implemented either by manual adjustments each day, using a time clock, or by implementing a programmable temperature controller capable of scheduling the ice temperature. This method is easily used at night when the flooding, lights and skaters heat loads are reduced. It is important, however to know how much time it will take to return the ice back down to normal ice temperature again before the ice is next used. For example, a rink with little excess refrigeration capacity will need more time to bring the ice back down in warmer months. Conversely, less time may be required to bring the ice back down in colder winter months. Every operator practicing this technique should have a good awareness of the capabilities of his refrigeration plant and adjust the timing and temperatures accordingly.

There is good merit in using infrared ice surface temperature controllers for setting up temperatur[illegible] brine adjustment[illegible] se the temperature without having a problem on the ice. An infrared controller however,

Figure #1 – Variation of Compressor Energy with Ice Thickness measures the ice surface temperature and can be programmed to automatically prevent the ice surface temperature from rising above an acceptable limit. With such a controller, the ice can be safely set closer to the high ice temperature limit and generate the greatest amount of energy savings.

The general rule for knowing if and when to set the ice up during an unoccupied period is determined only when the ice is unoccupied for 6 consecutive hours or more. If the ice is not open for at least 6 hours, there is lesser gain in adjusting the temperature higher for energy savings.

When performed regularly, this method of control for energy savings can generate savings of up to $600 to $1000 per month (depending on site specific conditions). This is a tremendous savings for a low cost measure and this higher energy savings results for two reasons.

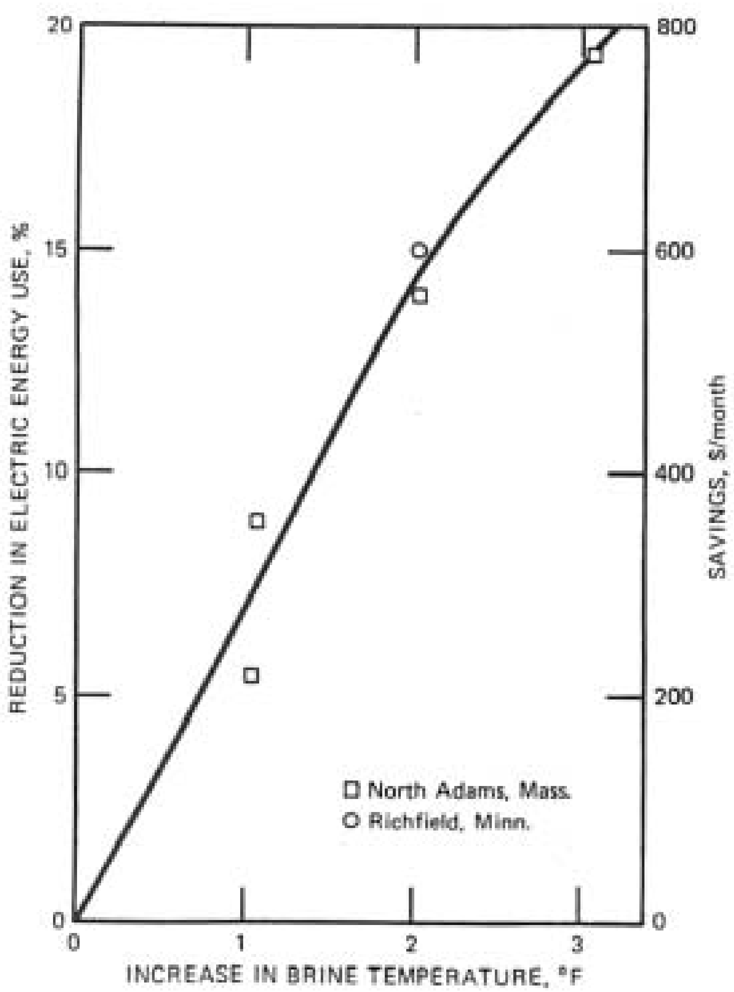

Fig. 3 Savings from raising the brine temperature.

First, the rate at which heat enters the ice slab (heat load) is dependent upon the temperature of the ice itself. As the ice temperature increases, the amount of heat that must be absorbed by the refrigeration system (heat load) is reduced. This requires the compressors and other refrigeration equipment to operate less. Secondly, a higher brine temperature setting will increase the coefficient of performance of the system (C.O.P. is the measure of system efficiency). More specifically, the C.0.P. is the ratio of the amount of heat removed by the refrigerant to the amount of work done in operating the refrigeration system. This will result in reduced energy and future maintenance costs due to less system run-hours during the operating season.

The following chart shows how refrigeration energy costs are

reduced as a result of higher ice temperatures. For example, a 1 F increase in ice temperature will save approximately 6% of refrigeration energy costs.
In addition to the energy savings, raising up the ice temperature at night can also result in a significant ice quality improvement. Specifically, when ice is raised to near its melting point for several hours at a time (i.e. 28 F for 6 hours), it undergoes a stress relieving process that helps make the ice tougher and less prone to chippiness or fracturing. This practice known as *tempering the ice* is often used as a regular maintenance practice to treat brittle or chippy ice.

Rink Space Heating

Every public facility has a responsibility to provide a reasonably comfortable environment for all its occupants. Because ice rinks are typically cold spaces, some form of heating is required for occupant comfort. The type and magnitude of heating however can have a drastic impact on ice rink overall energy costs. As such, there is definitely a trade off between the costs of heating an ice rink and the benefit realized by the rink users and occupants. The ideal heating system in an ice rink is one that will provide a reasonable amount of heat given the sedentary nature and dress of the occupants; and one that will do so while minimizing total rink energy costs.

There are two main costs associated with heating the air in an ice rink. The first is the cost associated with providing the heat. This may be the natural gas heating and electrically powered blower found in a large air handler heating system, or it mat be the electrical of gas heat found in localized unit heaters or radiant heaters located throughout the rink.

The second cost is the one associated with the extra ice refrigeration costs that occur as a result of having warmer air passing over the ice. This is the *convective* heat load. Whether the air is moving or still, the warmer it is, the greater the ice rink heat load will be and the more the refrigeration equipment will have to operate to remove this heat.

Rink #1
Rink #2

Considering that most patrons come reas[illegible]ssed to an ice rink, usually a small amount of heat is all that is necessary to maintain an acceptable occupant comfort. In most municipal rinks, this can be done without having to heat the entire volume of air in the ice rink space. Considering that the heat is only required where the people are, heating the [illegible] more energy than necessary. [illegible]d.

INCREASE IN ICE TEMPERATURE deg F

Figure #2 – Energy Savings with Increase in Ice

Localized heat using infrared radiant heaters can heat the occupants by radiation without warming the rink air volume as much. Further, because radiant heaters lend themselves more to localized control, an operator can heat many occupants in a section of the rink without having to turn on all of the heating. This in itself will save a great deal of heating energy.

Next, because radiant heaters provide warmth without directly warming the rink air volume, they also help reduce the convective heat load on the refrigeration equipment. Further, because the convective heat load can be as much as 25% of the total refrigeration load, the use of infrared radiant heaters can avoid substantial rink refrigeration energy costs.

Switching Off Lights

One of the most effective, yet simple methods for reducing electrical energy consumption in arena facilities is by simply switching off lights. By adhering to some basic time rules, a facility operator can ensure that the rink is consuming the least amount of energy required to operate related lighting systems. When considering incandescent lights, they may be shut off whenever an arena is unoccupied without adversely affecting the lamp life. There are, however, two basic time rules which exist when implementing this conservation measure for fluorescent and high intensity discharge (H.I.D.) lighting systems in order to satisfy manufacturer's lamp and ballast design conditions. With a fluorescent lighting system, to include such areas as compressor and dressing rooms, the lamps may be shut off if an area is to be unoccupied for a period greater than five minutes. When considering H.I.D. lighting systems, which include typical ice surface metal halide.(MH) and mercury vapor (MV) lamps/ballasts, the lights may be switched off at the breaker panel if the area is to be unoccupied for a period of at least two hours, provided the lamps have been burning for a five hour period. These actions will significantly reduce future energy costs without affecting lamp or ballast life. The following calculations has been provided to illustrate how this energy conservation measure will affect electrical consumption in a typical arena which illuminates the ice surface with forty (40) - 400 watt Metal Halide fixtures (assumed lamps shut off 5 times/week at 32 weeks/year for 2 hours each occurrence).

Total Wattage	= 40 fixtures (400 watts/lamp + 32 watts/ballast) = 17,280 watts (1,000 watt = 1 kilowatt)
Annual kWh Savings	= 17.28 kW x 10 hours/week x 32 weeks/year = 5530 kWh/year
Annual Dollars ($) Saved	= 5530 kWh x $0.055/kWh = $305.15

Of course this same thinking may be applied to those periods where ice maintenance is being performed. In this case 250/o to 500/o of the lamps may be shut off, depending upon the breaker panel configuration, thereby providing enough light for the performed task and, at the same time, reducing electrical costs.

An additional benefit from reduced lighting is a reduction in refrigeration costs. This is because lighting can account for 7% of the refrigeration heat load in the form of radiation. Every time the ice surface lights are shut off or reduced by a percentage during maintenance periods, the radiant heat load must be absorbed by the refrigeration system and is therefore reduced. As a result, the total electrical energy savings are a result of both lighting and refrigeration energy savings.

Dumping of Resurfacing Snow

The use of hot water sprays in snow melting pits can cause extremely high hot water heating costs in an ice rink. While dumping snow outside is often an option, this can also create some difficulties. Dumping outside can take up valuable space – especially in winter when the snow does not melt rapidly. In warmer weather , the snow melts rapidly outside but the regular opening of the exterior doors admits warmer and more humid air into the rink space – causing higher air dehumidification and ice refrigeration costs. Dumping outside can also create dirty or debris-laden resurfacer tires. Although this alone does not use more energy, the extra (warm) water that is used to regularly clean the tires will cost more energy. Rather, resurfacing snow can be more suitably melted in a snow melt pit that utilizes free waste heat from the refrigeration system.

The following example shows the costs associated with using hot water for melting snow. Using waste refrigeration heat or even dumping outside will eliminate most if not all of these energy and water costs. The following calculation illustrates the costs of melting with hot water in a typical arena that operates eight months each year, with seventy floods each week.

Operating Assumptions = 2240 floods (melts/year)
100 gallons of water/melt
140 deg F melting water
70% natural gas boiler efficiency

Natural Gas Savings = 2240 melts x 100 gallons/melt x (10 lbs/gallon
* I btu/ib F) x (140 F – 60 F Temp. Diff.)
* 1/.70 eff. x 1 cu. ft./1000 btu x
0.0283 cu. m/1 cu. ft.
= 7245 cubic meters of gas/year

Water Consumption Savings = 2240 melts x 100 gallons/melt
= 224,000 gallons/year

The above calculated consumption savings figures, when multiplied by current utility rates, will translate into a significant annual cost savings at no cost for implementation.

Reduced Air Infiltration

Controlling air infiltration (and exfiltration) has become a popular and effective method of reducing energy costs and improving arena environments in order to affect a high standard of ice quality. Infiltration is in essence the uncontrolled flow of outside air through cracks and openings in the building envelope. Infiltration occurs, predominately by wind effect, on the windward side of the facility. The absence of caulking and weather stripping components in an artificial ice arena will cause higher energy costs related to refrigeration operation due to warm/moist air entering the arena enclosure during the milder operating months.

This measure is often overlooked because arena staff does not typically see where all the air is coming in. Air leakage through cracks is very difficult to detect. One easy way to detect cracks and see if your rink is airtight is to turn off all of the lights and stand at centre ice. Then, look at the walls, doors, fan louvers, and overhead doors. With the lights off, if you can see daylight, you have air leakage. The same cracks that show the light coming through will also let the infiltration air come in. This method can be used to check the resurfacer room, rink entrance, and any other areas that could let air get into the rink.

In the colder operating months this same absence of the above components will result in higher energy costs associated with space heating. Ensuring that all roof-to-wall joints plus man and overhead doors are properly sealed with applicable caulking and weather-stripping components will often realize payback periods of less than two years as a retrofit measure. If incorporated in the initial design/construction phase of a new facility, such an action will nullify a potentially wasteful situation.

Energy Efficient Lighting

The development of the compact fluorescent lamp has provided an alternative to the less energy efficient incandescent lamp when considering life expectancy and the quantity of light produced.

Standard incandescent lamps (to include bulbs, flood and spot lamps), which typically have life expectancies of 1000 hours, requiring replacement two to three times each year. The compact fluorescent lamps, which have life expectancies of at least 10,000 hours, possess the potential to reduce maintenance costs associated with regular replacement.

The energy consumption reduction is realized as a result of the fluorescent lamp's ability to produce a higher luminous efficacy (more light per watt). Therefore, instead of operating ten - 150 watt incandescent bulbs to illuminate a refrigeration room, the operator may install ten - 26 watt compact fluorescent lamps to produce the same quantity of light at a fraction of the operating cost. Compact fluorescent lamps may be screwed into existing incandescent light sockets, re-wired into existing fixtures or installed with new fixtures. The implementation of the above noted conservation measure would often produce payback periods of two to three years. The following calculation will illustrate what energy savings may be realized by retrofitting an existing area with compact fluorescent lamps.

Sample Calculation:

Energy Savings: = Existing Fixtures-Compact Fluorescent Lamps + Ballasts
= 10 x 150 watts - 10 x 26 watts + 9 watts = 1500 watts - 350 watts
= 1150 watts = 1.15 kW at 2500 hours/year = 2875 kWh/year

Replacement of standard wattage fluorescent lamps with energy efficient lamps is an energy conservation measure, which achieves immediate results without adversely affecting the facility environment since the energy efficient lamps produce a similar quantity of light. This minimal cost energy conservation measure simply involves the replacement of standard four and eight foot fluorescent lamps with the more energy efficient equivalent. This type of conservation measure may be implemented on a lamp-to-lamp basis or as a group retrofit measure in order to realize the greatest benefit in energy savings.

Potential Energy Savings:

STANDARD LAMP	WATTAGE	REPLACEMENT WATTAGE	WATTS SAVINGS	% ENERGY SAVINGS
F4OTI2	40	34	6	*15*
F96TI2	75	60	*15*	20
F96TI2HO	110	95	*15*	14
F96TI2VHO	215	190	25	12

The introduction of the T-8 lighting system has revolutionized fluorescent lamp technology. The T-8 fluorescent lamp has the ability to produce the same amount of light as standard lamps, when coupled with electronic ballasts, at an operating cost as low as 60% of standard systems.

The T-8 lamp's lumen output equivalency is realized as a result of two factors. Firstly, the T-8 lamps are smaller in diameter (1" diameter as opposed to 1 1/4" for standard lamps). This reduces light absorption and shadowing within the fixture. As a result, a larger percentage of the light produced is reflected from the fixture to the task or working area. Secondly, the T-8 lamp's use of rare earth phosphors (tri-phosphor or tri-chromatic), which are more stable, reduces lamp lumen depreciation. The two above noted factors allow the T-8 lamp lighting system to produce illumination levels equivalent to standard fluorescent lamps at a fraction of the operating cost. As already stated, the use of T-8 lamps require the installation of new ballasts due to their operating characteristics. The use of electronic ballasts will reduce the overall system power requirements by 30 to 40%, thereby achieving the greatest potential savings when applying this technology in existing and proposed ice arenas.

There are three other low cost lighting conservation measures worth considering in an energy conservation program. Retrofitting existing fluorescent fixtures with high performance reflectors can facilitate the removal of lamps and thereby reduce electrical consumption. In a fixture with a properly designed reflector, a higher percentage of the produced light is reflected onto the work surface rather than absorbed by the ceiling. As a result, four and three lamp fixtures may be retrofitted so that one to two lamps may be removed without reducing light levels.

The use of occupancy sensors to automatically turn lights on and off is another low cost way of reducing electrical use. Too often when a space, i.e. compressor room, is vacated the lights remain on. Left unattended, these same lights can be left operating throughout the night. The installation of an occupancy sensor, which can be connected to an existing wall switch or installed as a ceiling/wall mounted unit eliminate the need to rely on a person to turn the lights off. These sensors will detect human motion (via passive infrared or ultrasonic motion) and turn the light on for a short time only when a person is present. Typical payback periods for this type of energy measure range between three to five years.

The fact that exit signs must operate through the day and therefore must be illuminated 24 hours a day, 365 days each year, provides an excellent opportunity to retrofit or replace existing units with a more efficient light source. The use of incandescent lamps in most exit signs is both costly from an energy and maintenance prospective. Most exit signs utilize 30 watt and 50 watt incandescent bulbs with a useful life of less than 1000 hours. Over the course of a year these same bulbs will require replacement up to eight times, incurring high maintenance costs at a high operating wattage. The retrofitting of existing units with 10 watt compact fluorescent lamps and ballasts will not only reduce electrical costs but also maintenance costs due to a requirement for replacement only once a year.

Other Low Cost / No Cost Measures

Here is a list of other no-cost and low-cost measures, which may be implemented within a facility to further reduce energy and operating costs.

- Ensure that the volume of flood water does not exceed 100 gallons
- Insulate all hot water tanks
- Insulate all service hot water lines
- Change filters to improve effectiveness of rink dehumidification equipment
- Check and turn off all unnecessary equipment associated with seasonal changeover (i.e. air conditioning pumps and fans in winter)
- Test and maintain all heating equipment to ensure a high standard of efficiency
- Replace existing shower heads with low flow units to reduce both water and energy consumption
- Install push butting shower controllers to eliminate the waste of hot water when units are left running
- Implement a manual setback program during unoccupied periods in office, lobby and dressing room areas by reducing the thermostat settings by 5 to 10 F overnight.
- Install photocells on outdoor security and parking area lighting systems to minimize use and energy consumption.
- Install automatic night set back systems to control heating/ventilating and refrigeration equipment.
- Shut all air-conditioning equipment off in office and auditorium areas when unoccupied.
- Purchase of high efficiency motors when replacements are required to reduce electrical consumption.

CAPITAL COST ENERGY CONSERVATION MEASURES

The development of capital cost energy conservation technologies has produced significant gains during the latter part of the 1980's. With the realization that energy costs will continue to increase, the designer or operator of an artificial ice rink facility must incorporate conservation measures, which will have a significant and lasting impact. The following capital cost energy conservation measures represent proven technologies. These technologies possess the ability to provide significant energy and cost savings reductions and, at the same time, an ability to maintain a high standard of quality pertaining to the operation of an artificial ice rink.

Low Emissivity Ceilings

Ice rinks are one of the only types of structures that involve a large amount of radiation heat transfer. In most commercial facilities radiation heat transfer is only considered in the design of low "E" windows and glazings. In an ice rink however, ceiling radiation is the single largest heat load impacting the ice. It can account for up to 28% of the total refrigeration heat load.

The reason that radiation is significant in an ice rink and not in other buildings is because an ice rink is the only space where a very large cold surface (the ice) faces an equally large warmer surface (inside ceiling). Because these two surfaces are at different temperatures, there will be a net heat radiation from the warmer surface to the colder surface.

Radiation is surface-to-surface heat transfer. Just as the sun (very hot) radiates heat to the earth (relatively colder), the warmer inside ceiling of an ice rink radiates heat to the colder ice surface. Radiation actually occurs from every surface whether warm of cold. The amount of radiation however depends on the surface temperature to the power of 4 (i.e. $R= F(T^4)$). Therefore, even a small temperature difference between the ice and the ceiling will create a significant transfer of heat to the ice.

A common misconception is that this ceiling radiation is directly a result of the sun radiating heat waves *through* the roof. This is not true. Rather, it is the temperature of the inside ceiling surface which faces the ice that is important. It is true however that the inside ceiling is warmed by a number of sources, one of which is the sun. Other reasons the ceiling is warmer is because of natural warm air stratification in an ice rink. That is, heat from lights, heaters, players and equipment all warm the surrounding air. Then, the warm air rises and naturally warms the inside ceiling. As such, the inside ceiling is typically the warmest surface in an ice rink. For example, in a typical winter day, the ice may be 20 F and the inside air temperature may be 30 F. The ceiling temperature in these conditions could very well be 40-50 F.

The amount of heat radiation to the ice is dependent on the temperature, the surface area and also on a surface property called *emissivity*. Emissivity is defined as the ability of a surface to radiate heat. For example, surfaces that have a high emissivity of 0.9 will radiate 90% of their maximum heat radiation. Conversely, surfaces with a low emissivity such as 0.03 will radiate only 3% of the maximum heat.

Here is a typical equation used to calculate heat radiation in an ice rink. It is clear that the amount of heat radiation is proportional to the surface temperatures, ceiling and ice surface areas and ceiling and ice emissivity.

$$Q = A\ f_{j\text{-}i}\ s\ (T_j^4 - T_i^4)$$

Where: Q = Amount of ceiling heat radiation (W)

A = Area of the reference surface (rink ceiling surface, m^2)

s = Stefan Boltzmann constant ($5.669 \times 10^{-8}\ W/m^2\ K^4$)

T_i = Temperature of the ice (K)

T_j = Temperature of the inside ceiling (K)

$f_{j\text{-}i}$ = Gray body configuration factor as shown below

$F_{j\text{-}i}$ = Geometric view factor (varies with ceiling shape and size)

e_i = Emissivity of ice surface (0.95)

e_j = Emissivity of inside ceiling surface (wood, paint, steel = 0.95)

$f_{j\text{-}i} = [1/F_{j\text{-}i} + (1/e_i - 1) + A_j/A_i\,(1/e_j - 1)]^{-1}$ (Gray body factor equation)

The only viable way of reducing the inside ceiling radiation to the ice is by lowering the emissivity of the rink ceiling surface which directly faces the ice. This is accomplished by installing a low emissivity ceiling barrier (radiant barrier) at the inside roof deck facing the ice rink.

Figure #3 - Typical EnerShield Low Emissivity Ceiling Installation

Such a radiant barrier is composed of a highly reflective polished aluminum surface having an emissivity rating of 0.03. To be effective, this reflective surface must directly face the ice. Then, with an emissivity of 0.03, a low emissivity ceiling can reduce the radiation heat load by up to 95%. So, if the radiation represents 28% of the total refrigeration load, a low emissivity ceiling can reduce this load by a total of 26.6%. For this reason, **low emissivity ceilings are considered the single greatest energy saving measure that an ice rink can invest in.**

Typical energy savings associated with low emissivity ceilings can range from $700.00 per month in northern Ontario climates to $2000.00 per month in hotter climates in the southern USA. (depending on electricity rates and site specific conditions). A thumb rule for energy savings in a typical Ontario rink operating 10-12 months per year is approximately $1,000.00 per month.

Another common misconception is that the painted or white ceiling liners are also low emissivity surfaces. This is not true. Low emissivity surfaces must be composed of a polished metal foil such as aluminum or silver to reduce heat radiation. So, although many rink owners and operators like the white look of insulation liners, it effectively costs a typical rink about $1000.00 per month more if there is not a true low emissivity surface facing its ice.

The installation of a low emissivity ceiling can also provide many other benefits to the ice rink.
In rinks with dark or wood ceilings, low E ceilings can help brighten the rink and improve lighting levels at the ice surface.

Next, because heat radiation to the ice is reduced, the unradiated heat will actually warm the topside of the low emissivity ceiling in the air space or cavity above the foil. This extra heat will cause the building materials behind the low emissivity ceiling to become warmer and drier. In fact, in retrofit cases, the extra heat behind a low emissivity ceiling has been credited for drying out wet bat insulation. The drying process can only take place when the low emissivity ceiling has been installed to allow air movement from one side of the ceiling to the other. As long as it has not been sealed, taped or glued, there will be a natural balancing of the vapour pressure on both side of the ceiling preventing any moisture from accumulating above or behind the low emissivity ceiling.

Low emissivity ceilings have also been known for improving acoustics in some rink facilities. While the degree of improvement really depends on how bad the acoustics are to begin with, their fabric like composition will usually make some slight improvement.

More recent studies on low emissivity ceilings shows that their effectiveness or efficiency in saving energy can be significantly dependent on the geometry of the ceiling structure. For example, energy savings will be greater in rinks with parabolic type roof shapes that are focused on the ice. Rinks with very high ceilings (35 feet +) will save less energy because the higher ceiling will permit more heat to reflect to the ice from the walls and stands surrounding the ice.

Heat reflection also is a factor in installations where low emissivity ceiling are installed above structural beams and joists. In these cases, the beams and structural steel members will not only radiate heat to the ice directly, but will also radiate heat to the ice by reflection off of the low emissivity ceiling. In fact in some installations involving many structural members below the ceiling, energy savings can be reduced by as much as 30% compared to other rinks without as many structural members.

Brine Pump Control

All rinks operating an indirect (brine / glycol) or secondary refrigeration system will make use of a brine or glycol circulation pump. The purpose of this pump is to remove heat from the ice rink and transfer it to the primary (Ammonia or Freon) refrigeration system where it can be rejected to the outside. In many facilities this pump will operate constantly whether the rink is calling for cooling or not.

The cost of operating a 30 hp pump motor continuously for 1 year is as follows.

Electrical rate of $0.055/kWh
30 hp is approximately 30hp x.746 kW/hp = 22.38 kW of power
Number of hours in 1 year = 365 days x 24 hours/day = 8760 hours/year
kWh of energy consumption = kW load x hours of operation per year
= 22.38 kW x 8760 hours
= 196,049 kWh per year

Cost of electrical energy = Cost/kWh x kWh in year
= $0.055 x 196,049
=$10,783 per year

The costs of operating a brine pump are further increased by the refrigeration energy required to refrigerate the frictional heat that brine pump produces when it operates. This additional cost is approximately 1/3 of the cost too operate the brine pump motor. As such, the total cost of operating a 30 hp brine pump for 1 continuous year is approximately $14,000.00 in the above example.

The pump however is only required to operate when the compressors are operating. That is, if there is no call for cooling and the compressors are not on, the pump does not have to be operating either.

In older systems using brine thermostats to indirectly control the ice, the brine thermostat will not work correctly if there is no brine flow. As such, many older rinks must operate the brine pump continuously. For this reason, most brine pump controls are installed together with ice temperature control systems. When using infrared ice surface temperature sensors or in ice probe type temperature sensors, the brine pump can be shut off without any problem.

There are various brine pump control schemes to reduce the operating cost of the brine circulation pump. Some of these are as follows:

On Off Systems – With no call for cooling, the compressors shut off and the pump is off; with a call for cooling the pump starts with the compressors.

Two Speed Systems – With no call for cooling the pump is on half speed (875 RPM) and the compressors are off. With a call for cooling, the pump runs at full speed (1750 RPM) and the compressor(s) operate.

Variable Speed & Multiple Speed Systems – With no call for cooling the pump runs at low speed (typically 750 RPM) and the compressors are off. As the ice temperature increases the pump speed increases gradually or by steps and the compressors stages gradually turn on. At maximum cooling, the pump is on full speed (1750 RPM) and the compressors are all operating.

Dual (Pony) Pump or Multiple Pump Systems – Similar to two speed systems, with no call for cooling, a small pump may run to circulate a small amount of brine. With a call for cooling, a large size brine pump starts and the compressor(s) turn on.

The energy savings of an On/Off system is quite clear in that when the pump is off, it is not using any electrical energy. The savings of the speed reducing systems however is slightly more interesting. That is, the power used by a pump varies with the cube of the speed. For example, if the speed is reduced in half, the power requirement is reduced by half to the power of three.

$P1/P2 = (N1/N2)^3$ or $P2 = P1 \times (N2/N1)^3$ & $Q1/Q2 = N1/N2$

These are known as the **centrifugal pump affinity laws** where if the speed is reduced by half, the power is $(0.5)^3$ = 0.125 or 12.5%. In other words, the theoretical power at half speed and half flow is only 12.5% of the power at full speed. It should be noted here that the actual pump power is quite different than the theoretical power. In practice, a pump running at half speed (875 RPM) will draw approximately 25-30% of its full speed power rather than the theoretical value of 12.5%. This difference occurs because the pump motor efficiency is reduced as the speed is reduced. Therefore, although the pump may only need 12.5% of full power at half speed, the motor actually draws 25-30% of full power at half speed. For this reason, brine pump energy savings have often been overstated.

Although the actual energy savings not the same as the theoretical savings, there is still a great energy savings potential in utilizing brine pump controls.

On/Off systems save a great deal of energy however the On/Off action of the pump and motor naturally causes more wear on the motor and pump drive train components. Soft start systems that gradually ramp up the pump to full speed are typically recommended with On/Off systems.

Two Speed systems have good energy savings and the transition from half speed to full speed is much less demanding on the pump motor and driving components. This is because it requires much less effort for the pump to speed up from half speed than it does to start from a dead stop. The two speed systems offer a useful tradeoff between energy savings and equipment wear.

Variable speed and multiple speed systems also have good energy savings comparable to the two speed systems. Because they typically require a VFD (variable frequency drive) these systems are higher in capital costs than the two speed systems. Further, because of the inherent use of electronics in the VFD, variable speed systems have been known to require much more maintenance and service than comparable two speed systems. In a direct comparison, the two speed systems would show a far better life cycle cost compared to the variable speed systems .

The dual pump, multiple pump and other pump combination systems offer other advantages for energy savings. When designed correctly, such systems can incorporate on/off controls together with the merits of two speed or multi pump systems to provide optimum energy savings. Such systems are slightly more complicated however and should only be designed by an experienced professional to ensure equipment safety, and reliability.

The selection of a pump control systems depends on a number of variables. The main guideline however is that the pump operation and brine flow should follow the compressor operation. If the brine flow does not track the refrigeration output then there is likely more brine flow than is necessary or there is not enough brine flow and equipment damage could result.

Safety is one very important aspect of brine pump controls that cannot be overlooked. Every brine pump control system should have both an electrical and mechanical safety interlock with the primary refrigeration system. That is, if the brine pump fails to circulate brine for any reason, the compressors must not be permitted to operate. Failure to include such a safety mechanism could result in serious equipment damage or even death in an extreme case.

Ice Surface Lighting

Second only in importance to ice quality, ice surface lighting quality is a major aspect of any arena operation. The Illuminating Engineering Society of North America (IES) has established the acceptable standard for sports facility lighting. In the case of hockey and curling rinks, IES recommends that lighting levels expressed in foot candles (fc), which is a measurement of light intensity, be maintained at 50 f.c. for amateur level activities. In order to maintain this recommended standard a large quantity of lamps must be incorporated in the system's design whether they are incandescent, fluorescent, or high intensity discharge lamps. There are many variations in designed lighting systems, which have been adopted over the years. In most existing cases, one will find two types of lamps in use; fluorescent and high intensity discharge (HID). There are two HID lighting systems more commonly used in arena facilities today; they include mercury vapor and metal halide. In mercury lamps, light is produced via the passage of an electric current through mercury vapor. The metal halide lamp, similar in construction to the mercury lamp, differs in that the metal halide arc tube contains various metal halides in addition to mercury and argon.

The above noted lamps are similar with the exception of three important areas. First, when considering the quality of light produced, color rendering plays an important role. Color rendering is a general expression utilized to define the effect of color appearance on an object. Of the two lamps being discussed, the metal halide lamp has a higher color-rendering index (CRI) of 65 to 90, as compared to that of the mercury lamps with a CRI of 45 to 55. Second, the rated life of the lamp is important when considering future replacement costs. For standard 400-watt mercury and metal halide lamps there is little variation in rated hours of life expectancy (mercury vapor = 24,000 hours, metal halide = 20,000 hours). Finally and most importantly, when considering an appropriate light source for an arena application, one must evaluate luminous efficacy. By definition, luminous efficacy of a light source is the total quotient of the total luminous flux emitted by the total lamp power (expressed in lumens/watt). In other words, it is the quantity of light produced relative to the operating wattage of the lamp. When considering mercury vapor and metal halide lamps, the metal halide lamp has an efficacy of 75 to 125 lumens per watt as compared to the mercury lamp, which has a lower efficacy of 30 to 65 lumens per watt. Based on all of the above factors, the use of metal halide lamps will prove to be the most cost effective, aesthetically pleasing selection for indoor ice rink facilities. The following example calculation of the retrofit conservation project will clearly illustrate the benefits of utilizing metal halide lamps to reduce future energy consumption.

SAMPLE CALCULATION:

Operating Assumptions	Ice Surface - 200' x 85' Annual Operation - 32 weeks Daily Schedule - 12 hours/day Existing Lamps - 60 x 400 watt mercury vapor Proposed Lamps - 30 x 400 watt metal halide
Energy Savings	(60 x 400 watts - 30 x 400 watts) x 1/1000 watts per kW x 32 weeks/year x 84 hours/week 32,256 kWh/year (12 kW reduction)

Additional electrical savings will be realized due to the fact that ice surface lighting can account for 7% of the total refrigeration heat load in the form of radiation. By eliminating 50% of the required lamps as shown in the above example, 3.5% of the lighting radiant load will be eliminated.

Hid Dimmer Systems

The requirement to reduce energy consumption, couple with varied light output requirements for different user groups has expanded the field of light source control to include the HID systems commonly found in arena facilities. Advances in solid-state electronics, including improvement in power semiconductors and integrated circuits, have provided the components necessary to accomplish reliable dimming control. Depending on the desired lighting levels, which may include 25% light output for ice maintenance or 50% light output for figure skating, dimmer systems possess the ability to reduce power requirements without affecting equipment life expectancies. In the case of a typical 400-watt metal halide ice surface lighting system, a dimmer unit may reduce power requirements to as low as 5007o when operating at 25% of the lamp's lumen output potential. When applying this conservation technology to a mercury vapour system, power and lumen output percentages can be reduced by as much as 85% and 90% respectively.

Compressor Heat Recovery

Heat reclamation (heat recovery) has become an effective method of reducing the high energy costs normally associated with heating water for domestic and ice resurfacing use in arena facilities. This technology is in no sense a new development. Heat recovery systems have been in use in processing and manufacturing plants for decades and have proven to be a cost effective method of reducing energy consumption.

The standard refrigeration system contained in a hockey arena or curling rink consists of many components, each critical to the manufacturing of ice. The major component, the compressor, compresses the refrigerant to a very high pressure and corresponding high temperature. This super-heated gas will normally proceed to the condenser where it is cooled and condensed from a gas to a liquid. It is between these two processes in a refrigeration cycle where a water-cooled heat exchanger may be installed to capture this otherwise lost energy source. This action will not only produce pre-heated water for use in the facility, but will also improve the efficiency of the refrigeration plant due to a need to reject less heat at the condenser. The de-superheater (heat exchanger) simply transfers heat through conduction from the hot refrigerant to the cold service make-up water (avg. 55 deg F). The most common type of heat recovery system in use today utilizes a shell-and-tube or plate-type heat exchanger made of corrosion-resistant alloys, to capture this superheat. The application of this conservation technology has shown that hot service water requirements do not always match recovery periods or heat transfer needs. In the colder winter moths, when compressor operation is significantly less then spring and fall periods, the production of pre-heated water will often not correspond to the facility's needs.

The incorporation of a circulating water loop and a minimum of 200 gallons of storage capacity in the system design will provide the needed buffer to compensate for those periods when the compressors are shut off. This pre-heated water will then act as make-up for the service water system. Empirical results have shown that this process can be expected to increase the average make-up water temperature from 55 F to 120 F throughout the operating season for an arena facility open eight months each year. As a result of implementing this conservation measure both hot service water heating and refrigeration electrical consumption will be significantly reduced. The following example calculation for a typical hockey arena will demonstrate the potential benefits.

SAMPLE CALCULATION:

Assumptions
- Temp Diff. via Reclaim 65 F
- Floods/Week = 84
- Weeks/Year Operation 32
- Gallons/Flood = 120

Potential Savings = 84 floods/week x 32 weeks/year x 120 gallons/flood x (10 lbs/gallon x 1 Btu/lbF) x 65 F x 1/35,000 Btu/cu. in. x 1/.70 eff.
= 8558 cu. in. of natural gas/year

There are numerous additional capital cost conservation measures worth noting which may be implemented in an artificial ice rink in order to further reduce energy consumption, including the following:

- The installation of a computerized control system to regulate the operation of all energy consuming equipment in accordance with daily schedules.
- The conversion of existing electric, oil, and propane heating equipment to more cost effective natural gas (where available).
- The installation of additional wall and roof insulation to reduce heat loss.
- The installation of high efficiency boilers or furnaces to reduce future space heating costs.
- The installation of double glazed windows to reduce heat loss and energy consumption.
- As required, the replacement to existing motors with high-efficiency units to reduce electrical consumption.

Air Handling & Rink Dehumidification

One of the largest ice rink heat loads is the load imposed by the humidity and air movement over the ice surface. This is known as the *convective* heat load. This load is a result of the air near the ice being warmer than the ice temperature itself. Further, when the air has a large moisture content (high humidity), it actually contains more heat than when the air is dry. As such, the higher the humidity is, the greater is the heat load on the ice.

The speed of the air near the ice is also a large contributing factor to the convective heat load. The faster the air is moving at the ice, the more heat transfers to the ice. That is why a fan or blower directed downward to the ice will often cause a soft or wet spot on the ice.

Energy conservation can be achieved by first keeping the air handling equipment from blowing downward at the ice surface and second by using dehumidification equipment to keep the air dry.

As a general rule, airflow from dehumidifiers or ductwork should be directed horizontally or even slightly upward along the roofline in the rink. This will prevent the high convective heat load on the ice. The air movement near the roof or steel beams will also help to prevent any moisture build up and condensation from those surfaces. Directing the air upwards will help mix the warmer, moist air and improve return air circulation back to the rink dehumidification equipment - making it work more efficiently. Also, by reducing air movement near the ice and between the boards, it will give the warmer air a chance to stratify upwards leaving cooler air down near the ice surface - again helping to reduce the convective heat load on the ice and saving energy.

There are various ways to dehumidify the air in an ice rink. While refrigerant-based ice rink dehumidifiers have often been used, desiccant type dehumidifiers are quickly becoming an accepted standard in most new ice rinks. Not only are desiccant dehumidifiers less costly to operate (depending on local gas & electric rates) they also provide far more dehumidification capacity than comparable refrigerant-based systems. In addition to the higher capacity, they are also effective through the entire ice season where refrigerant dehumidifiers are usually constrained between high and low limits of rink air temperature.

Compared to not having dehumidification however, refrigerant type dehumidifiers are still better than nothing. That is because the ice surface itself also acts as a dehumidifier removing moisture from the air. This process takes place using the ice refrigeration equipment, which is operating at parameters that make it a far less efficient dehumidifier than the basic rink refrigerant based dehumidifier. Therefore, it is still better to run the dehumidifiers than to rely on the ice as a dehumidifier.

ENERGY CONSULTING SERVICES

Unlike most types of commercial buildings, ice rink facilities are a totally different type of structure. They are the only commercial space in which an industrial process (refrigeration of ice) is used together with an occupancy type of building (the arena). For this reason, it is important to work with professional architects or energy engineers who have had experience specifically in ice rink facilities. Because ice rinks are different than standard commercial buildings, the energy consultant must understand the refrigeration process, the ice temperature and ice quality requirements, the building construction needs, and the special dehumidification, heating and lighting needs of an ice rink. Only when a consultant understands all of these rink specific needs will he be able to successfully apply energy management strategies to an ice rink.

Never should energy conservation be implemented at the expense of the ice quality or arena comfort. An efficient ice rink is useless if there are no user groups interested in playing there. For this reason, a successful energy conservation program should account for the needs of both the users of the ice and its spectators. Were an inexperienced energy consultant may not fully grasp these issues and could possibly cause harm to the facility, a experienced ice rink energy engineer or consultant will not only be able to apply the rink specific issues, but he might also be able to improve and enhance the ice quality and rink environment while saving the energy.

Since the mid- 1980's, considerable research has been conducted in the field of ice energy management. This is a trend that is likely to continue at a more rapid rate in the future. Reports and data on the findings from this research are available from a variety of sources. In Ontario, the Provincial Ministry of Environment and Energy has issued several comprehensive reports and brochures on Ice Rink Energy Management.

For further information on these publications contact:

Ministry of Environment and Energy
56 Wellesley Street West, 14th Floor
Toronto, Ontario
M7A 2B7

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SUMMARY OF PRECAUTIONS

Change Rooms

- Change room benches or seats should be affixed to the walls by steel angle brackets, using bolts rather than wood screws. Benches should be made of hardwood.
- Clothing hooks in change rooms should be made of steel in a J shape, and welded to a steel plate, which on turn is bolted to the concrete block wall. Hooks should be installed on slight angle.
- All rooms, especially change rooms should have floor drains with floor sloped sufficiently to permit liberal use of water from a high-pressure hose for cleaning purposes.
- There should be adequate water bib connections in corridors and in change rooms to facilitate cleaning of all floor areas in the arena.
- All change rooms should be well ventilated and a separated room should be provided for hockey equipment storage, for sanitary reasons.
- Rubber floor tile should be laid over concrete floors in dressing rooms and corridors on the specific areas used by players to avoid damage to the skate blades and to the floor.
- The ceiling should be of a durable material to prevent objects (hockey sticks) penetrating and defacing it.

- Vandal – proof protection should be used to cover all thermostat controls, light switches, water taps, or similar mechanical equipment in any public area.
- All doors should be metal or metal covered to reduce the possibility of vandalism and made of heavy gauged steel.
- All widows should be eliminated in change rooms. If windows exist, replace with Plexiglas to reduce breakage. Natural lighting (if required) may be supplied in some cases by an overhead transom. Exhaust fans will provide excellent ventilation in a windowless room.
- Showers may be fitted with temperature controlled and/or automatic shut-off heads to reduce water wastage. A push button is much less subject to damage than conventional taps.
- Change rooms on different levels than the main floor require stairs, which can lead to falls as well as cleaning problems in moving equipment or cleaning up and down a staircase.

Ice Surface

- The dasher boards should be made of plastic.
- Heating ducts should not be placed in close proximity to the ice surface edge to prevent undue melting from radiation.
- A large well-drained ice pit (for snow removal purposes) should be provided with removable screens on the ice pit drains for cleaning. If ice pit is at the ice edge, avoid putting a curb at this location.
- Sufficient drains should be provided for ice removal and water drainage, preferably at the side of the ice.
- The ice surface and the floor of the equipment gate should be at the same grade, to permit easy access the ice surface.
- Large gates should be provided for public skating, with direct access to corridors and change areas.
- Inserts should be provided on the main floor for summer court games.
- Electrical and telephone wiring should never be routed under the ice surface.
- Adequate height (min 14') and easy access should be provided for vehicles to be driven on the main floor to move equipment (chairs, stage etc.)
- All gates to the ice surface should swing away from, not on to, the ice surface.
- Ice cleaning equipment should be stored in a heated area for maximum operating efficiency and should have ready access to the ice surface.

Mechanical Equipment

- An operating logbook should be maintained, and all manufactures' recommendations should be followed.
- A detailed maintenance program for the refrigeration equipment must be in place.
- A pre-season, mid-season and post-season check of all refrigeration equipment should be part of a preventative maintenance program.

- The evaporator or condenser requires maximum freedom of air circulation. This equipment should be located outside the building, approximately 10 feet above ground level, within a fenced enclosure, if necessary.

General Building – Exterior

- There should be adequate roof overhang. Roof drains outside the building should be protected form vandalism. Electrical cables in the eaves can prevent ice build-up.

- All exterior doors should be designed to avoid drainage problems and ice formation.
- External vent pipes should be insulated.
- It may be necessary to treat exterior concrete walls to ensure waterproofing.
- Large expanses of glass should be avoided to reduce cleaning time and possibility of breakage.

General Building – Interior

- All concrete floors should be treated with urethane epoxy, painted, or treated and waxed as often as necessary to prevent a shoddy appearance; untreated floors are a constant source of dust, a high upkeep factor, and offer an uninviting appearance. Terrazzo, traprock or tile floors provide the best floor from both the appearance and upkeep point of view.
- All corridor walls should be colourful and cheerful in appearance. Glazed tile is often used, but if the walls are painted, a plastic-based paint helps reduce damage from marking on walls.
- If standing room is provided at the top of the seating area, a guardrail should be provided that is high enough to prevent interference between those persons seated in the back row and those persons leaning over the railing.
- Sufficient storage space is essential to arena maintenance efficiency. This applies to custodial supplies, as well as other necessary equipment (chairs, tables, mechanical and stage equipment, etc.)
- Heating should be provided to at least one large area in the arena, preferably in the same location as the concession (lobby), to allow a “between period warm-up” for fans.
- Collapsible scaffolding or man lifts are required for light replacement and other high to reach places.

Guidelines for Developing New Facilities

Ratio Standards – Arenas

Ice Activity Usage

If residents of your municipalities are *very active* in ice activities and you have a minor hockey system for boys and girls, skating club, adult hockey and senior hockey and community public skating.

Standard Ratio – One artificial ice rink per 8, 000 people

If residents of your municipality are *fairly active* in ice activities and you have a minor hockey system for boys and girls, skating club and adult hockey

Standard Ratio – One artificial ice rink per 14,000 people

If residents of your municipality are *somewhat active* in ice activities and you have a minor hockey system for boys, skating club and some adult hockey

Standard Ratio – One artificial ice rink per 20,000 people

The Provincial average based on a community that is fairly active in ice activities is one artificial ice rink per 14,582 people.

Single vs. Twin Pad Arena

There are several advantages to thinking and building big – a multi-pad or multi-purpose recreation facility as opposed to the traditional single pad or single use facility. This is of course, only if there are both, the need for such a facility and the ability to pay for such a facility.

The first obvious advantage is in construction cost savings. A double or multi-pad facility can be much cheaper to build compared to building the equivalent surfaces as single stand-alone ice pad facilities. The same would hold true for a multi-purpose recreation facility as opposed to building the equivalent facilities as separate stand-alone facilities.

Staffing accounts for the largest expense to operating a recreation facility. Larger multi-pad and multi-use facilities can allow for centralized management operations that can reduce overall management staffing levels. The larger facilities can also allow for considerable savings on operational staffing expenses. A single pad facility requires one operator plus various part time support staff during most peak program periods. A twin pad facility can still be efficiently operated with the same amount of staff during the same peak program periods. A multi-purpose recreation facility will also require fewer staff per shift compared to several single-use facilities. In a recent staff report conducted by the City of St Catharines, as seen in the chart below, it was concluded that there are lower costs to operating a four-pad arena complex compared to operating two individual two-pad arenas. The majority of the savings were attributed to staff savings costs.

Financial Comparison of Two Pad vs. Four Pad

Annual Operating Costs Two Pad	$625,636	$312,818/ pad
Annual Operating Costs Four Pad	$1,129,260	$282,315/ pad

Compared to the smaller single-pad and single-use facilities, the larger multi-pad and multi-use facilities due to the larger volume of patrons will generate substantially higher ancillary revenues from things like pro-shops, restaurants, concessions, vending machines, and arcades. In terms of food services, the larger multi-pad and multi-use facilities also have the opportunity to partner with well-known food chain franchises like McDonald's, Tim Horton's, Pizza Pizza etc. Some larger facilities have also been known to make additional retail space available within the facility that can be leased out to various businesses like health stores, doctors and chiropractor offices etc. These additional ancillary revenue streams can be used to offset various facility-operating expenses. From the previously mentioned staff report from the City of St Catharines, it was estimated that compared to a twin pad facility, the additional revenue streams for four-pad arena facility will generate an additional $215,000 per year. In another report by the City of Windsor, it is estimated that a proposed twin-pad arena facility is projected to make $60,000 to $70,000 per year. Where as their current single-pad rink facilities lose between 60,000 to $70,000 on average per year.

Less minor in importance, a multi-pad facility allows for increased tournament potential that provide great revenue potential both from ice rental revenues and from ancillary revenue streams – proshop and food services. Another benefit, average new ice resurfacer with an average life span of ten years costs about $70,000. One ice-resurfacer can meet the programming needs of a twin-pad facility and two ice-resurfacers can meet the needs of a four-pad arena facility. The same can be said for tools and equipment like floor washing machines that cost in excess of $10,000.

From a consumer's perspective, the number one reason affecting participating in recreation programs and activities is a "shortage of time issue". The multi-pad facility allows consumers to maximize the time they have by allowing a full range of program opportunities in a single location for all household members. When parents take their child to hockey practice or swimming lesson, they can also take part in a fitness class or take in a game of racquetball. Furthermore, multi-purpose facilities with flexible spaces allow for a variety of programming to meet the changing activities of different age groups, as well as changing leisure trends. While being able to meet the needs of the consumer, multi-purpose facilities will have more users, which equates to more revenues through the various forms of user fees and more public support to build such facilities with public funds. The common trend today is to build larger multi-purpose facilities as evident in the recent recommendation that came from Recreation Master Plan for the Township of Middlesex Centre. This recommendation called for the Township to build large, more diversified facilities that can offer a wide range of programming opportunities, including social services where needed, and which may be combined with other facilities such as libraries. It also recommended that in the development of multi-purpose facilities, there is the potential to design facilities that can also meet the increased demand for amenities from the use of outdoor facilities (e.g. trails, soccer pitches, ball diamonds) through strategic placement of washrooms, change rooms, and concession areas.