Sonification of the Invisible: A Large Scale Sound Installment on Building 54

Proposal for a temporary installation of 35 speakers on the facade of the Green building

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Thesis
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MIT

in Collaboration with
Haystack Observatory
MIT

revision 3.01 April 27 2005

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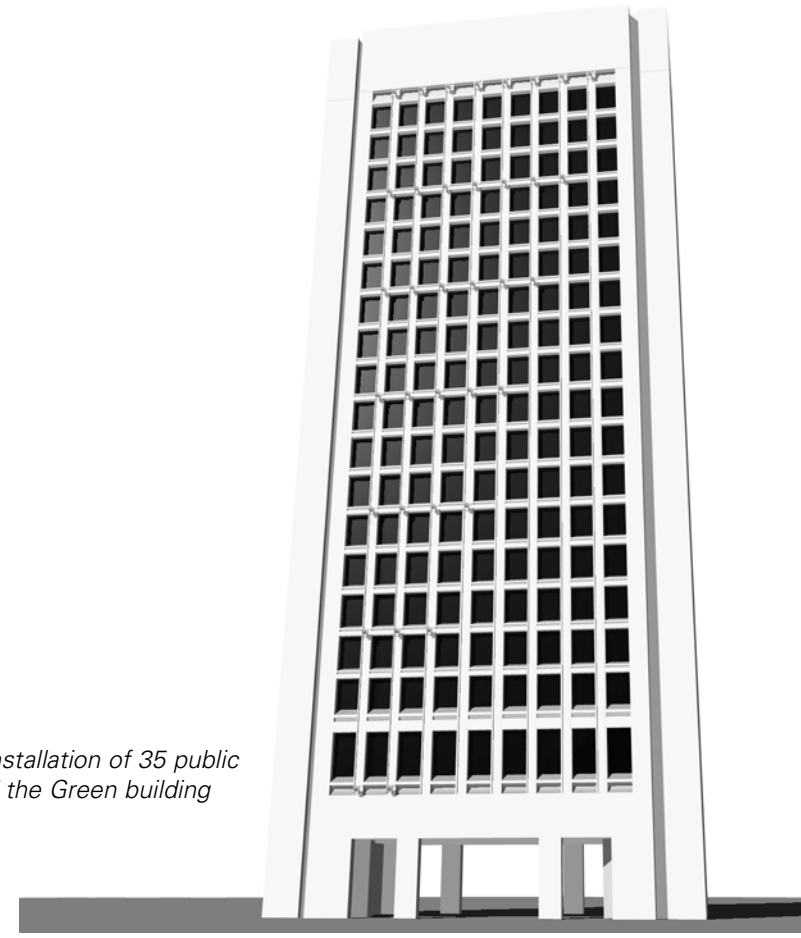


a long shot of the proposed temporary installation of 35 public address speakers on the south facade of the Green building

Introduction

The intention of this project is to utilize sound as representation of MIT research—extending out to the public what may be invisible, or less known to the broader community interested in MIT's spectrum of work. I am utilizing Building 54, also known as the Green Building, on the MIT campus to address the public and MIT community in an abstract representation of research going on here at MIT. Collaborating with scientists from MIT's Haystack Observatory, I am proposing the sonic display of research data from an architectural scale, a speaker setup on the south façade of the Green Building. This project will be a multi-speaker sound installment with a total of 35 Public Address speakers temporarily attached to the vertical concrete columns on the buildings' façade. The speakers will be broadcasting audio representations of sound waves embedded in Earth's charged upper atmosphere, or ionosphere. The broadcast sounds are in fact frequency scaled versions of ion-acoustic pressure waves within the hot ionospheric gas, which changes state in a complex interaction with the Sun's varying output. Physical parameters appropriate to seven different altitude levels in the ionosphere will be used to construct appropriate ion-acoustic sounds, and these will be broadcast from seven layers of speakers on the facade of the Green building. These sounds make tangible the state of the ionospheric portion of the terrestrial upper atmosphere, a region under active radar study by the Atmospheric Sciences Group at MIT's Haystack Observatory, the only observatory in the Continental United States currently performing this research. Changes in the makeup of the ionosphere, especially during disturbed periods, can affect the precision of GPS technology and other man-made long distance and satellite transmissions. Knowing and predicting the constitution of the ionosphere has become an integral interest for commercial interests as well as the national Space Weather effort funded by the National Science Foundation, and puts a spotlight on nearly five decades of study by the Haystack research group at MIT.
The speaker arrangement on the Green Building's façade visually reminds the listener of an upwards-sloping graph. This is representative of the spectral frequency distribution of the sounds, which vary both by time and in altitude.

This large-scale sound installment will make tangible the joint perspectives of contemporary arts and upper atmospheric science, representative for the advanced research focus of this institution, and exemplary for MIT's interests in creating an environment in which the arts merge with technology to create inspirations for artists and scientist likewise. The scale of this project is considerable, but so is the size of the Haystack observatory installation, the distance to the ionosphere, and the iconic silhouette of the Green building overseeing the MIT campus when viewed from the Boston bank of the Charles River.

Speakers are distributed accross the facade of Building 54. Pipe clamp bracket systems are used to temporarily attach the speakers to the vertical columns of the building.

Sound Detail

The sound of the project will consist of 35 audio channels across the façade of Building 54 (see detail). The speakers will represent the temporal change of conditions in the plasma which composes the ionosphere, a layer of the upper atmosphere that starts at an altitude of approximately 100 kilometers (60 miles) above ground. For the purposes of this project, the thickness of the ionosphere is subdivided into 7 layers. Each of the 7 horizontal speaker rows will sonically reflect the current composition and temperature of electrons and ions at a specific altitude, analogous to the elevation of the rows from the ground on the Green building. The vertical extent of the Green building façade becomes a representation of the ionosphere layer.

The sound that will be broadcast from the speakers is based on a translation of ion pressure waves within the ionospheric gas, transposed into audible frequency range. These pressure waves have a characteristic frequency spread which depends on the composition and temperature of the ionospheric gas itself.

The sound will vary from left to right to represent different discrete frequency bands from within the frequency spectrum of the sound translation. The bands will increase in frequency range from the left to the right. The distribution of speakers on the façade reflects the frequency distribution of the sound generated from the ionosphere pressure waves and the subdivision into different altitudes: Higher altitudes contain a characteristically wider ion-acoustic spectrum since masses are lighter and temperatures hotter there, while lower altitudes are narrower spectra typical of heavier ions and lower temperatures.

The conditions within the ionosphere undergo temporal change that will affect the sonic representations at all altitudes. The temporal variations of electron and ionic density in the ionosphere layer have complex physical responses which at lower altitudes have nearly tidal patterns, as the charged and neutral portions of the atmosphere interact with each other. Major influences on the make-up of the ionosphere are large variations both in solar radiation and in particle emission of the sun's outer atmosphere, resulting from magnetic variations within the gaseous body of the sun. Solar winds, the term for this solar atmosphere outflow which buffets the planets, create waves of highly energetic particles which can greatly affect the ionosphere. A visible example of this interaction between sun, upper atmosphere, and the magnetic field of the earth are aurora borealis, large glowing displays that can be seen in the sky usually above the northern and southern poles of earth and even sometimes over North America (for more information of ionospheric conditions and the interaction between sun and earth, see www.spaceweather.com). Relevant to this project, in an expanded sense of meaning, the sound structures emitted by the speakers on the façade will make audible the interactions between the sun and the earth in terms of ionospheric particle and radiation influence caused by solar radiation and solar winds - in a broader sense the audible channels broadcast by the speaker field sonify the effects of solar winds on earth. The sounds are specifically representative of ion-acoustic spectra in the ionospheric gas, scaled in frequency, with physical parameters appropriate to the altitude in question.

The data behind the calculation of the audible sound, done by collaborating scientist Dr. Philip Erickson at the Millstone Hill Observatory which is a part of MIT's Haystack Observatory, Westford, MA, stems from a large data base of ionospheric studies collected at Haystack Observatory over the past five decades using powerful ground-based radar techniques. An empirical model constructed from this data by Dr. Shunrong Zhang, also at MIT Haystack, allows for the calculation of a typical average ionospheric state (relative amounts and temperatures of electrons and ions in a given volume of ionospheric gas at different altitudes) for exactly the time frame the sounds are on display. In a statistical sense, what is audible is a representation of the physics taking place at this moment, approximately 100 to 600 kilometers above the Green building on the MIT campus.

MIT Haystack Observatory is one of four installations in the U.S. funded by NSF to conduct ionospheric studies using powerful radars, and the Atmospheric Sciences Group at MIT Haystack is the only observatory in the Continental United States dedicated to this research. Ionospheric research is becoming increasingly important to our technology-dependent society, as changes in the makeup of the ionosphere affect the precision of GPS technology and under severe conditions can disrupt radio transmissions or any type of broadcast relayed by satellite. Knowing and predicting the composition of the ionosphere (an effort known as Space Weather forecasting) has become an integral interest for the military and commercial sector, and plays a key role in the reliability of fundamental communication requirements.

Ionospheric studies have been conducted since the beginning of the space era by dedicated groups and have recently been the focus of intense public outreach and growing public interest in both the natural and human consequences of Space Weather events. By connecting ionospheric research with this large scale sound installation, we hope to build bridges between state of the art research and contemporary art at MIT that are audible and visible to the art interested community that MIT attracts.

Working with Undergraduate Physics and Architecture student, Bill Elliot, we have determined that the audible levels in the area of the Building 54 will not exceed a tolerable decibel amount that takes into consideration the occupants of the Green building and its neighboring facilities. We are currently in the process of acquiring wind distribution data of the building environment which will help us determine the boundary conditions for the sound distributions.

I am willing to make every compromise to not intrude the audible sphere of those in close proximity to the building. A schedule can be arranged during which the piece will produce sound temporarily.

The MIT Haystack Observatory

The Millstone Observatory, the installation from which surveys of the Ionosphere are conducted as part of the MIT Haystack Observatory

Hanging Detail

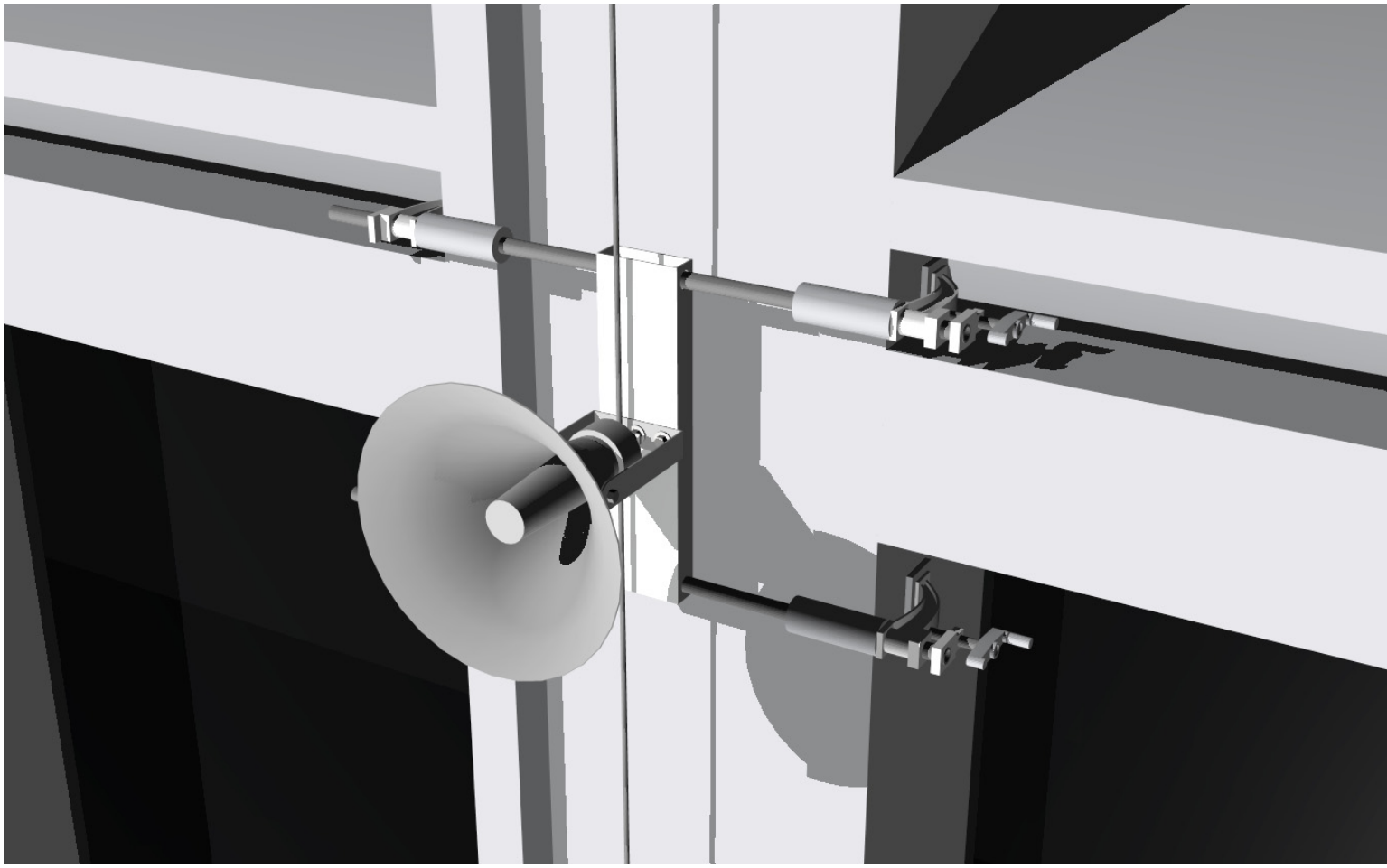
Installment of speakers will begin on Monday May 2, 2005. Installment will take two weeks, being completed by Friday, May 13, 2005. Completion of the speaker installment will coincide with my Master's Thesis Review and the Visual Arts Program Open House, Friday May 13-Sunday May 15, 2005. I would ask that the project be audible durning my Thesis Oral Review (Friday May 13th from 3-4pm) and the Open House hours of 6-9pm on Friday May 13, 2005 and then return to regular agreed upon 'on times' on Saturday May 14, 2005.

Speaker Cabling will go to the Radio Society's enclosed area on the roof of Building 54. 8 Saftey steel cables will run along each vertical column to ensure speaker support in the unlikely case that local, 4-point attachment fails. Safety cable will be attached after speakers have been locally attached to building (see clamping system section). The Safety cable will be attached at existing fixation points on the roof. All contact areas of temporal speaker set up and building will be lined with cushioning pads to ensure that the building facade will not be damaged by speaker brackets or safety cables.

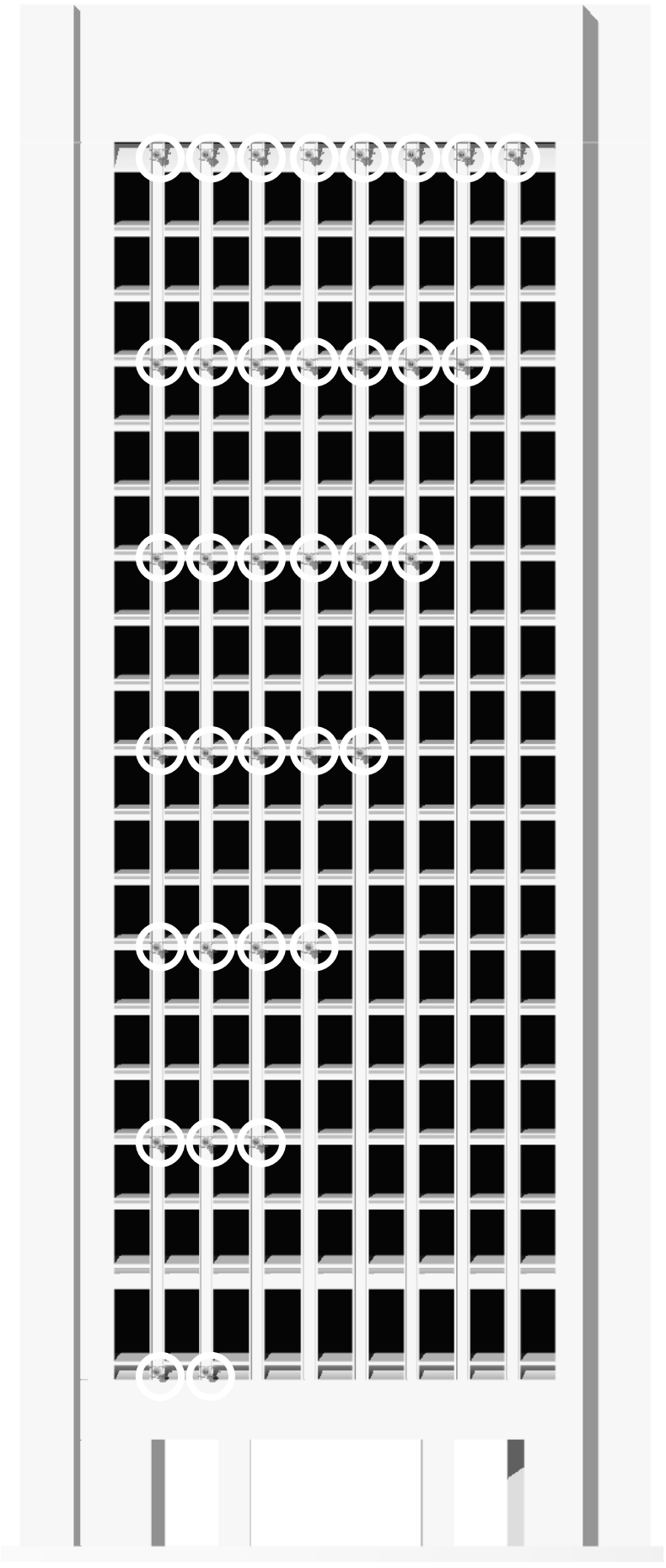
An exclusion zone will need to be sectioned off during the dates of the speaker hanging. This will entail an orange plastic snow fence suitable for the fall area around the northeastern façade of Building 54. Hard hats and safety glasses will be worn at all times in and around the work area.

The hired hanger for the speakers will be trained in OSHA standards for fall protection with specific knowledge in window washing and/or building maintenance. Full body harness will be worn by the hanger and helper on the roof. The securement will meet the requirements put forth by the MIT Health and Safety Department.

Public address speaker, attached to the vertical column of the Greeen Building using a double pipe clamp bracket.



Speaker arrangement on the facade



View up with 35 speakers attached

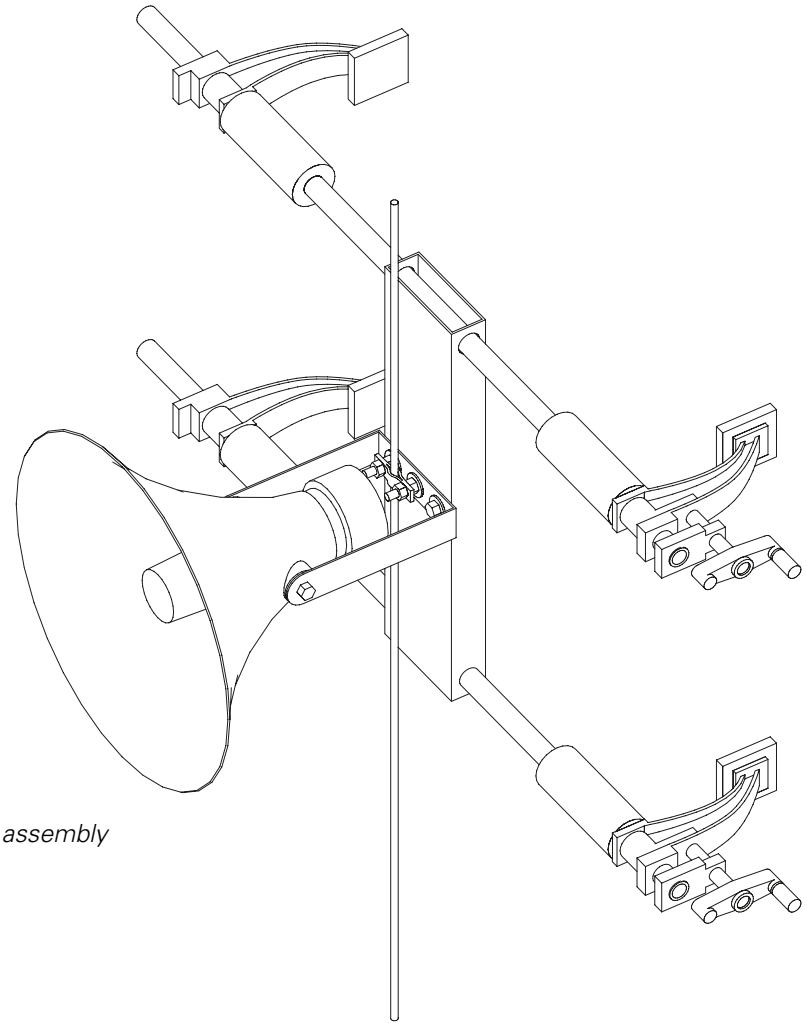
Exhibition details

I am proposing that the project is set up to be heard at particular times of the day agreed upon by the Institute. My suggestion at this point is 1 hour each day of the week from 2pm to 3pm, with an option to extend this period once the piece is installed and all parties in close proximity have a chance to verify the unobtrusive character of the piece.

There will be an information site at the base of the building with information regarding the sounds being heard, the story of the project, pamphlets of MIT Haystack Observatory, and exhibition details. These printed documents will reside in a pamphlet holder with a flashing led sign regarding next hearing time as well as information about the sounds. The information area will be located on the inside one of the large windows next to the revolving doors, visible and readable from the outside, with the pamphlet holder temporarily attached on the outside, using suction cups.

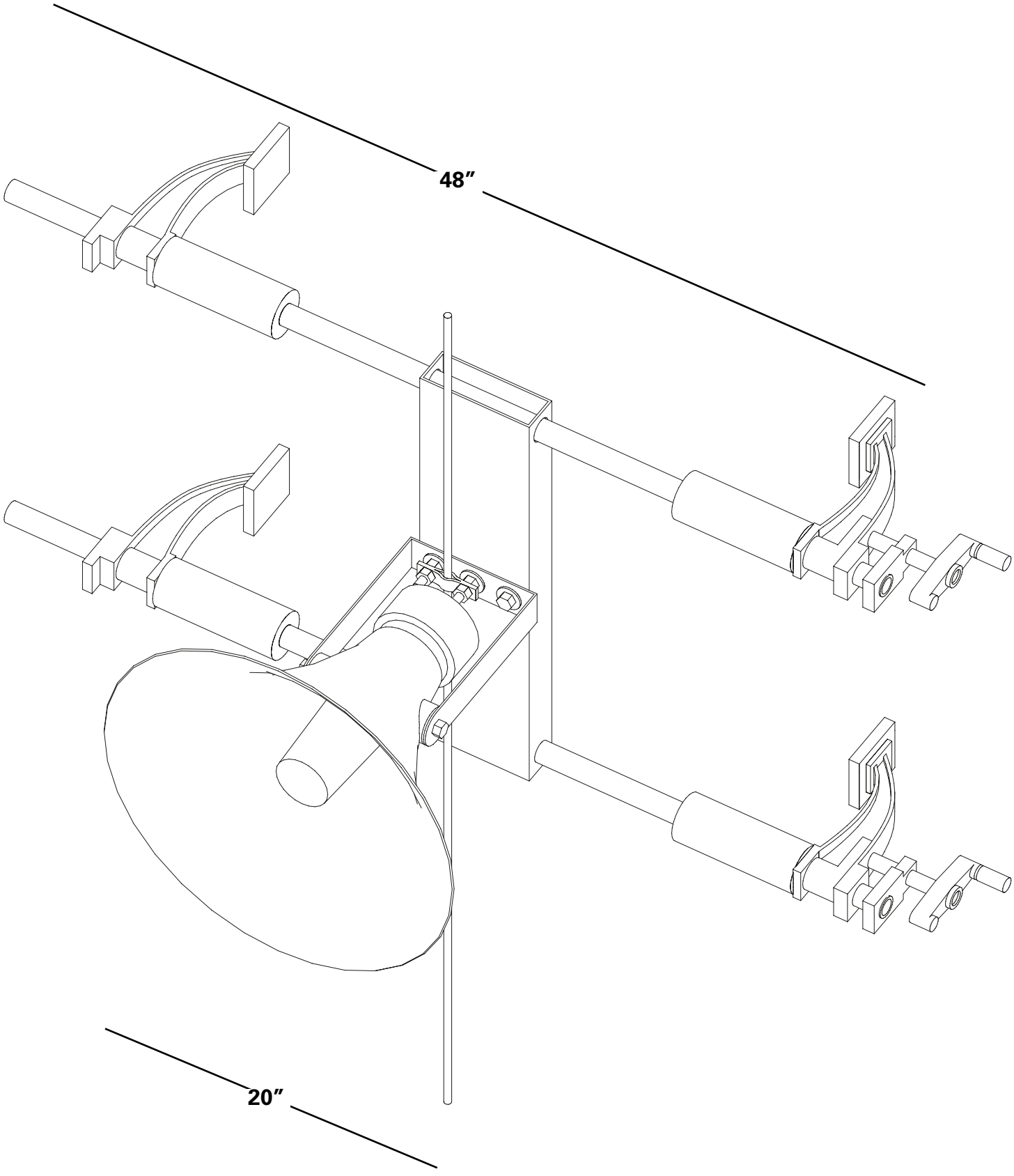
In all planning and detailing stages of the project installation, it is my first objective to not alter or damage any part of the building by permanent fixtures or modifications.

The project will be installed in completion by Friday, May 13, 2005 and I propose that the project be up for 1 month, ending on Friday, June 17, 2005.

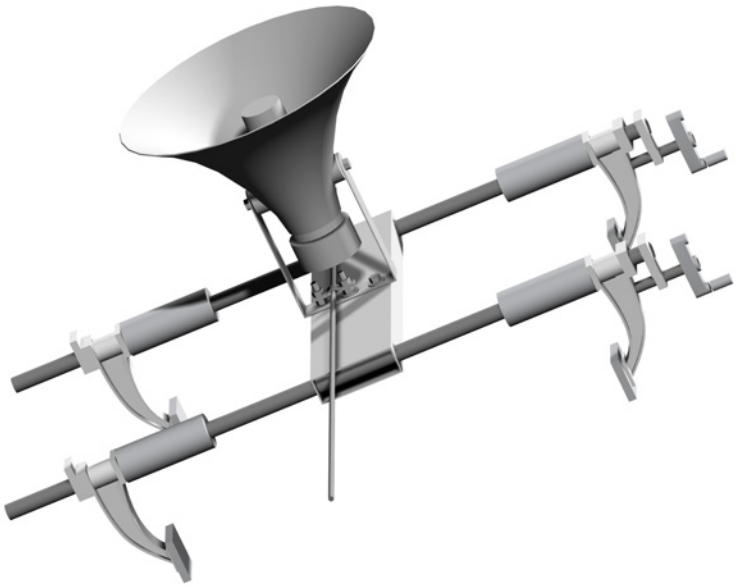


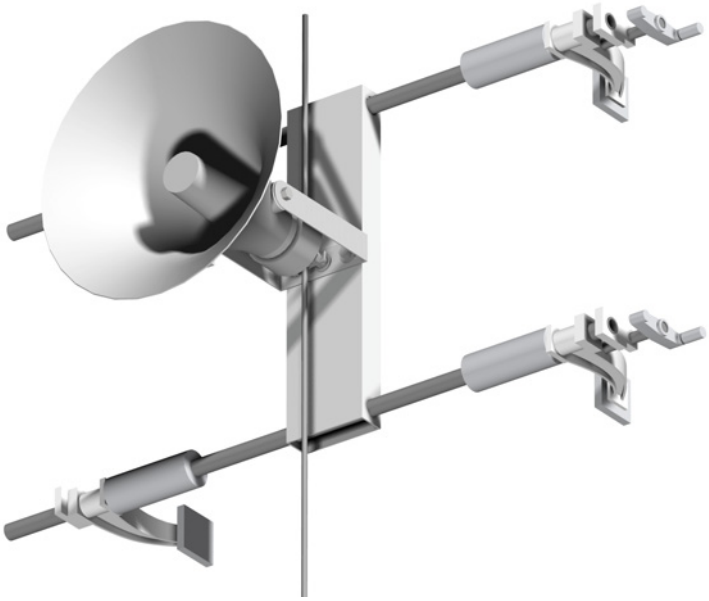
speaker / bracket assembly

Speaker clamp details

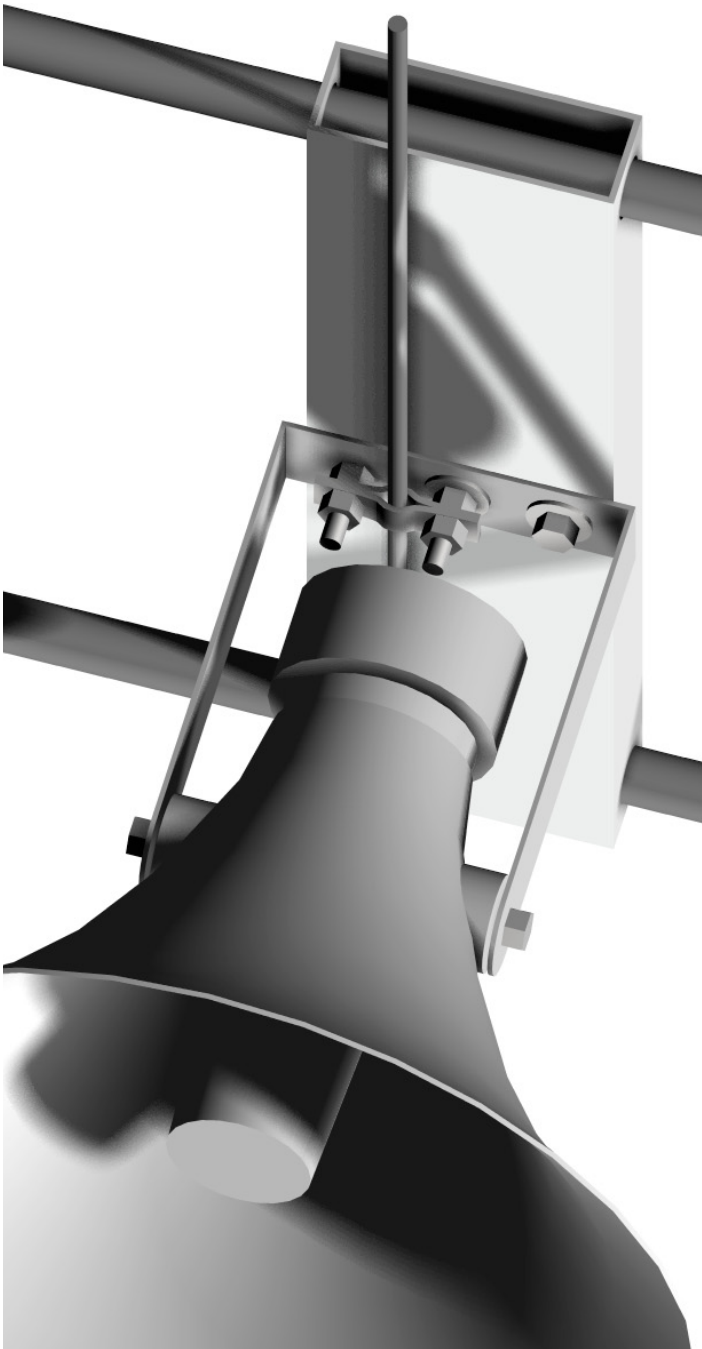


Speaker clamp details





.375" steel safety cable attached to the bracket (detail)



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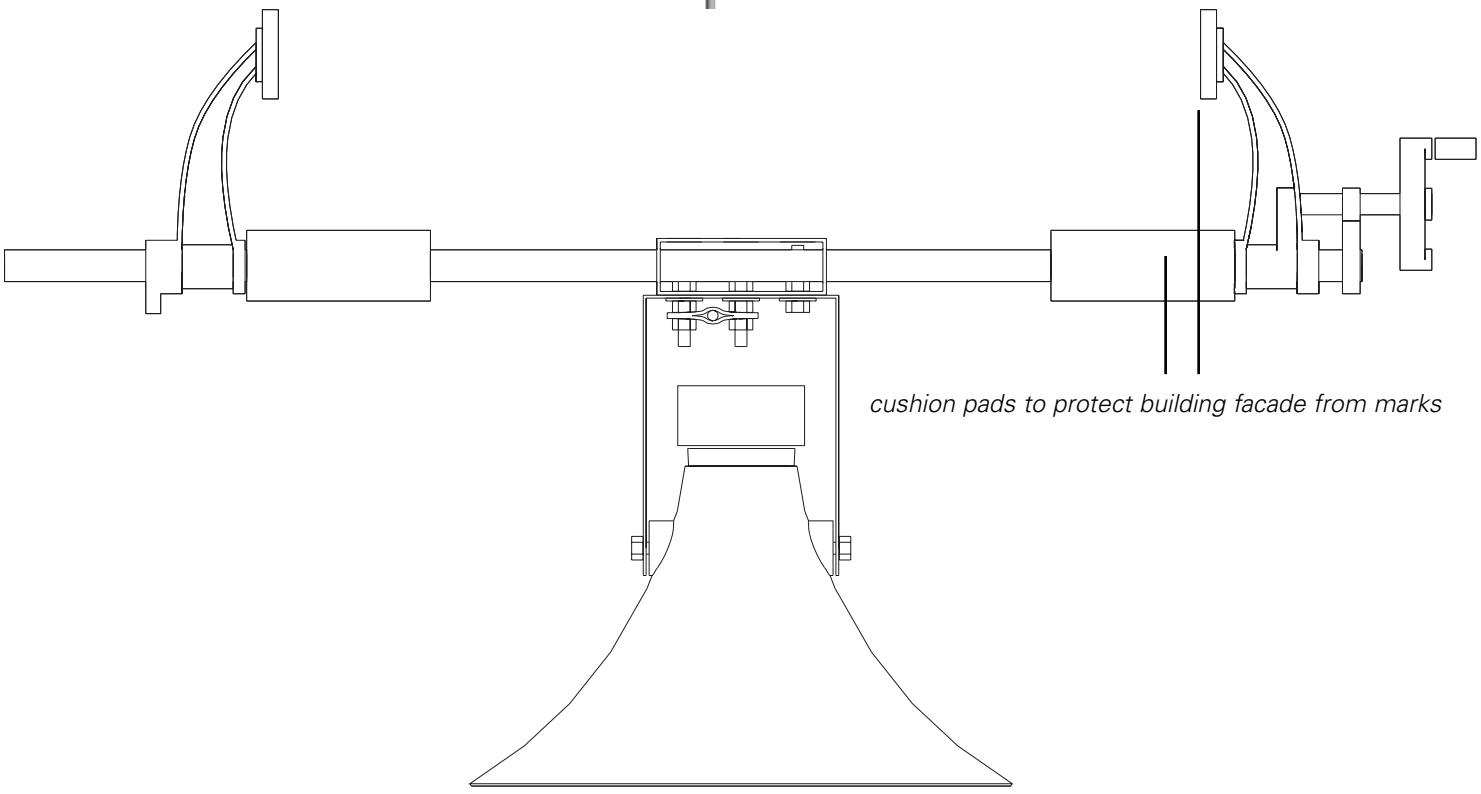

cushion pads to protect building facade from marks

Speaker clamp attached to the building