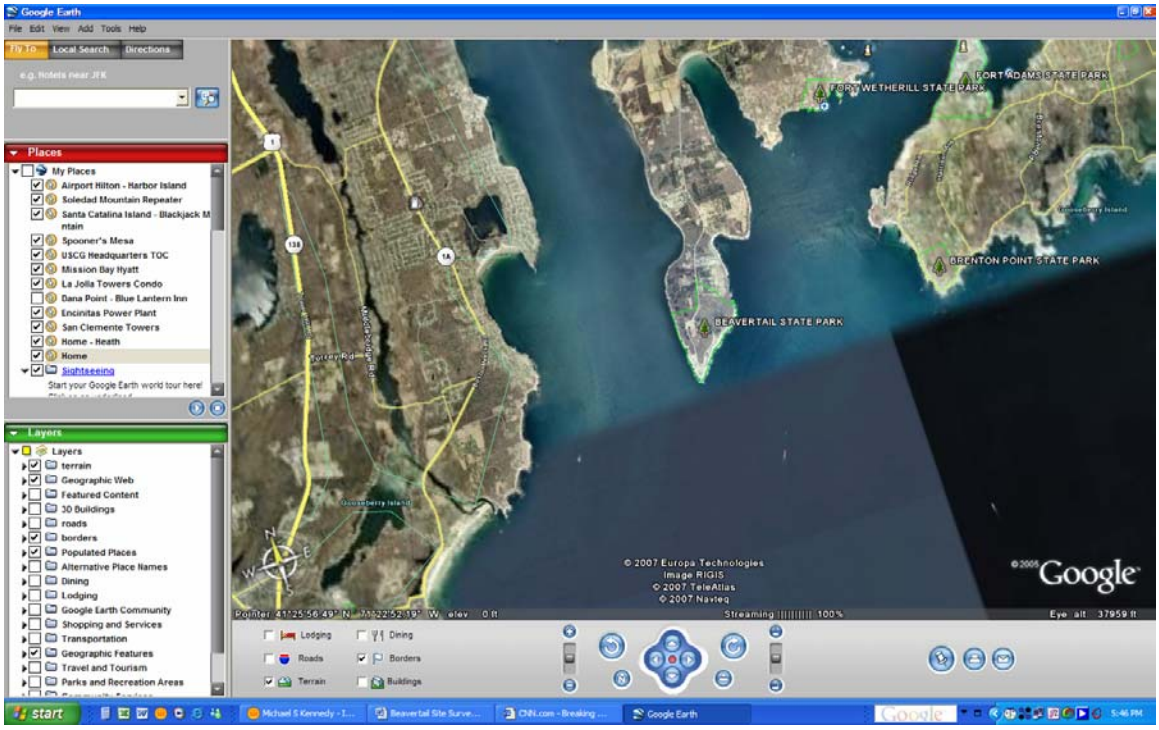
Beavertail State Park
Jamestown, RI
Terma Radar Installation Plan

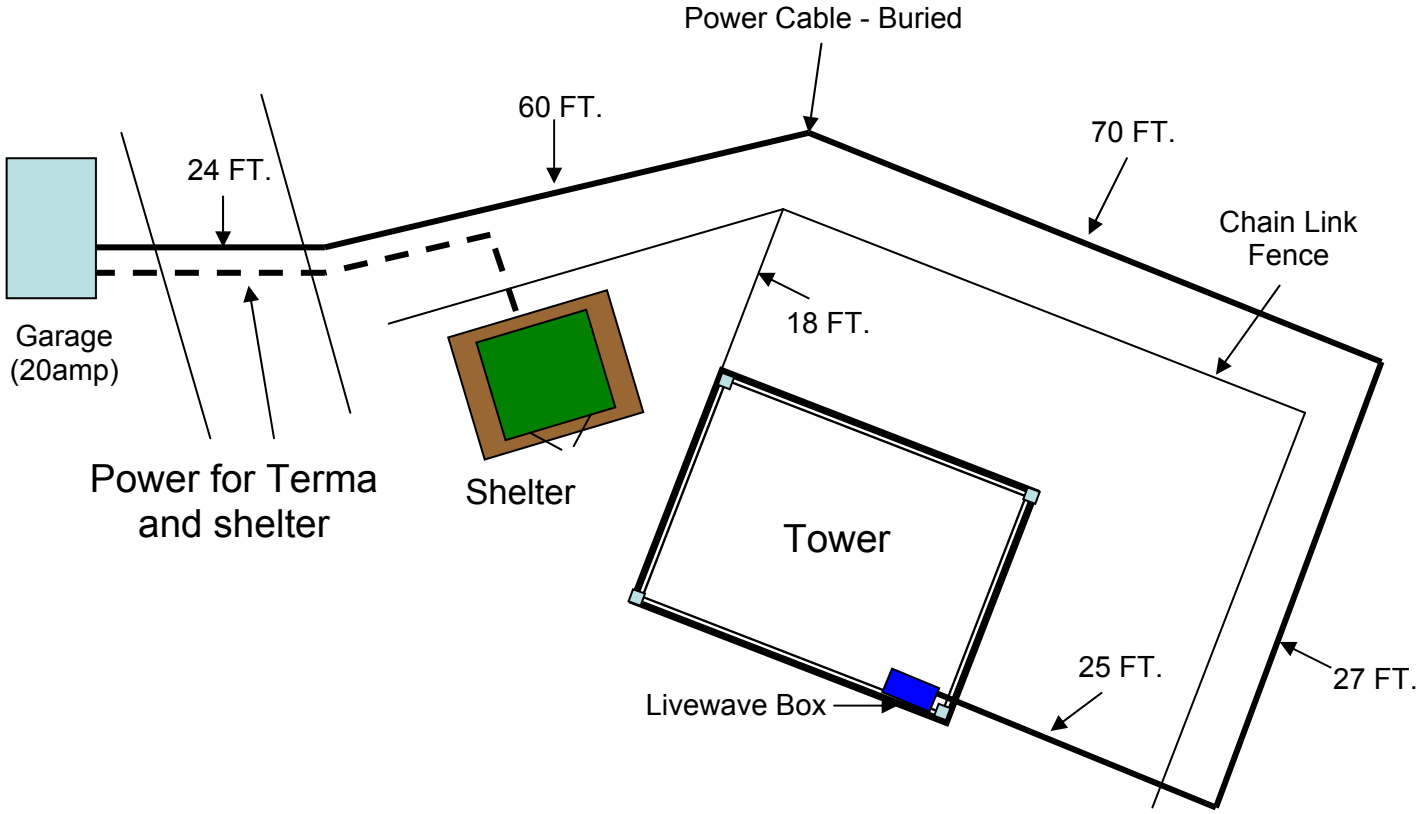
OVERVIEW. Raytheon has investigated the addition of a new radar site to support the RI Port Security Wireless Control Network project. The site that was chosen is located at the Beavertail State Park in Jamestown, Rhode Island. The Rhode Island Department of Environmental Management (RIDEM) has granted Raytheon permission to install the Terma X-Band radar unit on a tower located within the state park. The location very near the entrance to the Narragansett Bay estuary will provide an ideal location for monitoring maritime traffic.

INTRODUCTION. Beavertail State Park is known for offering some of the most beautiful vistas along the New England coastline. The Park's location at the southern tip of the island will provide an extensive coverage area for the entrance to Narragansett Bay. The proposed tower is approximately 100 feet tall and houses several antennas, two cameras and a radar unit of extreme age. The tower is approximately 10 miles from the Raytheon facility in Portsmouth. The site is visible from the roof of the Nimitz Building which will facilitate the data link required for the control and operation of the radar. The RIDEM representative did not provide much technical information regarding the specifications or history of the tower. Currently awaiting additional information concerning the tower from the state.



Google Earth webpage of Beavertail State Park

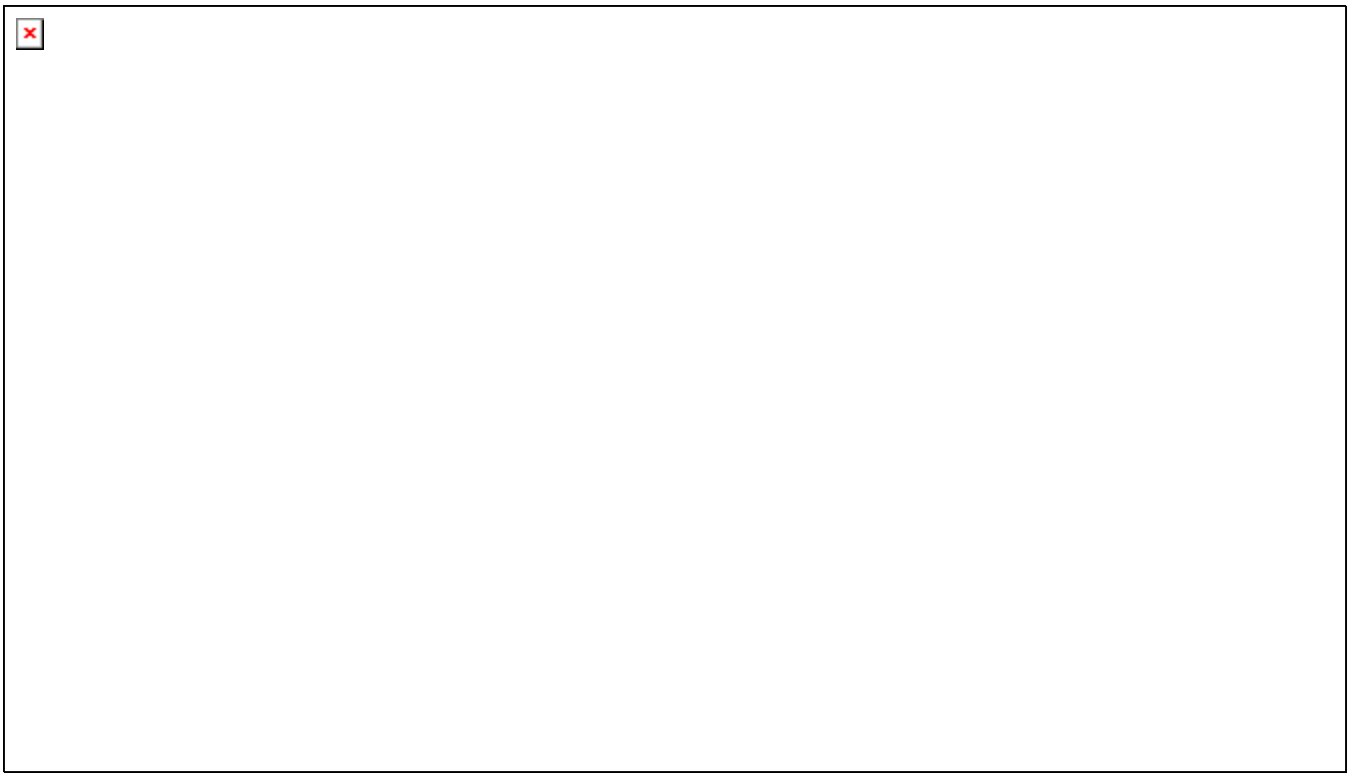
SITE PREPARATION. The Beavertail tower site is readily accessible and provides excellent radar coverage potential. The site location is 41˚ 27’ 19”.34N/071˚ 23’ 48”.46W with an elevation of approximately 58 feet. The nearest water is approximately 400 yards to the WSW and 450 yards to the ESE. The southern tip of the state park is approximately 800 yards. The land slopes away from the tower towards the water so no land masking interference exists for the radar. There are two existing structures in addition to the tower on the site. The building adjacent to the tower (16’) and the tower are enclosed by a chain-link fenced area. No lock was observed on the access gate. The Smith Detection/Livewave representative stated that the site has been 24/7 access.



Proposal for the site layout

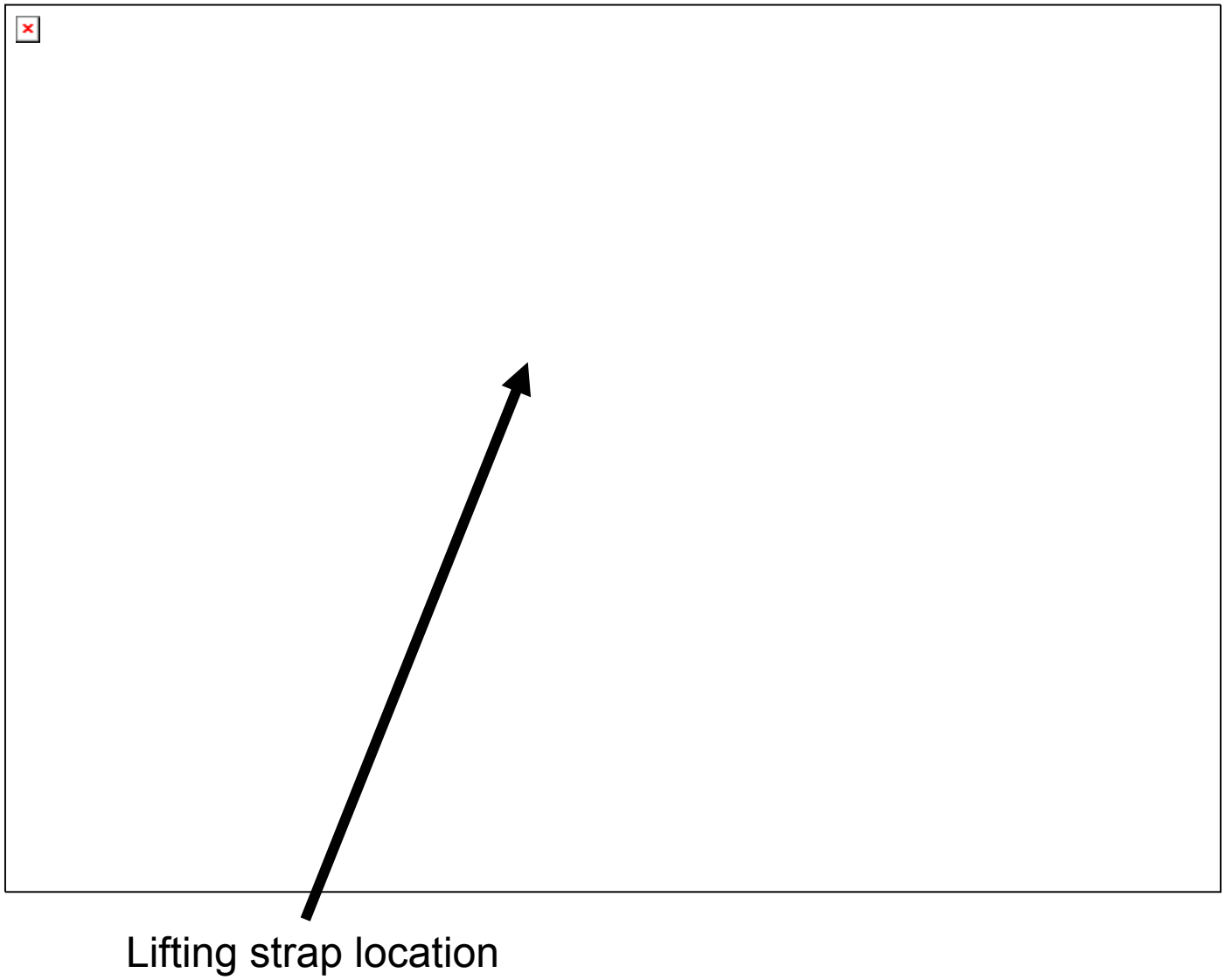
The main building is currently being used as a residence. No access to this building is anticipated. This will require the construction of a shelter to house the equipment associated with the radar. The other structure is a garage that is in very poor shape. Smith Detection/Livewave has mounted an outdoor electrical panel (20 amp service, single circuit) to this building to provide the necessary power for their cameras and communications equipment. The electrical conduit from the garage to the tower is buried underground. To power the radar equipment and the associated support equipment, additional electrical service with an in ground power cable will be buried next to the Smith Detection/Livewave cable. It was indicated that we could not use the conduit the current power cable is housed in because it is not large enough to add in another power cable. The run for the power cable will be significantly shorter if approved by the state because the shelter for the equipment will be placed approximately 40 feet from the garage inside the chain-link fence. The electrical service amperage level has not yet been determined for the equipment to be used for this sensor site. That calculation will be performed at a later date.

The tower is a 100 foot steel structure with footers of cement at the four corners. The depth and condition of these footers is unknown. The four tower legs are arranged in a 16' square pattern. The tower access is a series of metal pegs in one leg of the tower. This allows access to the vertical rung ladder at about 10'. The vertical rung ladder ascends to the top of the tower and is in very good shape. The tower structure appears to be in very good shape with very little corrosion observed. The tower currently contains a radar unit, three antennas and two cameras. The mounted radar dish is 6' high and 5'4" across. The radar antenna and the base unit are of an undetermined weight.



Tower with existing equipment

The cameras are owned by Smith Detection/Livewave and are part of the RI Port Security Wireless Control Network project. The cameras are below the swing radius of the Terma radar antenna and should not have to be moved. The ownership and status of the other tower-mounted antennas is not known. The antennas will have to be relocated or removed to allow for the TERMA radar to be installed. There are additional poles on the perimeter of the site that contain antenna wire presumably for an amateur radio group. The antenna cable is approximately 40 feet above ground. The renting of a bucket truck or contracting out for the services of a bucket truck will be required to remove the pole mounted antenna wire to allow for crane operations for both removal of the old radar antenna and for installation of the Terma radar.



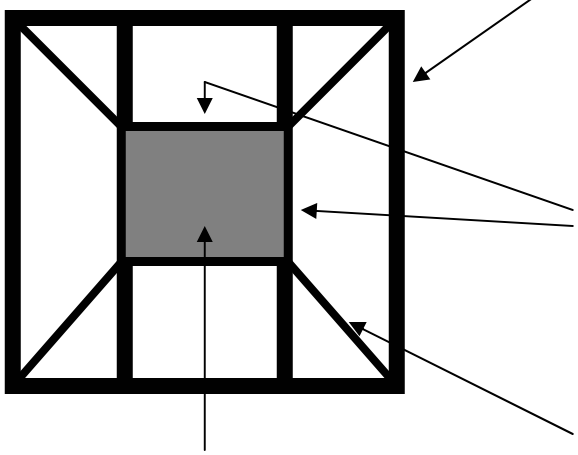
Bottom of radar base unit (Attachment point to tower top shown)

The current radar unit will be removed by crane. The lifting straps will be placed under the base section and above the pedestal and secured to the unit. The mounting bolts are all severely corroded and should be easily removed by the use of a 4-lb. hammer. The reciprocating saw will be used to cut off the mounting bolts if they cannot be removed with the hammer. The radar and associated cables will be removed.

The removal of the attached cables will be accomplished by cutting the cables near the base unit following confirmation that the power is secured. Access to the building will be required to verify that power is secured. Positioning the crane close enough to the tower to get the boom line over the radar antenna will require that the antenna cable that is strung between the telephone poles already be removed. It is assumed that these cables are being used as antennas for an amateur radio setup.

The tower platform is an 8’ square with a center opening for access. The platform is of open grid-type decking construction enclosed by a steel railing of 1.5” angle iron that is 3’ tall. The railing platform is bolted to the platform approximately 3 feet below the top of the tower. Very little visible corrosion was observed. The

tower top mounting structure will be further inspected for corrosion. The mounting surface will be preserved by sanding and spraying/brushing with a rust inhibitor.



Tower structure - Top
•3’ x 3’ tower top
•6” x 1.5” channel

Radar support structure
•3’ x 3’ tower top
•6” x 1.5” channel beam

Radar support member
•1.5” angle iron
•Bolted to channel

Radar support plate
•13” x 13” top plate
•Mounted to the channel

The mount for the current radar unit is the 3’ by 3’ tower top structure and is constructed of steel channel beams. The steel channel beams are 6” x 1.5”. The attachment bolts for the channel beams was inspected and they appear to be structurally sound. The 1.5” angle iron support members that are used to connect and stabilize the tower top channel beams to the radar mount channel beams are in very good shape. The attachment bolts were inspected and they appear to be structurally sound.

Terma Scanter 2001 Motor/Gear Box

Mounting structure example

The Terma radar motor/gear box will be mounted on an adapter plate that will sit on the tower top and fasten to the support structure currently in place. The exact dimensions of the mounting plate required to install the motor/gear box have been received from Terma. The mounting pattern for the motor/gear box has been determined and an exact drawing for fabrication of the mounting plate is in the process of being created. Following the removal of the current radar antenna unit and the placing of the mounting plate, measurements will be taken using a created template of the mounting adapter plate, and the bolt pattern as to the location of the tower fasteners will be determined. The mounting adapter plate will be pre-drilled based upon the template. The mounting adapter plate will be hoisted up and fastened to the tower top prior to hoisting the motor/gear box and antenna up to the tower top.

Encoder Assembly (Waveguide attachment point on the Motor/Gear Box)

The flexible waveguide will be prepared prior to installation to attach to the Encoder Assembly on the Motor/Gear Box. The Rotary Joint of the encoder assembly transfers the signals between the fixed, flexible waveguide mounted to the tower and the rotating waveguide in the shaft to the scanner (rotating, upper part of the antenna assembly).

Waveguide Adaptor Assembly

Assembled Waveguide Adaptor

Waveguide clamping assemblies

Terma recommends a support assembly be used every 2 ft. to fasten and support the waveguide and every 16 in. when critical bends are required. The installation kit contains many clamping assemblies. The purchase of threaded rod may be necessary to facilitate a stand-off from the tower as the waveguide descends.

The waveguide should not be bent more than a radius of 8 in. (E plane) and 16 in. (H plane) and should not be twisted more than 3º per meter. Care needs to be taken when the elliptical waveguide is cut. Humidity and foreign objects (especially copper dust and copper swarfs) inside the waveguide will cause decreased radar performance. The installation guide provides step-by-step instructions on how to prepare and install the waveguide.

Power cable shielding, example

The armored braid shield for the power cable and for the data and control cables should be connected at both ends of the cable. The shielded cables are connected to the Terma processor cabinet in the environmental

enclosure. The cable connection guide is contained in the installation procedures. The processor cabinet should be connected to the same ground as the tower mounted equipment.

Static Desiccator

To be sure that no moisture gets inside the waveguide it is necessary to mount a static desiccator. Terma also makes a dynamic dehydrator with which the pressure in the waveguide keeps the humidity out. This should not be needed for the Beavertail site as the extremes in moisture are not that severe. Before using the waveguide, it might be necessary to dry out the waveguide by blowing dry air through the entire length. This is done by opening a waveguide joint at the antenna mount end to let the air out and blow into the waveguide in the transceiver end with warm dry air. The Terma support person will provide the necessary guidance as to whether or not this is a requirement during the installation.

Terma Grounding Kit

To ground the waveguide, Terma has provided a grounding kit made for the supplied waveguide. Specific instructions on how to properly ground the waveguide are included in the installation guide. It is important that all units such as antenna, mast, lightning conductor, waveguide, environmental enclosure etc., are connected to the same grounding point. The environmental enclosure will have a mounted grounding bar to attach all of the enclosed equipment to ground. That grounding bar will be attached to the tower ground to ensure a common grounding point for all of the installed equipment. Additionally, a lightning protection system will be installed. The previous experience on Athena projects has shown that a Unistrut metal Framing assembly with a copper rod mounted on the end with a heavy-duty grounding clamp and grounding cable mounted to the tower top and of sufficient length to be outside the swing radius of the antenna will be adequate lightning protection. The materials for the lightning protection system will have to be procured.

Tower grounding example

Simple Safety Switch

The safety switch will be mounted in the environmental enclosure. This will give the operator the ability to activate the switch and lockout power to the radar transmitter. The switch will be mounted in a box with a hasp for a padlock. The control of the key access will be by PMO direction.

Possible environmental enclosure for radar equipment (7' x 7' Rubbermaid Shed)

The radar will be interfaced to the Athena test bed via a PC-based radar client software package which will transmit data via a wireless communication link. The PC and associated equipment (UPS, KVM, PIDU, etc.) will be installed in a temporary environmentally controlled shelter. Project Athena has installed several of these shelters on other projects. The base of the platform will be constructed of 4"x4" frame with ¾" plywood floor. The shelter will be erected and fastened to the decking with wood lag screws and cargo straps to ensure structural integrity.

The use of a transit case to rack mount the PC, UPS, Ethernet switch and Orthogon PIDU will be necessary due the amount of equipment that will be needed in the shelter. The 22U transit case should be adequate for this purpose. The radar equipment includes an AC power unit, radar processor and multiple PCs. There were three PCs and two monitors included in the material received from Terma. Not clear as to the purpose of all the PCs. We will mount the Terma PCs in a transit case and interface them to the KVM.

Additionally, an air conditioner will most likely be required and is planned for inclusion in the environmental enclosure. If room becomes an issue, than an externally mounted A/C unit will be required. This will require that a support structure be built and a penetration through the shelter be cut. Additional material for the structure (wood) and sealing foam will have to be procured.

RADAR EQUIPMENT INSTALLATION. The radar unit will be installed with technical assistance and support from representatives from the Terma Company. It is planned that a representative of the company will be on site for installation support and post-installation operational support. The company point of contact (Birger Nielsen) has sent us an installation procedure to install this model of radar. That procedure and the included checklists will be used to conduct the installation. The Terma Scanter 2001 radar unit consists of several pieces of equipment. These units are listed in the following table:

Unit Description	**Unit Purpose**
Terma Scanter ACU • S/N 3006 • Type 262382-004 • Voltage 3x208-240 V • Frequency 47-63 Hz • Current 3x16.7 A	AC power to the radar unit motor and magnetron.
Terma Scanter 2001 • S/N 3003 • Scan 2001 DU-R FD • Type 262001-032 • Voltage 3x400 V • Frequency 47-63 Hz • Power <2.7k VA	Radar processor.
Safety Switch	Lockout switch to control power to the transmitter.
HP-PC Compaq DC 7600 Convertible Mini Tower w/ Windows XP • S/N CZC63732LG • P/N EC834ET#UUW	Maintenance console
HP-PC Compaq DC 7600 Convertible Mini Tower w/ Windows XP • s/n CZC6332VW5 • p/n EC834ET#UUW	Radar HMI.

Scanter 2001 – Port of Rotterdam

Terma Scanter 2001 Radar Features –

Transceiver Controller

- Local or remote set-up and control of the transceiver
- Sector transmission, 4 sectors
- Storage of 16 operator-defined profiles
- Control of on-board BITE on the individual modules
- Remote control via Serial Interface or LAN

Receiver

- Low Noise Receiver: Typical 2 dB, overall system: 3.5 dB, max system: 4.5 dB
- Receiver Chain: Modified Logarithmic IF, 100 MHz
- Dynamic range: >125 dB
- Image rejection on RX mixer: ≥18 typically 20 dB

Transmitter

- Nominal Output Power: 25 kW (X-band)
- Transmitter frequency: Nominal 9375 MHz (X-band) Optional 9172 MHz, 9410 MHz, 9440 MHz, 9490 MHz
- Transmitter frequency for Frequency Diversity: 9170 MHz, 9438 MHz
- Tx Pulse Shape: Fast rise (20 ns), fast fall time (30 ns)
- PRF: 400-8000 Hz, programmable
- PW: (40) 50 -1000 ns, programmable
- Stagger: 0,2,4,8 %, programmable

- Full transmitter performance during short pulse transmission

Signal Processing

- Auto-adaptive Sensitivity Control (Adaptation to changes in sea clutter by automatic adjustment of STC in a large number of individual cells in range and azimuth)

Video Processor

- ADC: 80 MHz
- Digital FTC
- Sweep-to-sweep correlation
- 2-64 pulse azimuth integrator
- Digital, Analogue and Composite Video output

Frequency Diversity Processing

- Transmission on two frequencies. Transmitter power will be the total of two pulses, integrated non-coherently
- Target fluctuation reduced after integration of signals from independent pulses
- Time diversity, when using SWG antennas, enables de-correlation of sea clutter, thereby enhancing detection of small targets in situations with high Sea State
- Total system enhancement: Approx. 10 dB

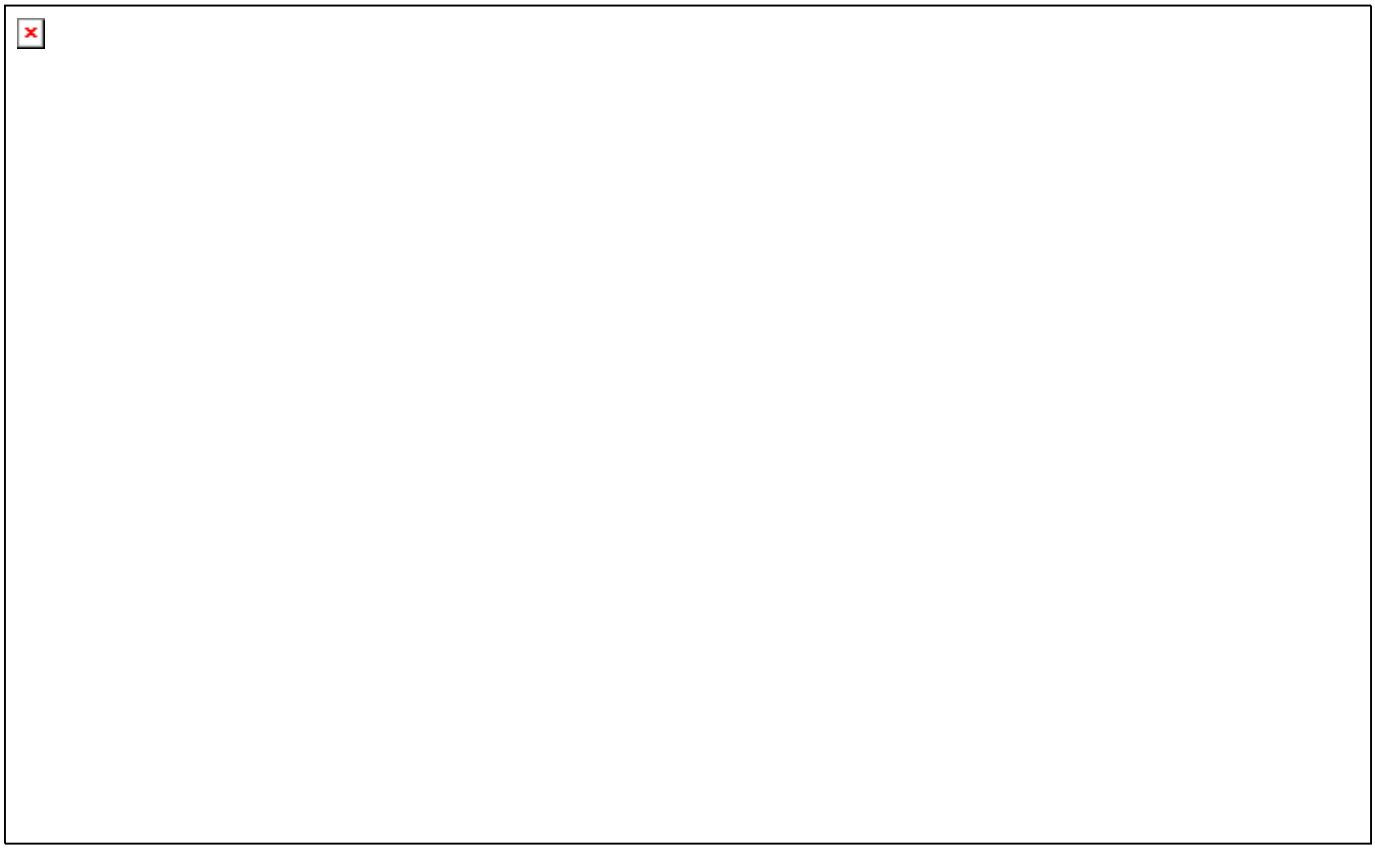
Sea Clutter Discriminator

- Scan-to-Scan processing in 3 parallel channels for enhancement of small target detection

Specifications: Technical data SCANTER 2001 Single FD

Transmitter	Magnetron
Peak Power	25kW
Antenna (non Stabilized)	Slotted waveguide (SWG)
Polarization	CP or HP
Dimensions	7', 12', 15' and 18'
Weight Motor/Gear Box & Antenna	82 – 380 kg
Power consumption	3 kW
Environment -	40° to +55°
Cooling	Air
Transceiver Unit Size	H: 910, W: 520, D: 275 mm
Transceiver Unit Weight -	55 Kg

DATA LINK. The close proximity to Raytheon will allow a data link that should not require a multiple relay path. The Raytheon facility is visible from the tower which would allow a direct line-of-sight communication connection. The data link will be created by installing two Orthogon Systems/Motorola wireless radios from the Athena inventory. The one unit will be installed on the Beavertail tower and on the other wireless radio will be mounted on the roof of the Nimitz building on the 1W platform. The units will be pointed to maximize the signal exchange. The potential for interference exists because the Newport Bridge lies directly in the path. A relay to the Hyatt on Goat Island or to the Quonset Point site, when available, may be necessary if the signal is degraded by the bridge. Coordination with the IT group will be utilized to ensure an adequate data link to the Raytheon Project Athena test bed.



View to Raytheon from the tower (Water tower is below the mid-span point)

SITE HAZARDS. No job site hazards currently exist for this site. The existence of live circuits will be checked prior to removal of the radar and antennas. Access to the building where the attached cables are run will need to be obtained to ensure no power is live going to the radar unit or antennas. When the crane is positioned for removal of the current radar antenna and then for installation of the Terma radar a hazard will exist. Close coordination of crane operations including direct radio communication with the crane operator will reduce the severity of the hazard.

Extensive climbing will be required for this installation. The climbing supervisor will ensure that the proper safety equipment is available and used to ensure 100% fall protection. To ease the burden of climbing, vertical lifelines will be installed. All climb equipment will be inspected prior to use and all climbing/positioning will be done in accordance with applicable company policy and procedures.

INSTALLATION ISSUES. The issue for operation of the radar under Raytheon's existing FCC license is a potential issue. The Terma is a dual frequency transmitting radar. The frequencies listed in the Scanter brochure lists the following frequency values:

Transmitter frequency:

- Nominal 9375 MHz (X-band)
- Optional 9172 MHz, 9410 MHz, 9440 MHz, 9490 MHz

The current license that is held by this Raytheon location is for the frequency ranges of 9300 – 9500 MHz. The Terma may transmit outside of this range. This would require Raytheon to obtain a separate license for this radar at the Beavertail location.