PASSIVE SOLAR FIRE STATION DEMONSTRATION PROJECT

An Interim Report

by

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Prepared for:

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
DIVISION OF PLANNING AND PROGRAMMING
RESEARCH SECTION
2301 Peger Road
Fairbanks, Alaska 99701

INTRODUCTION

The Division of Research and Development of the Alaska Department of Transportation and Public Facilities (DOTPF) funded the design of two solar-heated fire stations for the Chena-Goldstream Volunteer Fire Company. Volunteers would provide the labor for construction; the Institute of Water Resources would provide design and energy conservation information for the structure, as well as oversight to insure use of proper design procedures in the construction of the building. In order to insure a high standard of construction, Janet Matheson (architect, AIA) was hired to do schematic designs. Work was done in concert with the Chena-Goldstream Volunteer Fire Company, and each design was submitted to them for approval.

WORK ACCOMPLISHED

The first site considered for construction of a firehouse was at approximately 2 mile Murphy Dome Road, a site donated by a member of the Chena-Goldstream Volunteer Fire Department (CGVFD). Several onsite reconnaissance visits and meetings with the CGVFD established a clear awareness of the site characteristics and the economic and skill limitations of the fire department. These visits established the recommendations for the design of the firehouse from a solar and energy conservation standpoint. Since the site was ideal for passive solar design (i.e., it had a nearly unobstructed south aspect), it was recommended that the long axis of the building face south, with the doors on the east side of the building. The south wall was then available for use as a solar collection area. Using this recommendation, a passive solar design for the building was developed by Richard Seifert and sketched by Janet Matheson. The design was tested by using a computer simulation, TRNSYS, and solar radiation and climatic data for Fairbanks, Alaska. The results are shown in Table 1. The heat loss analysis of a firehouse with the structural features of the passive solar design is shown in Table 2. These tables indicate that the design would perform very well

TABLE 1

SOLAR FIRE HOUSE DESIGN - FAIRBANKS, ALASKA

TRNSYS Computer Solar Simulation

1976 Simulation Period	Q Aux.	Q S and L	Q CND (Wall Losses)	Solar Gain	Window Losses (unshuttered)	Percent Solar Heating (%)	Cooling Fan
Jan 15-21	2.009×10^6	2.054×10^6	2.974×10^6	7.037×10^5	1.647×10^6	24%	0
Feb 20-26	7.319×10^5	9.236×10^5	3.367×10^6	2.862×10^6	1.838×10^6	85%	0
Mar 15-21	3.941×10^5	5.978×10^5	2.256×10^6	2.035×10^6	1.222×10^6	90%	
Apr 15-21	(1.495×10^6)	(1.228×10^6)	1.606×10^6	3.222×10^6	9.128×10^5	100% (cooling required)	0
May 15-21	(2.403×10^6)	(2.136×10^6)	9.77×10^5	3.212×10^6	5.896×10^5	100% ↓	0
June 15-21	(1.066×10^6)	1.878×10^5	6.509×10^5	2.681×10^6	4.236×10^5	100%	9.328×10^4
July 15-21	(1.938×10^6)	(6.806×10^5)	5.272×10^5	3.114×10^6	3.615×10^5	100%	9.363×10^4
Aug 15-21	(7.626×10^5)	2.433×10^5	8.275×10^5	2.383×10^6	5.099×10^5	100%	6.983×10^4
Sep 15-21	(4.297×10^3)	5.258×10^5	1.265×10^6	1.601×10^6	7.301×10^5	100%	2.485×10^4
Oct 15-21	0	2.673×10^5	1.532×10^6	1.420×10^6	8.755×10^5	93%	0
Nov 15-21	2.395×10^5	4.626×10^5	2.006×10^6	1.143×10^6	1.134×10^6	57%	0
Dec 15-21	2.864×10^6	2.888×10^6	2.884×10^6	0	1.518×10^6	0	0
	6.238×10^6			24.367×10^6		61.7%	2.81590 KJ
Est. Annual	27.11×10^6			105.92×10^6 KJ			1.224×10^6

Units: Kilojoules

( ) Means overheat

384 ft^2 South windows

31 ft^3 Concrete/sheetrock thermal mass

TABLE 2 a. STRUCTURAL ENERGY LOSSES, FAIRBANKS, ALASKA

FIRE HOUSE, 1 STORY, 40-0X48-0, PASSIVE SOLAR

EXPOSED SURFACES	AREA SF	R-VALUE	TEMP DEGF	ENERGY LOSSES BTUHF	THERM
1.FLOOR 1ST 24 4 STY	1920.	36.30	55.0	53.	139.3
2.WALL FND 24 2STY	352.	14.17	55.0	25.	65.4
3.WINDOWS 1ST	384.	1.84	55.0	209.	549.5
4.DOORS SLID	640.	30.00	55.0	21.	56.2
5.WALL 12 FG	2656.	38.00	55.0	70.	184.1
6.ROOF 18 FG	2016.	56.00	55.0	36.	94.8
7.INFILTRATION	102. CFM	0.92	55.0	111.	293.1
	7968.	19.26	55.0	525.	1382.4

TABLE 2 b. ENERGY REQUIREMENTS AND COSTS, FAIRBANKS, ALASKA

FIRE HOUSE, 1 STORY, 40-0X48-0, PASSIVE SOLAR

ENERGY TYPE	UNIT	OUTPUT BTU	EFFIC-IENCY	QUANT-ITY	ENERGY COSTS($) UNIT	TOTAL
BIT COAL	TON	17000000.	0.55	15.	50.0000	739.
ELECTRIC	KWH	3413.	1.00	40503.	0.0646	2616.
FUEL OIL	GAL	138000.	0.65	1541.	0.7320	1128.
NATL GAS	CCF	100000.	0.70	1975.	0.2000	395.
PROPANE	GAL	91800.	0.70	2151.	0.7800	1678.
SPR WOOD	CRD	12500000.	0.50	22.	60.0000	1327.
STEAM	MLB	970000.	1.00	143.	5.3000	755.

NOTES
1.LOCATION: FAIRBANKS, ALASKA
2.ANNUAL MEAN TEMPERATURE 14.81 DEG-F FOR 273. DAYS.
3.AIR CHANGES PER HOUR 0.20
4.AVERAGE FLOOR TO CEILING HEIGHT 16.0 FT.
5.AREA FOR VOLUME COMPUTATION 1920. SQ FT.
6.AVERAGE VOLUME 30720. CU FT.
7.CHECK PRICES OF ENERGY WITH SUPPLIER.

AXEL R. CARLSON, EXTENSION ENGINEER, COOPERATIVE EXTENSION SERVICE,
UNIVERSITY OF ALASKA, FAIRBANKS, ALASKA 99701, 07/23/79 16: 9:20

INSULATION UNDER FLOOD PAD: 4-INCHES STYROFOAM WINDOWS UNINSULATED
(NO GAIN ADDED)

in Fairbanks, providing 45 percent of the heat load from solar energy on an annual basis. Furthermore, the well-insulated building shell requires less heat during the midwinter periods of low solar radiation.

Several other design options were also discussed with the fire company. We presented the option of using a 5,000 gallon water tank at the rear (north side) of the building for heat storage. Since a supply of water is always necessary at the firehouse, the tank would likely be present whether optimized for heat storage or not. The backup heating system was oil-fired, and had to be sized for the case of bringing two fire engines back into the building at -40°F with tanks full of water. The air changes that occur during a fire run, when the doors are wide open, also create a major heating problem; this requires the backup system since fire calls are likely to occur from November through January, when there is little incoming solar radiation.

A recent paper by Johnson (1978) describes this heat loss problem in aircraft hangars. The situations are similar in that both cases require fully opening doors, all of which are opened at the same time. The volume of air exchanged is proportional to the inside and outside temperatures. The rate of heat loss out the open door is expressed as the unit air flow (Q_{out}), which is in units of cubic feet per second per foot of door width

$$q_{out} = 5.33\sqrt{T_{in}/T_{out}-T}\ (H_d)^{3/2}$$

where T_{in} = inside temperature

T_{out} = outside temperature

H_d = half the door height.

The per foot of door width temperatures are in degrees Rankine. For an inside temperature of 70°F (543°R), an outside temperature of -40°F (433°R), and a door height of 10 feet (we use half the height or 5 ft), air change velocity is 54 ft^3/sec out the door for each foot of doorway. The doors are designed to be 14 feet wide, so the actual air volume loss rate is 759 ft^3/sec. At this rate, the entire volume of a 19,200 cubic foot firehouse could be exchanged in about 25 seconds, an event which would likely occur at each fire call. Johnson suggests an air curtain would remedy this situation, but it is unlikely that this solution would be acceptable in a firehouse because it is a visual obstruction.

The heating simulations in Table 2 show a heat loss coefficient of 12,600 BTUs per degree Fahrenheit day. Our more sophisticated model, which includes lower infiltration rates and shuttering of the windows, gives the heat loss coefficient as 9,480 BTUs per degree Fahrenheit day (Table 1), yielding a total annual heating requirement of 141,252,000 BTUs per year. Forty-five percent of this requirement can be provided by a passive solar design with shutters. The other 55 percent (the equivalent of 959 gallons of fuel oil burned at 60 percent efficiency) would be provided by a backup oil heating system.

Another problem is air infiltration around the doors of the structure. The doors are large and need to open rapidly; the normal overhead or sliding doors are very difficult to seal, so door infiltration is a continuing problem. We found no suitable solution to this problem.

The most pressing problem is shuttering. Without the shutters, the passive solar design is not worth pursuing because a glazed facade would lose (on an annual basis) much more during the heating season than it would gain. Consequently, shuttering of south-facing areas becomes extremely important. There is presently no good solution to this problem. However, we strongly suggest testing the heat mirror concept and using skylids as interior shutters to attempt to overcome the mechanical problems with the closing mechanisms of exterior shutters. The interior environment of the firehouse is expected to be very humid at irregular intervals. This is due mainly to hosing down and cleaning after fires. An interior shutter is unsuitable under these circumstances, since it is likely to freeze in place or to cause massive ice buildup on the windows. Only in situ tests will demonstrate the best shutter type. A sample of the descriptive literature for skylids is included on the following pages. Various glazing materials are suitable. I recommend Kalwall, but TUFFAK and glass are also satisfactory.

Figure 1 gives the recommended structural design for the Murphy Dome fire station. Additional details and a listing of the many further design considerations are included in the appendix.

OP/Overall Product — SKYLID

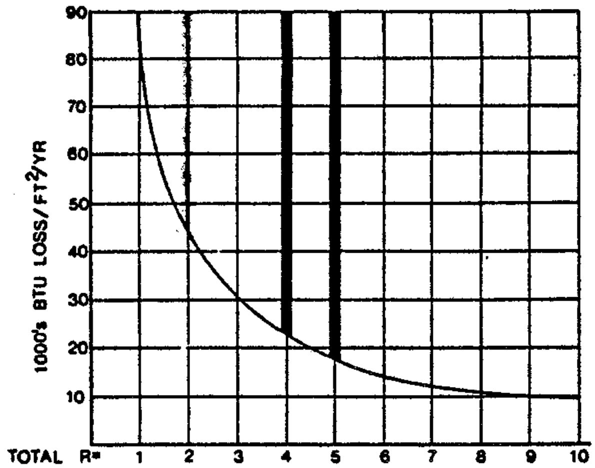
Skylids are aluminum-faced reflective insulating louvers which pivot in wood frames beneath skylights. They require no external power source. The louver which is the driver for the set has two refrigerant charged canisters mounted on opposite sides of one of its ends. When the sun shines on the black canister on the top side, liquid flows through a copper tube to the silvered canister on the room side, making the louvers open. After the sun disappears, the silvered canister becomes the warmer of the two. Liquid flows back and the louvers close. They can be tied in any position with simple override cords.

TS/Technical Support

The insulating value of movable louvers depends not only on louver material and thickness but on the angle of installation and the efficiency of the perimeter seal in stopping infiltration when the louvers are closed. Because Skylids depend on shifting of balance for opening and closing, one cannot expect them to seal as tightly as louvers operated by motors or hand-cranks. For this reason, their installed R-value against heat loss should be taken as 3. Against summer heat-gain, it is considerably better — a minimum of 5.

A simple graph, plotting R-values against night-time heat loss, shows the effectiveness of this range of insulating values. Sixty percent of a 6200 degree day heating season — about 92,000 degree hours — is assumed. (This represents a climate comparable to that of Denver or Chicago.) R1 and R2 may be taken as approximate values for uninsulated single and double glazing.

The greatest heat saving occurs in the step from R1 to R2. Beyond R5, savings from increased insulation diminish markedly. If one considers heat loss only and not heat gain, double glazing alone may seem a bigger bargain than glazing plus insulation of modest R-value. Double glazing does not, however, offer relief from the summer sun — even though its decreased transmissivity makes for less WINTER heat gain than single glazing. Movable reflective insulating louvers like Skylids, on the other hand, in addition to resisting convective heat transfer, effectively block outgoing or incoming radiation whenever they need to.



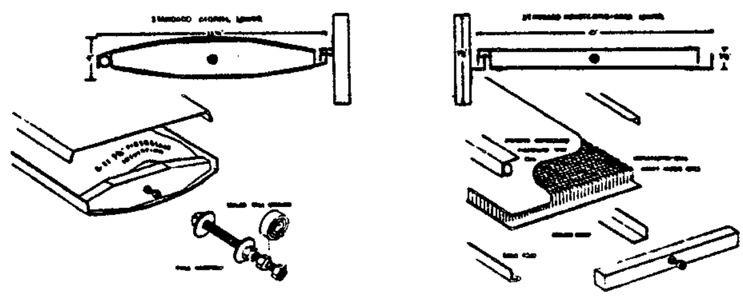
BTU SAVINGS FOR DOUBLE GLASS; SINGLE GLASS +SKYLID; DOUBLE GLASS +SKYLID

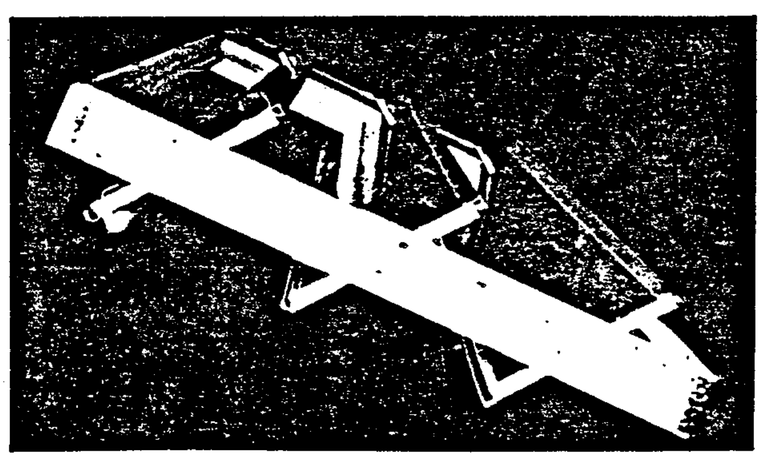
CP/Components, Parts

There are two types of louver. The Airfoil type consists of two pans of .040" shop-grade aluminum curved over wood ribs to form a cross-section 4" high at center, with interlocking sealing channels at the edges. Spaces between ribs are filled with 3½" fiberglass insulation.

The flat Honeycomb-core louver is formed of a 1½" Kraft-paper core sandwiched between sheets of .019-.024" aluminum. Edge-trim and sealing channels of .060" extruded aluminum make these louvers similar in other respects to those of the Airfoil type.

Skylid canisters are of .065" steel charged with R-12 refrigerant and joined by silver-soldered copper tubing. Frames are of ¾" AC plywood 7¼" deep (2" x 8" fir is used for sides on longer units). Tube seals in the louver channels are of silicone-impregnated fiberglass; sealing at the ends is achieved by strips of aluminized silicone/fiberglass fabric in the oak bearing mounts which lock the louver-axles into the frames. Adjustable turnbuckle-and-rod assemblies join the louvers and make them act in unison; adjustable weights on the driving louver control the rate of opening and closing.





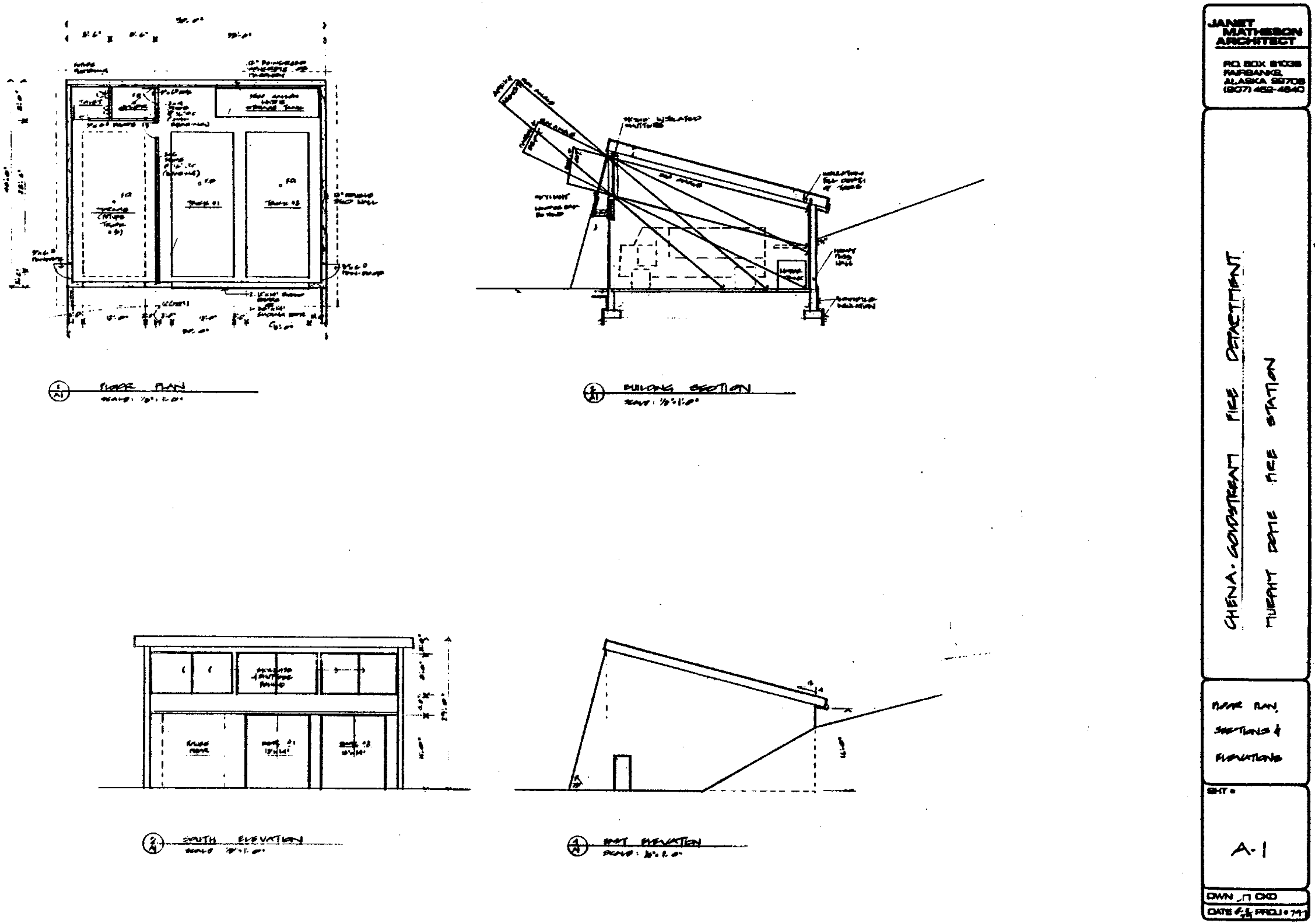

FLOOR PLAN
BUILDING SECTION
SOUTH ELEVATION
EAST ELEVATION
JANET MATHESON ARCHITECT
P.O. BOX
FAIRBANKS,
ALASKA
CHENA-GOLDSTREAM FIRE DEPARTMENT
MURPHY DOME FIRE STATION
FLOOR PLAN, SECTIONS & ELEVATIONS
A-1

FIGURE 1

The Murphy Dome fire station has been constructed and is functioning at present. Several recommendations of the design team were included; most were not. The design recommendations that were followed include: walls with 7 inches of insulation, an insulated concrete floor, rough-in plumbing, and barn-type doors. Since funds were limited to $150,000 for both the Murphy Dome and Chena Ridge fire stations, the cost of construction was the main reason the CGVFD did not opt to use our design. They did not fully understand our rationale for a passive solar design as opposed to an active solar design.

Work on the Chena Ridge fire station was begun in late 1979. Shannon and Wilson Engineers were contracted to conduct a site analysis and soils engineering assessment for the site. This was accomplished in August 1979, and was overseen by the principal investigator. Since that time, the site has been cleared, and the construction has begun. Several meetings were again held with the CGVFD and the energy designer and architect used the results of these meetings to develop ideas. The schematic designs developed are included here as Figures 2-4. Originals of these renderings are in the IWR 79-43 project files.

The result of our professional design advice and work has been the acceptance by the CGVFD of a plan calling for a south wall glazed with TUFFAK (a commercial acrylic glazing) functioning as a solar aperture. The entrance to the Chena Ridge station is on the east side, but otherwise the building design is similar to that of the Murphy Dome Road station. The need for shuttering the south facade is imperative, and the problem of how to adequately shutter this facade has not yet been resolved.

RECOMMENDATIONS

Since the main role of the DOTPF and its contractor in this project has been advisory, the fire company was not obligated to follow the professional recommendations generated by this project. Because of financial and time constraints that were encountered by the fire department, some of our recommendations were dropped from the construction plan. Much of the interaction (communication) with the fire company suffered because it was seldom done through the same people. Thus no single person ever got all the information. Future research projects related to nonprofit corporations should be done with either a single responsible arbitrator or through a general contractor.

The technical problems encountered in a firehouse design are interesting and often unique. The use of solar energy for supplemental building heating clearly has merit, as shown by the analysis in this report. With shuttering, 45 percent of the annual heat load of the structure could be met with passive solar gain; the remainder would be provided by oil-fired conventional heating. Well-insulated walls and ceilings (7 inches of fiberglass in the walls, 12 inches in the ceiling) also contribute to the energy savings of the design.

Doors are a major design problem in a firehouse. They must open quickly and infallibly, and yet seal well and be well-insulated for energy conservation. They must be both light in weight and easily movable. The designers spent considerable time seeking a good door system, but they did not obtain a satisfactory unit.

The Murphy Dome fire station presently has barn-type doors, which are sealed with garage door gasketing and operate on hinges. They function, but are heavy and slow to open.

The problem of air exchange during winter fire calls is not easily solved. A large transparent polyethylene (or a less fragile) transparent curtain is the only acceptable system for a fire station. In all likelihood, this problem will not be solved because of the unwillingness (and rightly so) of the fire company to put <u>any</u> obstruction in front of the truck driver during fire calls. As an example of the magnitude of the problem of air changes, it is best to refer the previous example of opening. A volume of 19,000 cubic feet of air requires the following amount of heat to raise its temperature from -40°F to 65°F:

$$(105°F)(0.24\ BTU/lb°F)(0.075\ lbs/ft^3) = 1.89\ BTU/ft^3$$

Thus a 100,000 BTU/hr heater would require 20 minutes of peak operation to heat the air exchanged in a fire call. This could occur twice in one hour. Furthermore, additional heating would be required to warm up the cold truck when it returns to the fire station. If the truck's thermal capacity is 960 BTU/°F (assuming 8,000 lbs of steel) and the water in the truck has a weight of 24,000 lbs and is at 34°F, the energy required to warm both the truck and water is:

$$\text{Heat required} = 960\,\frac{\text{BTU}}{^\circ\text{F}}\,(65^\circ\text{F} - (-40^\circ\text{F})) + 24{,}000\,\frac{\text{BTU}}{^\circ\text{F}} \times (65^\circ\text{F} - 34^\circ\text{F})$$
$$= \underset{\text{(truck)}}{100{,}000\text{ BTU}} + \underset{\text{(water)}}{744{,}000\text{ BTU}} = 844{,}000\text{ BTU}$$

This is the equivalent of 9.12 gallons of fuel oil (burned at 60 percent efficiency), which would require nine hours of peak operation of the 100,000 BTU/hr furnace. Obviously, the pulsed heating requirement is a critical design problem, and a larger capacity heating system may be called for.

The firehouse demonstration has been an interesting and challenging technical experience. The energy and engineering demands on a firehouse are very great, but they are irregular and unpredictable. An adequate backup system is required to overcome this irregular load, but the solar design can provide up to 45 percent of the routine heating requirements of the fire station. An awareness of additional research needs arose from this project:

1. Tests of interior and exterior shutter arrays, mechanisms, and operation cycles.
2. Door design for both large and small systems.
3. Optimal design for use of stored water or structural mass as a heat storage system.
4. Sizing and coupling a backup (oil) heating system to accomodate the extremely large, but uncommon pulsed heating cycles, such as a fire call and return within one hour during -40°F weather.

The firehouse design project was a beneficial project in project management experience, and has given the design team valuable experience and confidence in passive solar design for the interior of Alaska.

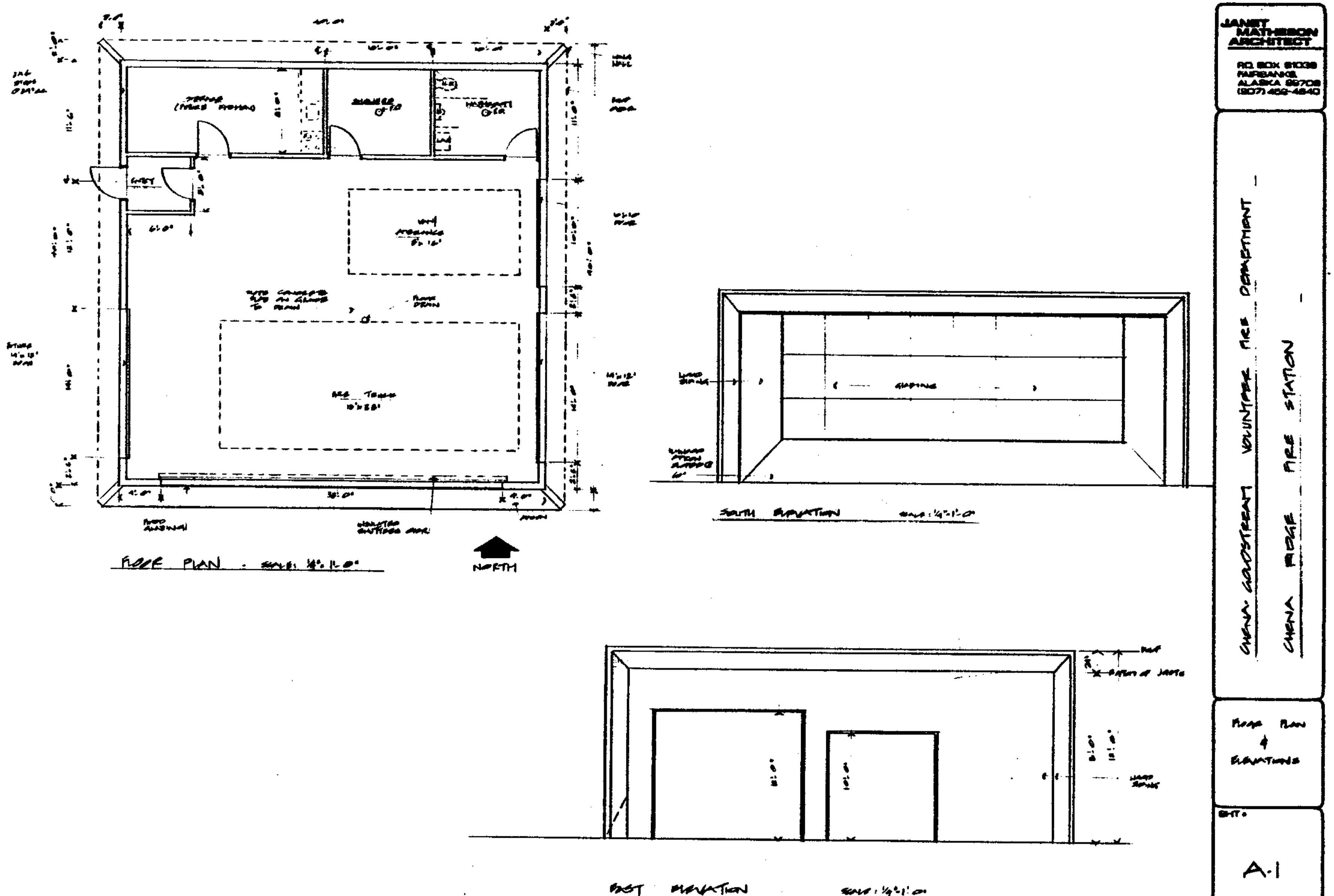
REFERENCES

Johnson, P. M. 1978. Heat loss through open doors. The Northern Engineer. 10(2):4-8.

Seifert, R. D., and J. P. Zarling. 1978. Solar energy resource potential in Alaska. Institute of Water Resources, University of Alaska, Fairbanks. Report IWR-89. 79 pp.

APPENDIX

Further details of meetings, design ideas, discussions and general activities of this project are described by the project architectural consultant, Janet Matheson, A.I.A., in this appendix.



FLOOR PLAN
NORTH
SOUTH ELEVATION
EAST ELEVATION
JANET MATHESON ARCHITECT
CHENA GOLDSTREAM VOLUNTEER FIRE DEPARTMENT
CHENA RIDGE FIRE STATION
FLOOR PLAN & ELEVATIONS
A-1

FIGURE 2

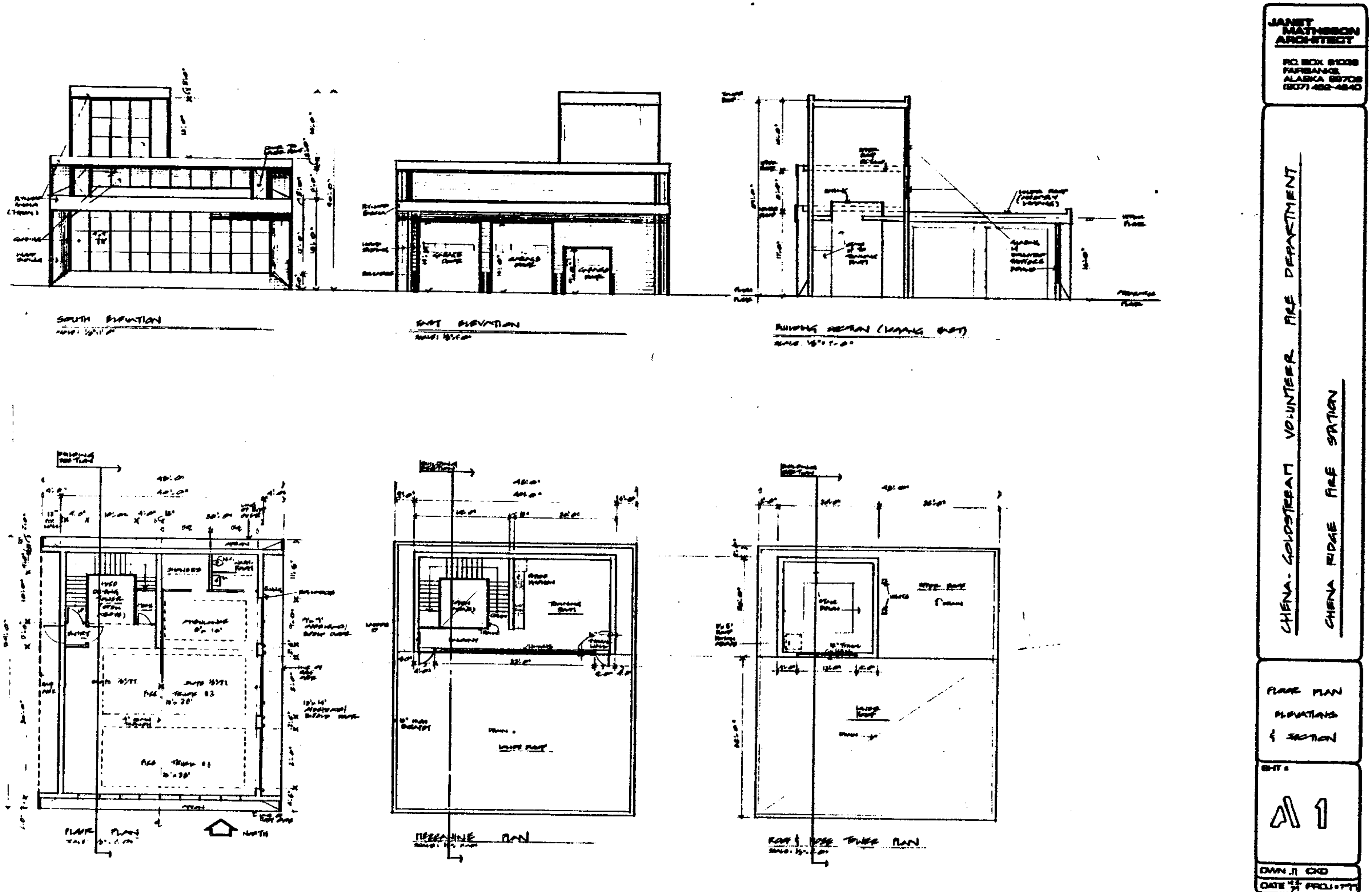

JANET MATHESON ARCHITECT
SOUTH ELEVATION
EAST ELEVATION
BUILDING SECTION (LOOKING EAST)
FLOOR PLAN
MEZZANINE PLAN
ROOF & HOSE TOWER PLAN
CHENA-GOLDSTREAM VOLUNTEER FIRE DEPARTMENT
CHENA RIDGE FIRE STATION
FLOOR PLAN
ELEVATIONS
& SECTION
A1

FIGURE 3

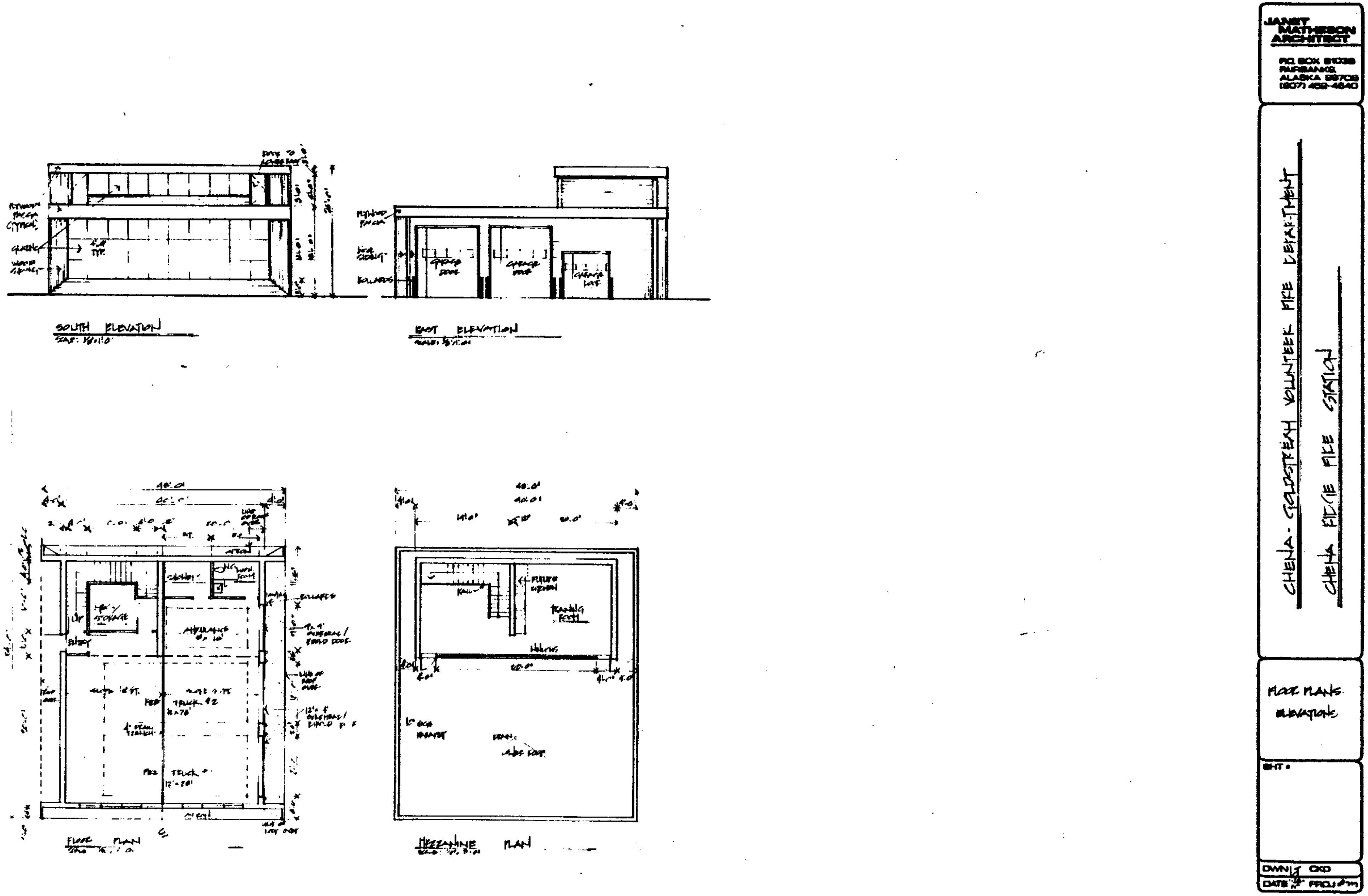

SOUTH ELEVATION
EAST ELEVATION
FLOOR PLAN
MEZZANINE PLAN
JANET MATHESON ARCHITECT
FAIRBANKS
ALASKA
CHENA-GOLDSTREAM VOLUNTEER FIRE DEPARTMENT
CHENA RIDGE FIRE STATION
FLOOR PLANS
ELEVATIONS

FIGURE 4

JANET
MATHESON
ARCHITECT

August 7, 1980

MEMORANDUM

To: Richard Seifert, Research Associate, IWR

From: Janet M. Matheson AIA

Re: Design Studies for Passive Solar Heated Fire Station Demonstration Project

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GENERAL BACKGROUND

A series of meetings were held, on June 13 and July 9, 1979, with the Chena-Goldstream Fire Department's Building Committee to ascertain their needs. (An earlier meeting on June 11, 1979, with Lee Leonard, had already defined the construction cost as $125,000; the probable (backup) heating system as forced air with space heaters; roof structure to be exposed; capacity: 3 trucks, therefore a 40' x 50' approximate size. A "saltbox" profile and Lexan (vandal proof) skylights were also discussed).

WE START WITH THE MURPHY DOME SITE

On June 13, we discussed:

- a 5,000 gallon water storage tank at the rear (north side) of the building.
- maximum weight of largest truck = 32,500 pounds.
- backup oil furnace required.
- bifold rather than overhead garage doors.
- an extra bay is needed, with roughin plumbing and metal stud interior walls, to be used for a community center and training sessions.
- future expansion should be provided on one side (for an ambulance).

On July 9, I visited the Murphy Dome site with Rich Seifert; Ivan Vail was clearing brush.

On July 9, we discussed, with the Building Committee, a preliminary floor plan, and the following design criteria:

- a monolithic 6" concrete slab.
- 3500 gallon, 68" diameter steel water tank.
- truck dimensions: 28' long x 12' high (35000 lbs. filled)
- door dimensions: 14' in height; 16' high walls.
- building dimensions: 40' x 50' (or 48').
- use of "microlams" and a pitched roof.
- steel beam to do engine repair on the trucks (see Ben Smith's design).

P.O. BOX 80567, FAIRBANKS, ALASKA 99708 (907)452-4640

- o "Beadwall" window insulation.
- o budget: $25,000 for equipment
  $50,000 for each building (= $25.00/sq.ft. each!)
- o no Trus-Joists to be used - all materials to be available locally.
- o mezzanine? Could be used for equipment storage and hose racks.
- o batt insulation for roof.
- o roughin plumbing (and showers).
- o need a foundation plan: showing drains, slab and footings.
- o heat exchanger on water storage tank.
- o Chena Ridge station to have 2 bays and a mezzanine; Murphy Dome station to have 3 bays and an extra bay for training and mechanical.
- o current concrete price = $80/CY delivered.
- o could use oil-fired ceiling-mounted space heaters.
- o architectural plans: site plan, floor plan, wall sections - needed.
- o exterior walls: plywood sheathing, with metal siding over?

Also after this meeting, I obtained a copy of Charley Lundfelt's NFPA Fire Protection Handbook, and reviewed it for information on equipment/apparatus space and recommended interior layouts.

I again visited the site July 27 with Rich Seifert. The slope had been cut and grading was in progress. Calls to the structural engineer, Bell, Herring & Associates, were made during July re preparation of the foundation plans. A meeting was held July 31 with Rich Seifert, Lee Leonard and Bell-Herring regarding the foundation design. During July, the floor plan was also revised according to the criteria presented at the July 9 meeting and elevations and a building section developed. However, at the same time, members of the Fire Department had been conferring with a local designer, Doug McLeod, re a structural design which was different from that discussed on July 9.

A meeting was held with Rich Seifert and Bell Herring on August 2 to discuss this new design, for which structural calculations had evidently been prepared. It had 2 bays east-west, with a 3rd bay separated by a bearing wall; a flat roof was planned, with a future 2nd storey planned over the 3rd bay. Sliding doors, like the hangar doors at Metro Field (the Air Logistics langar) were now planned.

On August 3, a meeting was held with Rich Seifert and members of the Building Committee, with Doug McLeod present, at the Murphy Dome site. We brought a copy of our revised July drawing along. The footings and slab had already been poured. Notes were made on the project's status as follows:

- o a well is being donated (was being drilled that day) and is located about 10' outside the building.
- o concrete block is going up for about $3.50-4.00/block (labor cost).
- o they are using 2' x 8' x 2" Styrofoam insulation for the perimeter footing and slab insulation.
- o flat trusses will be used, at about $3/LF; if scissor trusses are used, for a 60' span, at a 3:12 pitch, with a 8.5' peak, they will cost about $175 each.
- o doors to be constructed in 10' sections on separate tracks and made locally. Would be built of 7-1/2" styrofoam and fiberglas over metal or wood stud framing.
- o total estimated materials cost = $48,365 (cost of a comparable steel building = $55,000).

- o depth of flat trusses east-west would be 34"- 36", with bottom of truss at 14'.
- o 2 water storage tanks to be placed on end?
- o rear wall with a step-down footing at the slab. Insulation at rear wall extends 4' down the footing.
- o front wall: insulation angled out horizontally at top of footing.
- o undisturbed silt is under the footings, and gravel was placed under the slab (these comments by Doug McLeod).
- o a 5" deep gutter has been poured down the center of the building; it will drain through the side wall and into a leach box.
- o drain tile around the footings will discharge into a ditch at the rear of the building.
- o a 14" steel I-beam was donated to span the large door.
- o steel double core (man) doors have already been purchased.
- o cut at slope behind is 13' high - block wall to be 12' high?
- o mezzanine at front of building is a possibility - could it be hung from the roof trusses?
- o a grade beam is needed at the front wall.
- o collectors were suggested on the east side of the building and windows on the west side. (at training room)
- o final plans/sections changes were proposed:
    1. drop top of walls to 12'. Back wall to be shortened.
    2. frame in a second floor in the 3rd bay.
    3. allow a 12" floor.
    4. roughin for future washrooms and kitchen. Shower to be next to storage tank. 2 washrooms needed.
    5. need 13-1/2' for 3rd bay. (width)
    6. pitch of roof to be 3:12.
    7. future expansion will be upwards (office, training/classroom area, kitchen).

On concluding the meeting, it was decided to revise our drawings for the remainder of construction. Rich Seifert would call the following week with instructions.

<u>WE SWITCH TO THE CHENA RIDGE SITE</u>

On Monday, August 6, Rich Seifert called Bell, Herring and is setting up testhole drilling for the Chena Ridge site. (None was done at the Murphy Dome site). On August 9, I talked to Rich. The Fire Department indicated on Monday that their main station would be on Chena Ridge. Murphy Dome would be built as a 40' x 60' 1-storey structure with flat roof with an add-on (i.e. future) solar air system. We would have no further involvement with the Murphy Dome building but concentrate instead on Chena Ridge.

A site visit was made to Chena Ridge on August 10, followed by a review of Assessor's Office & Planning Office maps of the parcel. (No survey information exists on the parcel). The test holes were drilled by Shannon & Wilson on August 17 and a report prepared by August 20th.

A meeting was held on August 28, following receipt of the soils report, with Lee Leonard, John Zarling, and Rich Seifert. The following design parameters for the Chena Ridge station were confirmed, vis a vis computer simulations of its performance.

- o 6" wall insulation, 12" roof insulation.
- o no shutters as yet.
- o different factors would be checked for the walls.

- o doors to be: 10' x 10'
  14' x 12' (on north/east walls)
- o roof to have a 5 degree slope to the north, away from doors (but a flatroof).
- o the concept of a "drive-thru" building was discussed and rejected, due to heat loss.
- o water storage solutions were discussed.
- o building to have 2 bays and be 40' x 40'.
- o roughin for a kitchen, toilets and showers.
- o shutters: possibility of extra State funding.
- o is an existing "Beadwall" installation in Anderson.
- o garage doors will face east.
- o no clearing done yet.
- o south glazing = 384 sq.ft. - 32' x 12'
- o full fire truck will double the thermal capacitance of the building.
- o "refrigerator door" concept was discussed (larger than the opening - swings up and out).
- o cellulose insulation?
- o flat vs. pitched roof was discussed.
- o 1 mandoor to the west and 2 truck doors to the east.
- o "draft curtains" were discussed.
- o exterior siding: could be roughsawn cedar.
- o mural on north side?
- o would have standard foundations.
- o could prepare a color rendering.
- o schedule for completion of plans: Sept. 22nd.

Following this meeting, a drawing with floor plan, elevations and section was prepared, and discussed at yet another meeting Sept. 6th, with Joan Koponen, Charley Lundfelt, Frank (of Fire Dept.), Rich Seifert, and Lee Leonard.
We discussed:

- o foundation material at Koponen residence.
- o isolated water storage tanks.
- o budget: Murphy Dome building has used 1/3 of funds allowed, and is 40% complete.
- o cellulose insulation.
- o overhead doors were reinstated. Bifold doors would require a long overhang for snow protection.
- o ambulance could be parked outside.
- o end bay (14-16' wide) to have toilets and showers downstairs; training & kitchen upstairs. Roof to be used for gatherings.
- o need control joints in slab (at Murphy Dome, installed #4 rebar @ 2'o.c.).
- o trough in center of slab: 2" drop from garage doors; 4-1/2" wide x 4" deep, with a 4" diameter pipe to drain.
- o use 2" styrofoam layers and 6 mil vapor barrier for roof. 4" styrofoam down 4' at perimeter. 2" foam on foundation walls.
- o walls: (1st suggestion) 8" thick (2 x 8s) furred out with 2 x 4s; 8' of concrete block with 6' of framing above grouted with #5 @ 2' oc.
- o pitrun gravel under slab (2-3") compacted silt with gravel compacted over it.
- o garage doors: 2-12' w. x 14' h.
  1-9' w. x 9' h.
- o should be a partial 2nd storey (preliminary design was a rectangle).
- o maximum height of walls to be 14' (to bottom of trusses), based on Murphy Dome experience. Bottom bearing flat truss OK.

- o electric opener on 9' x 9' 3rd door for ambulance.
- o sloped concrete apron at front.
- o "barn doors" (refrigerator type) were discussed.
- o furnace/ceiling hung oil heater, with plenum in front of space heater.
- o final wall structure: 12" overall, 2 x 6s staggered (or 2 x 8 + 2 x 4)
- o if footings poured this fall, could be covered with sawdust.
- o need framing plan and footing sizes prior to slab work.
- o 34" top bearing truss was also discussed.
- o a 30' high hose tower was discussed.

A revised drawing was prepared after this meeting and delivered to Bell, Herring on Oct. 3 for their use. A copy was also sent to Rich Seifert, and on Oct. 24, another copy was sent to Charley Lundfelt for his review. The project was put on hold pending his response. No response was received by the end of the year.

Work began in 1980 with a call from Ivan Vail, newly appointed to continue work on the Chena Ridge station on behalf of the Fire Department. A meeting was held with him on Jan. 30, where we discussed the revised drawing of Jan. 30 (with hose tower) and asked for any changes. Ivan was to review our drawing with the other members of the Building Committee. Nothing was heard until May 13 at which time, Rich Seifert indicated he had talked to Nilo Koponen about the project. Clearing had begun on the building site. However, only $26,000 of the budget remained unspent and Ivan Vail had resigned as Building Committee Director. Therefore we were instructed to stop work, pending resolution of the Building Committee's input.

SUMMARY

In general, design problems were encountered in determining how many vehicles would be housed in each building, and what accessory uses (and therefore) spaces were needed. In addition, ad hoc construction proceeded in advance of design, so that changes had to be made in later phases of the design, after work was done on site and foundation items. Passive solar energy features have only been addressed in schematic form because design of an energy-efficient building shell has been held up by tardy (or no) input from the Fire Department. Therefore, future design assistance will have to be of an add-on nature rather than expressed in the whole building itself as was originally intended. In conclusion, we have to date prepared 4 schematic designs, none of which appear to have been accepted or used by the Fire Department, except for certain building shell features, in the construction of their two fire stations.

Attachments: Schematic Drawings of 8-3-79, 9-6-79, 10-3-79, & 1-30-80.