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ENERGY CONSERVATION: HEATING NAVY HANGARS

- TECHNICAL REPORT R-910 -

NAVAL CIVIL ENGINEERING LABORATORY

PORT HUENEME, CALIFORNIA 93043

SPONSORED BY
CHIEF OF NAVAL MATERIAL

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JULY 1984

POSSIBLE SOLUTIONS TO ENERGY LOSS PROBLEMS

Several solutions have been proposed and are being used. These are discussed in this portion of the report.

NYLON BRUSH SEALS

The Patuxent River Naval Air Station has installed nylon brush seals on hangar aircraft access doors**. The nylon seals were easily installed by Public Works personnel** and have none of the maintenance problems, such as cracking and deformation, normally associated with the rubber seals currently used on most military installations. While the nylon brush seal was cost-effective based upon reduction in seal replacement costs, data were not available on its effects upon hangar energy consumption.

Controlled tests were conducted at NCEL to measure the difference if any, in air infiltration rates with rubber seals and with nylon brush seals. These items were used to seal an opening in a pressure chamber; a variable speed blower, calibrated for air flow versus the pressure difference across the blower, was used to pressurize the chamber. The following table represents these test results. From this data, curve fit analyses were used to define the following empirical equations associated with the test results:

For rubber seals: $Q = 782S^{1.0574}$ per 100 ft of seal, ft/min^3

For nylon brush seals: $Q = 521S^{1.0157}$ per 100 ft. of seal, ft/min^3

Air leakage rates using rubber and nylon brush seals were calculated using these equations for wind speeds ranging from 1 to 20 mph, and a curve fit analysis was used to develop the following empirical equation for the differential leakage between the seals:

Differential leakage between
rubber and nylon brush seals: $\Delta Q = 266\ \bar{S}^{1.1215}$ per 100 ft of seal, ft/min^3
(where $\bar{S}$ is the average wind speed during the heating season in miles per hour)

Results of NCEL Leakage Test

Performed on 3½" to 4" gap using 4" brush installed to manufacturers specification.

Wind Speed (mph)	Rubber Seal (cfm/100ft)	Brush Seal (cfm/100ft)	Wind Speed (mph)	Rubber Seal (cfm/100ft)	Brush Seal (cfm/100ft)
5.1		3,000	13	12,100	
5.1		2.5	14.4		7,500
5.2	4,800		14.8	14,000	
5.4	5,000		15.5	15,100	8,500
6.3	5,100	3,200	16.6		9,000
6.6	6,000	3,500	17.2	15,700	
7		4,000	17.5		9,100
7.5	6,200		17.7		10,000
8	7,300	4,200	18	17,100	
10	7,500	5,600	18.2	16,400	
10.5	9,100	5,900	18.7		9,800
12.2		6,400	18.9		11,000
12.3	10,700		19.2	18,300	
12.5		7,200	19.5	17,800	
13	12,100		20		11,300
14.4		7,500	20.6	19,800	
14.8	14,000				
Blanks indicate data not taken					

By approximating the average annual heating season inside/outside air temperature difference (by Equation 15 in full report), p = 0.076 lb/ft^3. and c_p = 0.24 Btu/lb-°F, the annual energy loss, L_A, can be estimated from: $L_A = pc_p \Delta T_A \Delta Q_Y$ or

$$L_A = \frac{0.007D}{7} S^{-1.1215}$$

MBtu per 100 ft of seal

The following table presents the annual energy reduction obtained by using nylon brush seals versus average heating season wind speed for overall heating system efficiency of 60, 70, 80, and 100%.

Annual Energy Saving with Nylon Brush Seals

Average Wind Speed (mph)	Heating System Efficiency			
	100%	80%	70%	60%
5	40000	51000	55000	75000
6	50000	60000	70000	90000
8	70000	90000	100000	125000
10	90000	120000	130000	155000
12	112000	150000	160000	190000
14	140000	170000	190000	225000
16	160000	190000	225000	260000
Annual energy savings per degree day per 100 feet of seal (Btu)				