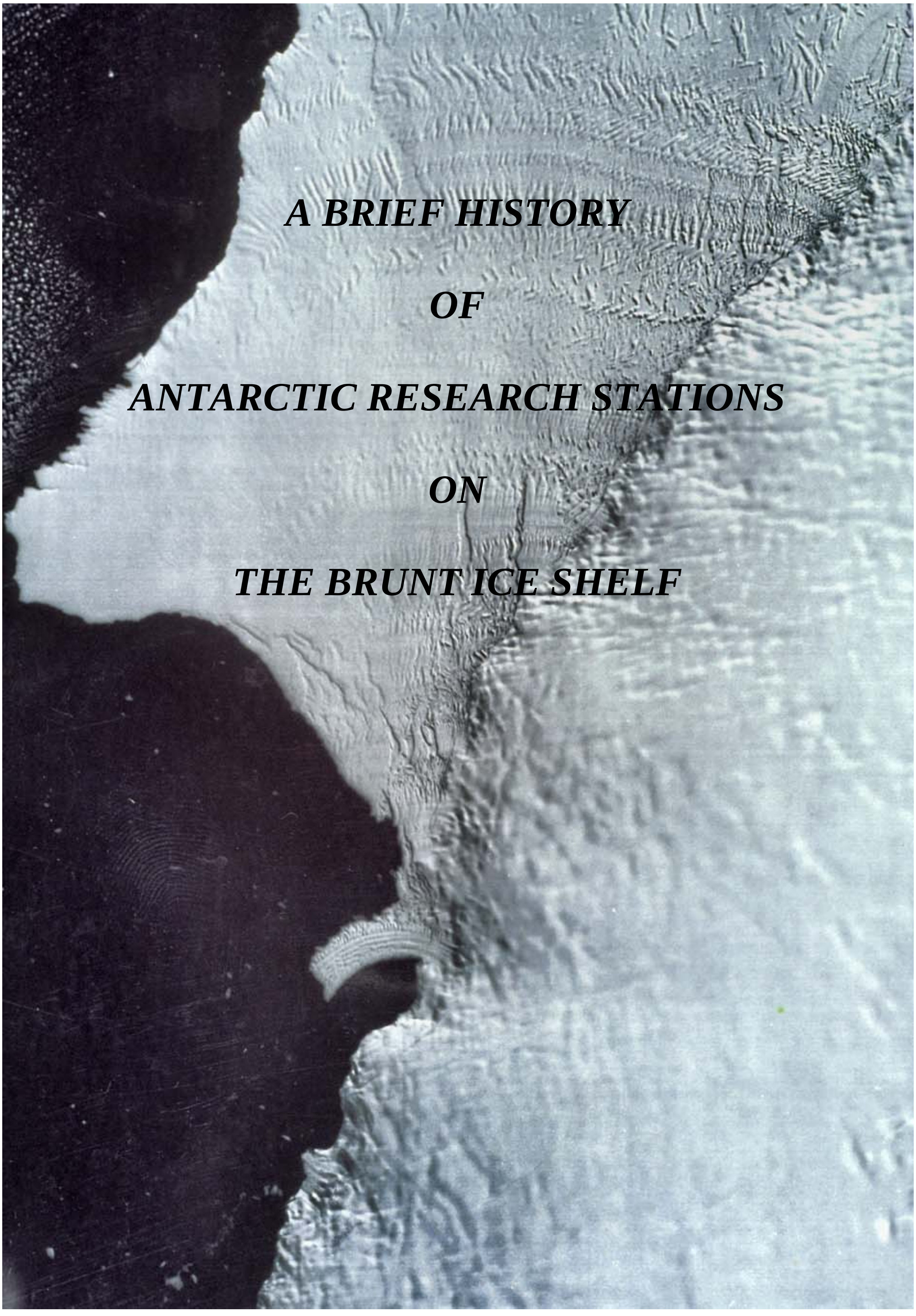


A BRIEF HISTORY

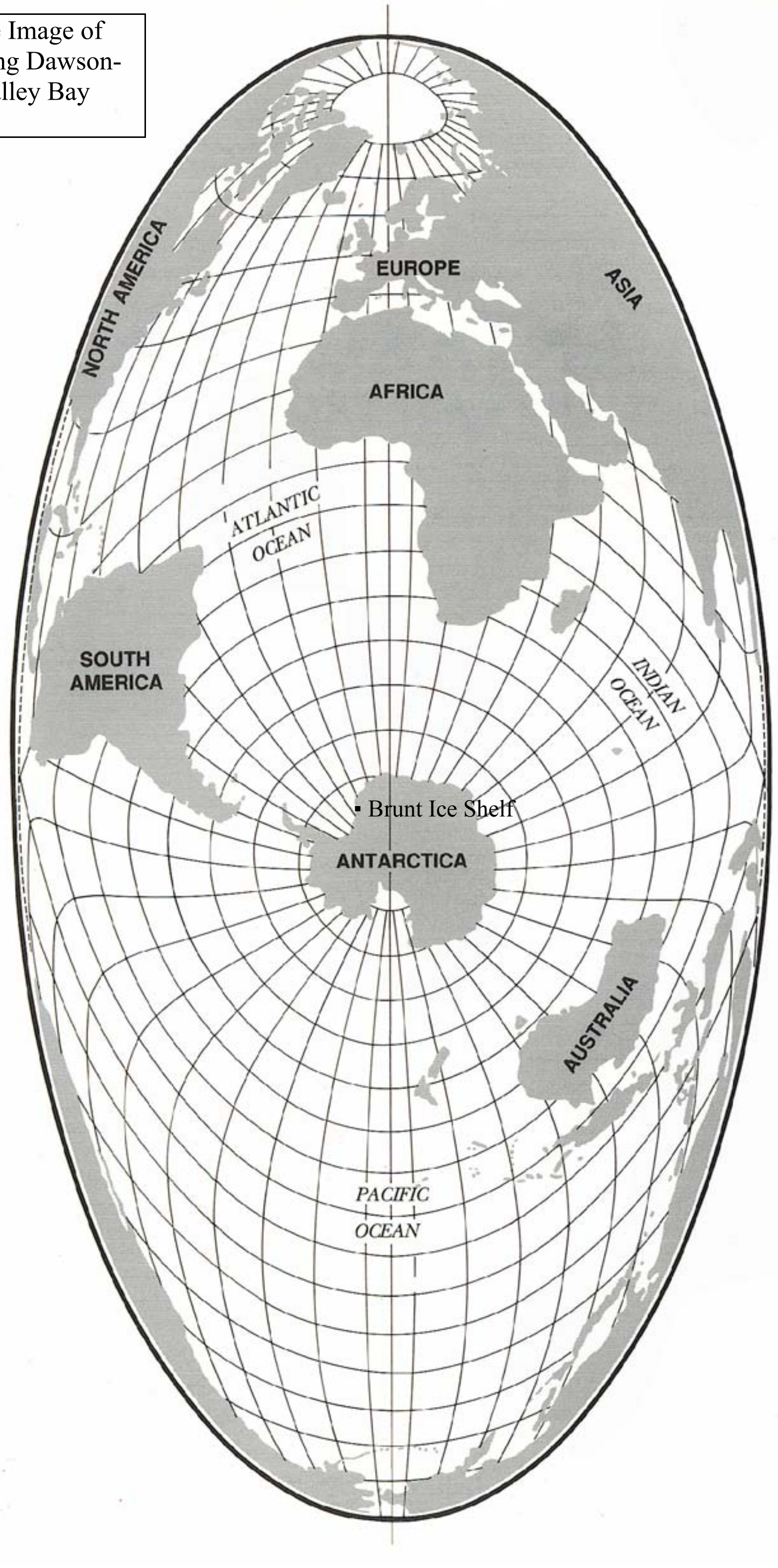
OF

ANTARCTIC RESEARCH STATIONS

ON

THE BRUNT ICE SHELF

Cover Photograph: Satellite Image of The Brunt Ice Shelf, showing Dawson-Lamdton Ice stream and Halley Bay area 1985.



An unusual map projection shows the Earth as a flat ellipse and depicts the relationship of Antarctica to the other continents.

British
Antarctic Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

A BRIEF HISTORY

OF

ANTARCTIC RESEARCH STATIONS

ON

THE BRUNT ICE SHELF

Written and compiled by Alan Smith 2005

DEDICATION

This article is dedicated to all persons who expended a great deal of effort and dedication in the construction and maintenance of all 5 scientific stations ensuring that the British Antarctic Survey always remained at the cutting edge of Polar Science.

DISTRIBUTION

1. British Antarctic Survey, archives.
2. British Antarctic Survey, library.
1. Ex-base members attending Halley 50th anniversary celebrations.

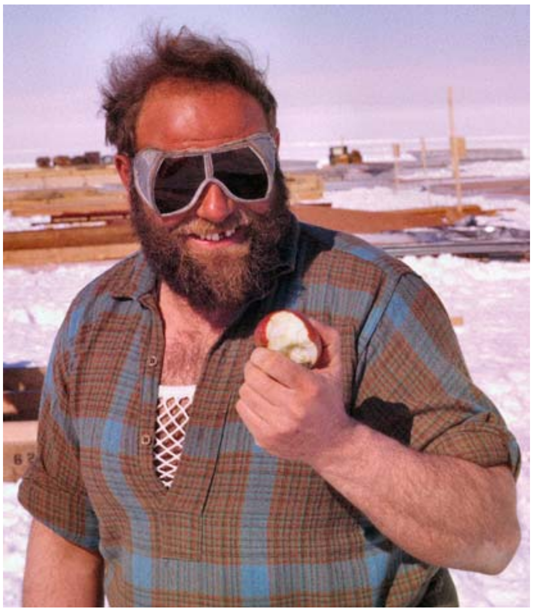
PROLOGUE

Britain has been involved in Antarctic exploration, science, sealing and whaling for over 200 years. The British Antarctic Survey has been building and maintaining scientific stations and carrying out scientific programmes and exploration for 60 years.

A research station was established on the Brunt ice shelf on 15 January 1956 by the Royal Society and named Halley Bay. On 15 January 2006 there will have been continuous occupation and science there for 50 years. Halley is the first British station to achieve this.

I joined the Survey in 1966 at the age of 32 where I wintered at Halley Bay, base No.2. After returning to the UK I spent several austral summers working on other Antarctic stations. I was then offered a permanent post as a technical officer within the Survey's Logistic Section. The Survey's Administration Division had various re-organisations over the years and eventually I became the head of the Building Services Section. I retired on 31st August 1995 after 29 years of Antarctic work. *A boyhood dream had become true.*

This article is my way of acknowledging the work and effort of both the support and scientific staff who helped ensure the continuation of science.



Alan Smith (Big Al) 1967

"My own bolt is shot; I do not suppose I shall ever go south again before I go west; but if I do it will be under proper and reasonable conditions. I may not come back a hero; but I shall come back none the worse; for I repeat, the Antarctic, in moderation as to length of stay, and with such accommodation as is now easily within the means of modern civilised Powers, is not half as bad a place for public service as the worst military stations on the equator."

Apsley Cherry-Garrard, 1929

CONTENTS

Introduction

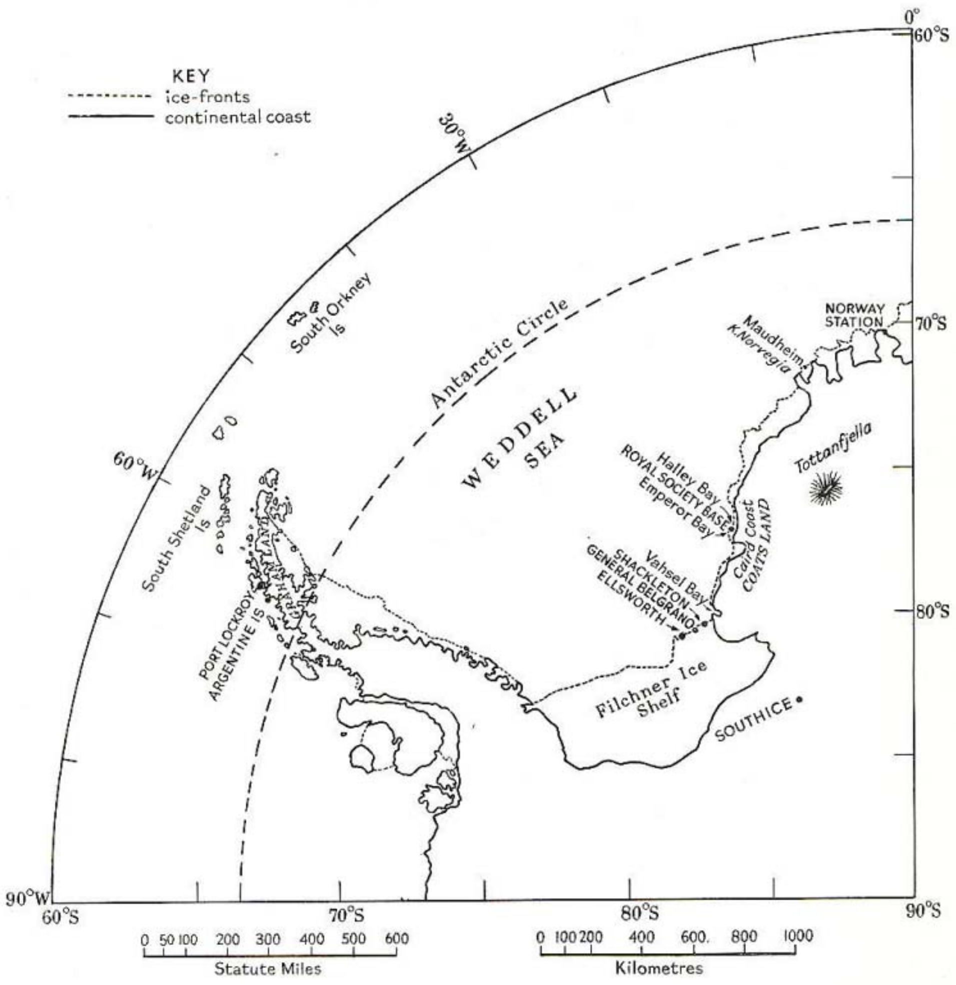
The first station was established in 1956 by the Royal Society for the International Geophysical Year (IGY) 1957-1958, and named Halley after the astronomer Edmond Halley. The station filled an important gap in the IGY Antarctic network with studies in meteorology, glaciology, seismology, radio astronomy, ionospheric physics, aurora and airglow and geomagnetism. Many of these studies have continued uninterrupted since 1957. The station was formally handed over from the Royal Society to the Falkland Islands Dependencies Survey at midnight on 13/14 January 1959.

The extreme environment of the Brunt Ice Shelf poses great technical problems to builders with blizzards and snow drift eventually burying everything. Buildings disappear beneath the snow requiring ever-lengthening vertical shafts to provide access to the surface. Because of burial by snow and movement of the ice shelf it was necessary to replace and resite the first Halley station in 1967 and subsequent stations in 1973 and 1983; all being abandoned before being crushed by the weight of overlying snow. The 5th station was built above surface and completed in 1992.

This article is a brief history of the five Halley stations. It does not take into account all the scientific facilities which have been established.

The British Antarctic Survey is in the process of seeking funds and designing a replacement station for which construction is scheduled to commence in 2006. An alternative location may be chosen.

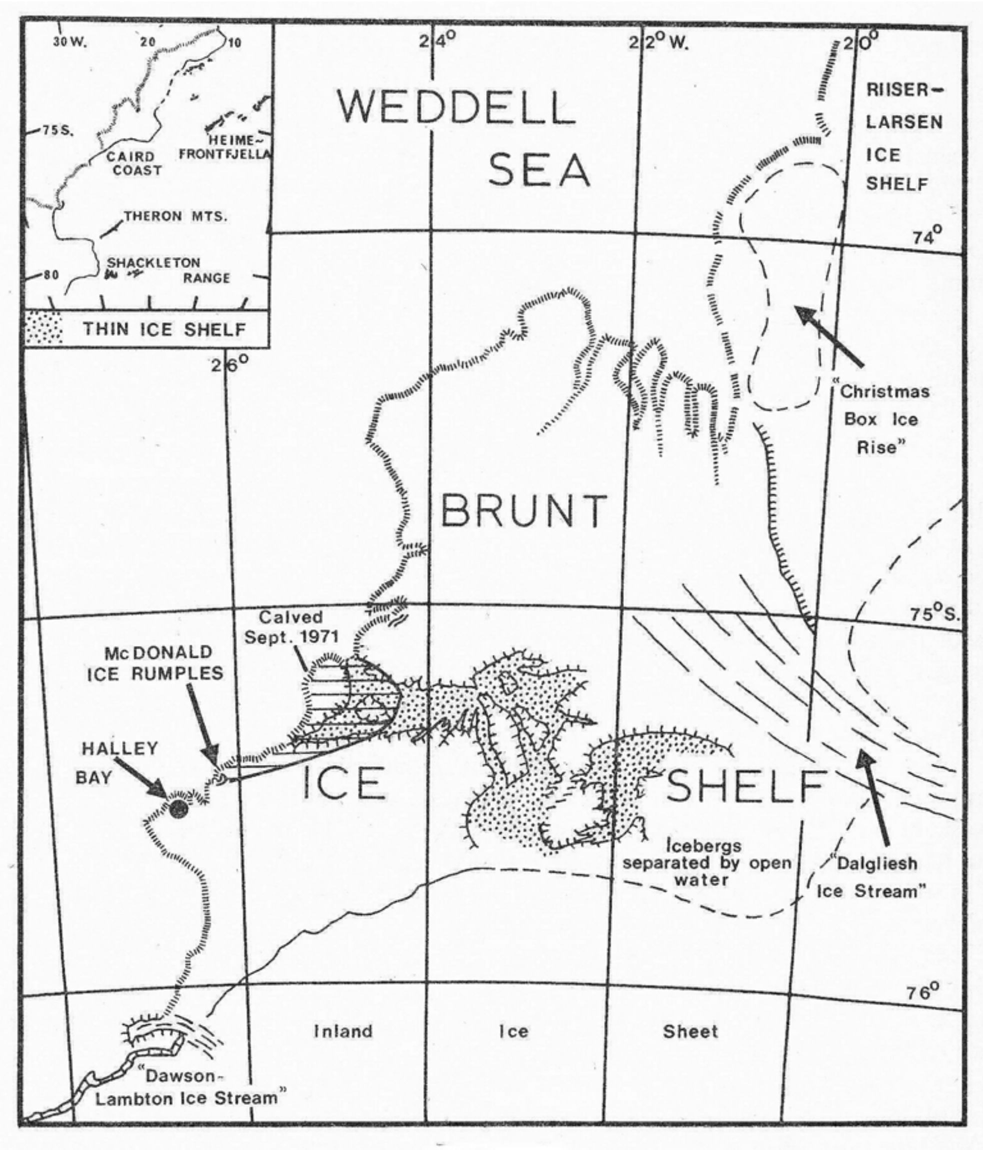
THE ROYAL SOCIETY EXPEDITION, HALLEY BAY 1955-1959



Sketch map of the Falkland Island Dependencies and adjoining sectors of Antarctica, from 60º S to the Pole: principal I.G.Y. bases are in capitals.

Chapter 1:

The Brunt Ice Shelf Environment



Map of the Brunt Ice Shelf (about 1973)

The Brunt Ice Shelf is one of several small ice shelves fringing the east coast of the Weddell Sea. It forms a 50-150km. wide fringe extending in a north-easterly direction along the Caird Coast from the "Dawson-Lambton Ice Stream" at lat. 76º 07' S., long. 27 º 00' W, to "Christmas Box Ice Rise" at lat. 74º 20' S., Long. 20º 30' W. The ice shelf is at its widest in the north where it fills a large bight in the Caird Coast and is supplied by the large and active "Dalgliesh Ice Stream" which drains the area to the west of Heimefrontfjella. Where the ice stream becomes afloat a zone of severe crevassing extends about 50km. into the ice shelf. Farther west, movement of the ice is confined by a small area of grounded ice, the McDonald Ice Rumples. Between this area and the rapidly moving ice associated with the "Dalgliesh Ice Stream" the ice shelf is severely fractured and large expanses of thin ice shelf have formed between isolated blocks of thicker ice shelf.

The surface of the ice shelf is no where completely flat; it consists of a series of waves of about 1km. wave-length and 5m. wave height. Up-stream from the McDonald Ice Rumples there are pressure waves which noticeably increase in frequency and wave height near the ice rise. To the south and south-east of the McDonald Ice Rumples, the junction (or hinge line) between ice shelf and inland ice sheet is marked by a 10-20km. wide belt of disturbed ice. As the hinge line is approached the surface becomes more and more steeply undulating and the ridges finally become recognizable as icebergs, calved from the inland ice sheet and subsequently streamlined by the accumulation of drift snow. Near the hinge line, the north cliff-like faces of the ridges are far steeper than the relatively gentle south slopes and oval basins aligned parallel with the prevailing east-west wind have formed beneath the cliffs.

To the west of each of the ice rises the ice front is incised by huge rifts. Near the Mcdonald Ice Rumples, these range in length from a few hundred metres to 3km., whilst those near “Christmas Box Ice Rise” extend for several tens of kilometres with widths up to 3km. They are floored with sea ice and heavy accumulations of drift snow. Actively opening rifts can be distinguished from others by the presence of expansion cracks in the sea ice. Their activity decreases with increasing movement down-stream from the grounded ice, and they finally degenerate into narrow inlets in the ice front leading to long ramps of snow. These provide easy access to the surface of the ice shelf, and it was their presence near the McDonald Ice Rumples that decided the position of the Halley Bay station.

Investigations showed that the ice near Halley was moving approximately due west at about 840m per year since the establishment of the IGY base.

Over the years there has been major changes in the seaward edge of the ice shelf, a major loss of ice front occurred in 1967 when Halley Bay disappeared. Since then creeks have re-formed and the survey has been able to gain access from the sea to the shelf ice on a regular basis, although there have been 3 occasions when the annual relief could not take place.

Any station built on the surface and allowed to be buried will travel through the ice shelf and will eventually reach the seaward edge of the ice shelf.

Picture shows Halley 3’s inside face of the Armco tube gable end. (BAS)

Air temperatures

Mean annual	-18·5º C
Extreme maximum	+4·5º C
Extreme minimum	-55·3º C
Winter mean	-30·0º C
Midsummer mean	-5·0º C

Winds

Prevailing wind direction	075º (true) = 15 N of E.	
Secondary direction	270º (true) = W.	
Frequencies of wind direction	easterly	68·8%
	All other	28·8%
	Calm	2·4%
Mean annual wind speed	13 kt.	
Extreme mean hourly speed	61 kt.	
Extreme gust	80 kt.	

Glaciology

Ice-shelf thickness.................... about 143m. to 280m.
Net accumulation .... about 38 cm water/year
Apparent ablation..................... about 12 cm water/year
Ice-shelf temperature at 12 m ... - 18·4 ºC

Historical note

The ice-front was first seen by W.S. Bruce, of the Scottish National Antarctic Expedition, when the *Scotia* was near to 72º 18' S 17º 59' W on 3 March 1904. The Expedition, which remained close to the ice-front for 10 days, reported on 6 March (Rudmose-Brown, Mossman and Harvey-Price 1906):

> *'The surface of this great inland ice, of which the barrier was the terminal face or sea-front, seemed to rise up very gradually in undulating slopes, and faded away in height and distance into the sky, though in one place there appeared to be the outline of distant hills: if so they were entirely ice covered, no naked rock being visible.'*

The Expedition interpreted the large number of birds seen as showing *'that not far distant were the beaches and rock cliffs of some actual land where they could nest'*. Bruce named the area Coats Land.

The region was next visited by Shackleton in 1915. The *Endurance* reached the barrier in about the same position as had the earlier Expedition and followed the ice-front towards the south-west. Soundings gave depths of between 100 and 200 fathoms. The most southerly point reached by the *Scotia*, 74º 01' S 22º 00' W, the way southwards being barred by a promontory extending northwards. This tongue, named after Dame Janet Stancomb-Wills, proved to be about 50 miles long, and a sounding at the western end showed 1357 fathoms. By the evening of 15 January, three sides of the great promontory had been skirted and the barrier again extended towards the south-west. Recent voyages have shown that this promontory no longer exists.

During the night of 15/16 January 1915, the *Endurance* passed the region later to be the site of the Royal Society Base. Halley Bay (75º 31' S 26º 42' W *position in 1956*) is located in that part of the ice-front which Shackleton had named the Allan McDonald Glacier, and it is interesting to compare the 1957 situation with Shackleton's description:

'Shortly before midnight on 15 we came abreast of the northern edge of a great glacier or overflow from the inland ice, projecting beyond the barrier into the sea. It was 400 or 500 ft. high and at its edge was a large mass of thick bay ice. The bay formed by the northern edge of this glacier would have made an excellent landing place. A flat ice-foot nearly 3 ft. above sea level looked like a natural quay. From this ice-foot a snow slope rose to the top of the barrier. The bay was protected from the south-easterly wind and was open only to the northerly wind which is rare in those latitudes. A sounding gave 80 fathoms, indicating that the glacier was aground. I named the place Glacier Bay.'
75º 25' S 26º 30' W (1915) Glacier Bay name should be used only in historical contexts.

There seems to be no doubt that 'Glacier Bay' was located somewhere in the Halley Bay complex. The ice-front cliffs now have heights of about 100 ft. while the short wavelength, very disturbed, pressure ridges are about 100 ft. higher. The McDonald Ice Rumples were so named to perpetuate the name given by Shackleton to the supposed glacier in this region. Shackleton reached the northern edge of the 'Dawson-Lambton Glacier' at 4 a.m. on 16 January 1915. It was not until 1954 that the Weddell Sea was again penetrated to such high latitudes.

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Chapter 2:

The Royal Society International Geophysical Expedition 1955-1958.

THE ADVANCE PARTY

The Advance Party preparations for departure

The final decision to send a Royal Society expedition to the Vahsel Bay area during the International Geophysical Year (IGY) could not be taken until July 1955. Between then and the sailing of the Advance Party in November 1955, all the necessary stores were organized with the co-operation of the Crown Agents for Overseas Governments and Administration and the Falkland Islands Dependencies Survey (F.I.D.S.) with Mr G.E. Hemmen, stores officer to the Expedition. Perhaps no other expedition has had to organize so much in so short a time.

The m.v. *Tottan*, 541 tons, had been chartered and being slightly smaller than the originally intended ship, the additional obstacle of reducing the bulk of the stores had to be surmounted. Many items had to be stored as deck cargo and stability tests were necessary before the ship could sail. In spite of such last-minute difficulties, the *Tottan* sailed on the evening of 22 November 1955. On board, under the leadership of D.G. Dalgliesh, were the personnel of the Advance Party and Mr Hemmen.

Advance party names

D. G. Dalgliesh	Base leader and medical officer
G. E. Watson	Chief scientist and electronic engineer
A. R. F. Dalgliesh	Tractor driver and general handyman
S. Evans	Physicist
C. F. Le Feuvre	Wireless operator
D. W. S. Limbert	Meteorologist
G. R. Lush	Tractor driver and general handyman
K. E. C. Powell	Diesel engineer
D. R. O. Prior	Carpenter
J. E. Raymond	Senior carpenter

M.V. Tottan in rough seas crossing Bay of Biscay, (D.W.S. Limbert)

The 1955-56 Voyage

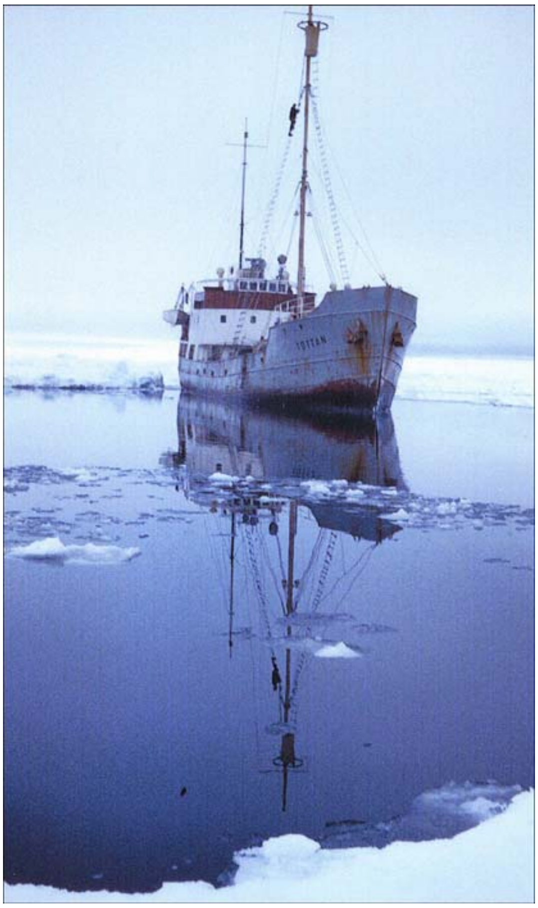
The original plans had been made in conjunction with Vivian Fuchs who was sailing in the m. v. *Theron* with the advance party of the Trans-Antarctic Expedition (T.A.E.). As they had left England a week earlier and had an Auster aircraft on board it was hoped that the *Tottan* would be able to follow them into the ice and benefit from their ice reports and air reconnaissance: it was thought that Fuchs might find a site suitable to the purposes of both expeditions. A week before Christmas, while in the South Atlantic, Dalgliesh heard that the *Theron* had already entered the ice, but he agreed with Captain Jakobsen to follow the course suggest by Sir James Wordie for entering the Weddell Sea. From South Georgia, the *Tottan* passed just south of the South Sandwich Islands to attempt a landfall in the region of Kapp Norvegia. Whenever old, heavy Weddell pack-ice was met, Jakobsen bore away to the east, passing Kapp Norvegia on 1 January 1956, and found open water again. He had the advantage of being able to go up to the *Tottan's* crow's-nest, 70ft. above the waterline, to seek suitable leads.

Meanwhile the *Theron*, sailing on a more westerly course, had become beset and the *Tottan* was unable to assist her in any way. The *Theron* did not free herself until nearly a month had elapsed and consequently the Advance Party in the *Tottan* were obliged to search the coast for a landing site without the aid of aerial reconnaissance.

On 3 January 1956 the *Tottan* reached approximately 76º 40' S, where she became beset in heavy pack-ice; the party dug themselves out on two occasions and on a third used dynamite with good effect. It was likely that they were in almost the same position in which Sir Ernest Shackleton in the *Endurance* became trapped in 1915; and they were, therefore the first Englishmen since that time to reach so far south in the Weddell Sea. Being unable to go further south, they turned towards the coast and proceeded to search for a landing site, sailing slowly up the coast. Three possible landing sites in the 'Dawson Lambton Glacier' region were examined but none here or further south was at all suitable as a base site.

Dalgliesh's instructions were to establish the base south of 75º and he had hoped to reach Vahsel Bay at 78º south. On 5 January 1956 another effort to go south was made but although a south-western wind had shifted much of the pack-ice the *Tottan* encountered impenetrable ice at about 77º S.

The conditions were so adverse that very reluctantly the *Tottan* turned from this farthest south point, within 69 or 70 miles of her goal, and sailed northwards. The bay known as Halley Bay had been noted on the original run south as being possibly suitable for landing and the establishment of a base, for the slope giving access to the ice-shelf had been observed by the Second Mate while on watch.



Picture by D.W.S. Limbert

Early on the morning of 6 January 1956 the *Tottan* rounded the cape to the south of Halley Bay and the Advance Party saw the slope up on to the ice-shelf clear of penguins, and apparently wider and gentler than the similar slope in the next bay south (named Emperor Bay by the Advance Party). To mark the tercentenary of the birth of Edmond Halley, the distinguished Secretary of the Society who was born in 1656, it was decided that the bay at which landing was made should be known as Halley Bay and this was confirmed by the Governor of the Falkland Islands on the recommendation of the Antarctic Place-names Committee.

The Base site Lat. 75º 35' S, Long. 26º 36' W.

Reconnaissance showed Halley Bay to be an ideal landing site with the ice-shelf quite flat and uncrevassed. The stranded tabular bergs lying offshore and echo soundings of about 100 fathoms suggested that the cape separating Halley Bay and Emperor Bay was grounded and on this account there seemed no point moving a long way inland. A site about 1¾ miles from the ice edge was therefore chosen by Dalgliesh for the Base (6 January 1956).

Unloading

Until the ship left, the Advance Party worked 15 hours a day from midnight, for although the sun still shone brightly the temperatures were lower at night and surfaces harder, which made for easier sledging of stores. Later, day-time working for periods of 10 to 15 hours was adopted.

A high wave which broke up much sea ice on 14 January 1956 justified a previous decision to take all stores immediately clear of the ship to safe sites. By 23 January 1956 the unloading of the 220 tons of stores had been completed and the *Tottan* left for South Georgia.

Building the Base hut

For just over a month the Advance Party lived in tents. Levelling of the hut site began on 15 January 1956 *(BAS have taken this date as the official occupation date*), all the foundations and floor of the hut were laid and then one end was erected to give more comfortable living accommodation. Towards the end of this time temperatures were around -23º C and with single sleeping bags all were very cold in their tents. After the party transferred to the hut the tents were left standing until they could be overhauled and put in an emergency dump.

The next major objective was the completion of the outer walls and the roof so that the chance of the wind tearing down the construction or filling the inside with drift snow would be lessened: the party could then put stores and building materials inside and continue their work in greater comfort during the dark of winter. With a view to minimizing the effects of drift, Dalgliesh had placed a corner of the hut into the prevailing wind. The sitting room was officially opened on mid-winter's day.

Main hut foundations (D.W.S. Limbert)

Fuel and power

Out of the 50 drums of diesel oil and 40 of aviation turbine fuel available, generally in drums of 44 gallon nominal capacity, a total of 25 drums were set aside in case the base was not relieved; otherwise fuel oil was used as needed. During the winter months the generator was started at 0900 hours L.M.T. and run until Evans had finished his all-sky camera work the following morning. In the spring, when aurorae were no longer visible, the generator was run until 0400 hours L.M.T. for the night watchman. By the end of the year there were about 3 drums over as well as the spare 25.

Anthracite was supplied in bags averaging 70lb. for the three hopper-fed closed convector stoves (with flueways encircling the stove), the thermostatically controlled cooker (fitted with a water heating unit used for melting snow in a 160 gal. tank), and the water-heating boiler. Consumption tests showed that altogether 60 bags (1·9 tons) per month were needed, but with warmer weather, consumption fell to about 40 bags per month and there were about 6 tons in stock at the end of the year. The closed-convector stoves were found to be most efficient and economical.

Early in February one 7·5KVA diesel-electric generator was installed in a converted tractor crate. Eventually three such generators were installed in the hut and the fourth was mounted on a sledge as a mobile source of power which proved most useful for the building operations of the main party. The equipment was efficiently maintained and there were virtually no power failures.

Emergency precautions

From the start arrangements were made for emergency accommodation, food, fuel, clothing and medical supplies, in case fire burnt down the hut and stores. The tents were struck singly, brought inside, thawed out and mended where necessary. Six two-man emergency boxes were made up with sledging rations, sleeping bags, Primus stove, paraffin, the remaining sledging rations, the trail radio set etc. were also put in an emergency dump with the tents. Later the tents, sledging rations etc. were housed in a tractor crate with 6 ft. legs to keep it clear of drift. The boat was suspended on davits to keep it free from drift for immediate use in any emergency.

The beginning of science

The following observations were made by the Advance Party.

Surface Meteorological Observations

On 27 January 1956 a few meteorological instruments were brought into use by D.W.S. Limbert and regular morning and evening observations began on 7 February. From 24 February the number of observations was increased to 6. As building work progressed, it was possible to increase the number of instruments in use to provide more detailed reports.

The weather was milder than expected, the winds being only occasionally over 40 kt. The annual average temperature was *ca*. -20º C and the minimum -50·6º C.

Upper Air Meteorological Observations

In 1956, 37 successful pilot balloon upper-wind velocity measurements were made. Launchings commenced on 9 July but were not made at regular intervals until October.

Visual and Photographic Auroral Observations

Auroral observations began in May 1956. An observer keeping a continuous visual watch in the sky as was practical and an all sky camera was operated whenever conditions were favourable.

Total Ozone Observations

The ozone spectrophotometer was installed in the loft of the main hut which was fitted with two 3 ft. square roof hatches permitting a view of the whole sky. Regular observations commenced in September 1956.

Radiation Observations

The solarimeters were installed on a platform fitted to the roof of the main hut. The recording galvanometers were installed in the meteorological office. From August 1956 the short wave radiation of the sun and sky incident upon a horizontal surface was recorded.

Glaciological Observations

A tentative programme was planned and D.W.S Limbert was responsible for the glaciological work which was confined to studies of accumulation and ablation in the base area and began on 14 June 1956.

Sea Ice Conditions

Visual observations were made irregularly in 1956.

The sea ice went out by 18 March, breaking off at the slope and leaving a 6 ft. cliff, but a few days later new ice was forming. By mid-September all the bay ice had blown out although it had been present between the headlands in January. After this there was a succession of break-ups and freezing.

THE MAIN PARTY: FIRST YEAR

The 1956-57 Voyage

The 20 men of the Main Party and Mr Hemmen left Butler's Wharf, London, on 15 November 1956 in the m.v. *Magga Dan*, shared with the Commonwealth Trans-Antarctic Expedition. The *Tottan* also left for Halley Bay on 17 November carrying additional stores.

Calls were made at Madeira and Montevideo, and after leaving South Georgia on 20 December the *Magga Dan* entered the pack-ice on 23 December at 59·5º S 26·7º W. Following three reconnaissance in the T.A.E. Auster aircraft, Kapp Norvegia was approached between 15 and 20º W. On 29 December an error was discovered in the ship's gyro compass, making her 80 miles further west than previously reckoned. As the ship was then in close pack with no promising leads, the course was retraced north, to search for a south-easterly lead. Twice on 30 December it was necessary to 'pole' the ship free, taking five hours on the first occasion, and four hours on the second. The shore lead off the east coast of the Weddell Sea was reached at 0730 L.M.T. on 3 January. Progress was then straightforward, and the *Magga Dan* arrived at Halley Bay at 1745 L.M.T. to find the *Tottan*, which had arrived some hours earlier, already moored at the ice edge. It proved possible to get both ships alongside the bay ice together.

Unloading

There were approximately 380 tons of stores to be unloaded from *Magga Dan* by the 41 men of the two Expeditions. The transport available between ship and Base comprised one Muskeg and three Ferguson tractors and eight sledges. The Muskeg provided by the T.A.E. was particularly useful, pulling heavy loads at speed. Unloading of the *Magga Dan* took from 5 to 11 January, the rate of unloading rising to 60 tons/day. After the T.A.E. and the Royal Society Advance Party had left on the *Magga Dan* on 12 January, the unloading of the *Tottan* by Main Party personnel and transport took until the early morning of 14 January 1957.

MV Tottan moored to bay ice at 75º.6' South (D.W.S. Limbert)

At the Base, store dumps were established in two long lines across the prevailing wind. Crates were arranged in numerical order and separate groups, so that individual items could be comparatively easily found. Many of the dumps were raised on 4 ft. platforms in order to delay drifting-up, an expedient which had a certain measure of success.

Building operations

On 14 January 1957 the Main Party had four major structures to begin erecting: the non-magnetic hut, the balloon shed, the generator shed, and the radio-echo hut. In addition, there were three small, sledge-mounted, remote aerial huts to be constructed. With good weather prevailing, all outside constructional work was completed by 20 March.

The non-magnetic hut presented the greatest difficulty, but despite previous doubts about the feasibility of driving wooden piles 20 ft. into the snow to provide firm instrument foundations this was quite easily done with the pile-driver, and other complexities of construction were surmounted with equal success.

Aerials were a major item. Two rhombic aerials (*each of 50 ft. masts*), one directed on London and one on Port Stanley, and a 78 ft. ionospheric mast were erected. The communication aerials and the new transmitter were brought into use on 14 February 1957. The radio-star scintillation aerials located at three remote sites, each with ten Yagi aerials, were completed by 6 March, while the radio-echo rotating aerial, with a 600 lb. motor at the apex of its tower, was operating by 15 March.

Setting-up of scientific equipment

A new power supply had to be installed before the full range of equipment could be brought into use, and this was provided by two 27·5 KVA generators, which were winched into the new generator shed. The switch-over from the old supply on 13 February 1957 went smoothly. Two of the superseded 7·5 KVA generators were in the generator shed as emergency and supplementary equipment and two remained in reserve.

The installation, testing and calibration of equipment made steady progress, for example, the Decca radar wind-finding equipment was brought into use on 14 February 1957, and the seismographs and radio-sonde equipment were ready on 21 February. Nightly observations of aurora commenced on 23 March, the ionospheric sounding equipment was brought into full operation on 1 April and installation of the geomagnetic instruments was completed in mid-April. Radio-star scintillations had been observed by 23 April, and radio echoes from a meteor shower by 29 April 1957.

Commencement of the International Geophysical Year

A signal was despatched to the Royal Society on 19 June 1957 reporting that the Base was fully equipped and in operational readiness for the commencement of the I.G.Y. on 1 July 1957.

The 1957 winter

By 4 April 1957 outside lights had been installed at all huts, including the remote aerial huts, and telephone lines laid to all except the remote aerial huts in preparation for winter. The telephone at the non-magnetic hut was necessarily installed in a box outside, and because of fire risk this was also done at the balloon shed. Stakes and shoulder-high guide ropes were put to the meteorological screen, and to all huts except the remote aerial huts. These arrangements permitted movement about the base site under the very worst weather conditions experienced e.g. a 60 kt. wind and 5 yd. visibility. Other precautions taken before the winter months included stocking the hut with sufficient food and fuel to last 3 months, and storing 6 weeks' supply of fuel oil inside the generator shed. Some of the precautions turned out to be considerably on the safe side. It had been assumed that certain activities might be impossible over long periods in winter, whereas in fact the cooks were able to bring in extra items from the dump throughout the winter, coal supplies were replenished on 5 June and 27 July, and there was not a single day on which fuel was not pumped from outside.

Although last seen on 29 April 1957 the sun is presumed to have dropped below the horizon on 3 May. The weather in the winter months was less extreme than expected as the following summary shows:

1957	Mean temp.	Min. temp.	Mean wind	Max. mean wind
May	- 21·4° C	- 41·2° C	16·8 kt.	52 kt.
June	- 23·4° C	- 40·9° C	17·8 kt.	55 kt.
July	- 27·2° C	- 50·6° C	18·0 kt.	60 kt.
August	- 32·3° C	- 50·2° C	09·1 kt.	26 kt.

The achievement of 1957

Summing up, 1957 went well. The building and unloading period went very smoothly, and the base was prepared for the I.G.Y. in good time as a result of a great deal of hard and willing work. The layout of the base site and the stores dumps proved satisfactory, stores remained reasonably accessible and every item was brought to light when required, although sometimes extensive digging was entailed.

Tribute must be paid to the way in which the whole party worked very long hours over a considerable period of time and all were exhilarated by the visible signs of rapid progress which could be seen from day to day. The end of 1957 concluded the first six months of the I.G.Y. The year 1958 opened with the party in good health and spirits, and looking forward to a further years work.

A view of main hut and construction site from the met tower 1957
(D.W.S. Limbert)

***THE MAIN PARTY:* SECOND YEAR**

The 1957-1958 Voyage

The m.v. *Tottan* left Southampton on 18 November 1957 carrying Dr A. F. Moore, the additional Expedition members and 100 tons of stores provided in case it should prove impossible to relieve the Base at the end of 1958. Also on board during this voyage was Lt J. F. Glennie, R.N., an observer appointed by the Admiralty, at the invitation of the Royal Society, to study ice conditions in the Weddell Sea.

On this voyage stores and relief personnel were also carried for the Norwegian I.G.Y. Antarctic Expedition, and the *Tottan* arrived at a mooring near the Norwegian advance base on Christmas Day. Norway Station itself was about 25 miles inland and Ellis made a ski trip to it. After unloading stores the *Tottan* left for Halley Bay on 28 December carrying three returning members of the Norwegian I.G.Y. team and a husky dog presented by the Norwegian party. The dog remained at Halley Bay throughout 1958; two dogs presented to the Advance Party by the T.A.E. had failed to survive 1956.

On 31 December 1957, Captain Jakobsen safely brought the *Tottan* to Halley Bay for the second time in the same year. The *Tottan* berthed against the fast bay ice 2¼ miles from Base along a route one mile longer than in January 1957. Long tow ropes on sledges were found advantageous to avoid the wet patches in the snow-covered sea-ice which soon appeared alongside the ship. During the six days of unloading, hourly sea current measurements were maintained.

Extensive use was made of indoor storage during 1958 and some of the food was stacked in the snow caverns alongside the hut. A store for scientific equipment was devised at the north end of the radio-echo hut where crates were stacked around the door of the hut to form a large roofed cave which when drifted over formed an extra room for storage.

Programme changes during 1958

The year 1958 saw some extensions to the scientific programme. Notable additions were the new aerial arrays at the remote sites, and the extension in the range of meteorological ozone measurements.

A 20 ft. high tower, constructed by Thomas to ensure an uninterrupted view of the horizon for the auroral all-sky camera, formed a new landmark.

Effects of snow accumulation

Several problems due to the steady accumulation of snow, aggravated by snow drift, were dealt with during 1958. On a flat drift-free surface snow accumulated throughout the year at a steady rate of 3 ft./year and packed to the consistency of soft sandstone around dumps and huts. Chutes fitted for the direct delivery of snow into bathroom and kitchen greatly reduced the labour of these tasks and a coal chute was constructed in February down to the north-west door of the main hut alongside the indoor coal store.

The insulation greatly improved with complete burial and temperatures remained high (about 20º C) and equable. The melting of the snow alongside the hut walls allowed air to circulate in the gap so that ventilation was not adversely affected by burial. Skylights were contrived for the kitchen and one bunkroom to let daylight into the windows some 12 ft. below the snow surface. Artificial lighting in the main hut was necessarily limited but with 6000 W distributed among 116 lighting points it was just adequate.

The outside doors fitted in the walls of huts soon became buried 15 ft. below the snow surface and were useless until tunnels were constructed from them through vertical shafts to the surface. No wall or roof supports were used in these tunnels but they were dug out from time to time as they compacted. One difficulty in tunnels was subsidence, accelerated by the heat of the main hut and freezing on the floor of the tunnel. Two tunnel exits were contrived for the main hut, and hatch entries were constructed for many other huts, the seismograph pit, and the emergency dump. The hatches in regular use consisted most conveniently of a small permanently open upward-facing entry maintained a few feet above the prevailing snow surface and not situated near strong wind eddies which drove snow-drift downwards.

Snow accumulation aggravated by the main hut drift was responsible for the severe bend which developed in the ionospheric mast in August 1958. A stand-by aerial was immediately erected for the ionosonde so that many comparative calibrations were possible before the mast finally collapsed. This occurred in October, despite frequent guy-rope adjustments made immediately after every gale. Replacement aerials for the absorption equipment were completed a week after the collapse and in the interval some absorption measurements had been made using the ionosonde aerials.

Main accommodation building September 1957

The balloon shed door required digging out after every spell of drifting snow and by September this meant digging the whole 10 ft. depth of the door after every spell of severe drift. Overheating of the generator shed, partly due to its burial and consequent insulation was countered in September by fitting a roof hatch and an extractor fan to prevent further melting beneath the shed undermining the foundations.

The 1958 winter

For the 1958 winter guide ropes were again erected, the existing posts being pulled out of the snow with block and tackle. The sun was last seen from 1325 to 1345 G.M.T. on 5 May: this was 4 days later than thought possible, and after making due allowance for normal refraction it appeared that a Novaya Zemlya effect to the extent of 44' had been observed. The sun remained below the horizon until 11 August. Near midwinter, from 1120 to 1230 G.M.T. on 18 June, there was an exceptionally fine and bright red northern sky.

All scientific work continued throughout the winter. The most unpleasantly cold weather of the year occurred early in winter when in a 19 kt. wind on 28 April 1958 the air temperature was -44·5º C; this was slightly less severe than that of 13 August 1957 (30 kt., - 45º C). Undoubtedly the most unpleasant conditions occurred during the highest winds, mainly irrespective of air temperature; these were days which involved many people in the unpleasant work of digging out the balloon shed door, and demanded skill and persistence in launching balloons in a visibility as low as 2 yds. A high gale frequency (about 6 gale days per month) was a feature of March and of the six months from June to October. The most severe month was June (8 gales) but 27 October 1958 brought the strongest gale: between 0630 and 0830 G.M.T. the wind was mainly force 11 (storm) or 12 (hurricane) with a maximum gust of 82 kt. To assist balloon launching during winter gales 1000 W of lighting was installed at the balloon shed and found invaluable.

Hoar and rime frosts were prevalent for much of the year and the insidious build-up of these deposits affected much outdoor equipment. Outdoor meteorological equipment needed frequent and repeated cleaning during these times. Frost built up on aerials, greatly increasing their wind resistance and in some cases impairing efficiency.

Preparations for transferring the Base to the Falkland Islands Dependencies Survey

Work carried out in the latter part of 1958 included the digging out and movement of stores and equipment, certain improvements to aerials and other outside equipment and outdoor scientific and survey work. An attempt was made to form a compacted route between the ice-front and the Base by daily tractor runs to the bay. By 15 December the route, marked by flags, was compacting well; it was tested with a load of 2 tons (12 fuel drums) on 5 January and thought satisfactory. Unfortunately the cloudy weather and high air temperatures encountered during unloading spoilt the route so that tractors occasionally bogged down with a load of only 8 drums.

In preparation for the Falkland Island Dependencies Survey party who were to take over the Base early in 1959, sets of notes covering all practical aspects of the day-to-day meteorological, geomagnetic, glaciological and seismological programmes carried out in 1957-58 and to be continued in 1959 were written up for the guidance of the F.I.D.S. party. Preparations were made for removing the ionospheric equipment to Britain for overhaul. The radio-echo equipment was put on a care-and-maintenance basis, but the radio-star scintillation equipment (except aerials) was brought back. In all, *ca.*750 $ft.^3$ of scientific records and equipment were packed.

GENERAL OPERATIONAL TOPICS

Communications

Regular communications schedules were established and worked with Port Stanley Radio Station by the Advance Party. Contact was made with Shackleton base and the U.S.S.R. base at Mirny, but not until mid-October 1956 was a satisfactory radio link with the T.A.E. established, after a beamed aerial had been erected. The main transmitter was on the air on 17 February 1956. In March 1956 successful tests were carried out with the British Broadcasting Corporation in London over a Post Office link: this method was later used by the T.A.E. at Shackleton Base. Much work was done by Watson, Powell and Evans on the suppression of electrical noise from the 7·5 KVA generators used in 1956.

A more powerful transmitter and new aerials were brought into use on 14 February 1957, after which the Base had excellent communications facilities, maintaining regular schedules with London, Port Stanley, and many Antarctic bases.

Fire precautions

Fire precautions, organized by Lush for the Advance Party, included the daily topping up of the kitchen (160 gal.) and bathroom (80 gal.) tanks. A fire point half way down the centre corridor comprised two 40 gal. oil drums filled with water and elevated 2 ft. to prevent freezing. Buckets, stirrup pumps, breathing apparatus, axes, asbestos smothering cloths etc. were set aside and a crowbar was suspended as an alarm with a striker and a whistle. Specially marked snow shovels were put at the outer doors and fire extinguishers of both the carbon dioxide and dry chemical types placed throughout the buildings.

There was only one occasion on which there seemed any real possibility of an outbreak of fire; that was on Midwinter Day 1957, when a small silver spirit lamp overflowed on to the table. The resulting blaze was extinguished with great promptitude by the Fire Officer, using an asbestos blanket. On another occasion a quantity of fat caught fire in the kitchen; this was also readily extinguished with an asbestos blanket. Once, the blockage of a bunkroom chimney resulted in the production of a detectable, although not dangerous, quantity of carbon monoxide.

Mail

The Base Leader acted as Postmaster. In 1957, for example, the Post Office was open for the sale of stamps from 26 to 31 January, from 10 to 13 December and on 30 December 1957, a total of 4,786 Falkland Islands Dependencies stamps of all denominations being sold, including some of the issue bearing the T.A.E. overprint.

Besides the annual postal delivery by ship, 'mail' came in with the aid of the radio link between Port Stanley and Halley Bay, on average once a month although there was none during the winter months. Telegrams could be sent and received at any time. A telephone service was started on 2 December 1957 and was operated regularly with varying success. A regular news service was maintained by daily posting of Ship Press News Bulletins.

SPECIAL EVENTS and OBSERVATIONS

Sighting of Tottanfjella

In October 1956 abnormal atmospheric optical conditions enabled a range of mountains to be observed on the eastern horizon from Halley Bay and Dalgliesh called them the '*Tottan Mountains'*, On 11 January 1957 the Otter aircraft of the Trans-Antarctic Expedition piloted by J. Lewis, flew from Halley Bay to inspect these mountains from the air. The passengers included V.E. Fuchs, G. Lowe, D.G. Dalgliesh and R.A. Smart. These mountains are 230 miles east of Halley Bay in the Norwegian sector of Antarctica and are about 50 miles in length; some of the snow-free peaks exceed 9000 ft. The name *Tottanfjella* has been given to them by the Norwegian Antarctic place names committee.

Reception of signals from artificial earth satellites

Radio signals from the U.S.S.R. artificial earth satellite 1957 (Sputnik 1) were heard at Halley Bay on 7 October 1957 on 20 Mc/s at 1000 G.M.T and subsequently. The second U.S.S.R. satellite was not identified with certainty, but was possibly picked up on one occasion. Satellite 1958 (Sputnik III) was heard on 20 Mc/s on 16 May 1958 during its fourth revolution.

Solar eclipse

The solar eclipse of 23 October 1957 was observed as very nearly complete at Halley Bay, and reached its maximum at 0700·5 G.M.T. A corona was clearly visible. Due to storm-type disturbance prevailing at this period the ionospheric effects of this eclipse could not readily be interpreted.

Reception of television signals

British Broadcasting Corporation television sound transmissions from London on 41·5 Mc/s were monitored using a five-element Yagi array. Around 21 April 1958 the broadcast was received daily from 1300 to 1800 G.M.T. depending on ionospheric condition; it was not received during the summer or winter months. The television vision signals on 45 Mc/s were received occasionally but were not systematically monitored.

Journeys

The Base was not equipped for extensive travelling and there were few personnel whose work permitted them to be absent for more than a few days at a time. There was nevertheless considerable keenness and enthusiasm for this type of activity, and journeys were encouraged. A number of man-haul journeys totalling some 180 miles were made during 1957, and topographical, meteorological, and glaciological information obtained.

Such trips continued to be keenly supported in 1958: four excursions were made by groups of two to four members (sometimes with the dog), who altogether covered a total of about 300 miles. The object of the two journeys was to reach the slopes of the ice-cap abutting the ice-shelf. In March, Constantine, Brenan and the dog were prevented from attaining this object by a series of deep steep-sided valleys 30 miles south of Base, and in October, Bellchambers, Burton, Edwards and Harrison were held up by bad weather on an apparently clear route along 120º E of N. The latter route was seen from the air in 1957 to lead into an area where the ice-cap merged into ice-shelf with minimal disturbance. The greatest distance covered was in a round trip during November of about 125 miles in 10 days by Barclay and Brenan with the dog on a bearing 070º from Base.

Recreation

There was a weekly film show on Saturdays throughout 1957-58. Other than this, no need was felt for regular organized entertainment. Time does not hang too heavily on an Antarctic base, the difficulty being rather to find time for all to be done. On a typical evening, people who were not working were engaged in reading or listening to music in the lounge, in washing, or in mending clothes, but in winter there were occasional games of chess. The dartboard was used fairly often, especially on Saturday nights, but its popularity was spasmodic. In fine weather there was a good deal of walking or skiing particularly to the penguin rookery, or to Halley Bay. The six mile walk from the Base along the sea ice from Emperor Bay to Halley Bay and back remained popular. In October 1958 fast ice under the intervening cap broke away; it was at its most spectacular during the moonlit nights of winter.

Domestic social occasions in 1957

A message from the Base was conveyed to H.M. the Queen on Her Birthday, 21 April 1957, and was graciously acknowledged. Being Easter Sunday, this date was marked by a religious service and a luncheon at which the loyal toast was given.

Midwinter Day was celebrated on 21 June 1957. Following a luncheon which included items from a hamper presented by the President of the Royal Society, appropriate toasts were given. A gift box from the Scott Polar Research Institute was also greatly appreciated. Greetings were exchanged with other Antarctic bases and various bodies and individuals in the United Kingdom.

Highlights of the 1957 Christmas celebrations were the broadcasts by H.R.H. Prince Philip and Sir David Brunt on Christmas Eve; a traditional Christmas dinner and tree; a special edition of the Base newspaper, the *Halley Comet*; and a film show on Boxing Day.

Domestic social occasions in 1958

H.M. the Queen's Birthday was celebrated on 21 April 1958. On Midwinter Day, 21 June 1958, there was a feast from a hamper provided by the Royal Society, a special edition of the *Halley Comet* and an exchange of greetings. The birthday of Edmond Halley was appropriately marked on 29 October 1958.

On Christmas morning 1958, H.M. the Queen's radio message was heard in the lounge, which had been decorated a few days earlier with traditional paper chains and balloons, and this was followed by a magnificent lunch. The last edition of the *Halley Comet* was issued and in the evening there was a film show.

Note: Extracts from pages 11 to 26 of Volume 1 of the Royal Society I.G.Y. Expedition.

DESIGN OF THE BUILDINGS

Introduction

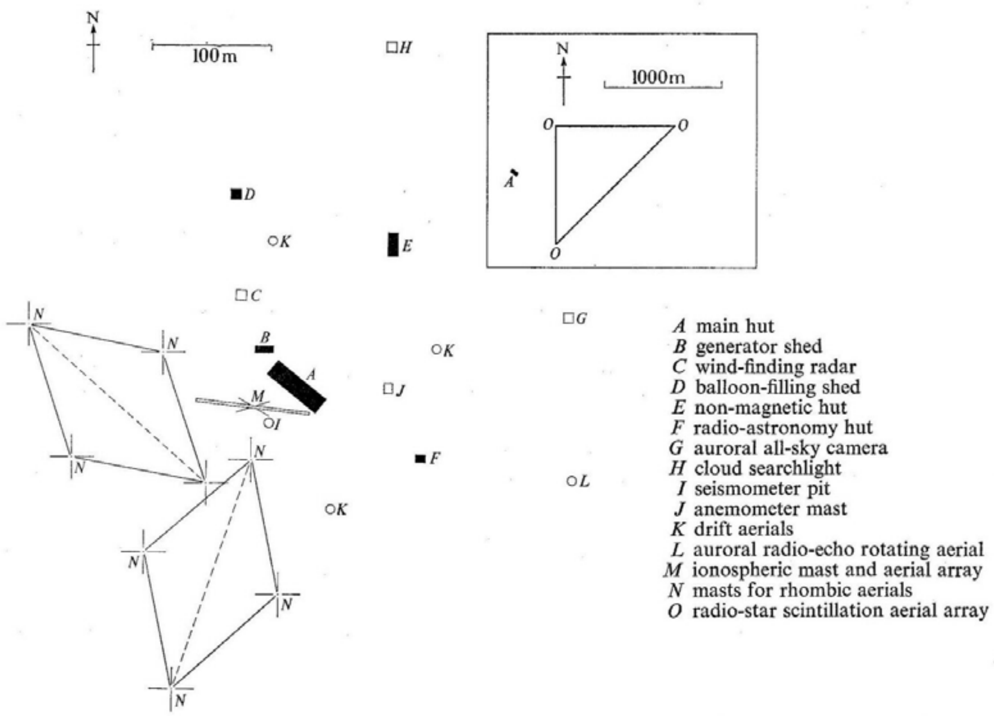
The station at Halley Bay comprised five main buildings and three remote shelters for radio-scintillation receiving equipment. The buildings were designed by the Civil Engineering Department of the Crown Agents for Overseas Governments and Administrations in consultation with the scientific programme supervisors and Expedition personnel. The huts were supplied and prefabricated by Boulton & Paul Ltd.

Siting of the buildings

When erecting the main hut, the only effects of drifting snow that had to be considered were those directly related to a solitary structure on an otherwise flat surface. The distribution of the drifts generated by the main hut was communicated by the Advance Party towards the end of 1956, and a provisional layout of the buildings was planned with this information. The final location of each building departed only slightly from this plan. The two principal factors which affected the location of the huts were:

(a) The pattern of the drifted snow.

(b) The nature of the scientific work to be undertaken in each hut.



I.G.Y. Base plan showing the final location of each building and the disposition of the aerials; the inset shows the layout of the radio-star scintillation aerial arrays.

Design

The design was influenced by the need to restrict the weight of the individual components to about 100 kg wherever possible.

The building was designed to withstand a wind speed of about 90kn, with an allowance for gusts in excess of this value (up to 110kn), although the effect of the wind would become progressively less as the snow accumulated.

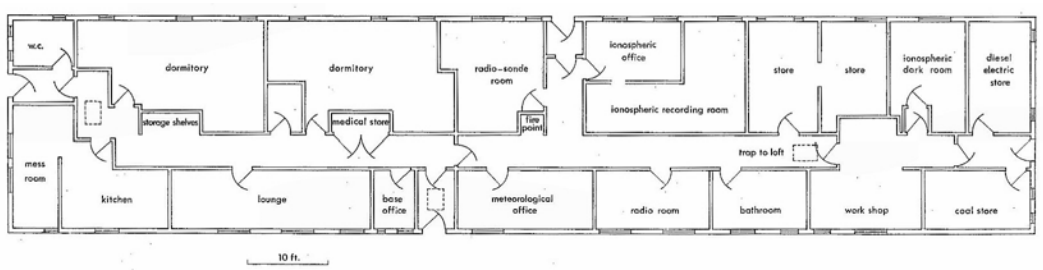
In calculating snow loading, it was envisaged that the building would become completely buried within two years. The ultimate snow loading was not readily assessable, although there was evidence that when a building had become completely buried, there was a tendency for the compacted snow to 'arch' over a roof structure so giving a greater incidence of pressure at the eaves than at the ridge. Horizontal pressure was also expected against the side walls. Allowance was made for these conditions: the vertical snow pressures finally adopted were 730 kg/m² on the upper half of the roof slope and 1460 kg/m² on the lower half for all arching effects. Evidence that even higher local pressures had been recorded by the Norwegian – British – Swedish expedition, and the belief that high pressures could quickly develop under the influence of the relatively unpredictable effects of drifting and ice shelf movements, led to the conclusion that the loadings adopted were reasonable for the design of long-term structures. It was expected that the building would be required for a period of 3 years. In fact, the main building was still occupied 10 years after erection even though heavy drifting caused asymmetric sinking of the building which tilted by 2º from the vertical in the first 3 years.

A summary of some principle characteristic of the building is given in Table 1.

TABLE 1	Dimensions (ft.)	Weight (tons)	Shipping Space Required (ft³)	Building Period Required (days)	No. of men Employed
Main hut	128 x 27 x 16	112	10800	75	10
Non-magnetic hut	73 x 17 x 10	43	4950	51	5
Generator shed	31 x 18 x 13	14	1406	68	3
Balloon-filling shed	21 x 15 x 18	10	950	41	6
Radio-astronomy hut	25 x 12 x 8	5	550	22	2
Remote shelters (3)	7 x 5 x 8	2	305	10	1

Main living building

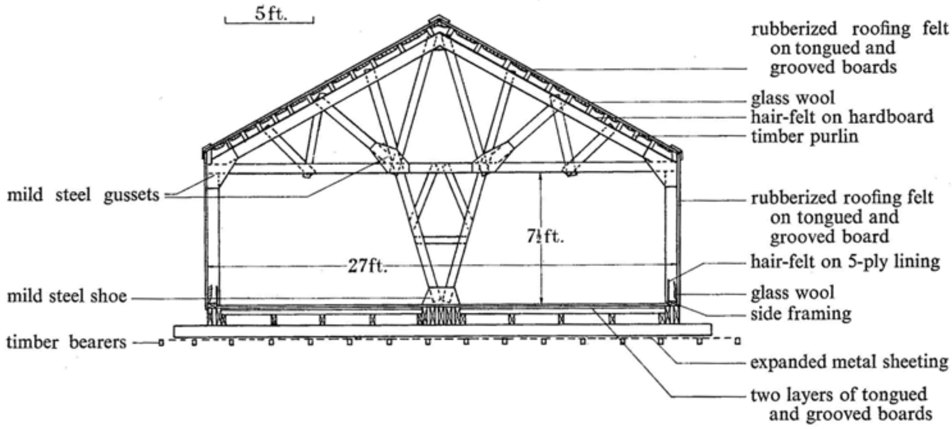
The main living building must have been one of the largest single buildings to have been erected in Antarctica. It provided accommodation for 20 men, rooms for meteorology, ionospherie and communications, darkrooms, a workshop, stores and other facilities together with extensive storage space in the roof. Although the design loading led to heavy framing, the living building, in common with the other buildings, was constructed of timber since this was the best material for handling in conditions of extreme cold and offered congenial living conditions.



Layout of the rooms in the main hut at Halley Bay

For all buildings except the non-magnetic building, a heavy timber grillage base was laid directly on top of flat expanded metal sheeting secured to timber bearers. This construction, while ensuring satisfactory support, resulted in a pressure of only 68 to 137 kg/m² on the snow surface.

The framing adopted is shown in the typical cross section diagram, the timber trusses having a centre shoe to resist the upward pressure of snow beneath the floor and to give the necessary lateral resistance to wind and snow pressures. Adequate lateral and torsional strength appeared to be an essential requirement particularly for the larger buildings. Although the living building tilted and the ice shelf moved about 850 metres each year, no structural failure was observed. The outer walls were clad externally with bituminous felt on tongued and grooved boarding and with 5-ply wood on 6·3mm thick hair felt. Glass wool insulation was provided between the inner and outer skins. The roof cladding consisted externally of two layers of bituminous felt secured by battens to a layer of tongued and grooved boarding and internally of a hardboard lining and hair felt, glass wool insulation being provided. The floor joists were covered with two layers of tongued and grooved boarding separated by bituminous felt while the intervening spaces were packed with glass wool protected by hardboard. All internal partitions were non-load bearing to facilitate ready removal and re-arrangement.



Typical cross section though the main building showing the framing.

Precautions were taken to insulate the floor from the heating and cooking stoves to avoid melting the snow below the foundation mat. Slight depressions in the snow surface under the stoves were noted in 1959, nearly 4 years after erection of the building, but the grillage foundation and expanded metal mat were found to be in perfect condition in 1960.

Snow accumulation and drift soon prevented the full use of all the doors and windows set in the walls. Bulkhead type doors fitted to two unburied entrances in 1957 were a great improvement over the ordinary doors previously fitted. Jamming was experienced, but was considered inevitable with almost any type of door under the prevailing conditions. Eventually, the openings were modified to lead into tunnels with vertical shafts to the surface whilst hatches were cut through the roof. Once the building was completely buried, the temperature became more stable and the ventilation was improved largely due to the cavern produced by melting and digging near the walls. The level of natural lighting could not be improved and 6kw of artificial lighting was just sufficient.

Generator building

The generator building consisted of a series of closely spaced timber portal frames supported on a heavy timber grillage with independent foundation rafts for the generators. Although the site was levelled, the varying degree of snow compaction was probably responsible for the occurrence of some differential subsidence and twisting of the foundations.

The independent timber grillage rafts on which the generators were mounted sank gradually until they fouled the main raft. The unbound foundations were occasionally shored up and this produced some undesirable vibration.

The full design snow load was never borne as the heat produced in the building quickly melted each batch of drifted snow on the roof. The building was lightly insulated with fibreglass in the walls and roof only, with heavy insulation in the floor to prevent melting the snow beneath the foundations.

Partially constructed generator shed from the north-west in 1957.

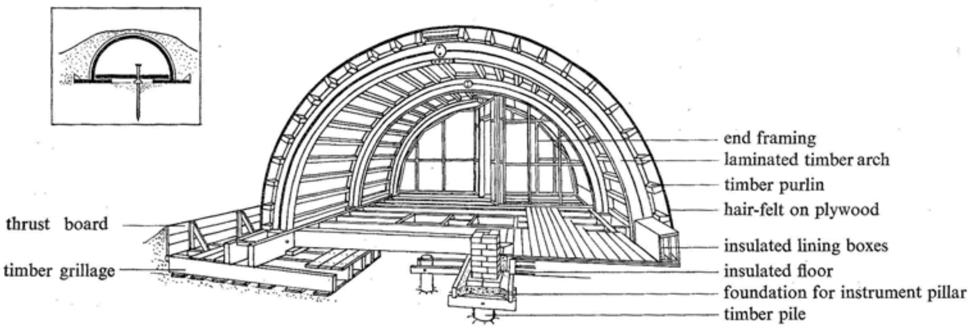
Non-magnetic building

A building constructed externally from non-magnetic material was required to house the geomagnetic recording instruments. The materials used, aluminium, brass and copper fittings and the sand, cement, brick and marble were all tested for freedom from magnetic properties.

Orthodox roof-framing was discarded in favour of semi-circular arches constructed of laminated timber, the laminations having been bonded in manufacture with waterproof resorcinol glue. Two parallel timber grillages supported on boards laid on the surface on the snow formed the support for the arch ribs. An insulated suspended floor spanned the grillages and, between the arch ribs, an interlocking system of insulated timber panels was fitted with timber wedges to obviate the need for metal fastenings. Trapezoidal section timber purlins were laid over the outside of the arch ribs.

The completed structure was in the form of a long barrel vault, clad on the outside with resin-bonded plywood laid over the purlins. The space between the external plywood covering and the internal insulating panels was ventilated and connected to ventilation trunking at the gable ends. The vents fitted inside the building could be sealed with removable insulating plugs.

As the magnetometer had to be provided with firm supports independent of the main structure, the instrument was mounted on marble slabs and brick piers supported, in turn, on round timber piles driven about 6 metres into the snow. The instrument pillars were thus physically isolated from the remainder of the building, an arrangement which avoided the transmission of vibration to the instruments.



Sketch of the non-magnetic building; the inset shows the relative size of the timber piles supporting the instrument pillars.

Balloon filling shed

The balloon filling shed provided accommodation for generating hydrogen and filling balloons, and storage space for the chemicals and radar reflectors. The shed was constructed with prefabricated timber components and was not insulated. In the west side was located a large door in the form of a roller blind shutter through which the inflated large diameter balloons were manoeuvered prior to launching. A smaller door, 1 metre high was fitted in the north side. An outward opening hatch which was fitted in the roof proved too heavy to use as an alternative balloon exit. The entire structure was carefully made to avoid sharp projections and corners which might have damaged the balloons. Precautions were also taken to avoid pockets where hydrogen gas might have been trapped. The hydrogen generator was housed in an insulated compartment of sandwich panel construction fitted with pyrotenax heating cable.

Three sides of the shed were kept free of snow by wind eddies which caused the formation of a 4·5 m wide chasm immediately in the lee of the west door. This down-wind exit became buried during periods of heavy drifting making it frequently necessary to dig away the snow.

Radio-astronomy hut

The radio-astronomy equipment was housed in a small timber-framed hut which was electrically screened throughout by aluminium foil 0·004 in. thick. The screening was bonded electrically across the doors and to the expanded-metal mat by contact strips. The doors, walls and roof were lightly insulated with fibre-glass, the heat output from the electronic equipment (*ca.* 3 kW continuous) being sufficient to maintain an equable temperature. After burial, an arch formed over the roof of the hut which, therefore, did not bear any snow load; however, melt water collecting on the flat roof gradually leaked into the hut.

Bulkhead-type doors were fitted to both entrances. These doors were quite successful, after the latches had been modified to prevent unlatching in high winds. A large porch was constructed from packing cases outside the north door, and this was approached by a vertical shaft entrance which could be raised progressively as the snow level rose. The 2 ft. square hatch opening, about 3 ft. above the snow surface, did not require a cover.

Radio-astronomy hut

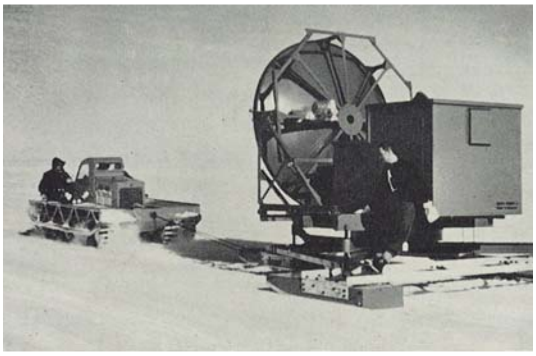
Remote aerial shelters

The three wedge-shaped remote shelters for the radio-scintillation receiving equipment were mounted on sledge-type runners so that, after being assembled near the Base, they could be towed to their final location. The sledge runner was integral with the shelter, the under side being covered with resin-bonded plywood curved fore and aft. Once installed at the remote sites the shelters did not need to be moved.

As only occasional entry was required, a bulkhead-type door secured with quick-release fastenings was originally fitted to each hut. However, as these catches were difficult to manipulate, access was eventually contrived by cutting a small hole in each door just below the snow surface; each entrance was protected by a canvas bag.

Wind-finding radar sledge

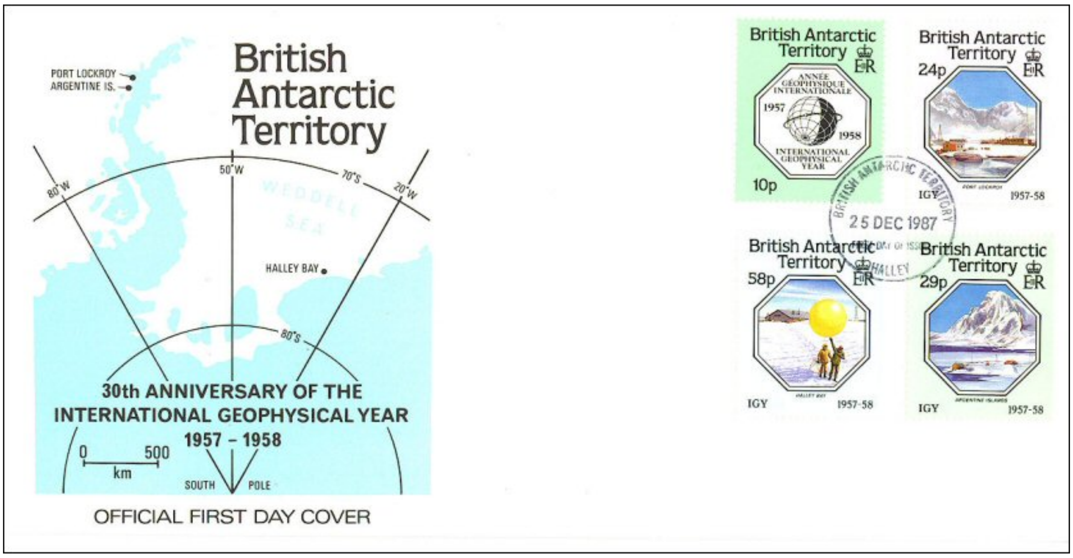
In order to prevent the 2½ ton Decca wind-finding radar from becoming buried, it was mounted on a mild-steel frame set on three wooden sledges which were faced underneath with resin-bonded plywood. The forward sledge unit was mounted on a pivot and equipped with a tow bar so that the whole assembly could be dug out periodically and winched clear of drifted snow. This arrangement was very successful.



Note: Extracts from pages 387 to 394 of Volume 4 of the Royal Society I.G.Y.

The main IGY hut practically covered by drifted snow in 1958 showings the beginning of a tunnel dug from door in the south-west side of the hut, and the plat-form mounted above the roof for the diffuse and total solarimeters.

30th ANNIVERSARY OF THE INTERNATIONAL GEOPHYSICAL YEAR 1957-1958



Official First Day Cover issued at Halley on 25 December 1987

The 10p stamp shows the logo and the other stamps depict three of the most important British IGY stations. Port Lockroy (24p) – the centre of British ionospheric research in the Antarctic Peninsula area – had been established in early 1944. Meteorological observations commenced there in 1944 and ionospheric work in 1952. The station was closed in 1962 and its programmes were transferred to the Argentine Islands. *(These islands were given their name by the French Polar explorer Jean Charcot.)*

The Argentine Islands *(Faraday)* station (29p) was set up in 1947 at Winter Island and moved in 1954 to the nearby Galindez Island. It was developed into a full geophysical/meteorological observatory for the IGY. It was occupied continuously for a total of 49 years and 31 days by FIDS and BAS.

Halley Bay (58p), now known as Halley. Notable among its long-term achievements are high quality continuous ozone measurements dating back to 1957 which, together with observations from the Argentine Islands, provided the first evidence of serious depletion of the Earth's ozone layer subsequently confirmed by US satellite data.

IGY programmes were also carried out at six of the other nine main British stations in operation in 1957-58 in the Antarctic Peninsula area, South Shetland Islands and South Orkney Island.

Chapter 3:

Falkland Islands Dependencies Survey Base

Halley Bay No.1 1959-1967

The 1958-59 Voyage

The *Tottan* had again been chartered to relieve the Base at the end of 1958 and she also carried the party of Falkland Islands Dependencies Survey **(F.I.D.S)** personnel led by G.R. Lush who were to continue the scientific programme during 1959. She left Southampton on 21 November 1958 and good radio contact was maintained during her voyage to Halley Bay. On 7 January 1959 she was at 68·9º S 4·8º W in heavy drift-ice which was destined to be met again. Two days later she was in a wide shore lead at 71·8º S 15·8º W, the vicinity of the subsequent besetment. When the *Tottan* berthed in Halley Bay on 10 January 1959 in perfect weather, she was first sighted by base members at 1826 L.M.T. steaming along with a superior miraged bow wave. The edge of the sea ice was 2¼ miles from Base and three small cracks in the ice were bridged with heavy corrugated iron sheets.

Unloading began on 11 January but the weather and surfaces deteriorated the next day and work had to be terminated early in the afternoon. On 13 January it was worse and the *Tottan* was forced from Halley Bay to take shelter to the north. During this interruption and at other convenient times the new party from F.I.D.S. was instructed on the equipment so that the continuity of observations was ensured. Command of the Base was formally handed over from MacDowall to Lush at midnight on 13/14 January 1959, but in bad weather it was only possible for five members of the IGY Expedition to go aboard the *Tottan* for the night of 14/15 January 1959. When the storm had abated the ship was able to moor 1¼ miles from Base, and as the bulk of the remaining stores was coal and fuel oil which would not be required for use until late in 1959 or early in 1960 these were unloaded to a dump on the ice-shelf.

Unloading was completed by midday on 16 January 1959 and after saying farewell the Royal Society Expedition sailed at 1930 L.M.T. The removal of the fast bay ice from Halley Bay by the storm meant that the *Tottan* soon moved out of sight of the F.I.D.S. party and into a wide shore lead.

The *Tottan* passed unobstructed through heavy open hummocked drift-ice in the Weddell Sea until 18 January when progress became very slow in closer pack. From 19 to 23 January the ship remained beset and drifted slowly westwards with the ice. Slow progress was made on 24 January towards a water sky in the north-west as from time to time the ship was freed from the grip of the ice by dynamiting and ‘poling’ operations, so that she slowly moved into less severe ice. On 25 January she came into an area of open pack which led to the open sea. As far as could be ascertained the edge of the close heavy drift-ice lay at 71·7º S 18·0º W and extended without interruption to the ice-front. From then onwards the *Tottan* had a clear but rough passage and met only small remnants of pack-ice at 68º S 19º W together with many icebergs. On arriving at Capetown on 6 February 1959 the members of the IGY Expedition left the *Tottan* and returned to Britain by several routes.

The Base

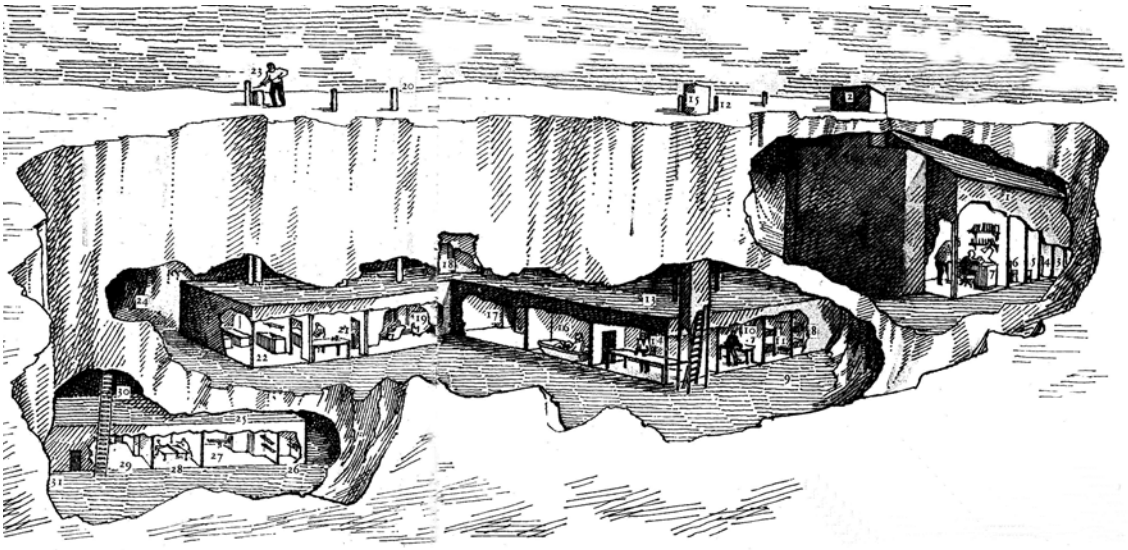
The 12 winterers of 1959 continued the IGY scientific programmes. At this time the base was well below the surface and this was the start of FIDS being known as troglodytes *(a name given by Sir. Vivian Fuchs).*

In 1960 it was decided to replace the main living building as it was continuing to sink deeper and deteriorate, and there was a need to increase the wintering personnel from 20 to 30. The replacement was to consist of 2 buildings about 60ft long by 26ft wide, one for living accommodation and the other for sleeping, which would be linked together.

The buildings would have strong flat roofs to allow for vertical expansion at a later date. The Crown Agents were responsible for the design, bills of quantity, procurement and the supervision of the packing.

In 1961 3 builders were employed to erect the buildings and they over wintered. There was a shortfall of major structural fixings. The building team did everything possible to erect the building in such a way that it was structurally stable by using nuts and bolts from base supplies and in some cases manufacturing them. I believe it was their intention that these fixings would be replaced the following year where accessible, but this proved impossible. It must be said that when the 2 buildings were completed they provided excellent facilities for living and sleeping on one floor.

As field and scientific programmes expanded there was need for a dedicated office building. This was erected in 1964.



Sketch of the Halley Bay Base central area 1956-67

Key		
1. Office block (built 1964)	11. Bunk room	21. Dining room
2. Aerial feeder hatch	12. Ventilator shaft	22. Kitchen
3. Meteorological office	13. Main living hut (built 1961)	23. Snow chute for water tanks
4. Geophysice office	14. Washroom	24. Tunnel leading to old hut
5. Surveyor's office	15. Main hatch	25. Old hut (built 1956)
6. Surgery	16. Bathroom	26. Paint store
7. Radio operator's office	17. Linkpiece	27. Carpenter's shop
8. Bunk room section	18. Old auroral office	28. Games room
9. Dog tunnel	19. Lounge	29. Old radio-sonde room
10. Drying room	20. Chimney	30. Ladder to IGY old hut

By 1966 the base was in a terrible state. Everywhere melt water was dripping through the roofs of the distorted buildings, plastic sheets hung beneath the ceilings and drainage gutters festooned the walls. Even bits of string were hung about to direct the drips. All this water drained into numerous buckets strategically placed, which required emptying two or three times a day. Tunnels in the ice outside the buildings were wet with standing or trickling water. The cause was movement of the enveloping ice which had fractured the buildings, allowing the internal heat to escape and melt the ice outside.

Building services

24 hour electrical power was provided by two Medoes 4-cylinder water diesel engines driving a MacFarlane magnicon.

27.5 KVA 240/415V 50 c/s 3-phase alternator.

The electrical loading (46kw) eventually proved to be far greater than was anticipated by the Royal Society. BAS upgraded the alternators by replacing with new ones.

Heating was provided by coal fires with some electric heaters. Cooking was done on a coal fired cooker, all the chimneys extended to the surface. 18 tonnes of anthracite stove nuts were used annually.

Ventilation was principally by natural means with the occasion use of extractor fans.

A simple system of snow melt tanks and hot water tanks was situated in the washing facilities and kitchen. There was no piped supply. Hot and cold water was obtained directly from the tanks. Water from sinks and shower discharged directly beneath the building. Snow pits to a depth of 12m approx were used as toilets and for disposal of wet kitchen waste.

Field work

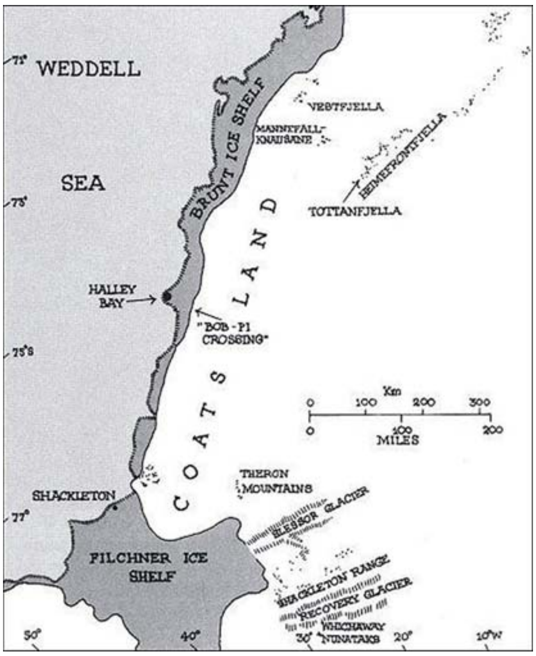
The siting of Halley Bay base was ideal for static geophysical scientific programmes at that time, but a major obstacle to future field programmes was the wide area of crevasses and chasms where the inland margin of the shelf ice met the land ice which became known as the 'hinge zone'. In 1960 and 1961 serious attempts were made trying to find a route across this zone.

In October 1961, Ardus and Johnson, after travelling 75 miles due east from base were at last able to turn southward and succeeded in crossing the fracture zone. For another 80 miles they followed the edge of the inland ice looking down on a confused and impenetrable maze of crevasses below them. From their height of 2,000ft they could see the peaks of the distant Tottanfjella along the eastern horizon and being unable to resist a challenge they pushed on for another 100 miles and on 14 November 1961 became the first men to set foot on these mountains. Thus it was learnt that from Halley Bay a detailed study of the Tottanfjella and its geology could be mounted.

In February 1962 a crossing was made by Muskeg tractors across the hinge zone almost due south of the base and this became known as the 'Bob-Pi Crossing'. As a safety measure maps were made of the crossing of the hinge zone using numbered flags and recording bearings and distances between flags.

Mapping and geology of the Heimefrontfjella, which includes the Tottanfjella went on apace in 1963 and 1964 and was completed in 1965.

In 1956 TAE surveyors had drawn a preliminary map of the Theron Mountains. Ten years later FIDS had the opportunity to complete the work in detail, provided that a land route from Halley Bay could be found.



In October 1966 a trail was broken towards this area with 3 dog teams. Four weeks later a support party followed them in three Muskegs, establishing depots at fifty-mile intervals. Seventy-five miles from 'Bob-Pi Crossing' they were surprised to find themselves at over 4,700 feet but thereafter it was downhill all the way to the Therons.

In November the tractors caught up the dogs and the survey began, the teams working ahead to find crevassed areas which began to appear fifteen miles from the mountains. These caused the vehicles some trouble but no major recoveries were necessary. In a few weeks the mapping was finished and only a small part of the geology still remained to be done.

2 glaciological projects commenced in 1965/66. One was to sound the depth of both the inland and the shelf ice using radio-echo equipment developed at the Scott Polar Research Institute. The other was to establish the dynamics of the Brunt Ice Shelf.

Field huts

For safety reasons the Bob-Pi hut was erected in November 1962 on the inland ice side of the hinge zone about mid-way up the final ascent slope to crossroads depot.

Coats base hut was erected in November 1964, and removed in March 1965 200 miles south of Halley Bay to allow the triangulation of ionospheric measurements between it, Halley Bay base and the Argentinian General Belgrano base.

Memorials

On a sad note there have been 5 fatalities at Halley. Memorials have been erected to:-

N.S. Mann who was lost on sea ice in 1963, along with his dog team: plaque at Halley.

J.T. Bailey, D.P. Wild and J.K. Wilson who died in a crevasse accident in 1965 in the Tottanfjella region: plaques erected on Survey Point, Vardeklettane, Heimfrontfjella and at Halley.

M.V. Mosley who died in an aircraft accident in 1980: plaque at Halley.

Sledge mounted memorial 1967 (A. Smith)

Survey historical background 1943 to 1967

In 1943 the British Government established its first stations in the Antarctic as part of the wartime expedition known as Operation Tabarin. The objectives were to prevent access to anchorages by enemy ships and to strengthen Britain's claim to the Falkland Islands Dependencies. This provided the opportunity to undertake scientific work. Operation Tabarin was a joint undertaking by the Admiralty and the Colonial Office. In 1945 it was renamed the Falkland Islands Dependencies Survey *(FIDS)* and all control passed to the Colonial Office. At this time there were four stations, three occupied and one unoccupied.

In 1962 FIDS was renamed the British Antarctic Survey *(BAS).* Until 31 March 1967 the Survey was under the overall control of the High Commissioner for British Antarctic Territory (who is also the Governor of the Falkland Islands and its Dependencies). With effect from 1st April 1967 responsibility for the organization was transferred to the Secretary of State for Education and Science, who decided that it should be brought under the direction of the Research Councils which controlled the whole field of Government relations with science under the Science and Technology Act of 1965. Since the Survey's activities are predominantly in the environmental sciences, responsibility for controlling its work was delegated to the Natural Environment Research Council *(NERC).*

At that time the director of the Survey was Sir Vivian Fuchs and its headquarters were at 30 Gillingham Street, London, SW1. The scientific sections were housed with various university departments.

- Geology at Birmingham University.
- Geophysics at Edinburgh University.
- Botany at Birmingham University.
- Zoology at Monkswood Experimental Station, Huntingdonshire.
- Glaciology at Scott Polar Research Institute, Cambridge.

Until 1967 all permanent research facilities established by the British Antarctic Survey and its predecessors were called bases. Those operating since then have officially been referred to as research stations. At the same time the title of the person in charge changed from base leader to base commander.

Chapter 4:

Establishment of the British Antarctic Survey Research Station

Halley Bay No.2 1967-1973

Recruitment

All the people who have gone south have gone through some form of interview board. For a number of years I had been writing to the Survey, then one day in 1966 a letter arrived inviting me to attend for an interview in London in mid-August for the post of over wintering GA/Builder. At that time I was a Building Inspector with a local Council with prospects of a job for life and a pension.

I had always been interested in the historical past of the Antarctic expeditions and had knowledge of the building techniques of building on perma frost.

On the train to London I was apprehensive but on arrival at Gillingham Street there was a warm welcome. My interview board consisted of W.O. Sloman, D.R. Gipps and J. Shirtcliffe. I was surprised to find that there were very few technical questions. They were more interested in how I would cope with the environment and my work colleagues. I left the interview feeling that I had done all I could but was not sure I had been successful. Ten days later a letter arrived saying I has been accepted and to attend a conference in Cambridge at the Scott Polar Research Institute, the first week in September 1966.

The 1966 BAS conference

The conference started at 1pm. on a Monday afternoon and finished at noon on the following Friday. Everyone who was going south that season attended the conference. At the conference I found out that I would be paid and to which base I would be going and I thoroughly enjoyed it. Each of the scientific sections gave an illustrated lecture. The majority I could understand but not the one on upper atmosphere and beyond given by Joe Farman, too far into space for me. We were all given a handbook, full of information, and in the foreword by Sir Vivian he says 'a constantly recurring (and quite inaccurate) cry of past generations of 'Fids' has been 'nobody ever tells me anything'-well here it is!

Design of the buildings

The design and procurement was undertaken by the Civil Engineering Department of the Crown Agents for Overseas Government and Administration. The architect was Colin Baldwin. The design criteria used were the same as those used for the IGY buildings.

There were seven buildings, each 72ft. long by 19ft. wide by 13ft. to the ridge, consisting of steel portal frames linked with timber rails and purlins and clad overall with factory built insulated panels.

Two buildings provided sleeping accommodation, washroom, and drying rooms for 40 men. One building comprised a lounge, library, base office, and radio room; another building comprised a kitchen, dining room, and glaciology office. A fifth building was the tractor garage and workshops and the sixth building housed the two generators. There was also a bulk fuel store housed in a steel multiplate Armco arch. The last building contained the scientific offices. The buildings were spaced 20ft. apart so that the snow accumulation between them formed a natural fire break. The buildings were linked to a central cold corridor which had a toilet pit at one end and the main goods shaft at the opposite end. Each building had an emergency escape shaft.

Building services

24 hour electrical power was supplied by three generators for lighting, heating, scientific and communications equipment (One set held in reserve to allow rotation for overhaul).

Generators type: Rolls Royce McFarlane 96kw. 220v 50 c/s single-phase.

The total electrical load requirement was 80kw.

Heating was provided by electrical dimplex heaters. Reclaimed heat from the generators was used to heat the tractor workshop.

Cooking was done on a coal fired cooker.

Fire detection and alarm systems were provided with portable fire fighting equipment.

Ventilation was originally natural. Later extraction fans were installed in certain buildings.

Water supply: The 2 dormitory blocks and kitchen block had their own snow melt tanks situated in the lofts and both hot and cold water was supplied by gravity fed pipes to the showers and sinks. The hot water was heated by 9kw ‘Sadia’ heaters. Water from sinks and showers discharged directly beneath the buildings.

Snow pits to a depth of 12m approx were used as toilets and for disposal of wet kitchen waste. All other domestic waste was burnt away from the station complex.

The 1966 voyage

I embarked on the RRS John Biscoe at Southampton during the first week of October for a three month voyage. I found the John Biscoe an uncomfortable ship, mainly because of the smell of the diesel oil and of my being seasick for a week. Once past the Bay of Biscay I started to live again.

Life on board was not monotonous as we all took turns in being helmsman, helping to keep watch and maintaining the superstructure of the ship, holy stoning the wooden decks, washing down the paintwork and re-painting. Ship routine was set up as base life, serving food, washing up and keeping the common areas, showers, toilets and lounge areas clean on a daily basis *(gash duty).* On Sunday mornings there was a total scrub out of the ship and the captain’s inspection took place at noon.

There were lectures on first aid and other topics, and a film at least once a week. One person was elected to be the liaison between the fids mess and the captain, he was known as ‘King fid’.

Crossing the equator ceremony (A. Smith)

After 21 days we arrived at Montevideo where the ship was re-supplied with fuel, water and food, *(Uruguayan steaks for Saturday night dinners).* The duration of our stay was approximately 72hrs. I found Montevideo exciting and a great place to see American vintage cars, to dine out and visit the bars. As soon as we left the river Plate estuary the weather began to get cooler. 48hrs later we had sightings of penguins.

We arrived at Port Stanley in the Falkland Islands four days after leaving Montevideo and we discharged the cargo for the BAS Stanley office and the Royal mail for the Falkland Islanders. We received our Antarctic clothing from the logistics store, visited the communications office, had our interview with the Governor of the Falkland Islands and attended the Governor's official welcoming reception. The Falkland Islanders made us very welcome, especially at the Rose and Crown hotel run by George and Velma. At that time there was no place to get a hot meal ashore other than in people's homes. Velma would always provide egg and chips.

RRS John Biscoe moored at the public jetty in Port Stanley (A. Smith)

The voyage continued south to Signy Island encountering seven tenths sea ice en-route. We eventually arrived at Signy base where only a part relief was possible due to sea ice. A number of the Halley building team left the ship here to help with restoration work on the jetty. I was allocated to stay on board to assist with the geological landings at various points on the peninsula en-route to Argentine Island base. Whilst assisting the geologists I found out that although the Survey had employed the geologists for almost a year they did not know their area of work until they opened their sealed orders after the ship had left Southampton. This, I believe, was to ensure an open mind.

On arrival at Argentine Island a full relief of the base was possible. After discharging the coal our shiny new clothing was anything but shiny. I shall never forget the voyages through the Lemaire channel *(normally people going to Halley went via South Georgia and Signy).*

The Biscoe arrived back at Signy where we were able to complete the base relief. We took on board mail from the base and the Halley builders who had been working on the jetty. The ship returned to Port Stanley for fuel, water, mail and the builders destined for Halley base transferred to the Danish charter ship 'Perla Dan', which contained all the new base cargo and where we joined the rest of the wintering base members, Sir Vivian and a French observer.

The Perla Dan left Port Stanley with the John Biscoe for Halley Bay via King Edward Point on South Georgia and Signy and arrived at Halley Bay the first week in January 1967. On board the John Biscoe were the Adelaide and Stonington bases' relief personnel.

Lemaire Channel 1966 (A. Smith)

Picture to the right shows the Perla Dan moored at the public jetty Port Stanley. (A. Smith)

Relief of base

A 24hr 2 shift system of 12hrs each was operated, people being dedicated to work on board ship, existing base, new site or the transportation team. The first priority was to discharge the cargo from both the Perla Dan and the John Biscoe.

Whilst the relief was going on, a large piece of the ice shelf calved, setting up a chain reaction which resulted in further collapses of the seventy to ninety foot cliffs of the ice front north and south of the base. In turn this caused a swell which broke off part of the ice slope onto which we had been unloading. Suddenly the ships were forced to cast-off and move hurriedly into open water, many square miles of which were now covered with large fragments of brash ice. After a few hours we nosed our way cautiously back but Halley Bay had vanished. Discharging became more difficult but full relief and all building materials were put ashore without the loss of any item. The relief took 10 days.

During this time the medical team had their problems by having to undertake an appendix operation at the existing base under very difficult working conditions.

The Base site Lat. 75º 31'S, Long. 26º 39'W.

The new base site was 2 miles from the existing base and 3 miles from the new ice front.

Building the new base

The building programme started by dividing the building personnel into 2 teams, a day shift and a night shift, each working 12 hours on site and travelling to and from the ships. Colin Baldwin was in charge of the day shift and Jim Shirtcliffe of the night shift. There was only one break of half an hour during the shift for bread and soup.

A bulldozer was used to level the site. The finished surface was tamped using screed boards. Galvanised corrugated sheets and galvanised mesh was placed on the level snow surface to form sub-foundations. (E.J. Chinn)

Picture above shows the timber grillage raft foundations and also the laminated timber beams, which weighed 16 cwt. each, to support the floor and steel portal frames. (E.J. Chinn)

Picture to the left shows floor panels in situ and wall and roof panels being fixed. (E.J. Chinn)

Picture to the left shows the Butyl sheeting being fixed to the roof panels using adhesive. This was very successful. (E.J. Chinn)

Picture to the right shows the Armco tube completed and housing the fuel oil flubber. This was the first time this type of bulk fuel storage had been used at Halley Bay (E.J. Chinn)

The John Biscoe sailed on 1st February 1967, with the relief personnel for Adelaide and Stonington bases, when four of the buildings had been erected and weatherproofed. The Perla Dan sailed on 28 February 1967 when all seven of the buildings had been erected leaving the wintering team to complete the work. The build would not have been as far on as it was without the help and total commitment of all the base members and all the relief members, including those for Adelaide and Stonington.

The total wintering complement at the two bases numbered 38 with Ricky Chinn as base commander and Jim Shirtcliffe in charge of the building team. During the winter the fitting out and decorating of the sixth building was completed. The seventh building, the office block could not be completed due to a shortfall of internal fitments.

The mechanical and electrical services were installed by the diesel mechanic, the tractor mechanics and the electricians. Communication aerials were erected and equipment installed by the two radio operators.

Base Commander E.J. Chinn (A. Smith)

The 1967 winter

The station complex became known as '*Grillage village*'. The winter was no different to any other and work on the base continued at a good pace. The wintering team moved out of the loft and into their allotted 2 man bedrooms. Stores were transferred from outside into the loft storage areas. A snow cave was dug for use as a refrigerator and a snow tunnel was constructed for the dogs.

I found that time did not drag. There was always something to do. It was agreed that the official working time for the team would be 12hrs per day Monday to Friday. On Wednesday evening the rum ration was issued and it turned into an informal gathering. Saturday morning was dedicated to 'scrub out' and outside work which included bringing in coal, fuel for the generators, and raising each outside dump in turn. When this work was completed there was a special buffet lunch. On a Saturday night the old base members invited us down for a meal and a film show. As the winter progressed the temperature in the living area of the old base went down to -18º C. There was no doubt in our minds that we needed to finish the new base as soon as possible. I also realised that what was happening to the old base would, in time, also happen to the new one.

On mid-week evenings lectures and instruction were given on communications in the field i.e. learning Morse code, first aid in the field and travelling techniques. The scientists would also give us talks on their specialised subjects and what they hoped to achieve. Through this the two bases bonded. Sunday was a so-called day of rest but most people continued to work. The hard worked cook had a day off and some lucky or unlucky fid had to cook. Base members' birthdays were not celebrated individually but monthly, which co-incided with the twelve special party boxes supplied by the survey *(real goodies).*

Midwinter's day was special and lasted about three days. A mix of old and new base members had been secretly writing and rehearsing a pantomime. This was given on midwinter day after a 5 course lunch. The pantomime was a great success and is well documented elsewhere.

After midwinter's day planning started in earnest for the forthcoming field season i.e. the big push for the Shackleton range. The sun returned, although the temperatures were still low. The dog teams' training programme commenced and outside maintenance of the new building also started.

At the end of November John Brotherhood, our doctor, and Jim Shirtcliffe, were on a man-hauling medical research project when they unfortunately had an accident. BAS HQ was advised on 1st December 1967 that John had been seriously injured and that he needed expert medical attention soonest. Sir Vivian arranged with his American colleagues for them to do a medi-vac. Base was advised on 4th December 1967 that two L-C130 ski-equipped Hercules aircraft had left the American station at McMurdo Sound and would arrive in 2½hrs time. Everyone helped to dig out used fuel drums and to lay them out in two lines at 50yds intervals, marking a strip 1½ miles long by 30yds wide. At the approach end the entire stock of cocoa was used to mark an arrow pointing eastward along its length to indicate to the pilot where to land. The pilot landed some distance from the base complex and taxied in thinking that our indicators were some form of experiment. He said the markers had been visible at 15,000ft and asked what we had used. When told, he did not understand the word 'cocoa', so we told him it was 'drinking chocolate' and that we had used our entire stock.

After the American doctor had examined him, John was transferred to the aircraft. The aircraft took off amid the combined roars of engines and JATO *(jet assisted take-off)* bottles and a rising cloud of billowing snow. It flew to McMurdo, landed to take on fuel and then flew directly to New Zealand, 6,000 air miles in total. John made a full recovery. 10 day later another Hercules was seen flying over the base complex at about 10,000ft. We managed to make contact with the pilot who said he would be air dropping some supplies. We all thought about American steaks, etc., but when the parachuted containers were opened, you've guessed it, they were found to contain drinking chocolate!

One good thing to come out of this incident was that John Brotherhood wrote a field medical guide *(KURAFID first edition 1970)* for use in the Antarctic by BAS. This medical guide has been updated regularly and is in use today, not only by BAS, but by other organisations.

L-C130 ski-equipped Hercules (A. Smith)

Whilst the base commander was advising Stanley office that the aircraft had left he was told to clear the airways because of the volcanic eruption at Deception Island base where evacuation was needed.

The 1968 relief

The John Biscoe and Perla Dan were both in the Weddell Sea but at different locations, sailing towards Halley Bay when they both encountered sea ice and became temporarily beset. At H.Q. in London Sir Vivian was receiving early satellite images of sea ice conditions and was able to advise the two ships where there were open leads. Thereafter they made good time and the John Biscoe arrived at Halley two days before the Perla Dan which had the personal mail on board.

Unloading of the John Biscoe started immediately with the discharge of the elephant seal carcasses for the dogs. When the Perla Dan arrived a 24hr unloading routine commenced. The cargo included materials for the Geophysics Laboratory and Balloon launching facilities which were erected during the relief period.

The two teleprinters already on base were commissioned and came on line. Halley base was the first BAS base to have this type of communication. Argentine Island base followed.

The remainder of the scientific equipment from the old base was transferred to the new base complex. The old base was finally closed in early 1968. The John Biscoe departed and the Perla Dan sailed on 26th January 1968.

Field work

As the field work had been completed in the Tottanfjella and the Theron ranges the emphasis now turned to the Shackleton range. Two dog teams left in late September 1967 to find a safe passage through the Bop-Pi crossing. Two Muskeg tractor teams left in late October to lay depots at the head of the Goldsmith Glacier in the Therons. To hasten their travelling over the known safe terrain, they adopted the original method of carrying pre-made dog kennels mounted on cargo sledges towed by the tractors for picking up and transporting the dog teams. The tractors were able to travel 24hrs a day when conditions were right.

After setting up the depot the tractors returned and arrived at Halley base 17 day later for further supplies, a thousand mile round trip. 10 days later after carrying out major servicing they left again, this time in an attempt to reach the Shackleton range.

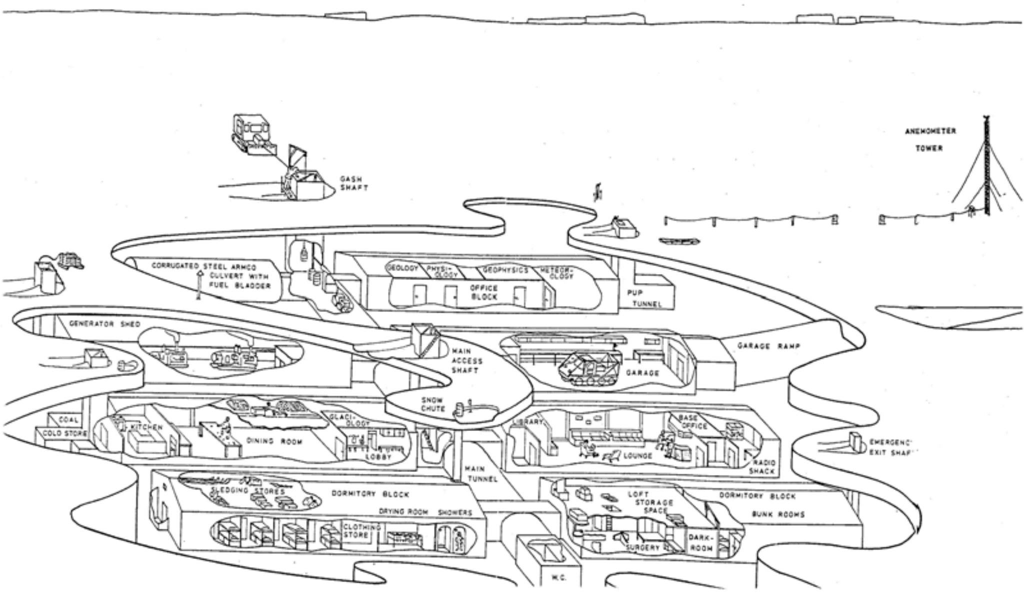
The tractors re-supplied the Goldsmith depot and returned to base. One dog team continued to search for a further month for a way across the Slessor Glacier and eventually reached the Shackletons at 80º 18'S, 17º 05'W. The other dog team successfully reconnoitred a shorter route to Bob-Pi crossing.

In 1968 the overland party was successful in reaching the Shackleton range using two heavily modified International Harvester tractors and two Muskegs, towing between them 12 sledges with a total load of 29 tons. On return to base they had covered in excess of 1,000 miles and paved the way for future substantial work. Also in 1968 the Americans flew in and picked up from Halley 6 men and 3 dog teams, and later returned them to Halley. It took a further two seasons to complete the work using American aircraft in both cases.

Over this period of time glaciological work continued to be carried out. This was the end of the era of major overland exploration by BAS at Halley.

Picture to the right shows Lenton Bluff Shackleton range (BAS)

The base 1970



Sketch showing the layout of the main station complex (BAS)

The base became once again a static geophysical station with only local field travel being made from base. As the station continued to be buried the station ran into structural problems. All support and scientific staff did their best to ensure that it provided a safe and comfortable station. In 1972 it was decided to seek funds for the design and replacement of the station. Lessons learnt from the first Halley were taken seriously. In 1973 all scientific equipment and surface facilities were transferred to the new station complex.

In 1973 the depth of the snow to floor level was 8m approximately. Picture to the right (A. Smith)

Picture to the left shows the crushing effect of the overburden pressure on the steel portal frame, timber purlins and roof panels (1982). (Doug Allan BAS).

Chapter 5:

Establishment of the British Antarctic Survey Research Station

Halley No.3 1973-1984

Design of the buildings

BAS was successful in obtaining funds but not as much as was requested. The Engineering Division of the Crown Agents was instructed by BAS to design a new station complex to accommodate 20 persons and to consist of a number of prefabricated timber buildings housed inside inter-connecting Armco steel tubes.

The idea of Armco to enclose the buildings was based on information gained from the behaviour of the Armco covering the fuel store and the garage workshop access ramp.

Armco

The main outer shell consisted of galvanised corrugated steel multi-plates which were bolted together to form a pipe profile. The main function of the pipe profile was to accommodate all pressures exerted by the surrounding snow and ice.

This profile was called the Armco Multiplate Vehicular Underpass type with a height of 5435mm and a width of 9197mm. This size provided adequate space for the required internal building. The elliptical profile selected helped the snow to form a natural arching effect without causing any excessive pressure points on the steel shell. The steel plates were of different gauge thickness.

A smaller profile was used for the toilet block and for the inclined vehicle shaft to the garage. This shaft provided access for all vehicles from the surface to the garage workshop below.

The communicating tunnels between the buildings were Armco pedestrian underpass type with a span of 1778mm, a rise of 2336mm and 7.3m long. Each had a T piece section at each end for access to the escape shafts

4 persons worked on the erection of an Armco underpass on a motorway site in the UK to gain experience. This proved invaluable.

Armco gable ends

The gable ends of the Armco tubes were closed using steel ladder beams fixed to the Armco shell in steel shoes in a vertical position and were provided with telescopic action at the top end in order to accommodate any deflection that might take place in the steel shell. Two ladder beams were provided to act in pairs, a total of 5 pairs per end were used.

Scaffold poles were clamped to the vertical beams in a horizontal position at 600mm centres and also provided with telescopic action at the ends and fitted into steel shoes.

Exterior grade ply cladding of 25mm thickness was then fixed to the horizontal pipes and all the joints were sealed using sealing tape. The joint along the circumference of the steel shell and ply was sealed off with canvas sheeting securely fixed to both members.

Sub bases of internal buildings

The purpose of the sub bases was to transfer the dead loads and imposed loads of the building to the Armco shell and snow foundations.

4 timber sole plates ran longitudinally and were cut to shape to suit the Armco profile. 4 steel lattice girders built up of bolted galvanised steel angle rested on the timber sole plates. The 4 longitudinal steel girders were tied together with steel angle diagonal braces at 1.2m centres. Folding timber wedges were used to maintain the sub base level. This type of construction was used to support the dormitory, living, scientific office and light workshops blocks.

A different method was used to support the floor of the tractor/garage workshop building and the generator building. This consisted of bagged 'Aglite', on top of which was placed a timber grillage system on which the building rested. No adjustment could be made to this floor. 'Aglite' was used to act as insulation and to distribute the imposed load more evenly over the Armco bottom and invert plates.

Internal buildings

The buildings were of various lengths but all were 5.3.m wide by 4.42m high to the ridge with a 2.4m ceiling height. The corridors were very narrow.

These buildings were made of self supporting, prefabricated, insulated, interlocking timber panels which were of softwood framing filled in with 50mm resin bonded fibreglass with a polythene vapour barrier, covered on the inner face with 6mm flame guard hardboard, covered on the outer face with 12mm exterior grade plywood and glued and nailed together. These formed the walls and roof.

The floors of the accommodation building were of a stronger specification using plywood on both faces and more insulation. For the floors of the generator building and garage/workshop facilities a timber grillage system was laid directly onto the 'Aglite' and two layers of diagonally opposing tongue and groove boards were fixed on top.

Partitions were constructed of 50 by 50mm timber framing cladded on both faces with 6mm hardboard.

There was a small loft space for the storage of some items but it was agreed that the existing base would be used for emergency stores.

Dimensions table			
Buildings	Armco	Internal building	Internal floor area
Dormitory	24m long	22.3m long	118.19m²
Kitchen and living	25.6m long	23.3m long	123.49m²
Scientific office	13m long	11.2m long	59.36m²
Garage/workshop	10m long	8.8m long	46.64m²
Generator	11m long	9.8m long	51.94m²

The existing station had a total floor area of 1,492m² = 37.3m² per person (40 persons).
This station would have a total floor area of 400m² = 20m² per person (20 persons).

The facilities housed in the following buildings were

a) *Dormitory.* Surgery, bedrooms, darkroom, drying room and bathroom.
b) *Living.* Scientific darkroom, kitchen, lounge, dining room, B.C.'s office and Radio office
c) *Scientific office.* Field store, Geophysical office and Meteorological office.
d) *Garage/workshop.* Vehicle workshop and office
e) *Generator.* 3 generators and fuel tank.

The void between the building and the Armco was ventilated using extractor fans in an attempt to keep it cool.

Personnel access shafts

The main shafts and escape shafts were constructed on site of timber and plywood. Inside the shafts were steeply inclined ladders leading to platforms placed every 2.4m approx.

Service shafts

The generator exhaust and service shafts were of similar design but used vertical ladders with no platforms.

Building services

24 hour power was supplied by 2 Dorman diesel generators for lighting, heating, scientific and communications equipment. (One set held in reserve to allow servicing).

The total electrical load requirement was 70kw.

Power distribution: All electrical cables for lights, power points, etc. were surface mounted.

Lighting: Fluorescent fittings were used throughout the station. Emergency lighting was provided.

Fire protection: Fire detection and alarm systems were provided together with portable fire fighting equipment.

Heating: This was provided by Dimplex, permanently oil filled, thermostatically controlled electric radiators.

Cooking was done on an oil fired cooker with a flue to the surface.

Ventilation: Outside air was required throughout the year for fresh air requirements, for cooling of the Armco void and passages, and for ventilation of power block and workshop blocks. This air was conveyed to each building by ventilation ducts.

Water supply: 2 x 200-gallon heated melt tanks were provided which were housed in the sleeping quarters and living quarter loft. The water was pumped to the common header tanks and domestic hot water was supplied by two 9kw ‘Sadia’ heaters.

Waste water and waste disposal: Waste water was taken away from the building complex in the form of a draining system discharging into a snow pit. All basins, sinks and showers were at a level sufficiently high to provide free drainage.

Snow pits to a depth of 12m approx were used as toilets and for the disposal of wet kitchen waste.

All other domestic waste was burnt away from the station complex.

Recruitment

The wintering team consisted of 5 builders, 1 diesel mechanic and 1 electrician. The summer team included 12 volunteers from the Royal Marines stationed in the Falkland Islands. The total summer workforce was 45.

I was in charge of the building programme and was the night (12hr) shift leader. Jim Shirtcliffe was the day (12hr) shift leader and Alan Etchells was in charge of the mechanical and electrical installations working a day routine (12hr+)

The 1972-73 Voyage

The voyage on the Bransfield proceeded normally calling at Montevideo where Sir Vivian Fuchs embarked and then the Falkland Islands where the Royal Marines embarked. Then on to South Georgia where we picked up additional building material from the whaling station (BAS had purchased these materials from Salveson's).

The voyage continued, calling at Signy Island to carry out the station relief. The captain knew that there was winter sea ice in the bay. The berth was so neat that there was no need to use mooring lines. It was a difficult relief but at least this time a complete relief was achieved. Valuable experience of working on sea ice was obtained by the persons bound for Halley.

We left Signy in good heart but we were aware that the ice conditions in the Weddell Sea were not favourable for a speedy voyage. On board the Bransfield there had been a sea ice image receiver installed but its resolution was not as good as that given by today's equipment, but it did prove an invaluable tool for the captain to find open leads. On three occasions the ship became beset for 48hrs each time. Arrival at Mobster Creek was in early January 1973.

Relief of base

On board the Bransfield there were the normal relief stores for the station. Also on board were 600 tons of stores and materials for the establishment of the new station, Halley 3. The cargo had been colour coded to ensure that each item went to its correct destination. A depot was set out near the building site, laid out in building order and priority of use.

Mobster Creek was very narrow and the Bransfield only just managed to moor alongside the sea ice front. Emphasis was given to discharging all the cargo. The ship was plagued with sea swell and the sea ice kept breaking back and the ship had eventually to moor as best as it could to the ice cliff and snow ramp at the head of the creek. We were all aware that this was a potential hazardous situation. The worst scenario happened, the ice edge of the snow ramp collapsed and fragmented with people standing on the fragments. The bosun, who was driving the crane reacted immediately and rescued the stranded people. All credit goes to the crane driver and stranded people in remaining cool and professional.

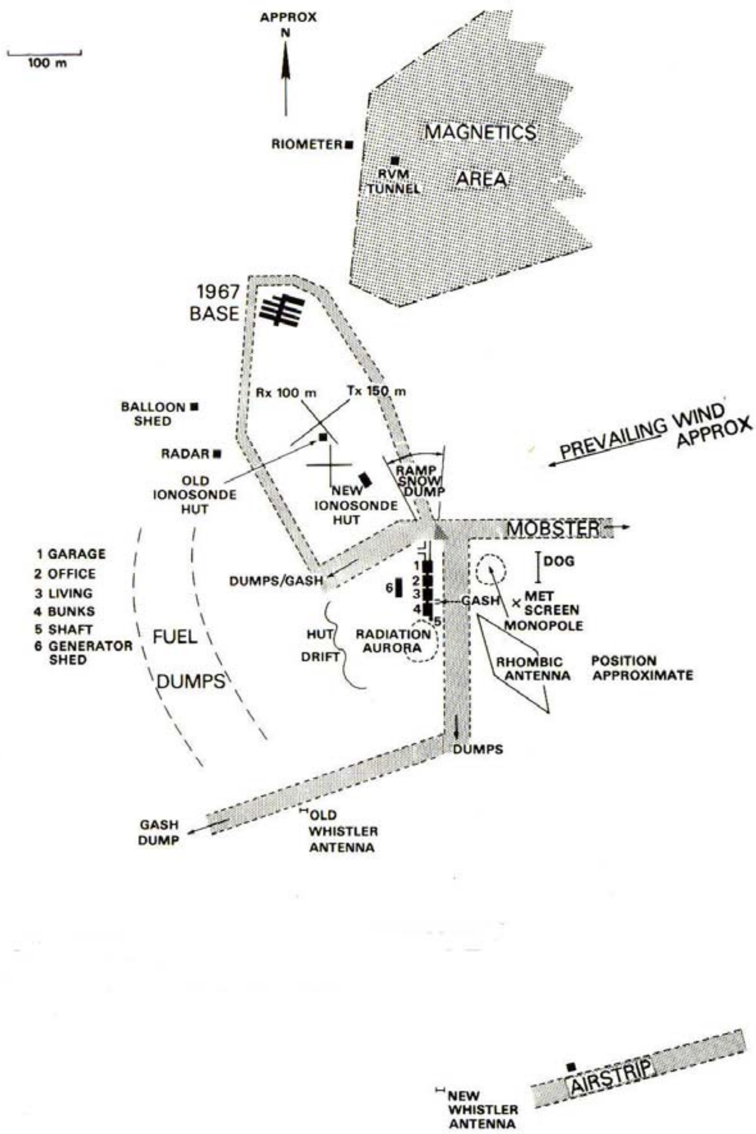
Now the Bransfield had to moor alongside the 30ft. high ice cliff. On 29 January 1973 it was decided that it was no longer necessary to work 24hrs per day on cargo discharge so the night shift was cancelled. On the same night the ice cliff collapsed onto the ship, damaging it. The ship had to leave Mobster creek and everybody was turned to with shovels, to remove the snow and ice from the decks.

The ship eventually returned and once again tied up alongside the ice cliffs where we were able to discharge the last remaining fuel drums. The collapse of the ice cliffs I believe was caused by large swells being created by storms further away in the Weddell Sea and the breaking up of all the Weddell Sea ice.

The Station site Lat. 75º 31'S, Long. 26º 43'W

Discussions had been held in the UK with the various scientific heads of division and it had been agreed that we would site the new station complex as near as possible to the existing station because all the surface scientific equipment could not be relocated for scientific reasons. The site chosen was south east of the existing station, approx 800 metres away.

Whilst the relief was taking place the site was surveyed and the station complex set out. Sir Vivian was invited onto the site and agreed with what I had done, so the building work could commence.



Halley 3 Station Complex Layout

Building the new station

During the voyage to Halley the 45 persons scheduled to work on the rebuild project were divided into a day shift and a night shift, each of 21 people.

Each shift consisted of

1. An excavation of foundations team, whose work was to excavate and prepare the foundations for the Armco erection team. *(4 people)*
2. An Armco team was responsible for the erection of all the Armco. The Royal Marines had a major role in this. *(6 people)*
3. A gable end team was to erect the gable ends and ensure that the Armco was snow proof. *(4 people)*
4. An internal building team was to erect the sub-floor and the buildings. *(6 people)*
5. A cook to prepare tea breaks and lunch which consisted of bread and soup.

All the teams helped each other as and when necessary.

The mechanical and electrical services team consisted of a Diesel mechanic, an Electrician, a Tractor mechanic and were under the control of Alan Etchells and worked a day shift.

Work first began on the generator building, then the garage workshop facilities, then the scientific facilities, then the living facilities and finally the dormitory facilities.

We had good weather and by the 5 February 1973 work was progressing well. Arrangements had been made for Sir Vivian to fly out to Adelaide station which would be the first time ever that aircraft had flown from Adelaide to Halley and returned a 2000 mile trip. The good weather still prevailed enabling the work to progress quickly.

Table of construction times in actual hours worked and in construction order

	Generator	Garage workshop	Scientific facilities	Living facilities	Dormitory facilities
Excavations	1.87	1.70	2.30	4.40	4.10
Foundation levelling	5.50	5.00	6.50	12.80	12.00
Armco	33.00	31.00	37.00	72.00	70.00
Gable end No. 1	48.00	48.00	48.00	48.00	48.00
Sub-floor	26.00	24.00	31.00	61.00	57.00
Internal buildings	66.00	60.00	52.00	102.00	96.00
Gable end No. 2	48.00	48.00	48.00	48.00	48.00

Each shift returned to the ship on open sledges for the rest period, dinner and breakfast which put pressure on the ship's catering staff who had to cook meals for them at different times than normal. The on site cook was working from a caboose and could only produce soup/stew and tea.

There was no special provision for shelter from bad weather or for tea breaks until part of the base complex had been built.

If for any reason the shift could not get back to the ship the rest period was to be taken at the existing station.

Towards the end of February the Bransfield departed leaving a total of 21 persons to winter. 7 of which wintered at the new station to complete the work. There were 5 builders, 1 diesel mechanic and 1 electrician.

Some building plant, i.e. mobile hydraulic crane and the mini excavator were returned to the UK for major servicing.

Generator Armco

Picture to the right shows special working platforms and hydraulic crane in use (first hydraulic crane used at Halley). Great care was needed when walking on the Armco base plates.
Electric nut runners were used for tightening all the Armco bolts to the correct torque. (A. Smith)

Picture to the left shows the gable end in course of erection.

Armco completed (BAS)

The 1973 winter

The new wintering team completed the remaining inside work to a high standard and using the additional materials purchased from South Georgia were able to make interior fitments, thus leaving their individual mark.

On my return to UK I submitted a building report and made a recommendation that separate working areas should be provided for the wintering builder and electrician. This proposal was accepted and a sum of money would be made available from the recurrent finance. To save money it was agreed that the Armco and the raw materials required for the manufacture of the gable ends and internal building structure would be purchased and the internal buildings would be made in the workshops in Port Stanley.

The relief of Halley Station 1974

Prior to arriving at Halley my work brief was to build a new slipway and boat house at Signy station which I had designed and specified. The construction team consisted of myself and 5 others, 2 of which had been recruited in the Falkland Islands plus base members. By working with the tides we were able to leave the Signy project partly completed and returned later to finish the work.

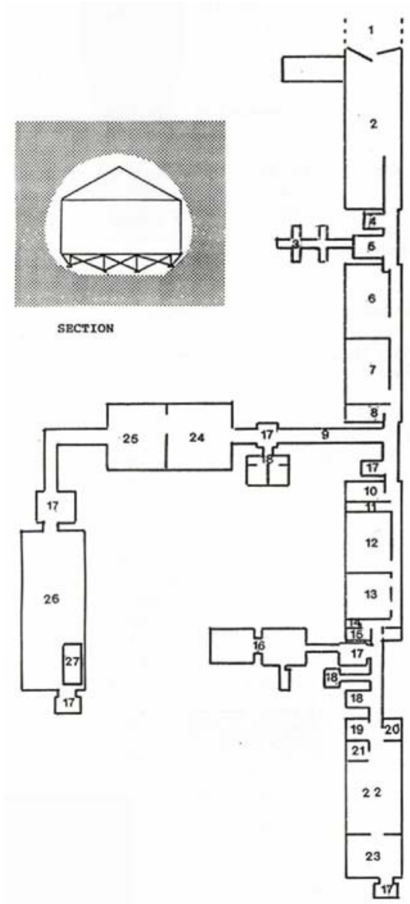
Work commenced immediately on arrival at Halley in January. The work this season was to erect the workshop building and its links to the generator building and the main complex. Armco was recovered from the old garage access ramp and re-used as the new garage access ramp.

In early February 1974 the old station was closed except for access to the agreed storage areas. The changeover went quickly and smoothly thanks to all the scientific staff.

The station 1975

Key

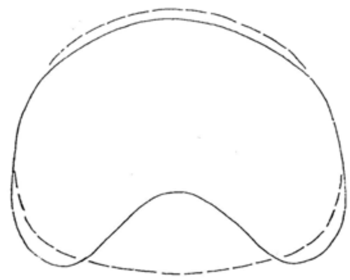
1. Armco/snow ramp.
2. Garage workshop and office.
3. Dog tunnel
4. Store
5. Met. Shaft.
6. Met. Office.
7. Geo office.
8. Field store.
9. Link tube.
10. Radio office.
11. B.C.'s office
12. Lounge.
13. Dining.
14. Kitchen.
15. Darkroom.
16. Food cave.
17. Main shaft.
18. Toilet.
19. Bathroom.
20. Drying room.
21. Darkroom.
22. Bedrooms.
23. Surgery.
24. Chippy workshop.
25. Elec. Workshop.
26. Generators area.
27. Fuel tank.



Sketch showing the layout of the main station complex 1976

Over the years a structural maintenance programme continued with people working in difficult conditions. Minor alterations to the inside decorations were made and snow caves were dug for various purposes. It was a homely base.

Over the years I monitored the performance of the Armco. Eventually the upward thrust of the Armco base plates was such that adjustments to the sub-base of the building could no longer be made. Consequently the Armco came into contact with the buildings which then began to distort.

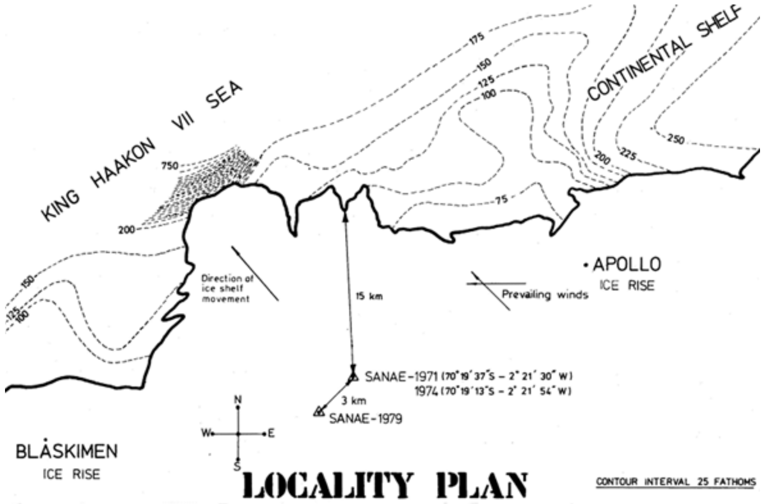


Armco tube deflection x 25

This data was passed to the South African Public works department who were responsible for the design of their new station *SANAE* No.3 and who were considering the use of Armco. Their previous stations, built in 1962 and 1971 had been of similar construction to the IGY base. Data was also given to the West German Antarctic Research Institute as they were also considering using Armco in their next design for *Neumayer* station.

Representatives came to BAS from South Africa and representatives from BAS went to West Germany. Both these countries had much larger budgets than BAS but they were impressed with what we were able to achieve on such a small budget.

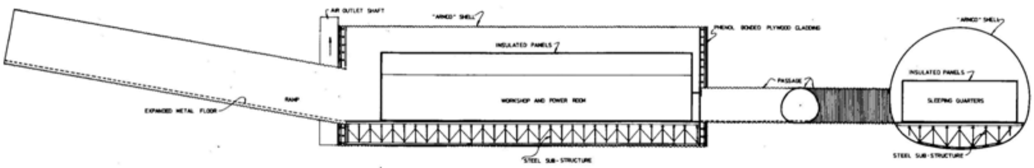
__The SANAE station built in 1979__

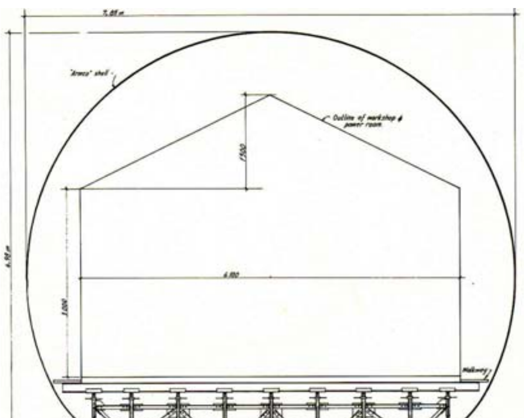


The Armco used was Profile I.V.U. 18 with a height of 6.98m and a width of 7.85m. The bottom and corner plates were 7mm thick and the side and top plates were 5mm thick. The station provided individual bedroom accommodation for 22 wintering persons and a total floor area of 725m².

Dimensions table	Armco	Internal building	Internal floor area
Administration	17m long	6.2m wide 15m long	93m²
Sleeping quarters	30m long	6.2m wide 28m long	173.6m²
Power and workshop	27m long	6.2m wide 22m long	136.4m²
Living quarters	30m long	6.2m wide 26m long	161.2m²
Sciences	25m long	6.2m wide 22m long	136.4m²
Bulk store	17m long		
Bulk fuel store	17m long		

SANAE STATION FLOOR LAYOUT AND SECTION

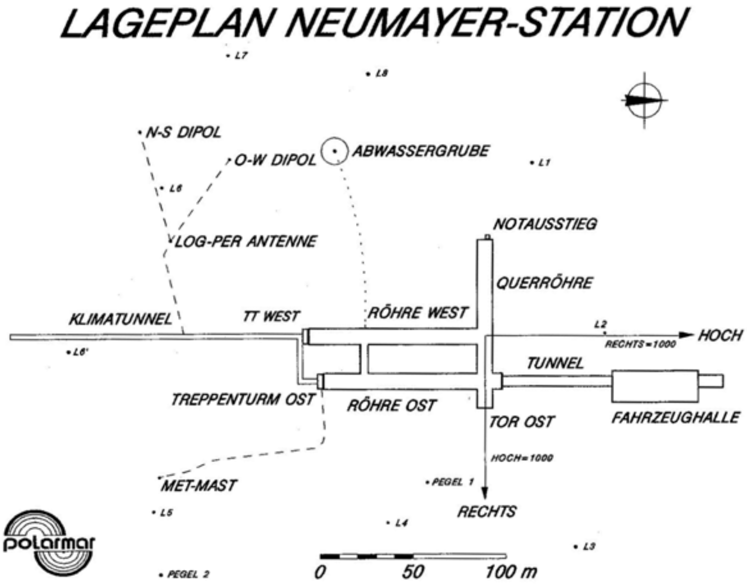


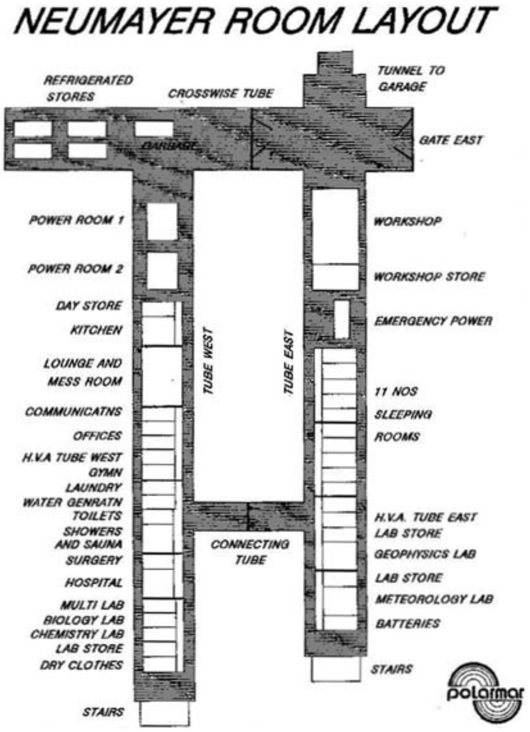


TYPICAL SECTION

The Neumayer station

The *Neumayer* station was built in 1981 and was a turnkey operation. A commercial company was employed to design, procure, ship and construct the complex *(Christiani & Nielsen GmbH)*. The station was fully operational in one year. *(765m² heated floor area with a total net floor area of 2201m² for 11 people wintering team)*





Modern comfortable camps are essential to good morale and high productivity for personnel living in Polar Regions. This is particularly true … where the occupants are isolated for long periods, recreational facilities are limited, and scientific exploration has replaced high adventure.

Brier and Moser 1968.

Chapter 6:

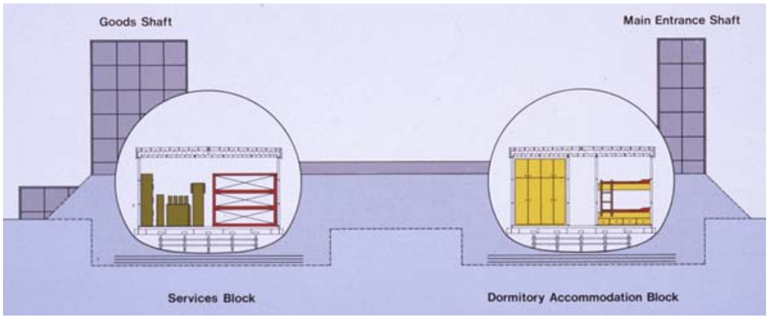
Establishment of the British Antarctic Survey Research Station

Halley No.4 1983-1992

Introduction

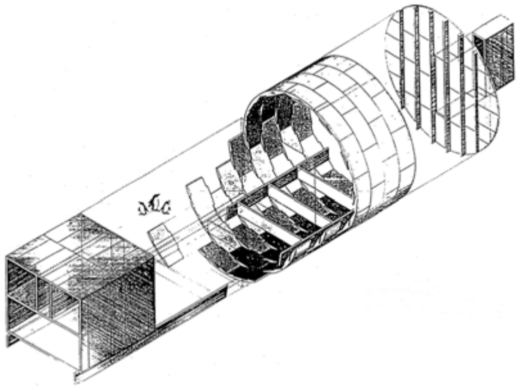
The Survey had now embarked on major in house building programmes at Station H Signy, Station F Faraday and Station R Rothera. Rothera being a completely new site covering a number of phased building programmes. These were all in house design and procurement.

At the same time I was also preparing design specifications and costs for Halley 4 so that the director could seek finance. This included, for the very first time, dedicated temporary accommodation to house the summer building team in the event that we could not return to the ship after each shift. My original design for Halley 4 was again to consist of timber buildings housed inside Armco tubing but of larger dimensions than Halley 3.



Proposed Halley 4 typical cross section

However, Structaply Ltd., who had manufactured and supplied the station complex for Rothera and others, were given a brief on the Armco structures. Structaply Ltd. engaged their own structural engineers and mechanical and electrical service consultants to come up with feasibility studies for the construction of a 9m dia. tube to house 2 storey buildings. Their projected costs were very similar to my projected costs but their concept gave a larger floor area (1344m²).



Exploded view of the tube construction and 2 storey building

I advised the director that I considered it a high risk venture and that independent structural tests should be carried out by the Timber Research and Development Association (TRADA). Tests were carried out and some problems were highlighted but after much soul searching a decision was reached to go ahead with the Structaply method.

The design

The station was to consist of 4 timber prefabricated 2 storey buildings housed inside 4 x 9 metres diameter interconnected timber enclosures.

The facilities were:-

1. Dormitory and storage. **Block A.**

2. Scientific offices, medical and workshop facilities and storage. **Block B.**

3. Living, communications, recreation and storage. **Block C.**

4. Power generation, workshop facilities and storage. **Block D.**

Structural enclosures

The structural enclosures were 9.16 metres in diameter. A and B blocks being 27 metres long, C and D blocks being 33 metres long. Enclosures were formed by interlocking compression rings made up of prefabricated curved insulated stressed skin plywood panels. The enclosures were designed to withstand the overburden pressures and provide a stable, insulated and weatherproof environment for the accommodation buildings.

The central corridor was connected to the main enclosures with special link buffer zones. At one end of the central corridor was the main entrance; a staircase with landings. At the other end of the central corridor was an electric self supporting goods elevator. Emergency exit shafts to the surface and to the adjoining enclosure were provided at one end of each enclosure as shown on the general layout diagrams.

Particular attention was given to safety in the event of fire or an explosion. Each cylinder was zoned with non-combustible diaphragms to restrict the spread of fire. In the event of a serious mishap such as an explosion, damage would be restricted to the loss of one cylinder only. The station complex was also designed so that injured personnel could be brought firstly to a safe area and thence to the surgery and medical facilities without exposure to surface conditions.

Snow foundations

The design required specially curved foundations to an accurate tolerance. How to do this with a limited budget was quite a problem. I designed a steel former which would run on steel lightweight railway lines. The excavation would be done in a series of steps and the former used to create the profile.

The former was left in position so that the snow foundations could be regularly checked by running the former backwards and forwards.

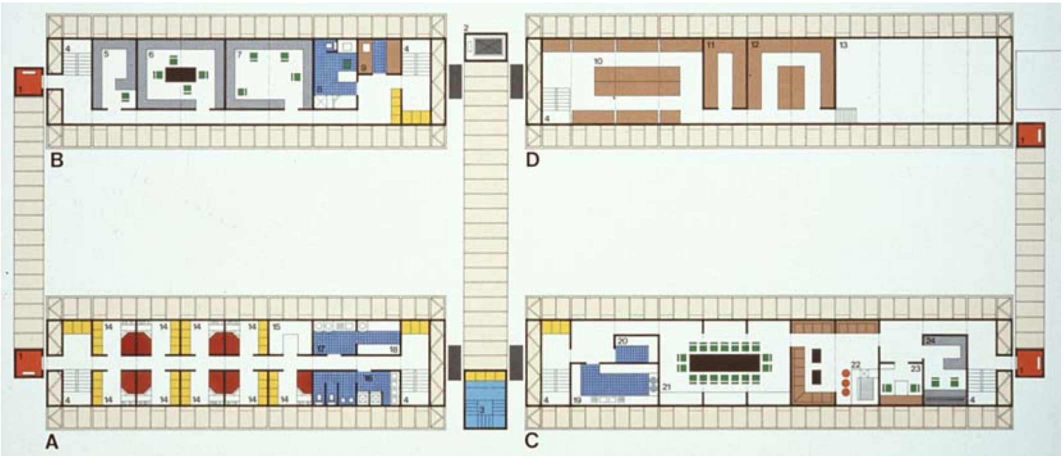
Sub bases of buildings

These consisted simply of a longitudinal beam, of plywood box construction, along each side of the enclosure with plywood box cross beams suspended from the longitudinal beams. The longitudinal beams were positioned where the calculated deformation of the enclosure would be at a minimum.

Buildings

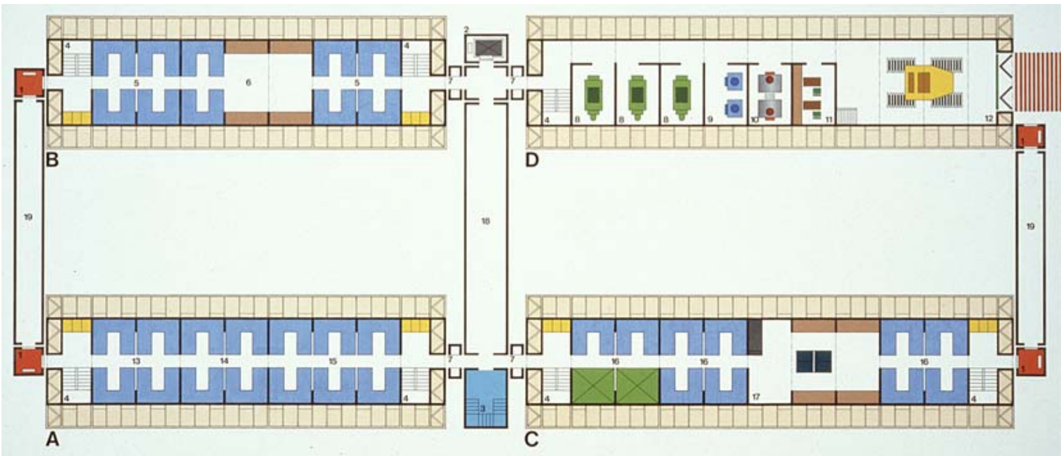
All buildings were of 2 storey construction and made up of self supporting, prefabricated, interconnecting and insulated stressed skin plywood panels. Each building had an internal lining for structural fire protection and decoration. Floor finishes varied according to the use of the area.

Plan at upper floor level



Key			
1. Escape shafts	7. Scientific office	13. Garage upper part	19. Kitchen area
2. Goods elevator shaft	8. Surgery	14. Bunkrooms	20. Kitchen area
3. Main entrance staircase	9. Dark room	15. Storage room	21. Dining room
4. Staircase	10. Services area	16. Washroom	22. Lounge area
5. Library	11. Storage area	17. Laundry	23. BC. Office
6. Scientific office	12. Mechanical office	18. Drying room	24. Radio room

Plan at lower floor level



Key			
1. Escape shafts	6. Carpenter's area	11. Machine room	16. Storage area
2. Goods elevator	7. Link buffer zones	12. Garage workshop	17. Recreation area
3. Main staircase	8. Generator area	13. Storage area	18. Central corridor
4. Staircase	9. Generator area	14. Storage area	19. Emergency exit and shafts
5. Storage area	10. Electrician's area	15. Storage	

The building services design

Power generating

24 hour power was supplied by generators for lighting, ventilation, scientific and communications equipment. Three generators; each of 80 KW, 415/24V, 3 phase, supplied the station power with one machine running at a time. Each machine was housed in a separate fireproof and soundproof enclosure which was provided with an automatic fire detection and CO^2 extinguishing system.

The total electrical load requirement was 70 KW.

Fuel

Fuel was stored in 205 litre drums and a 4500 litre steel holding tank. This tank was housed in a special building behind the cargo elevator, from which fuel was pumped to day tanks in blocks C and D. Average annual fuel consumption was about 1100 drums.

Power distribution

A system of 13 amp socket outlets was provided utilising a ring main principle with 110v in workshop areas. All electrical cables for lights, power points, etc. were surface mounted.

Electric low volt, low wattage, trace heating was provided in addition to thermal insulation on all vulnerable services containing fluids.

Lighting

Fluorescent and bulkhead light fittings were used throughout the station. Emergency lighting was provided.

Fire protection

Fire detection and alarm system and an automatic fire fighting system were provided together with portable fire fighting equipment. Positive pressure breathing apparatus was also provided to assist in the evacuation of an injured person from a smoke filled area.

Heating

Warm air heating: storage areas and the power and garage areas were heated by warmed air distributed in duct work.

Low pressure hot water radiator heating: the offices and living accommodation were heated by means of radiators which had individual thermostatic controls.

Ventilation

Fresh air supplies: A minimum amount of fresh air was introduced to the complex to ensure that CO^2 and odour levels did not increase to unacceptable levels.

Extract ventilation: Extra ventilation was provided for the following areas:-

1. Garage for vehicle exhausts and welding operations.
2. Kitchen for extraction from cooking equipment.
3. Generator compartments for exhausting engine gases.
4. Dark room
5. Enclosure voids.

Water supply

Snow melting facilities for water supplies were provided, capable of producing 2250 litres/day i.e. melting of 4,500 litres of snow in a period of 4-5 hours. A minimum of 2,250 litres raw water storage was provided.

Hot water was provided from 3,450 litre calorifiers and housed in blocks A, B and C. The hot and cold water supply was pressurised.

Waste water and waste disposal

Waste from sinks, basins, showers and urinals, was piped to a main holding tank in block (A). When this tank was full the waste was automatically discharged into a piping system which ran in an Armco steel tube to a snow pit.

Waste from the dark room sink discharged into a transportable plastic container and was shipped back to UK.

Humus toilets which operated by the natural biological decomposition of waste were installed (unsuccessful, so returned to the old method).

50% of the empty fuel drums were placed on a dump and left to become buried.

Documentary film

I had requested in the original budget for a sum of money to make a video of the design and establishment of the new station. However, this was not forthcoming, but it was decided to allow a small sum of money to buy 35mm film for slides.

Personnel funded the post for a wintering team leader/photographer. Dougie Allen willingly took on this role. Due to his skills BAS archives probably have the best collection of slides of a major station construction.

In 1984 the BBC were making a series of ½ hour programmes on design and innovations and they included approximately 10 minutes of time to show the design details and construction of Halley 4. They also made a model showing the station buried below the surface.

Recruitment

Recruitment of the building team was done 3 months earlier than usual because there was to be a trial erection in the UK.

The building team consisted of a team leader, 5 builders, 1 electrician, 2 mechanical services engineers, 1 diesel mechanic, 1 general assistant, 1 radio operator/installer and a cook.

Trial erection

This took place at Structaply Ltd, Herefordshire. A full tube with gable ends was erected with part of the 2 storey building inside to check tolerances and to familiarise the team with the construction methods and for me to obtain a time schedule. When completed Structaply held a small reception in the dining room area which the Director, Dr R.M. Laws attended. At this time BAS aircraft were doing training flights from Cambridge so a decision was made to fly to Herefordshire for this event.

Shipping volumes

These were expected to be high but because it was decided to crate the curved panels in blocks of 5 for ease of loading and unloading the volume escalated. Therefore RRS Bransfield was dedicated solely for the relief of the existing station and the construction materials of the new station and fuel. Part of the construction materials had to be shipped on both the forward and aft decks and the building plant was shipped on the helicopter deck. Special care was taken in securing the deck cargo. This was the highest volume of cargo ever shipped.

The 1982 voyage

As all the work force, which totalled 45 and which included persons destined for other stations, were on board it was decided to take an alternative route to Halley via Cape Town because the sea conditions and approach would be more favourable. I joined the ship at Cape Town and was pleased to see the deck cargo still intact.

From Cape Town I held daily discussion groups to ensure that everyone who had not been on the trial erection programme was aware of the tremendous task ahead and to divide them into teams and work allocations. Arrival at Mobster Creek was on 20 December 1982.

Leaving Cape Town (A. Smith)

Encountering bad weather (A. Smith)

Relief of base

Mobster Creek had widened since 1972/73 and there was 6km of sea ice to the ramp which was in good condition-not too steep.

As normal, we worked 24 hrs per day and all the cargo was discharged in 6 days. Whilst the unloading was taking place the temporary/emergency accommodation was erected.

Shipping identification numbers were used to identify the contents of each crate. In addition the crates for the mechanical and electrical services had different coloured disks attached according to each discipline.

Depot (A Smith)

Temporary/emergency accommodation

This was a low cost agricultural steel framed building which had a span of 8 metres and a length of 18 metres. The covering was 2 layers of industrial black polythene with 75mm of insulating quilted material between. Each gable end had an access door. The floor consisted of pallets.

For the first time hot meals could be provided for the workforce. These were pre-made catering size containers which simply needed re-heating. There were also on site toilet facilities.

The accommodation was used for sleeping on two occasions when it was not possible to return to the ship.

Temporary accommodation with kitchen, dining facilities and also heated (BAS)

The Station site Lat. 75º 36'S, Long. 26º 40'W.

The new site was 12km south east of the old site and 16km from Mobster Creek.

Building the new station

During the voyage to Halley the 45 persons scheduled to work on the rebuild project were divided into a day shift and a night shift, each of 20 people.

Each shift consisted of:-

1. An excavation of foundations team, whose work was to excavate and prepare the foundations for the buildings *(Surveyor, bulldozer/snow-miller driver and 3 other persons).*
2. An enclosure team was responsible for the erection of all the timber enclosure *(crane operator, crane operator's mate, 4 tube assemblers).*
3. A gable end team was to erect the gable ends and ensure that the enclosure was snow proof.
4. An internal building team was to erect all the buildings *(4 assemblers and fixers).*
5. Cook.

All the teams helped each other as and when necessary.

The mechanical services team consisting of 2 engineers a diesel mechanic and an electrician, who worked only the day shift.

On board ship special cabooses with seating were made for travelling to and from the ship to give the personnel protection and a more comfortable ride. Each shift travelled back to the ship for rest and food i.e. dinner and breakfast. The total actual travelling time for the 2 shifts was approx 264 hrs (11days) and the distance travelled was 2600 kms. Some people found the travelling tiring and it affected their work performance towards the end of the project.

Due to the early arrival at Halley we had a total of 77 days work time. The relief took 6 days. It took 55 days to erect all the 4 enclosures and internal buildings, 10 days to construct the central corridors, staircase, goods elevator shaft and all emergency escape links and shafts. One day was spent removing the temporary accommodation. 5 days were lost due to inclement weather conditions during which we celebrated Christmas day, New Year's Eve and New Year's Day. It was a great achievement in the time allowed and not always in favourable weather conditions.

Table of construction times in actual hours worked and in construction order

	Block D	Block B	Block C	Block A
Excavations	41.30	32.40	37.90	32.40
Foundation preparation	54.60	45.20	50.20	40.20
Enclosures	280.00	230.00	260.00	210.00
Gable end No.1.	72.00	72.00	72.00	72.00
Internal buildings	369.00	302.40	370.20	302.40
Gable end No.2.	72.00	72.00	72.00	72.00

Construction of the enclosure began at one end by laying the base panels and gradually both building upwards and forwards to spread the load on the foundations. Steel adjustable Acrow props provided temporary support until the enclosure was completed.

Enclosure almost completed. (BAS)

Timber scaffolding with several different height working platforms was used and could be winched along the enclosure and from one enclosure to another on runners on the building sole plate.

65 days after commencement. 4 enclosures, interconnecting access corridors, all service shafts and all 2 storey buildings were completed.

Without the full cooperation and professionalism of the officers and crew of RRS Bransfield we would not have achieved our target. The 77 days was not an easy time for the ship which had to re-moor constantly to the sea-ice and in March the fresh water tanks were beginning to freeze.

RRS Bransfield departed 6 March 1983 leaving a wintering team of 13.

The 1983 winter

The wintering team was left with the enormous task of completing the installation of the mechanical and electrical services, fixing all the internal linings and all the fixtures and fittings including 2 walk in freezers, 1 for storage of food at -20ºC and 1 for storage of food at +5ºC. This work was completed in good time and to an excellent standard.

Before the next relief both stations made preparations for the transfer of scientific equipment etc. This was well planned and executed with 90% of the equipment being transferred in spring prior to the ship's arrival. The closure of Halley 3 station took place in February 1984.

February 1984. Fully functioning scientific station with satellite communications systems (BAS)

The station life expectancy

The original design concept was based on a life of 8-10 years and the design allowed for a 250mm (500mm ultimate) change in shape from circular to elliptical. However de-formation took place quicker than expected and to prolong the life of the station some of the crown panels were removed and snow excavated from around the tubes. In hindsight it might have reached its expected life span of 10 years if straps had been fixed around the rings at their junction to one another.

The station closed on 19 Feb. 1992 a life span of 8 years.

Chapter 7:

Establishment of the British Antarctic Survey Research Station

Halley No.5 1992-2002

Introduction

Funds were made available for a replacement station so market research was carried out to select a design consultant for the new Halley station. It must be said that this was a limited market. BAS set up a working committee to select a design consultant.

Christiani and Nielson of Hamburg (C & N) were first given a contract in 1986 to carry out a feasibility study for a station which would be capable of being maintained above the snow surface.

Wind tunnel tests were carried out on a scale model of C&N's design to ascertain snow drift formation, the height and the orientation of the buildings.

An in house feasibility study by BAS was also carried out for a part sub-surface and part surface station.

The fundamental advantages and disadvantages of both designs are as follows:-

1. Above surface station

Advantages:
- Natural light, view though windows.
- Heat leaks, no severe consequences.
- Air intake structures easily placed high enough to reduce snow ingress
- Accessibility.
- Easy changes of layout, replacement

Disadvantages:
- Snow drift accumulation causing repeated replacing or jacking up of station buildings
- Exposure to winds:
  Danger of vibration and noise
  Need for horizontal anchoring of structures.
  Heat loss.
- Exposure to outside temperatures requiring additional insulation and/or fuel for heating,

2. Sub surface station

Advantages:
- Not directly exposed to wind and surface air temperatures.
- No wind induced noise or vibration.
- Known design life.

Disadvantages:
- No natural light.
- Difficult access.
- Heat leaks leading to melting with subsequent loss in insulation and/or change in structural conditions.
- Air conditioning/ventilation difficult (ingress of drift snow).

To help the committee to reach a decision I prepared a drawing of the proposed new Halley station accommodation platform and building and superimposed it onto a drawing of the main administration building of BAS HQ using the same scale.

Christiani and Nielsen of Hamburg were awarded the contract in 1986 to design, specify and prepare Bills of Quantities (BOQ) for a complete replacement station. In 1988 Christiani and Nielsen London were awarded the contract for the procurement of all items specified in the bills of quantities.

The station took six years from conception on the drawing board to commission in February 1992 and the cost of the entire project was in excess of £8 million. The construction took place over 4 summers from 19 December 1988 to 23 February 1992, a total of 177 working days. Personnel worked 2 x 12hr. shifts per day and the average number of personnel employed each year was 45. It is novel in that the buildings sit 4.5 metres above the snow surface on independent jackable steel platforms. The height of the platforms above the ice shelf affects the local wind turbulence and the build-up of drifting snow. Each year the platforms must be raised an average of 1.1 metres to compensate for the accumulated snowfall. Small adjustments throughout the year are made to compensate for differential movements.

DESIGN OF THE STATION BY CHRISIANI NIELSEN

Sub-surface structure

The sub-surface structures comprise:

- One 302m long elliptical tunnel connecting the Accommodation Building (ACB) with the Ice and Climate Building (ICB).

- One 86m long elliptical tunnel leading from the Space Science Building (SSB) to a sub-surface fuel storage and snow melter.

- Two tunnels of respectively 33m and 13m in length leading to sewage dumps and placed transversely to the 302m tunnel.

- Four arched structures which are semi-circular tunnels 5.75m wide and 16.1m, 9.1m, 7.5m and 6.5m long, with room for fuel storage and for snow melting equipment.

- There are 7 seven service shafts.

The tunnels are constructed as elliptical culverts of Armco MP200 corrugated steel metal plate with a vertical axis of 2.13m and horizontal axis of 1.92m. The arched structures are Armco MP200, placed on a horizontal foundation of timber planks.

Both tunnel and arches have end walls of wooden construction. The vertical shafts are constructed of rectangular steel metal plates.

Armco tunnel connecting ACB to ICB (A. Smith)

Platform and foundations layout and orientation

The three buildings of the station are placed on steel platforms comprising timber raft foundations and steel columns and the platform deck consists of beams spanning in two horizontal directions.

The three platforms' longitudinal axes run more or less South-North (more exact 165º-345º), and the crosswise direction is East-West.

The ACB platform has 20 legs, 10 each in the East and West rows. The SSB likewise has 6 legs, the ICB only four. There are two legs to a frame. Frames consist of two legs and a main cross beam connecting them. On top of these cross beams are secondary beams running longitudinally.

All the platforms are the same design and are capable of being raised by mechanical jacks.

Timber and steel raft foundations (A Smith)

Picture to the left shows lifting steel cross beam into position to save manual jacking time. (A. Smith)

Picture to the right shows platform manual jacking system. This system was changed to a mechanical system at a later date. (A. Smith)

Buildings

The station consists of 3 single storey buildings, providing working and living accommodation for 20 wintering persons with a maximum of 30 in summer.

The buildings are of prefabricated, insulated plywood stressed skin panels with windows and flat roofs. The heaviest panels weighed 540 kg each, while the average panel weight of an outer wall panel was 250 kg.

Each building being at least 302m from the next building and arranged in the form of a triangle. This was done for two reasons i.e. snow drift control and scientific requirements.

The accommodation building is by far the largest building. It is 58.68m long, 14.64m wide and 2.986m high. The science buildings, though having the same width and height as the accommodation building, are only 12.20m long. The Ice and Climate building is 9.76m long. The Space Sciences building has a covered platform area attached to the building adding 4.5m to the length so that this building is then 14.26m long altogether.

The accommodation building comprises three sections which can be described as services/technical support area, living area and sleeping room area. These sections are separated from each other by building joints and doors.

The three sections are connected by the central corridor extending through the whole length of the building with wind locks at both ends. The corridor is 1.83m wide in the services and living areas, narrowing down to 1.43m where the bunk rooms are situated, giving them more space. A 2m wide and 0.57m deep niche was designed in the corridor at the recreation room to accommodate fire fighting equipment and installations.

When entering the building at the main entrance from the platform, the service rooms are to the left. They are all containerised, including the laundry/dry room. On the right side of the first room is the cloakroom where wet clothes can be dried. A small room for collection of garbage is situated at the south-west corner and can be reached from the cloakroom if the weather does not allow the transport of bins or drums through the outer door of that room via the open platform.

Mechanical and electrical workshops follow on the same side, being situated across from the generation plant room. The last rooms of the section, adjacent to the electrical workshop, are three cold and frozen provisions rooms together with a fourth room containing the cooling conditioning plant and providing some extra space for general storage. These rooms are insulated in the same way as the outer skin of the building and are provided with cold room doors.

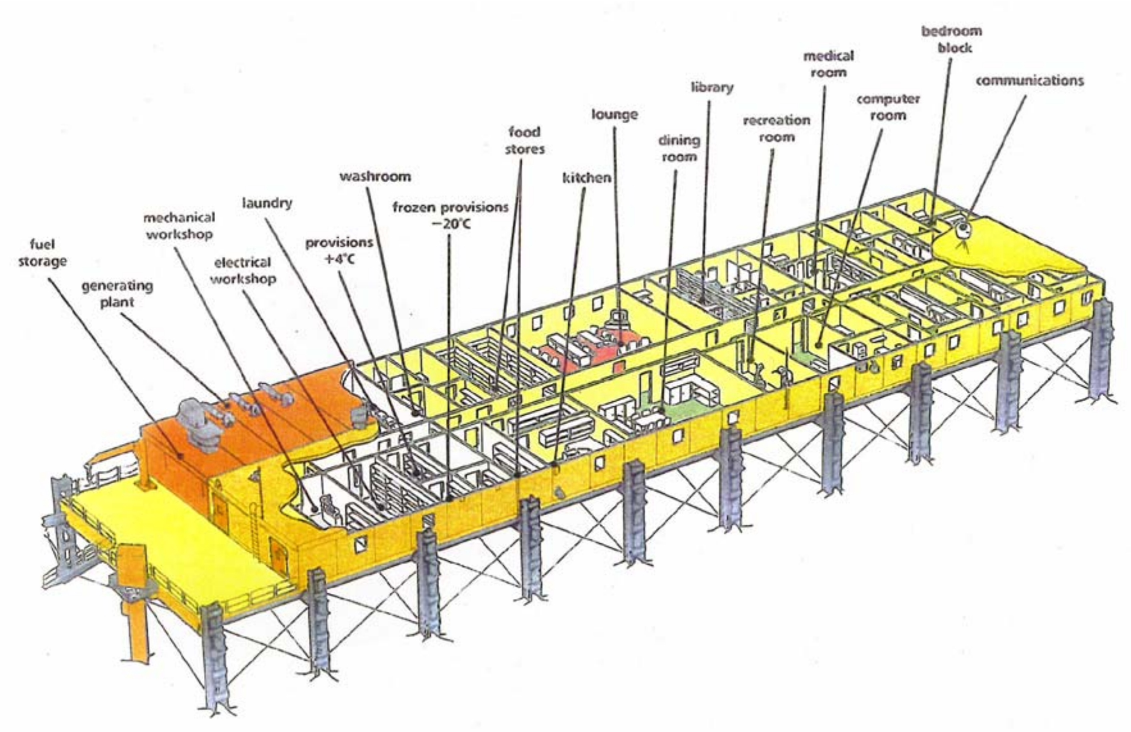
In the central section, washrooms and toilets are placed at both ends. There is an extra washroom/toilet facility for women near the bunk room section as well. Between the washrooms on the left (west) side there are photographic facilities and store room, two general (provisions) storage rooms, the lounge, bar store and library. On the opposite (east) side there is another food storage room, the pantry and the kitchen, the dining room, the recreation room, and the block containing the computer/communications/commander’s rooms. The kitchen is thus situated centrally between cold and general provisions rooms, pantry, and the dining room. A service hatch is arranged between kitchen and dining room.

The communication room can only be entered through the computer room, as both rooms have close functional linkage. The base commander has a small room for administration within the same block, but with separate entry from the corridor.

The hospital in the northern section of the accommodation block is split up into a smaller compartment meant as an office for the physician and a larger hospital room. The dividing wall between these rooms has a glass window.

In the layout, consideration has been given to the separation of “noisy” areas or rooms, from the quiet zones. A strict separation was not possible everywhere. The door at the northern end of the corridor is regarded as an emergency exit only and is kept closed under all normal conditions.

The inner room height is 2.5m. The corridor in the accommodation building has a false ceiling to cover the ventilation ducts, pipes and cables running along the corridors.



The Ice and Climate building (ICB) contains the meteorological office, the meteorological laboratory, ozone laboratory, boundary layer laboratory, and toilet facilities.

Picture to the right shows the ICB building 1992/93 season. (BAS)

The Space Sciences building (SSB) contains generating plant facilities, AIS facilities, optical laboratory, electronics laboratory, Avdas laboratory, science office, sciences store and toilet facilities.

Picture to the left shows the SSB building 1992/93 season. (BAS)

Power generating and distribution

Power generating: 24 hour power is generated by 3 diesel generating sets in the accommodation block, each rated 80kw, and 2 in the Space Sciences building each rated 40kw.

The diesel generating sets are housed in fireproofing and soundproofing canopies. The canopies have doors to ensure easy inspection and maintenance.

Picture to the right shows the generating set housed in fireproofing and soundproofing canopy. (P. Bucktrout)

Picture to the left shows the generating and distribution panel. (P. Bucktrout)

Picture to the right shows the ACB mechanical and electrical workshop (P. Bucktrout)

Heat recovery: In the accommodation building, heat from the engines' cooling water and the exhaust gases are recovered. The recovered heat is used for the heating of buildings, snow melters etc. In the Space Science building only heat from the engines' cooling water is recovered.

Fuel system: Fuel is stored in 45 gallon steel drums on the surface then pumped into the collapsible tanks in the tunnels, from which it is pumped to day tanks in the buildings and distributed to the engines.

Earthing system: The protective earthing system is TN-S. The neutral point of the alternators is connected to the main earth terminal. To this terminal is connected the equipotential bonding and the protective earthing conductors.

Bonding: All the steel structures of buildings, tunnels, shafts and major equipment such as snow melters are interconnected by equipotential bonding.

The equipotential bonding system is connected to all pipes and metallic ducts. Pipe runs are interconnected and connected to the equipotential bonding system every 20m.

Screening: All cables are screened. The screens are connected to protective earthing terminals.

Heating ventilation and air conditioning

The air conditioning machine is placed in the service plant room (utilities rooms in the Ice and Climate building and Space Sciences building) and supplies all rooms of the buildings except the generating plant room, the cold provisions rooms and the fuel storage room with fresh air. The air is a mixture of fresh and recirculated air at the requested temperatures. The machine has been designed as a multi-zonal conditioner to give optimal supplies to three zones or areas in the building requiring differing conditions. A fourth strand was introduced to avoid too many cross-overs in the ducting and would provide additional opportunity to vary climates between the left and right sides of the corridor in the central part of the building. Air flow in each strand can be individually controlled by amount and by temperature. Some strands are fitted with humidifiers.

Water supply, sanitary installations and waste water system

Snow melter: Snow melters are provided in order to supply potable water to the station. One melter is in a subsurface melter room branching off from the tunnel connecting the accommodation building and Ice and Climate building, another is in a subsurface melter room branching off from the tunnel at the Space Sciences building.

The melters are rectangular tanks in which snow fed from the surface is melted by a heat exchanger powered by cooling the generator sets and/or by the heat from an electric heating coil. The melted water is pumped to day tanks and from here it is pumped into the hydrophore sets that supply water to the station.

Hot water systems: All three buildings are equipped with hot water systems. The energy is taken from the waste heat provided by the diesel engines.

Waste water system: All sewage is collected in tanks and pumped from there to dumps. In the accommodation building there are four smaller sewage tanks allocated to areas where water is consumed. Sewage water is led through gravity flow PEH piping into these tanks. There is a Grifter unit to each tank comprising macerator, pump, float switch and all required control gear. The sewage is pumped through copper pipes to a somewhat larger sewage tank in Room 4 from where an equal Grifter unit pumps it to the dump. All pumps are therefore of the same type. Pumping takes a little longer from the main collecting tank which has been given a bigger capacity for that reason. There is only one tank required in each of the science buildings. Liquid waste not suitable for dumping in the snow, as may occur in the hospital or in the photographic laboratory, is collected in drums for shipment out of the area protected by the Antarctic Treaty.

Platform monitoring

An automatic system for monitoring the structural behaviour of the platforms has been designed; this enables control of the calculated values for the stability of the platform structures.

The electronic sensing equipment is distributed over five frames, three at the accommodation building and one each at the Space Sciences building and Ice and Climate building. All data is transmitted via data cable to the central data logger in the accommodation building.

Fire protection, fire fighting, alarms

Fire is one of the biggest hazards and the most feared danger in Polar stations. It should be remembered, however, that most accidents with fire are caused by negligence of station members and that a constant awareness of the dangers will be the best insurance against loss by fire.

The Survey has always maintained a night watch system. This has proved invaluable. One night carbon monoxide levels increased to a dangerous level due to fumes from the coal fires coupled with -56º C temperature. The night watch saved the day. The balloon launching facilities were once lost due to explosion and fire but there were no casualties.

Fire precautions in the design: The accommodation building has been divided into three sections with separating walls of 60 minutes fire rating. This separation will also be effective with the same rating at the doors and at all lead throughs for ducts, pipes and cables. The accommodation building is then split completely by two fire barriers, and two additional doors subdivide the through going corridor at the cold porches.

Fire detection and alarm systems: A comprehensive system of detectors and alarms distributed through all buildings has been designed.

Alarm in the generating plant room, accommodation building

- Close fire section doors in corridors
- Shut off diesel engine (with consequent stoppage of all ventilation)
- Emergency lights will provide illumination
- Release extinguishers

Alarm in the fuel storage room, accommodation building

- Close fire section doors in the corridors
- Shut off diesel engine
- Release extinguishers

Alarm in computer or communication room, accommodation building

- Close fire section doors in the corridors
- Stop air feeding into the area
- Cut power supply to both rooms
- Release Halon extinguishers

Alarm in any other zone, accommodation building

- Close fire section doors in the corridors

Alarm in any zone, Ice and Climate building

- Shut off ventilation

Alarm in Space Sciences building

- Similar activation as in accommodation building

BAS IN HOUSE DESIGN, SPECIFICATIONS AND PROCUREMENT

1. Temporary site accommodation 1989.

It was agreed that temporary accommodation would be provided for a work force of 50 to reside permanently on site and be self sufficient from either ships or existing base.

Market research had been carried out and it was decided that the best option would be to purchase from a Canadian company called Weatherhaven who manufactured large scale, insulated, fabric structures. These shelters had been used successfully in both the Arctic and Antarctic in the past.

The floor consisted of lightweight plywood insulated panels and the sides and top by a covering of a two skinned insulated fabric over semi-circular tubular steel frames.

Two shelters were provided. One was for the sleeping accommodation which was divided into three compartments. The central compartment housed the plant room and washroom facilities which included 2 showers, 6 wash hand basins, urinals and toilets. The two outer compartments were the sleeping quarters for the two separate shifts. The second shelter housed the kitchen and dining facilities, food store, plant room, laundry, and toilet facilities plus a recreation area. Each of the shelters had its own melt tank facilities directly outside.

One 80 kilowatt generator was housed in a ventilated container and there was a walk in cold room for frozen food. The two containers which had contained the components of the Weatherhaven shelters were used for storage.

2. Meteorological sub-surface gas storage facilities 1991.

The meteorological department had decided to use bottled helium gas. This meant that a system had to be devised to house the bottles in specially designed crates which could be transported by ship in accordance with the appropriate legislation and also handled on site with the existing cranes.

The storage facilities comprised Armco steel multi plates, as used in the past, to form a horizontal tube with a track way purposely made for the crates of helium bottles to move along. The ends of the tube were closed by plywood panels.

Braithwaite 1m² steel plates were used to form a shaft at one end of the tube for personnel access and one at the other end for the gas bottle crates.

A special monitoring system was also devised.

3. Replacement melt tank 1992.

The melt tank was made up of Braithwaite multi plate steel sections. C & N had been advised that there had been problems in keeping this type of tank leak proof but had used this design to save on shipping volume. The melt tank had begun to leak due to the foundations distorting and the Survey decided on a complete replacement using a different design concept.

The snow melter is now a large insulated stainless steel cylinder housed in a 6m dia. x 9m high silo constructed of 1m² Braithwaite steel panels bolted together with a steel base. The silo was constructed at the same level as the previous facilities which were 9m below the snow surface.

4. Mobile garage/vehicle servicing facility

Introduction

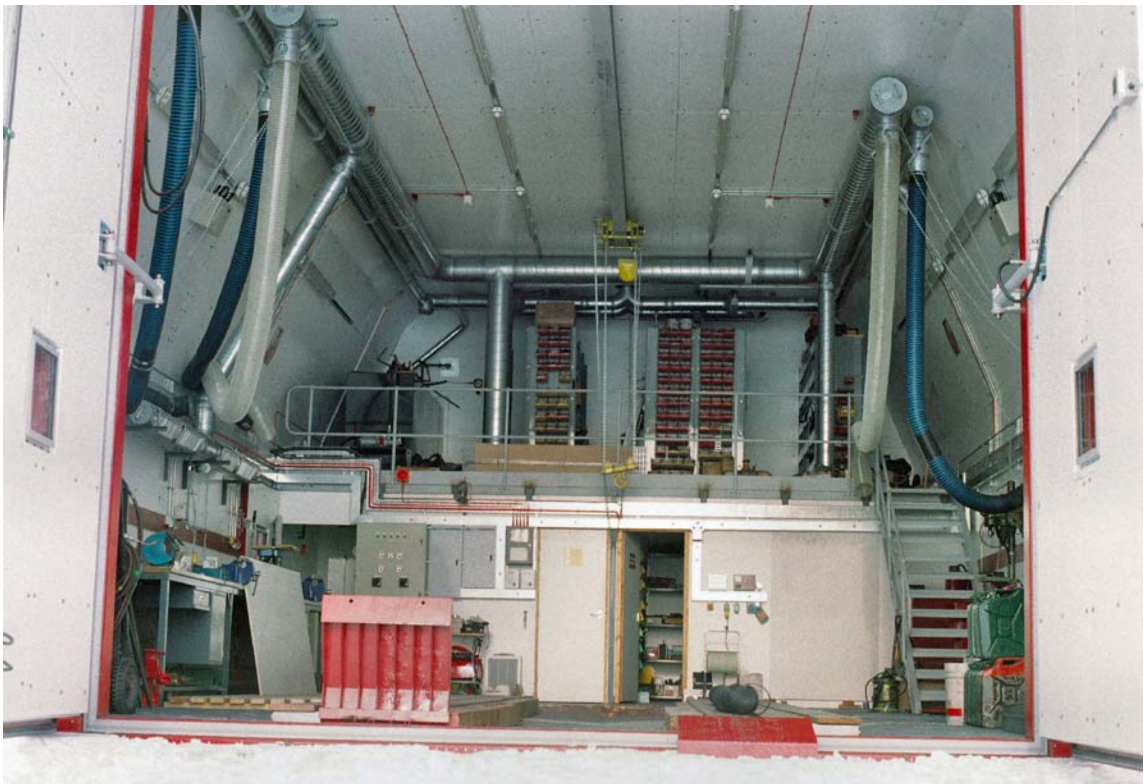
To support scientific operations at the Halley station, extensive use is made of tracked vehicles. This reliance brings with it a requirement for a major facility for front line servicing and maintenance. Traditionally the requirement has been met by the provision of a surface structure which has been allowed to become buried, access to the garage being via an inclined tunnel. With the development of the fifth Halley station and the move away from sub-surface structures in favour of a surface facility elevated on 5 metre high jackable platforms, the provision of a vehicle maintenance facility had to be addressed.

After a rigorous appraisal of options, a relocatable above surface garage/vehicle servicing facility was selected. This offered greater benefits in access and maintenance and complimented the elevated main station facilities.

The concept of a re-locatable unit on skis was first considered in the early 60's but until recently had never been fully evaluated by the British Antarctic Survey. A feasibility study was completed and a detailed performance specification prepared for the mobile garage. Accommodation had to be provided for the largest vehicle in the fleet, this being the Nodwell 110C tracked crane (7.m x 3.2m x 3.7m, weight – 15.25 tonne). This resulted in the need for a structure of sizeable proportions which, when fully equipped, would weigh in the region of 50 to 55 tonnes.

The method of procurement reflected the fast track nature of the project with concurrent engineering principles being adopted. Following fabrication the unit was subject to trial erection in the UK before transport to the Antarctic. From receipt of the instruction to proceed, to loading on the ship, was a total of 13 weeks. This unit was erected on site during the Austral summer of 1992/93. Construction was rapid, the building shell was largely completed in five days, the mechanical and electrical installation was underway by day 13 and the facility was operational on day 39. The fully self-contained facility was used extensively during the following winter and performed well with the snow accumulation around the structure being less than predicted.

I believe that these facilities were the best that anyone could expect whilst working in a remote and hostile environment and they exceeded the standards of the legislation of the time.



Design parameters

These were to provide a self sufficient and re-locatable facility for vehicle and plant maintenance in a safe working environment and to include adequate storage for equipment and spares.

Other considerations were:-

- Light but strong construction.
- Totally waterproof floor and sump.
- Creation of sump for containment of melted snow from vehicles and any other spillages.
- Speed of erection and of installation of internal services.
- Energy efficient.
- Low shipping volumes.
- Low cost maintenance.
- Climatic conditions
- A maintained internal temperature of +15ºC bearing in mind vehicle reheat loss and ice melt loss.
- Aerodynamics of structure to minimise snowdrift.
- Prevention of snow and water ingress.

Design philosophy

When producing the design of any major piece of plant or equipment there are two factors to be taken into consideration. The first is to produce an item which will not only satisfy the operational functions but also pre-empt any unforeseen requirements. The second consideration is to produce a design which can be successfully and economically manufactured and assembled in the time required.

The final design of a ski mounted mobile garage/servicing facility was produced as a team effort co-ordinating the expertise of the main contractor (V & M Fabrications Ltd.), their designer (M.G. Bennet & Associates Ltd), and BAS technical officers. Because the building was to be towed around the snow, the design had either to be flexible enough to adjust to uneven ground during movement, or rigid enough not to distort as it move over an uneven surface.

It was concluded that a flexible solution would result in unacceptable distortion of the building during towing which in turn would cause internal wall cladding, doors, etc. to require resetting. Therefore it was the rigid design concept that was used. In order to produce a rigid concept the whole building and wall cladding had to be used to produce what is effectively a “torsionally stiff box” on skis. Any other form of design where a steelwork super frame structure is supported off a base with skis would either be much heavier to produce the same degree of rigidity, or be much more flexible for the same weight. A complex analysis tool, ANSYS finite element modelling, was used to assess the inherent strength and flexibility of the structure as a whole.

The period of time allotted for assembly of the facilities on site was particularly short and a structure composed of a large number of small bolted components would require a long period, together with exact assembly tolerances. It was therefore concluded that a small number of large components would enable the outer structure to be rapidly assembled with a minimum of bolts being required for the initial temporary assembly, allowing the remainder of the bolts to be fitted from within the enclosed structure. The method of construction resulted in only 30 major items needing to be coupled together to produce the basic structure. Furthermore, it enabled some internal bracketry to be pre-bolted to the major components, thus reducing any ambiguity on site during assembly.

Because the whole building had to act as a totally stiff box the outer steel panels or skin of the building had to be rigidly attached to the frame. It was initially assumed that the skin would need to be continuously welded to the main portal beams, however, for two reasons this was not the best possible solution. Welding would have resulted in distortion during manufacture of the major components which in turn would have complicated assembly and have been detrimental to the overall appearance. However, more importantly, the outer skin would have been subjected to the lowest temperatures and embrittlement of the welds would cause brittle fracture during the towing. The versatility of the main contractor and their advice as to the “least distortion design”, allied to techniques developed in the aerospace industry, led to the conclusion that riveted external sheeting would be the only suitable technique.

The ski base for the building involved a significant degree of development. Originally the skis were to have sheets of low friction nylon attached to the underside. Of concern was the fact that differential expansion would cause the sheets to bulge which would then enable ice to build up around the skis and “key” the skis to the ice. The exact behaviour and temperature differential was not known, so to prevent any possible problems alternatives were considered. Finally a low friction paint used for ice-breaking ships was used. This removed the problem of ice keying to the skis. The underside of the base modules were also designed to have as smooth a profile as possible and these were also painted with the same material. The skis were not attached directly onto the base. This was to ensure that heat loss through the base would not be transmitted into the skis and encourage the possibility of the snow melting around the skis.

The design concept thus far produced a basic carcass. However, certainly not a base which could support vehicles or panels that could take the full wind and snow loading required. Furthermore, insulation of the whole building against an outside temperature of -50ºC with no cold spots was required. Following intensive research into special materials, an expandable foam was found which satisfied all the stringent requirements. This was applied into the base units and the inside top of the panels. This technique produced the required insulation, stiffness and bearing capacity. It could also be applied prior to assembly and shipping which reduced the content of on site work.

Description

Structure

The garage/workshop consists of a series of 5 steel insulated modular rings. Individual modules of base, sides and roof bolted together, trapping a 10mm foam rubber gasket between the mating faces thus providing a rigid air and watertight building. Each module is 3m long resulting in a total length of 15m. The overall height is 6m and the overall width is 8.6m.

The gaskets in the sump area are of composite construction, manufactured from E.P.D.M. rubber on the underside, which provides resistance to water at low temperatures, and nitrile rubber on the upper side, which provides resistance to water and aromatic hydrocarbons.

For ease and speed of erection lifting eye bolts were fitted to each module.

The main door opening is 5m wide x 5m high. There are 2 leaves to the door which is hydraulically opened, closed and secured. To protect the main door sill and seals 2 hinged ramps are lowered before the entry or exit of a vehicle.

The 2 personnel doors are wide enough for skidoos. All the doors have Neoprene “P” seals and the door frames are trace heated. Each door has a viewing port.

Internal cladding consists of 0.5mm colour coated steel panels backed with 40mm insulation.

Internal partitions divide plant room, office/store room, toilet facilities and a mezzanine floor storage area.

The garage is mounted on 2 ski-runners. The runners and the under surface of the base modules are coated with marine coating Inerta 160. This provides a smooth low friction surface for the whole of the underside of the unit. The exterior walls and roof were painted red.

Services

All the services needed to make the garage self sufficient are provided.

These include:-

- **Electrical Supply:** 10kw is taken from the station generators to supply the boiler, the fire and gas detection system, the gaseous extinguishing system, the lighting system, battery charging and a certain amount of power distribution. A 16kw generator provides additional power.

- **Heating and Ventilation Systems:** Provide fresh air supply, hot air supply and exhaust extraction.

- **Lighting:** There are two systems for lighting. The first is the main lighting system, which controls the operational lighting i.e. the garage fluorescent, the office and plant room and external flood lighting. The second is the emergency lighting system, which is battery fed, and cuts in on any mains failure. Additional mobiles are used when and where required.

- **Fire Alarm System and Gaseous Extinguishing System:** Manufactured and supplied by Thorn Security Systems Ltd., and is their System 1700.

- **Gaseous Detection System:** Manufactured and supplied by Sieger Ltd. It is designed to detect flammable gases at high and low levels along with carbon monoxide (for rogue exhaust emissions).

- **Utilities and Services:** Include the following items

  Snow melt tank   Capacity 50 litres. water temperature 45ºC for hand washing only.

  Waste oil tank   Capacity 1200 litres.

  Dry package toilet

- Oily water separator used when emptying the sump. The separated water is pumped outside and separated oil is placed into the waste oil tank.

- Air compressor used to operate tools and for inflating the pneumatic air bags.

Siting and snow drift accumulation

The garage/workshop is sited 500m from the main station complex so that the snow drifts do not interact with one another. The electrical supply cable is maintained above surface and this also acts as a personal safety line.

The classic wind scoop has been created and all access doors are free of snow.

Re-location

The garage/workshop is re-located annually. The internal equipment is safely stored and fuel and oil tanks are almost emptied. The snow is cleared around the base and pneumatic air bags are used to break the adhesion between the skis and the snow. 2 Caterpillar Bulldozers D4H LGP, with 20 tonne winch capacity are used to winch the unit out of the wind scoop onto a higher surface. The wind scoop is filled in and the area groomed.

Performance

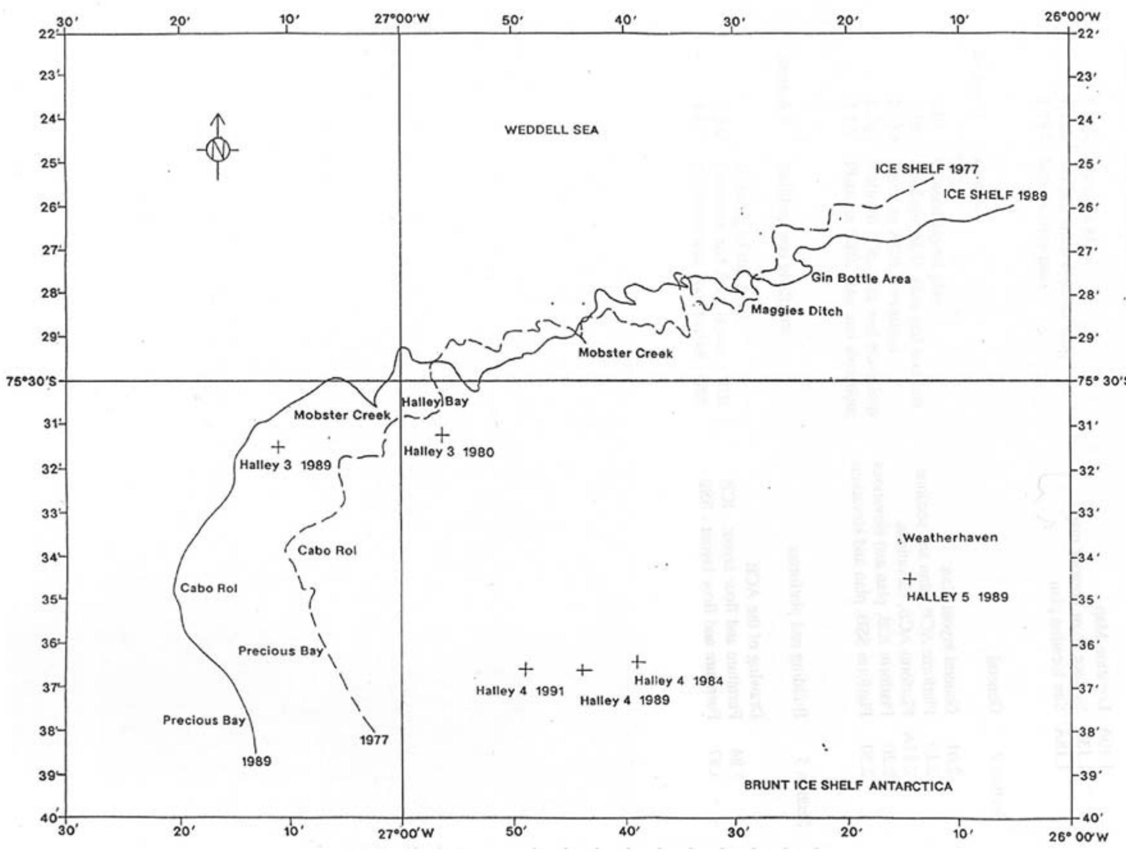
The mobile garage/workshop facility has proved to be a significant success and on present performance it is anticipated that it will exceed its original design life of 15 years. Given the ease with which the unit can be re-located, the Survey has adopted the basic design philosophy of the garage in designing an additional accommodation unit which is scheduled to be erected at Halley during the 1994/95 summer.

5. Bunkroom furniture 1993.

The Survey made the decision to increase the summer accommodation from 30 to 40 people. This meant supplying new 2 tier bunks, fitted wardrobes, etc to convert the single accommodation to double accommodation.

THE STATION SITE, Lat. 75º35'S Long. 26º14'W

The station site was about 12km from the existing and about 24km from Mobster Creek and about 16km from Maggie's Ditch.



ON SITE CONSTRUCTION

The construction took place over 4 summers from December 1988 to February 1992, a total of 177 working days. Personnel worked 2 x 12hr shifts per day and the average number of personnel employed each year was 45.

Halley 5 began operating as a full scientific station on 19 February 1992.

Phase 1

Phase 1 was carried out during the Austral summer of 1988/89. The RRS *Bransfield* arrived 9th December 1988 and departed 21st February 1989.

This consisted of

- Survey of the site area.
- Transportation of 802350 kg of building materials by sledge, a distance of 25.3 km one way. There were 225 sledge loads, average weight per sledge 2566 kg.
- Building of the temporary site accommodation.
- Construction of the sub-surface structures.
- Construction of the three steel platforms.
- Repair and maintenance of building plant for over-wintering.
- Setting up of the wintering building depots.
- Winterisation and closing of the temporary site accommodation.

Phase 2

The RRS *Bransfield* arrived at Halley on 2nd December 1989. Immediate priorities were the relief of Halley 4, transport of materials and equipment to Halley 5 and commission of the temporary accommodation structures. The relief was completed in 10 days and the temporary accommodation was occupied by 7th December.

Work accomplished

Accommodation building

- The platform was lowered and steel work completed (replaced main cross beam damaged in transportation in previous season).
- Underside cladding completed as far as possible.
- 6 prefabricated containers jacked into position and secured
- Building panel construction started and completed.
- Platform was raised to its operational height.
- Service and melt tank shelves raised.
- Internal fixtures and furniture, unpacked and construction started.
- Generators commissioned.
- Mechanical and electrical services 90% completed in building and sub-surface structure.
- Monitoring system sensors installed and cabling complete to panels.
- Automatic fire detection and fighting systems were installed.

Ice and Climate building

- Service and melt tank shafts raised.
- Building panel construction started and completed.
- Mechanical and electrical services components sorted and stored.
- Monitoring system sensors installed.

Space Science building

- Monitoring system sensors and cable extension were installed.
- No further work was done on this building. All appropriate materials were lifted into position for storage over winter.

The accommodation building was occupied by the wintering building team of 10. The aim of the wintering party was to finish off any outstanding work, monitor the performance of the structures and the building surfaces. RRS *Bransfield* departed on 26 February 1990.

Phase 3

The RRS *Bransfield* arrived at Halley and Maggie's Ditch, so named because its potential was realised on the day the Prime Minster resigned, was reached on 22 December 1990. It had been a voyage of 42 days from Rio de Janiero, through the worst sea ice in memory. Plans had to be continually reviewed and changed, a reduction of the season from 84 days to 40 days. RRS *Bransfield* departed 27th January 1991.

Work accomplished

- Relief of Halley 4 and Halley 5.
- Column extensions and the raising of platforms.
- Construction of the outer shell of the Space Science building.
- Establishment of Polar Anglo-American Conjugate Experiment (PACE).
- Closing of the temporary site accommodation.

Final viewpoint

Within the aims of the revised plans, the truncated season could be considered a success. It now remained for the wintering team to build on that, and for a small team to fly over from Rothera station early the following season to commission both the SSB and ICB.

Apart from the success, the season served to remind people that working in the Antarctic is not a straightforward process. We experienced the worst ice in recent memory; a failure of the *Bransfield's* motor; loss of half our accommodation; poor ice at Mobster Creek nearly forcing a relief from the low ice shelf; the loss of a crane before relief was complete; indifferent weather and again, on the journey north, delays caused by heavy pack ice. Without the ability to change and remain flexible the same degree of success would have been doubtful.

Phase 4

The RRS *Bransfield* arrived at Halley 15th December 1991 and departed 23rd February 1992.

Work accomplished

- Relief of Halley 5 and transportation of materials and supplies to depots.
- Erection of temporary site accommodation.
- Survey of platforms and surrounding snow surfaces.
- Completion of Phase 3 outstanding work.
- Construction of Meteorological sub-surface gas storage facilities.
- Lowering of Space Science platform and mounting of scientific AIS caboose.
- Raising of all platforms and access shafts.
- Construction of the mobile garage/vehicle servicing facility.
- Transfer, installation and commissioning of all scientific equipment from Halley 4 to Halley 5.
- Assessment of Halley 4 contents in preparation for clearance in 1992/93 season.
- Setting up of winter depots.
- Closure of Halley 4 for winter.
- Winterisation of building plant.

Building plant and equipment

The following equipment was used during the four summer construction periods.

3 Nos	Canadian Foremostracked vehicles Nodwell 110C and 60 with hydraulic 12.5tm crane (max reach 14.2m/400 kgs).
8 Nos	1700 series Tucker Sno-Cat tracked tractors 6 to 8 tons towing capacity.
1 No	2000 series Tucker Sno-Cat tracked tractor with 8-way light duty blade.
1 No	International Harvester TD8 B bulldozer with angle-blade and winch 10 to12 tons towing capacity.
1 No	Caterpillar D4 bulldozer with mounted Øveraasen snow blower.
1 No	Rolba-Peter 1700k track rotary snow plough. 2300mm wide cut.
10 Nos	Steel sledges with a 6 x 2.44m deck cover, 10 ton capacity, suitable for carrying 20' ISO containers.
26 Nos	Sledges (BAS cargo) size 14' 6" x 6' 6" (4.42 x 1.98m) deck cover. 3 tons capacity.
1 No	Mobile hydraulic one man working platform.

Rolba-Pete 1700k track rotary snow plough with a 2300mm wide cut in use. (A. Smith)

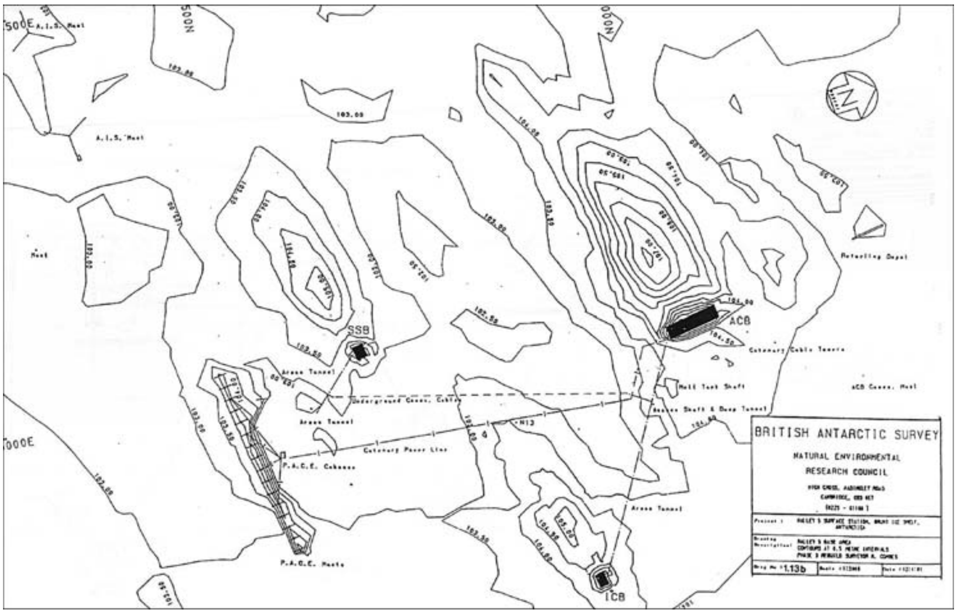
ACB foundation trench dug during relief. Wind reached 25 knots and drift filled the trench. A learning curve for the incoming workforce.

SNOW ACCUMULATION STUDIES

The construction of the Halley 5 surface station has given rise to new site management implications not otherwise necessary with the past sub-surface bases. The surface platforms have affected the surrounding morphological characteristics of the ice shelf which is constantly striving to engulf and bury the structures.

Initial preventative measures have involved detailed instrumental surveys to monitor this dynamic area for a greater understanding of the factors involved. Since the base's construction a snowdrift survey programme has resulted in the production of detailed plans contributing to the research and design studies necessary for a successful Antarctic surface station.

Contour maps at difference scales have been produced of Halley 5 over the 4 construction phases providing important additional information for the design height of the platforms above the ice shelf. The design height affects the wind turbulence around the platforms and the deposition of drifting snow. Early snowdrift prediction studies involved wind tunnel experiments to help formulate platform design heights above the ice shelf. Heights from 3.5 to 4.5 metres were recommended and therefore detailed survey monitoring work was undertaken to ensure specifications were adhered to. The ultimate aims of such a management programme are to ensure specifications are adhered to and to find the natural dynamic state of equilibrium between the base and ice shelf itself. Survey plans also indicate suitable areas for the siting of future base development and help in attaining the overall design criteria layout.



For these reasons it is important that such survey work is developed and continued into the future. Hopefully this will see the updating of the 2-dimensional plans into 3-dimensional digital terrain models providing a powerful information data base and the greater manipulation of field survey data. This will undoubtedly help formulate base management policies crucial to the overall lifespan of such an Antarctic surface station.

1992/93 Season

During this season two major projects were undertaken in addition to the annual maintenance programme.

1. Replacement of the melt tank facilities using a different design concept.

2. Establishment of a new mobile garage/vehicle servicing facility.

Work accomplished

- Relief of Halley Station.
- Recommissioning of temporary accommodation.
- Survey of platforms, local and general areas.
- Construction of mobile garage/vehicle servicing facility.
- Construction of replacement melt-tank facilities.
- Raising of all platforms and access/service shafts.
- Upgrade of Micro Vax computer system.
- Snow management grooming of area.
- Environmental clean-up of old abandoned Halley 4 station.
- Winterisation of temporary accommodation.

1993/94 Season

This season another 3 major projects were undertaken in addition to the annual maintenance programme.

1. Realignment and replacement of steel columns on ACB platform.

   This Halley station had now been operational for four years. Each year a maintenance programme is carried out on the structure and facilities and there is an annual survey of the movement of the steel platforms and the development of the snowdrifts.

   The average snow accumulation on the ice shelf at Halley is 1.2m per year and the snowdrift on the lee side of the accommodation building (ACB) had grown to 5m above the surrounding area. As expected with the design concept, the steel columns had moved out of the vertical and there had also been some upward and downward movements. This distortion was primarily due to the snowdrift deforming under its own weight. The science platforms (ICB and SSB) are much smaller than the ACB and had formed smaller snowdrifts. Consequently, there had been less movement of their columns.

   To continue the annual raising of the platforms, it was decided to replace two columns and to realign the other 18 on the ACB platform. Two load-bearing towers temporarily supported the main steel platform cross-beam near the columns being exchanged or realigned. Each column being exchanged was cut off below the snow surface and removed. New foundations and new columns were installed.

   For a re-alignment, the snow around the base of the column was temporarily removed and the top of the column released from the steel cross-beam. A temporary guy was attached to the column and was used to pull the column in the desired direction. Each column was exchanged or realigned separately.

   The replacement and realignment of the columns was a new venture not tried before. Good experience was gained for future realignment.

   The designer of the structure, Mr Dietrich Enss, was on site to carry out a condition appraisal. He concluded that all the structures were found in very good condition generally, with the exception of the columns at the ACB platform. But continuing the annual maintenance programme and realignment and/or exchange of columns as and when necessary, there was no reason why the platforms should not stand for a long time to come.

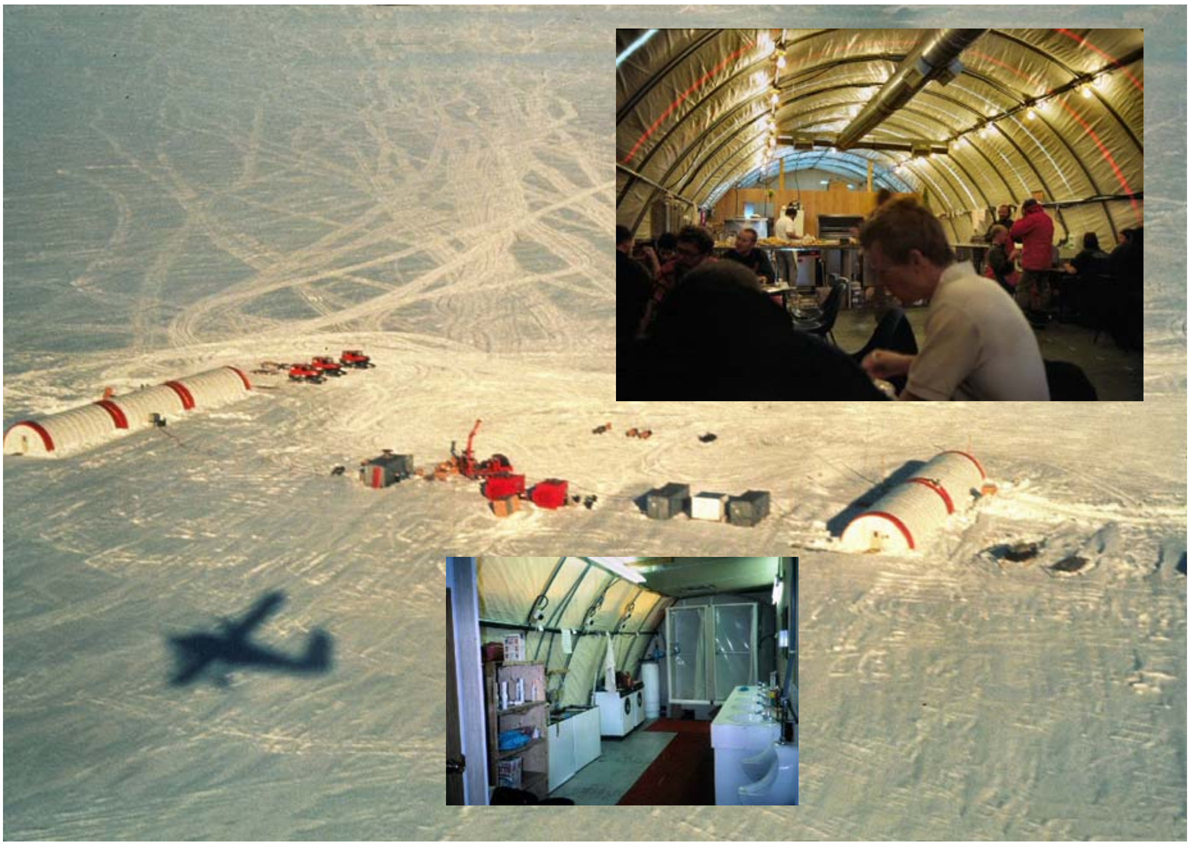
2. Replacement of 10 bunkrooms' furniture on ACB platform to increase sleeping accommodation from 30 to 40.

3. Installation of a waterproof membrane to exterior of roof on ACB platform.

Work accomplished

- Relief of Halley station.
- Recommissioning of temporary accommodation.
- Survey of platforms, local and general access.
- Realignment of ACB columns.
- Raising of all platforms and access/service shafts.
- Fixing waterproof membrane to ACB roof.
- Installation of extra bunks in ACB.
- Installation of safety lines to all roofs and shafts.
- Garage re-located.
- Snow management grooming of area.
- Dismantling and removal of temporary accommodation.

PICTURES OF BUILDING PHASES



Temporary site accommodation 1989 (BAS).The inserted pictures shows the kitchen/dining and toilets.

Commencement of excavations by rotary snow plough for the ACB platform foundations and sub-surface Armco tunnel between ACB and ICB platforms December 1988 (BAS).

The top left inserted picture shows the timber/steel raft foundations and a steel column being erected.

The top right inserted picture shows the completed ACB platform 15th February 1989 (A. Smith).

The bottom left inserted picture shows the ACB/ICB main service shaft (A. Smith).

Picture to the right shows the Foremostracked vehicle Nodwell 110C with hydraulic 12.5tm crane (max. reach 14.2m/400 kgs) December 1989 (A. Smith).

Picture to the left shows the Armco tunnel between ACB and ICB buildings and building services being installed January 1990 (A. Smith).

Picture to the right shows the ACB platform being raised by 2.5m February 1990 (A. Smith)

Picture to the left shows the jacking operations February 1990 (A. Smith)

Above picture shows the replacement tank under construction 1992/93 season. (BAS)

Picture to the right shows the ACB snowdrift 1993/94 season. (BAS)

Picture to the left shows the snowdrift grooming of the ACB area 1993/94 season. (BAS)

Picture to the right shows the two load-bearing towers temporarily supporting the main steel platform cross-beam and the column being exchanged 1993/94 season. (BAS)

Picture above shows the summer accommodation after being moved. (BAS)

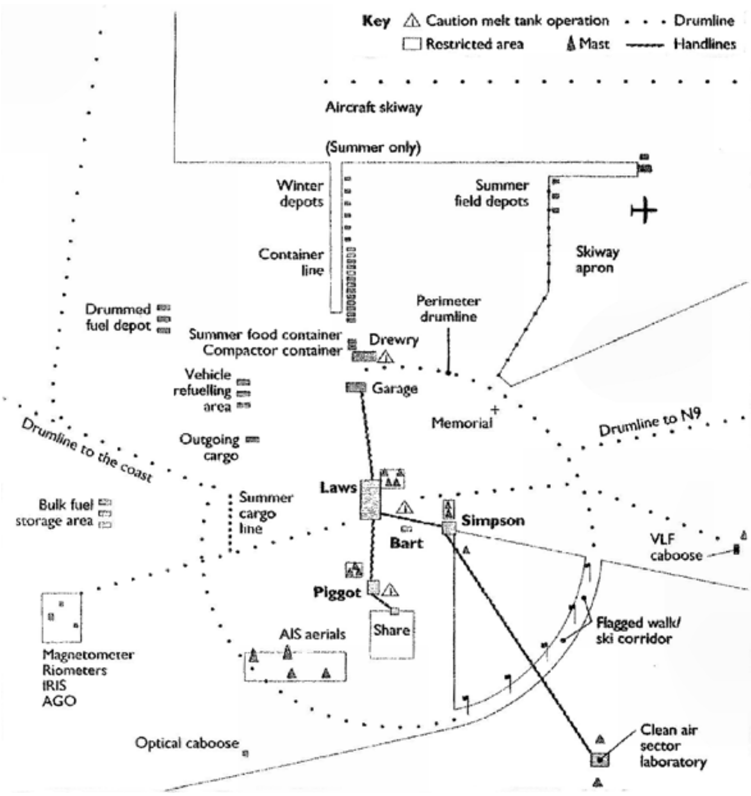
Picture to the right shows the summer accommodation in occupation. (BAS)

BUILDINGS – NAME CHANGES 1996

The Survey decided to rename the buildings as follows:-

1. Accommodation Building (ACB) to the Laws' Building.
2. Ice and Climate Building (ICB) to the Simpson Building.
3. Space Science Building (SSB) to the Piggott Building.
4. Summer Accommodation Building to the Drewry Building.

STATION LAYOUT PLAN 2002



Chapter 8:

Changing Times

At an annual Cambridge conference held at the Scott Polar Research Institute Sir Raymond Priestley gave his last lecture on Exploration Today and Yesterday. I had the opportunity to speak to him privately and I found it very enlightening. My closing statement to him was ‘Sir, may I say that you were men of steel who sailed in wooden ships and I am a man of wood who sails in steel ships’. His reply was ‘no Alan, I am a man of my time and you are a man of your time’. He also said that when he accompanied Prince Philip during his visit to the Antarctic in 1957 on the maiden voyage of RRS John Biscoe he saw more of the Antarctic than he did on his early expeditions.

DEVELOPMENT OF THE SURVEY 1945 to 1995

When, in 1945, steps were taken to transform a naval operation to a civil operation the nearest established British Administration was in the Falkland Islands and the bases had been set up in the dependencies so operation Tabarin was officially renamed the Falkland Islands Dependencies Survey (FIDS).

The changeover was complicated and there was a need for a scientific and administration organisation to be formed. Commander E.W. Bingham was appointed as the new field commander (*Ted Bingham was well known in the polar community, having served with the British Air Route Expedition 1930-31, Challenger Survey Expedition and the British Graham Land Expedition)*. He was responsible for purchasing all the necessary stores and items required to operate and maintain the 5 Antarctic bases with a total wintering force of 30, made up of 12 support staff and 18 scientists. He had a small office and one office assistant. Funds were made available from the Colonial Office Development and Welfare vote.

In 1946/47 the Survey bought their first aircraft, an Auster ‘Autocrat’, which operated from Stonington.

In 1947/48 HMS Pretext was purchased, renamed M.V. John Biscoe, and used for relief. In June 1953 the M.V. John Biscoe took part in the Royal Fleet Review and was given the title of Royal Research Ship.

In 1954/55 the Survey purchased the Norwegian ship, M.V. Arendal, and renamed it RRS Shackleton.

On 11 March 1952 the FID Coat of Arms was granted by Royal Commission. Permission was given by the Governor for its use by FIDS. In 1962 a Royal Warrant was applied for, and granted in 1963, to transfer the Coat of Arms to BAT.

In 1950, on his return from the Antarctic, Dr. V.E. Fuchs had been appointed Principal Scientific Officer and set up an office in London responsible for scientific matters, the FIDS Scientific Bureau, with direct responsibility to the Colonial Office Secretary. The purpose was to plan new programmes more efficiently and to enable young scientists to write up their work.

In 1952 the British National Committee for Antarctic Research was set up by the Royal Society.

In 1953 the life of the Bureau was extended for a further 3 years and from 1 April it became an integral part of FIDS.

Sir Raymond Priestley became temporary Director of FIDS from 1955 to 1958 whilst Dr. V.E. Fuchs was on leave of absence to plan and execute the Trans-Antarctic Expedition (TAE).

By 1957 there were still only 54 scientists in FIDS distributed among 11 stations.

After his success, Dr. V.E. Fuchs, now Sir Vivian, returned as Director. At this time the scientific sections were dispersed in various university departments.

The Survey had 2 ships, RRS John Biscoe, launched in 1956, and RRS Shackleton and a vessel was chartered solely to relieve Halley. In 1970 RRS Shackleton was de-commissioned and RRS Bransfield made her maiden voyage and the charters then ceased. RRS Bransfield became the main logistics ship and could carry a much greater cargo volume than the earlier ships.

In 1971 the Cabinet Dispersal Committee approved the transfer of BAS to Cambridge.

Sir Vivian retired in 1973 having largely directed the Survey since returning from the Antarctic in 1950, apart from a break for his Trans-Antarctic Expedition. During his 14 years as Director the Survey underwent a transformation. With skill and vision he had guided BAS from its political origins and emphasis on geographical exploration to become a front-rank Antarctic research organisation. By the time of his retirement the Survey was one of the larger bodies in the NERC; its organisation, its efficiency and its cost effectiveness in an expensive field of endeavour, were the envy of most other countries engaged in such work.

Dr. R.M. Laws became Director in 1973 when the Survey had 7 Research stations with a total of 98 wintering personnel, made up of 35 support staff and 63 scientists.

The erection of a purpose built headquarters in Cambridge in 1976 and the closure of the London office and the reduction of staff in the Stanley office took place.

Under his guidance all the scientific disciplines were transferred to the new complex and new scientific programmes were introduced, thus keeping the Survey at the forefront of modern polar science.

In April 1982 the armed forces of the Argentine Government invaded the Falkland Islands. This had a major effect on the British Antarctic Survey's operations.

The Survey members on South Georgia were taken prisoner and later released. For a time the Survey lost all communications with their Antarctic stations because at that time all communications were routed via Cable and Wireless in Port Stanley.

After the conflict the British Government decided on major investment in the Falkland Islands to increase the military capabilities of the Islands by the provision of major air and personnel facilities. This became known as the Mount Pleasant complex.

Also the Government of the time, Prime Minister Mrs. M. Thatcher, decided that the British Antarctic Survey be given major capital investment for the following:-

1. Satellite communication facilities for all stations, ships and HQ.

2. Extension of B.A.S. H.Q. at Cambridge.

3. Replacement for the R.R.S. John Biscoe.

4. Improvement of BAS air facilities and capabilities by the procurement of a Dash 7 aircraft and the carrying out of a feasibility study of a design for skis for the aircraft. Also the construction of a new runway at Rothera Point.

5. Replacement of Halley Station.

Dr R.M. Laws retired in 1987 and Dr. D.J. Drewry became Director and oversaw the execution of the rebuilding of Halley, the provision of air facilities at Rothera and the design and commission of a new research ship, the James Clark Ross.

British Antarctic Survey Cambridge headquarters 1995 (BAS)

DOGS AT HALLEY 1956 to 1981

Dogs have been at Halley from the start. 2 Huskies were presented to the Royal Society's advance party of the IGY expedition by the advance party of Trans – Antarctic expedition, but these failed to survive. The Norwegian IGY expedition also gave a Husky which remained at Halley throughout the IGY period.

Dogs, together with vehicles, played a major part in reaching the mountain areas.

In BAS Club Newsletter, No.18, 1985, Nick Mathys who wintered at Halley Bay in 1967 and 1968 wrote the following article:-

Halley Bay is essentially a static geophysical base, but, with a large area of unknown hinterland beyond the ice shelf, a sledging programme to map the mountain ranges discovered by the Trans-Antarctic Expedition became an important feature of the work.

Dogs first arrived at Halley in the early sixties, and the first priority was to establish a route to the plateau. With limited resources this was achieved, and the Bob-Pi crossing over the hinge zone became the key to further travel. This remained a constant and ever changing hazard and led to the development of the basic technique used in all overland journeys. Dog teams went ahead to recce and mark a route for tractors and these followed laying depots at 50 mile intervals for the return journey.

On reaching the mountains, or other objective, a large depot was laid, the tractors returned to base, and the scientists and dog men operated from this through the summer season. Eventually the teams returned along the line of depots, minds concentrated by the necessity of getting back before the onset of winter at the end of April. Winter sledging was not possible.

Using these techniques, the Tottanfjella were mapped and by the middle sixties attention turned to the Theron and Shackleton ranges respectively, some 200 and 400 miles south of base.

In common with everything tackled by Fids, facilities were limited, and the two major problems involved were the long hauls with heavy loads across a featureless plateau, dispiriting to both men and dogs, and the more immediate difficulties of just keeping the dogs alive on base over the winter.

Seal meat was shot on South Georgia, with little collected locally, and this was stored outside where, of course, it became deeply buried under 8 to 10 feet of snow. Raising carcasses, and then cutting feeds, even in the shelter of the snow tunnel, was time consuming work and by mid-winter only a hand saw had any effect on meat that was as hard as the bones inside it. Help from anyone on base who could give it was greatly valued.

In most years the dogs were spanned outside, with inevitable casualties among the weakest. None the less a strong and healthy dog population survived, seldom sufficient in numbers but always game to the task, and no journey failed through weakness of the dog teams.

Breeding, as on all dog bases, was an essential part of the programme. The first stage was easy, and usually the first sign of a bitch on heat was Suaq, off his chain, running around with a grin on his face. Planned breeding was also achieved, and by 1967 all blood lines had been used except for Wilfred, who was friendly, but ageing and arthritic. We explained the problem to Andy Bellars, the vet who came down during the summer, and he gave us some little yellow pills. I tethered Frosty in a dog tunnel, and we lowered Wilfred down in a sack. For the next few days he was given these little yellow pills, and the transformation was remarkable. He jumped up when one arrived, breathing year old seal meat fumes over one's face, and was positively bounding around the tunnel. Hope ran high. One evening I went down to feed the pair, and after I had given them their rations Wilfred paused, then went up to Frosty with a curious look in his eye. She, I swear it, winked at him. Wilfred then pinched her lump of seal meat.

Other pregnancies, none the less, occurred, and then we had to face the biggest obstruction to breeding that Halley had to offer. The pups froze to death. Up to 1968, 50% of pups were dead in 24 hours and over 80% dead before they were 6 months old. We just did not have enough facilities. However, Harry Wiggans achieved a breakthrough. With the abandonment of the International Geophysical Year base, a spare hut and garage were available. Harry took all the pregnant bitches down to the old base, rigged, with Abdul Smith's help, heating in the garage, and brought 19 live pups through to maturity. At last Halley had a strong and sustainable dog population.

(A. Smith 1967)

Sledging proceeded. After Tottanfjella had been mapped, teams in 1966 set out for the Therons, relaying 30 day loads. Muskegs followed and sufficient depots laid to achieve the survey and geology work, together with a special glaciology programme, and all personnel returned safely to base, though not without a long and difficult journey over featureless and morale-sapping terrain.

The following year, 1967, a major push past the Therons to find a route to the Shackleton Range was initiated. With stronger teams and the advantage of a partly-known route, great progress was made, but the Slessor Glacier proved to be too extensive, and the forward party of Peter Noble and Mike Skidmore had to turn back 20 miles from their objective, but nearly 600 miles from base. Despite a five-month journey, no survey or geological work had been done.

In 1968, the Americans lent us an aeroplane to fly direct to the Shackletons. When the Hercules arrived at Halley some surprise was expressed by the crew at finding 27 dogs, rather than motor toboggans, to be transported. We assured them that they were all tame and would do no damage. We were wrong, of course, but I understand that the plane was repaired sufficiently to be used the next season. In the Shackletons, despite some minor setbacks, a major part of the survey and geological work was completed.

Sledging in the mountains was fun compared to the long hauls across the ice cap, previously so much a feature. It was still testing for the dogs and they were always hungry. Nothing edible was left uneaten. On one occasion going through an old camp site, my leader seized a pair of under-pants discarded by Peter Clarkson (we had a rule to change our underwear every 80 days whether necessary or not). About a week later they had been eaten and partially digested by every dog in the team. We asked Peter over the radio sked if he would like them back as a souvenir, but he decided not.

Two further trips to the Shackletons were made the following season, again with American air support. After this the dogs continued to be used for local journeys from Halley Bay, but by 1972 their function had been superseded by motor toboggans, which were much easier to maintain and use from Halley, and the primary function of the Base as a geophysical observatory resumed its precedence.

In the relief of February 1973, 16 of the dogs were shipped to Stonington, leaving only two Muff and Bray, to act as a reminder of earlier journeys. A dog population remained at Halley for some years, rising to a total of four in 1979, and provided a valuable support to morale, but the problems of looking after them remained and, reluctantly, after twenty years of dog experience at the base, the last two left in 1981 to join the teams at Rothera.

Will dogs ever be used again for long journeys? undoubtedly, but never because they are the best form of transport, only for less tangible reasons. It is unlikely that ever again will a broken down motor toboggan have to be towed back to base by a dog team and even less likely that a sledging party, many weeks from base, will know that, at an average of 10 miles a day, the dogs will get them back.

I am proud to have been involved at a time when dogs were used, not because of sentimental reasons, but because they were in fact the fastest, safest, and most efficient means of transport.

"Last Spring people were awaiting the arrival of daring aviators from the other side of the globe. And I thanked God I had been born in an age when… exploration by dog sledge was not yet a thing of the past."

Rassmussen writing in 1927.

Dog team 1967 (A. Smith)

VEHICLES AT HALLEY 1956 TO 1995

During the IGY period 3 Ferguson diesel tractors, which in the beginning were fitted with half-tracks and later modified to be used with full tracks, were used for transporting materials from ship to Base site. When the Base was fully functioning they were used as necessary around the Base. During the relief periods the Trans Antarctic Expedition's Muskeg and Sno-cats were also used.

When the Survey took over the Base the Muskegs were re-introduced.

Muskeg 1967 (A. Smith)

International Harvester bulldozer 1967 (A. Smith)

Around 1962 the first International Harvester (I.H.) bulldozer with an angle-blade and winch was introduced. This vehicle was robust *(fit for FIDS to drive)*, had a powerful winch, a good m.p.g and was used to bulldoze snow. The Muskeg and the I.H. also played an important part in field work.

The prime function of all the vehicles was the relief of the Base, depot work and the support of science. Later on the Survey used Sno-cats which were much easier to drive and very efficient in pulling loads over various types of surfaces. Automatic gear boxes were fitted at a later date. It was interesting to see the vehicles working during the relief period. When leaving the sea ice to ascend the ramp to the ice shelf these automatic vehicles changed gear at the same place which eventually led to a large hole appearing at the bottom of the snow ramp. There is no doubt in my mind that when the first I.H. was introduced at Halley it made life easier for all.

The Survey purchased 2 Lansin vehicles from Canada. These had 4 cylinder 4 litre De-Havilland engines with a 6ft solid aluminium propeller. On good surfaces they could do 60 mph. one of the vehicles was destined for Anvers Island (Base N) on the Antarctic Peninsula and the other for Halley. The Halley one proved not entirely reliable and or suitable for Base purposes. It was taken off the indent but was re-activated in 1967. The other Lansin, I believe, whilst parked blew over an ice cliff during bad weather.

Picture to the right shows the Lansin 1967 (A. Smith)

On the 1967-68 relief Sir Vivian Fuchs and Derek Gipps, head of logistics, were anxious to see the new Station as soon as possible because the sea ice conditions were deteriorating *(this is the time Halley Bay disappeared)*. The Lansin, driven by Geoff. Smith arrived at the ship and Sir Vivian and Derek boarded the vehicle and were driven safely but at high speed across the sea ice, up the ramp arriving a few minutes later at base. This reminds me of the old saying 'never put all your eggs in one basket'. When it was time to return to the ship it was noted that they chose another form of transport.

About 1964 an Eliason motor toboggan was introduced. Bob Thomas, who came into Halley in 1966, used this vehicle to carry out his scientific glaciological studies of the Brunt Ice Shelf. Over two years it travelled 2000 miles, averaging 10 m.p.g and pulling average loads of 1300lbs. In 1966-67 2 Skidoos were introduced. Joe Porter was allocated one, named 'Molly' and I was designated the other, named 'Kath'. I used this to assist Bob Thomas.It covered about 600 miles, pulling a similar sledge load to Bob's. One day when returning to base I covered 61 miles in almost 24 hours and worked at the same time.

Picture above shows the Eliason motor toboggan in the left of the picture 1967 (A. Smith)

I believe this was the beginning of the use of small vehicles on scientific field work. The Eliason and Skidoos were of light construction and there were endless problems, mainly with the track and suspension systems.

It was the policy of the Survey for all the maintenance work to be carried out on Base but periodically a vehicle would be returned to the UK for a full overhaul by the manufacturer. When Cambridge HQ. was built with full garage workshop facilities mechanics who would be going to Halley were employed early to carry out the modifications and major overhauls on returned vehicles previously carried out by the manufacturers. They were supervised by an experienced Antarctic Technical Officer.

Picture to the right shows Charlie Blossom's 'Dream machine' made up of odds and ends found on Base. Charlie was the cook (1967) and used the vehicle for bringing in food supplies. (A. Smith)

The survey gave permission for 2 base members to take in 2 trials motorbikes, for later use in the Falkland Islands and South America. These wintered and performed well over various snow surfaces. (A. Smith)

BAS cargo sledges have been used from 1960 to the present day. Steel pontoon sledges with a 10 ton capacity, suitable for carrying 20' ISO containers were purchased in 1982. These were used during the Halley 5 construction period and proved very successful.
(A. Smith)

Picture to the left shows the Tucker Sno-Cat tractor, 6 to 8 tons towing capacity.
(A. Smith)

CLOTHING AT HALLEY 1960's TO 2000's

Over the 49 years since the establishment of Halley station there have been many changes made to the clothing issued to personnel. Designs to clothing have changed as have the materials used. In the early days most of the materials were of natural fibre-cotton and wool. However over the past 30 years there has been significant development in man-made fabrics and these now provide a range of materials which have changed much of what is available on the outdoor clothing market. In the 1960's and 1970's most of the clothing supplied was manufactured of cotton or wool. In the 1980's more synthetic materials were being supplied on the outdoor clothing market and now a much larger percentage of clothing is made of a range of synthetic fabrics such as Goretex and other outer fabrics; Polartec and other fleeces for the mid-layers; and various microfibre materials for next to the skin which insulate as well as transferring moisture (wicking) away from the body.

In the earlier years it was not always possible to obtain some of the specialised clothing garments required so those purchasing the clothing in the London office, and later Cambridge, went out onto the marketplace and found suppliers who were able to make clothing to suit the Survey's requirements. Such items included Base and Sledging Anoraks and windproof over trousers made from Ventile. The design of garments from some of the larger clothing manufacturers could also be modified to suit Survey needs.

However in recent times the outdoor clothing market has become so extensive that there is a very good selection of garments and footwear available. More people are going on expeditions in Polar and mountain regions in the word, and designs and materials continue to improve. The clothing issued to the Halley Fids during IGY and the 1960's has changed significantly in materials and design to that issued to personnel wintering now.

At the Cambridge conference people filled in a clothing form giving sizing information and this was sent to Port Stanley clothing office for kitting out on arrival in the Falkland Islands. This was done until the Port Stanley office closed then clothing was issued during the Cambridge conference.

NOTES ON PERSONAL CLOTHING ISSUED TO MEMBERS OF F.I.D.S. 1960

The following notes are provided to help guide you in the proper use of your personal equipment. This equipment is constantly being revised as effort is made to improve the standard, so it is possible that some items with which you are issued will be different from those shown on the list.

F.I.D.S. clothing is designed on the layer system to provide a great number of possible combinations of garments to suit many different types of weather conditions you will meet on the Bases. There is nothing rigid about the way you must use this clothing and, provided some basic rules, which are included in the notes below are followed, your personal tastes can be followed wherever you wish.

The clothing for someone dog-sledging, for instance, in the spring season would probably be somewhat as follows:

Head: Balaclava cap (rolled up) or Ski cap; Snow goggles

Upper Body: String vest
Woollen shirt
Heavy sweater (with another sweater carried as a reserve)
Sledging anorak (windproof)

Lower body: Short cellular drawers or long woollen drawers (depending on the temperature, probably both would be taken)
Sledging trousers
Windproof trousers

Feet: Woollen socks
Duffel inners or duffel slippers
Mukluks or **Moccasins or snow boots – base issue** or Expedition boots and gaiters

Hands: Long wristed mitts
Duffel inners
Sledging gloves
Silk gloves and chamois leather gloves would be carried by the Surveyors and the like for use when separate fingers are necessary to manipulate screws etc on the theodolite.

On the worst days, with lowish temperatures of perhaps -20 to -30ºF all this clothing would be worn, and if winds were blowing and raising drift the balaclava would be worn with the hood of the anorak raised and all openings of clothing would be closed. On a fine day however, with no wind and the sunshine temperature at about 20ºF the party would probably be stripped down to their shirts, with rolled up sleeves, no hats (although still wearing snow goggles) and no gloves.

It is very easy to ring these changes with the clothing provided and yet always to be ready to meet any sudden change in temperature or condition.

Notes on particular items

Anorak, Base: An overall smock made of windproof cloth (Ventile) with hood and pouch pocket, used generally in the Base area on local trips, skiing etc.

Anorak, Sledging: Issued only to those going to sledging Bases and used on sledge journeys. A developed version of the Base anorak with Wolverine fur trimmed hood, reinforced back, zipped pouch pocket, crutch strap and batwing sleeves. The latter make it possible to draw the arms through the sleeves into the body of the anorak to warm the hands, without taking off the anorak. This is very useful in foul weather.

Boots, vapour barrier: A general purpose cold climate insulated rubber boot, for use when working in the base area. These boots have been used with some success as ski boots by man hauling parties. You may find your feet perspire a lot when you first use these boots, but large scale American tests during their Operation Deepfreeze projects have established that no harm comes of this and that even though sweating may persist, the disadvantage of the minor discomfort so caused is outweighed by the advantage of warm feet.

Boots, R.B.L.T: A calf length Canadian type working boot with rubber foot and leather top.

Boots, ski-marching/climbing: The general purpose leather boot, mainly for recreational skiing.

Boots, expedition: A special leather boot with a plastic insole issued only to those going to a sledging base, designed for low temperature wear. Use of this boot means that skis with hard bindings can be worn with comfort at much lower temperatures than is possible with normal leather boots. This boot **must not** be worn as a general rock-hopping or working boot as, due to the processes to which it is subjected, the leather will scratch and tear easily.

Boots, felt, inner: A combination boot. Felt slipper which fits into a proofed rubber and canvas over boot for brief excursions away from the hut.

Braces: The type provided can be used to support either inner or windproof trousers.

Gloves, heavy duty: A leather fingerless glove with a separate duffel (felt) inner and securing strap at the wrist, used for work outside in cold weather.

Gloves, sledging: A drift proof leather glove with a gauntlet secured with quick release fastening; used when sledging. The duffel inners, used with this as well as with the heavy duty glove, are made separately instead of with a fixed lining to the glove so that they can be taken out and dried easily. This is most important when sledging where the glove, if wet when put on in the morning, will freeze solid and be most uncomfortable.

Gloves, silk: Sometimes used inside both the preceding items for extra warmth. The silk gives protection if fingers are needed for a delicate task and the outer gloves must be removed.

Jackets, working Army combat type: A general purpose windproof and shower proof Base jacket.

Jackets, reefer: A heavy woollen over-jacket.

Jersey, heavy wool: Heavy natural wool sweater for general and sledging use.

Jersey, light wool: A lighter wool sweater for leisure use, or use in combination with the previous item for extra warmth.

Mitts, woollen, long wrist: Designed for use with sledging and heavy-duty gloves to give extra protection against cold to the wrists. Usually the long wrist is taken up over the shirt cuff for maximum efficiency and if necessary, the mitt will keep the bare hands warm for quite long periods even at low temperatures.

Mukluks: A thin-soled rubber boot with a knee-length canvas upper and laced fastening, worn with a felt and mesh insole and several pairs of socks and duffel inner were designed for use in cold weather and dry snow. Properly used, Mukluks will keep the feet warm at temperatures down to -50ºF and lower, always providing of course that you do not stand perfectly still for long periods. The snow boot is a simplified version of the Mukluk, rather lighter in weight and often preferred for actual sledging.

Neck square: Possibly of silk, artificial silk, or an open weave material was an important article of wear which sealed the gap at the collar of the clothing and kept the warm air contained next to the body.

Slippers, duffel: A thin felt outer sock of the same material as the glove inners, generally used with Mukluks, Snow boots and the like.

Snow-goggles: These will generally be available in two types:-

a) With panoramic eye-shield.

b) With twin eye-pieces.

Both types have their good points and probably, no other items of equipment provokes so much argument on the Base as the one between those who prefer type (a) and those who think (b) is best. Goggles, which prevent snow blindness by giving protection against ultra-violet radiation and glare, must be worn a great deal of the time when outside the hut, and on a sledge trip they are generally only taken off inside the tent. Men who wear glasses often have difficulty in wearing both the goggles and their spectacles. If you are affected in this way it is advisable either to buy a pair of special goggles with tinted lenses designed to fit over spectacles, or to obtain a pair of glasses with lenses ground to your normal prescription from tinted glass.

Socks: It is essential that socks are well, but not tightly fitting if your feet are to stay warm; tightly fitting socks will restrict the circulation of the blood.

Trousers, battledress: A heavy woollen trouser for general use.

Trousers, drill or denim: For general working use; lighter and easier to clean and dry than the previous item. Can be supplemented by wearing 'long johns' in cold weather.

Trousers, sledging: Designed specifically for sledging use of a light, tough material; usually worn under wind proofs.

Trousers, windproof: The equivalent of the Anorak for the lower half of the body, made of Ventile cloth with fastening tapes at the bottom of the legs and side pockets with snow-excluding flaps.

Vests, string type: The well known garment, the large mesh of which allows the formation and circulation of a layer of warm air next to the skin under the layers of clothing.

General notes

All F.I.D.S. clothing is purchased in large amounts and although attempts are made to obtain variety in colour, pattern etc these are not always successful. Therefore if you have some particularly striking sweater, knitted cap or the like which you would like to take with you do not hesitate; colour is always pleasant on the Bases.

Crossroads depot 1967 (A. Smith)

The following lists compare personal clothing issued to Halley personnel during the 60's, 80's and the present day.

Item	1960	1980	2000
OUTER (SHELL) LAYER			
Anorak, base, ventile	*	*	
Anorak, sledging	*	*	
Base Parka		*	*
Field jacket, ventile			*
Field jacket, synthetic			*
Jackets, working, Army combat	*		
Jacket, waterproof, various		*	
Salopettes, base			*
Salopettes, field, ventile			*
Trousers, windproof, ventile	*	*	
Trousers, waterproof		*	
INSULATING (MID) LAYER			
Jackets, working	*		
Jackets, reefer/duffel	*		
Jacket, fleece/pile		*	*
Jersey, heavy wool (Norsk)	*	*	
Jersey, light wool (Icelandic)	*		
Shirts, woollen	*	*	
Shirts, lightweight		*	
Shirt, fleece			*
Suits, boiler	*	*	*
Trousers, battledress or combat	*		
Trousers, drill or denim	*	*	
Trousers, fleece/pile			*
Tracksuit		*	
BASE (FOUNDATION) LAYER			
Drawers, woollen, long	*		
Drawers, long, thermal		*	*
Drawers, short, briefs	*	*	
Vest, woollen, long arm	*		
Vests, thermal, long arm		*	*
Vests, string	*	*	
FOOTWEAR			
Boots, working, leather/rubber, various	*	*	
Boots, field, leather/plastic, various	*	*	*
Boots, Onitsuka		*	
Boots, RBLT	*	*	
Boots, Mukluk with insoles and inners	*	*	*
Boots, indoor	*	*	
Slippers, carpet	*		
Slippers, duffel	*		
Work shoes			*
Socks, various	*	*	*
Stockings, various	*	*	*

Item	1960	1980	2000
HEADGEAR			
Caps, balaclava	*	*	*
Caps, ski	*		
Field hat			*
Field hat, fur			*
Headband	*	*	
Headover		*	*
Neck square	*	*	
Safety helmet			*
GLOVES			
Gloves, sledging (bear paws)	*	*	*
Gloves, duffel	*		
Gloves, inner, Dachstein/Helly Hansen		*	
Gloves, chamois	*	*	
Gloves, silk	*	*	
Gloves, outer, Neoprene/oiled palm		*	
Gloves/mitts, fingerless		*	
Gloves, woollen, fingered	*	*	*
Gloves, working, leather	*	*	*
Mitts			*
MISCELLANEOUS			
Braces	*		
Belt		*	
Housewife/sewing kit	*	*	*
Handkerchiefs	*	*	
Knife	*	*	*
Laces	*	*	
Pyjama suits	*	*	
Snow glasses		*	*
Snow goggles	*	*	*
Suits, Boiler (for mechanics)	*	*	
Towels, hand	*	*	
Towels, bath	*	*	*
Water bottle			*

COMMUNICATIONS

Radio communications

During the IGY period regular communication schedules were established with Port Stanley radio station. When more powerful transmitters and new aerials were brought into use on 14th February 1957 they were able to maintain regular radio schedules with London, Port Stanley and other Antarctic bases. On occasions they were successful in having direct telephone conversations with London.

When the Survey took over the station (January 1959) they continued to use Morse code communications via the Survey's office in Port Stanley just as the Antarctic Peninsula stations had been doing for a number of years.

In 1967 Halley was the first station to have a radio teleprinter installed and went on line in January 1968. Later the same year Argentine Island station (Base F) came on line with their newly installed teleprinter. This was a great improvement but still worked alongside Morse code. When the BBC "Calling Antarctica" programme ceased (1969), BAS used its teleprinter to send bi-monthly newsletters to bases and scientific units.

When the Survey's Falkland Islands Stanley office closed permanently communications were handled by Cable and Wireless directly to headquarters in Cambridge UK.

The next improvement was the installation of a Fax machine which, as far as I was concerned, had a great advantage over teleprinters. Drawing and manufacturers instructions could now be sent.

Immediately after the Falkland Islands conflict, the Survey installed Inmarst satellite communications at all their stations, Halley being one of the first. This also meant the installation of a computer network communications system i.e. everything was digitised, compressed and transmitted at high speed, a powerful tool.

Picture to the right shows the current communications room operated by a computer manager, wireless operators are no longer employed at Halley. (P. Bucktrout)

Personal message facilities

Every person was allowed to send home 100 words per mouth free of charge and in the 1970's there was a charge of 0.5p per extra word. When the communications arrived at the appropriate collection centre they were then posted on. 200 words were allowed to be sent by the next of kin to the appropriate collection centre and then transmitted.

The BBC also recorded messages from the next of kin and transmitted them on Christmas Day or thereabouts, on a programme called "Calling Antarctica".

Telephone calls were allowed on special occasions at a cost. I believe that today each person has an e-mail address.

Communications and Scientific Aerials

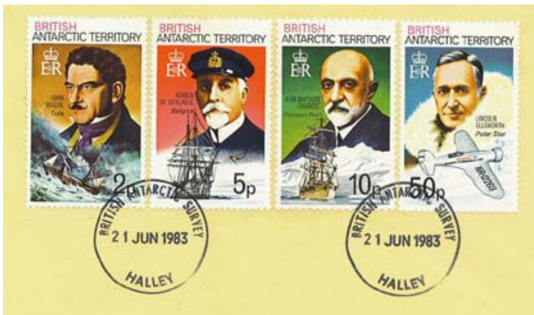
Over the years there have been different types of aerial arrays, the scientific aerials becoming higher and more complex.

There was a need to improve the technique of erecting aerial masts of more than 20m high. Mike Pinnock was the prime leader in organising the first erection of a more that 20m scientific mast and of the writing the first in-house code of practice. Later on the Survey decided to send persons on specialised mast erection courses held by British Telecommunications. This was invaluable and covered all the Health and Safety aspects. When BT ceased to run courses the Survey provided training facilities at BAS HQ using a BT instructor.

Above picture shows the erection of a scientific mast (BAS)

Mail facilities

In the IGY period a Post Office was established at Halley and this continues today.



There have been some wonderful official first day covers issued. Mail has always arrived and left annually. Philatelic organisers used to send in vast amounts of mail for franking which was either done at the relief period or sometimes on a special franking date.

In the early days the Survey arranged for the next of kin to send a small parcel to them for forwarding to the Base Commander for members to open on mid-winters day as a surprise present.

MEDICAL

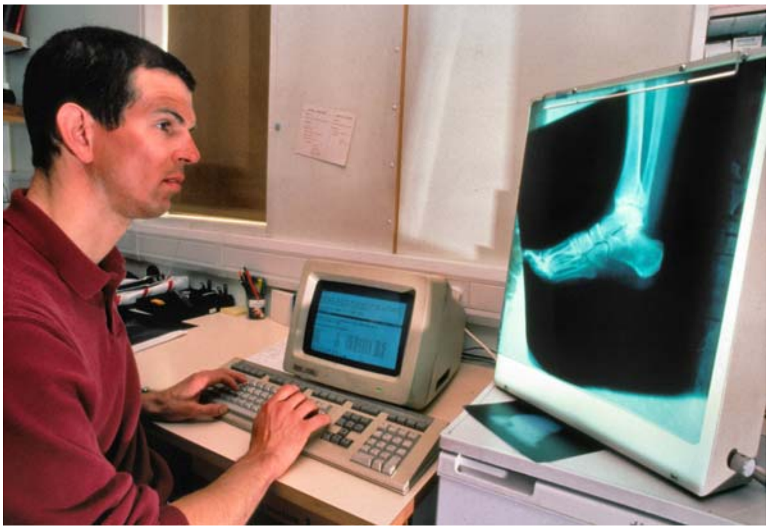
Halley has been fortunate in always having an over wintering doctor. I cannot recall a year when this was not so.

Before going to the Antarctic personnel had medical and dental checks and at one time the Survey recommended the removal of the appendix.

Doctors filled two important roles, the health and care of base members and also medical research involving base members.

Halley doctors played a major part, working together with the Survey's consultants, to re-evaluate and update the medical indents which led to the annual replacement of all consumable items thus eliminating items becoming out of date.

The use of computers enables the Doctor to send x-rays or any other medical information directly to the Survey's consultants.



Picture to the left shows the use of computers. (P. Bucktrout)

Picture to the right shows part of the current medical facilities. (P.Bucktrout)

FOOD

Food is very important to the well being of station personnel. If you have a well balanced diet of approx. 3000 calories and a good cook to prepare menus and cook the food then you have, in my opinion, an efficient and happy base and a very valuable base member.

The cook's day off was Sunday when a base member took over the role. This led to some interesting meals.

In the beginning all the food supplied for base consumption was either tinned or dried. The tinned products were specially canned for the Survey and stamped with a special code to determine the contents. The reason for this being that during the Tabarin period the cans lost their labels!

A certain amount of fresh meat sufficient for one meal per week, usually served on a Saturday night and stored in an ice cave, was supplied. Fresh eggs were obtained from the Falkland Islands for serving on special occasions and stored in flour or isinglass. This was quite successful and certainly better than the powdered variety at that point in time. Fresh fruit and vegetables were only available for immediate use after relief.

During my winter a group of us, while hunting seal for dog meat, decided to try cooking and eating seal meat. Gerald T. Cutland who had been a wintering general assistant/cook (Argentine Islands, 1956-57) and eventually became a chief steward on the RRS John Biscoe had written an article on cooking wild life called "Fit for a FID" or How to keep a fat explorer in prime condition. I used his recipe which is as follows:-

Casserole of seal

Cut the meat into steaks as required and sprinkle with salt and pepper to taste. Dip the steaks in flour, shake off the surplus and part fry in the fat with a little of the onion. When brown on each side remove and place in casserole dish and lay the vegetables on top. Cook the flour for a few minutes until brown in the remaining fat. Add water slowly, stirring all the time, until the gravy is of the desired thickness.

Add Bovril and a little salt and pepper to taste. Bring to the boil and pour over the meat and vegetables and cook in a moderate oven for one to two hours, or until the meat is tender and cooked, keeping the meat etc., covered with the lid.

Seal meat can be made quite wholesome and very tasty if cooked with a little care and attention. At first the characteristic strong smell tends to put people off. This can be, and must be, destroyed if it is to become palatable.

Permission was given to cook and eat one Emperor penguin egg per person on one occasion only. Some chose to make omelettes, others to fry it. My choice was to fry it. On cooking, the yolk was the usual yellow but the white remained transparent, a wrong choice.

It was not until the commissioning of the RRS Bransfield which had additional freezer space and the installation in 1983/84 of 2 walk in deep freezers at Halley, one with a temperature of -20º C and the other +4º C, that the Survey was able to supply frozen as opposed to some of the canned food. The diet/cuisine has changed considerably over the years in the Antarctic as well as in the UK by becoming more international.

Over the years various fuels have been used to heat different types of cooking ranges. Firstly coal, secondly oil and finally bottled gas. Electricity has always been used for other kitchen appliances.

The present kitchen was designed to the 1986 catering standards.

Traditionally tinned food which had to be kept above freezing was stored in the lofts of the building. There were two problems in doing this i.e. access and the loft being the warmest part of the building. In the 1983 station *(Halley 4*), the design accommodated storage areas with 2.4m high ceilings and was maintained at the correct temperature.

The picture on the right shows the kitchen's main cooker. (P. Bucktrout)

Picture on the left shows a current food storage area. (P. Bucktrout)

BASE LIVING

The position in which Halley is located makes life difficult. When the station is newly built it is a pleasant environment in which to live and work but as it gradually becomes buried life becomes much harder.

The climbing of near vertical ladders to gain access and egress, both personal and for stores was awkward. This access problem was addressed in 1983, Halley 4, with the provision of a stores elevator and a staircase with landings which meant that people and stores could move more easily between base and surface.

Over the years, with the various improvements in all areas, living has become easier. This also applies to living in the UK. Although most of the current station is above the surface it is still a struggle to maintain its position.

The gash rota is still in operation as is the weekly scrub out of the communal areas. With more efficient water making systems there is no restriction on the use of showers and the current station has flush toilets.

Halley has always shown films on a Saturday night coupled with a special evening meal. This still happens today but I believe the base members use videos.

In the 1980's the Survey stopped the issue of tobacco and alcoholic drinks but provides soft drinks. Base members are allowed to take in a limited amount of alcoholic drink.

In the past, spending 2 winters at Halley was the norm, in some cases 3 winters, but now the norm is only 1 winter, and females are now part of the wintering team.

People still travel by ship to Halley but there is also an air bridge from the UK to Halley. This is from Brise Norton in the UK, via the Falkland Islands, then Rothera station and on to Halley station. If all goes to plan it is possible to be at Halley in 5 days.

The Survey, have a policy of taking waste products out of the Antarctic Treaty area.

Picture to the right shows cardboard being compacted. (P. Bucktrout)

An old Fid coming to terms with flush toilets and toilet roll holders. (A. Smith)

Picture to the right shows the current dining room at lunch time. (P. Bucktrout)

The Gym!

Picture above shows the current lounge. (P. Bucktrout)

Chapter 9:

Epilogue

This is written from my personal records and memory. My main aim was to bring together a brief record of the establishment of the 5 Research Stations at Halley so that people could see the changes at a glance.

I know there are items in this document which ex-winterers will say I should have included or enlarged upon, but once again, these are my views and records.

Over the years Polar Medals, Fuchs Medals and British Empire Medals have been awarded for various reasons to various Survey members who have wintered at Halley.

There has always been a team spirit at Halley with everyone working together and pulling in the same direction and I hope this will continue.

Since the beginning, each wintering team has considered that they had the best winter and I would not argue with this.