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NATIONAL RADIO ASTRONOMY OBSERVATORY
Tucson, Arizona

7 January 1999

*Memorandum*

To: All Tucson Engineers

From: J. M. Payne

Subj: 4K Refrigerators for Evaluation Receivers

Harry Fagg has done some research on commercially available 4K systems, the results of which are shown below. The conclusion is that the NRAO system is superior to the commercial systems in all respects. Combined with the excellent reliability of the NRAO system and the fact that we have built many of them, the recommendation is that the Evaluation Receivers use this system. Larry D'Addario agrees with this recommendation.

I have checked with the Green Bank shop and Phil Jewell about fabricating the necessary parts and there does not appear to be a problem.

I would like to draw up a schedule for this work as soon as possible if there are no objections.

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**MMA Evaluation Receiver: Cryogenic Systems**

Traditionally, NRAO has used commercial GM systems linked with in-house JT systems to provide a maximum 1.5 watts of cooling at 4.2K. These systems have been used for many years and have been periodically modified to improve performance and/or reliability. These systems provide adequate third stage power and stability, while the other stages can be chosen from the commercial GM suppliers to match the requirements of the receivers being built.

It was decided that we would look to industry to supply the systems for the initial MMA evaluation receivers. This would give us a chance to evaluate the performance of commercial cryogenic systems on real telescopes. The only serious contenders from industry were the two systems available through IGC APD Cryogenics Inc. They were the Daikin CG308S system and the APD HS-4 system. Both are three-stage, closed-cycle systems.

After several weeks of discussion with various company representatives and system users and evaluation of the specifications, it has been decided that both systems were inadequate for our purpose. The general specifications are listed below in Table 1.

| | NRAO System | Daikin CG308S | APD HS-4 |
|---|---|---|---|
| 1st Stage Capacity @77 | 115 watts | 25 watts | 14watts |
| 2nd Stage Capacity @20 | 15 watts | 2 watts | 6 watts |
| 3rd Stage Capacity @4.2 (all capacities may not be available simultaneously) | 1.5 watts | 2.25 watts | 1 watt |
| 3rd Stage Stability (p-p) | <5mK | 70mK | Not Available |
| **Complete** | ~$51,000 | $99,975 | $46,000 |

**Table 1: General Specifications**

| | Price |
|---|---|
| Balzers GM Cold Head | $15,000 |
| JT/GM Compressor | $12,000 |
| JT | $4,000 |
| Labor | $20,000 |
| **Complete** | ~$51,000 |

**Table 2: Cost breakdown for NRAO system**

The 3rd stage temperature instability is one of the overriding factors that make the Daikin unsuitable. While it is true that passive and/or active measures could be used to overcome this problem, the initial system purchase cost is also high.

The APD HS-4 is priced competitively, but is at the very minimum estimated power requirements. APD appear unwilling to put a specification on the 3rd stage temperature stability.

Based on this information, it is proposed that the MMA evaluation receivers will use a Balzers GM (UCH 130) refrigerator in conjunction with a NRAO JT system.

cc: Bob Brown
Peter Napier
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MMA Division Heads