Introduction:
This study analyzed 634 irradiations of the stereotactic radiosurgery (SRS) anthropomorphic phantom from a population of 321 institutions. These results are a combination of irradiations from institutions that irradiated the phantom for their own quality assurance (QA) through the Radiation Dosimetry Services (RDS) and for NCI funded clinical trials through the Radiological Physics Center (RPC). Many institutions have used and continue to use this phantom regularly (at least annually) to ensure delivery quality.

Methods and Materials:
The anthropomorphic SRS head phantom consists of a water-fillable head shaped plastic shell that has been altered to accept imaging and dosimetry inserts. This phantom works with fixed and re-locatable localization systems, with CT and MRI imaging, and with linac and Gamma Knife treatment machines. The water-fillable imaging insert houses a 1.9 cm diameter nylon sphere as the target. The dosimetry insert houses two TLD capsules and radiographic film in coronal and sagittal planes, corresponding to planes through the center of the target. The dosimetric precision of the TLD is ±3%, and the spatial precision of the film and densitometer system is ±1 mm.

Institutions imaged the phantom, developed a treatment plan and irradiated the phantom according to the plan. Institutions were instructed to create treatment plans delivering 30 Gy to the center of the target. The target was covered by an isodose line typically between 50% and 85%. The dose measured by the TLD showed no significant differences in their abilities to meet the four evaluation guidelines. However, the minute dose to the target guideline was achieved less often using Gamma Knife units than with linear accelerators. This difference is likely due to the Gamma Knife’s limitation in cone size where the largest available cone is 16 or 18 mm in diameter, depending on model. The cone size is 1-3 mm smaller than the phantom target size. In order to ensure uniform dose to the TLD in the center of the target, institutions were historically asked to irradiate the phantom with only one isocenter. We now have the ability to ask for doses to the actual TLD location so the single isocenter limitation is not always enforced. The SRS linear accelerator systems do not have this limitation.

Discussion:
The results for both linear accelerators and Gamma Knife units show that both delivery systems have similar results for three of the four evaluation guidelines. However, the minute dose to the target guideline was achieved less often using Gamma Knife units than with linear accelerators. This difference is likely due to the Gamma Knife’s limitation in cone size where the largest available cone is 16 or 18 mm in diameter, depending on model. The cone size is 1-3 mm smaller than the phantom target size. In order to ensure uniform dose to the TLD in the center of the target, institutions were historically asked to irradiate the phantom with only one isocenter. We now have the ability to ask for doses to the actual TLD location so the single isocenter limitation is not always enforced. The SRS linear accelerator systems do not have this limitation.

The four SRS linear accelerator treatment planning systems showed no significant differences in their abilities to meet the guidelines.

Conclusions:
Institutions are capable of meeting the SRS phantom guidelines for all available machines and treatment planning systems studied.

Results: Between 2000 and December 2010, SRS phantoms were irradiated by 321 institutions for a total of 634 irradiations. 125 of the irradiations were performed with Gamma Knife and 509 were performed with linear accelerators. The percent of institutions meeting all four guidelines was 54% for accelerators and 39% for Gamma Knife units. The average pass rate for this guideline increased from 77% to 90%. There was improvement shown for subsequent irradiations for the other three guidelines; however it was less dramatic, with pass rates improving by only four and six percentage points. The white lines indicate which results fall inside the guideline.